

## **APPENDIX A. High Priority Species and Habitat Summary Data**

The summary tables on the following pages provide detailed information on the distribution and habitat associations for high priority animal species and high priority plant species identified in the current assessment.

### Distribution by Ecoregion

In the following lists, high priority animal species are listed alphabetically within the following groups:

AA = aquatic arthropods  
AM = amphibians  
BI = birds  
FI = fishes  
MA = mammals  
MO = mollusks  
RE = reptiles  
TA = terrestrial arthropods

Ecoregions are indicated by the following abbreviations:

SA/RV = Southwestern Appalachians/Ridge & Valley  
BR = Blue Ridge  
PD = Piedmont  
SP = Southeastern Plains  
SCP = Southern Coastal Plain

## Distribution of High Priority Animals by Ecoregion

A-2

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
AA	<i>Callinectes sapidus</i>	Blue Crab					X
AA	<i>Cambarus coosawattae</i>	Coosawattee Crayfish		X			
AA	<i>Cambarus cryptodytes</i>	Dougherty Plain Cave Crayfish				X	
AA	<i>Cambarus cymatilis</i>	Conasauga Blue Burrower	X				
AA	<i>Cambarus distans</i>	Boxclaw Crayfish	X				
AA	<i>Cambarus doughertyensis</i>	Dougherty Burrowing Crayfish				X	
AA	<i>Cambarus englishi</i>	Tallapoosa Crayfish			X		
AA	<i>Cambarus extraneus</i>	Chickamauga Crayfish	X				
AA	<i>Cambarus fasciatus</i>	Etowah Crayfish	X	X	X		
AA	<i>Cambarus georgiae</i>	Little Tennessee Crayfish		X			
AA	<i>Cambarus harti</i>	Piedmont Blue Burrower			X		
AA	<i>Cambarus howardi</i>	Chattahoochee Crayfish			X		
AA	<i>Cambarus manningi</i>	Greensaddle Crayfish	X				
AA	<i>Cambarus parrishi</i>	Hiwassee Headwaters Crayfish		X			
AA	<i>Cambarus scotti</i>	Chattooga River Crayfish	X				
AA	<i>Cambarus speciosus</i>	Beautiful Crayfish		X			
AA	<i>Cambarus strigosus</i>	Lean Crayfish			X		
AA	<i>Cambarus truncatus</i>	Oconee Burrowing Crayfish				X	X
AA	<i>Cambarus unestami</i>	Blackbarred Crayfish	X				
AA	<i>Cordulegaster sayi</i>	Say's Spiketail				X	X
AA	<i>Distocambarus devexus</i>	Broad River Burrowing Crayfish			X		
AA	<i>Gomphus consanguis</i>	Cherokee Clubtail	X				
AA	<i>Macromia margarita</i>	Mountain River Cruiser		X			
AA	<i>Ophiogomphus australis</i>	Southern Snaketail				X	
AA	<i>Ophiogomphus edmundo</i>	Edmund's Snaketail		X			
AA	<i>Ophiogomphus incurvatus</i>	Appalachian Snaketail	X	X	X		
AA	<i>Procambarus acutissimus</i>	Sharpnose Crayfish			X	X	
AA	<i>Procambarus gibbus</i>	Muckalee Crayfish				X	
AA	<i>Procambarus petersi</i>	Ogeechee Crayfish					X
AA	<i>Procambarus verrucosus</i>	Grainy Crayfish				X	
AA	<i>Procambarus versutus</i>	Sly Crayfish				X	
AM	<i>Ambystoma bishopi</i>	Reticulated Flatwoods Salamander				X	
AM	<i>Ambystoma cingulatum</i>	Frosted Flatwoods Salamander				X	X
AM	<i>Ambystoma tigrinum tigrinum</i>	Eastern Tiger Salamander	X			X	X
AM	<i>Amphiuma pholeter</i>	One-toed Amphiuma				X	
AM	<i>Aneides aeneus</i>	Green Salamander	X	X			
AM	<i>Cryptobranchus alleganiensis</i>	Hellbender	X	X			
AM	<i>Desmognathus auriculatus</i>	Southern Dusky Salamander				X	X
AM	<i>Eurycea aquatica</i>	Brown-backed Salamander	X				

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## Distribution of High Priority Animals by Ecoregion

A-3

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
AM	<i>Eurycea chamberlaini</i>	Chamberlain's Dwarf Salamander			X	X	
AM	<i>Gyrinophilus palleucus</i>	Tennessee Cave Salamander	X				
AM	<i>Haideotriton wallacei</i>	Georgia Blind Salamander				X	
AM	<i>Lithobates capito</i>	Gopher Frog				X	X
AM	<i>Necturus punctatus</i>	Dwarf Waterdog			X	X	X
AM	<i>Notophthalmus perstriatus</i>	Striped Newt				X	X
AM	<i>Plethodon petraeus</i>	Pigeon Mountain Salamander	X				
AM	<i>Plethodon savannah</i>	Savannah Slimy Salamander					X
AM	<i>Urspelerpes brucei</i>	Patch-nosed Salamander		X	X		
BI	<i>Ammodramus caudacutus</i>	Saltmarsh Sparrow					X
BI	<i>Ammodramus henslowii</i>	Henslow's Sparrow				X	X
BI	<i>Ammodramus maritimus macgillivraii</i>	Seaside Sparrow (Macgillivray's)					X
BI	<i>Ammodramus nelsoni</i>	Nelson's Sparrow					X
BI	<i>Ammodramus savannarum pratensis</i>	Grasshopper Sparrow	X		X	X	
BI	<i>Calidris canutus</i>	Red Knot					X
BI	<i>Charadrius melodus</i>	Piping Plover					X
BI	<i>Charadrius wilsonia</i>	Wilson's Plover					X
BI	<i>Colinus virginianus</i>	Northern Bobwhite	X	X	X	X	X
BI	<i>Coturnicops noveboracensis</i>	Yellow Rail				X	X
BI	<i>Egretta caerulea</i>	Little Blue Heron				X	X
BI	<i>Egretta tricolor</i>	Tricolored Heron				X	X
BI	<i>Elanoides forficatus</i>	Swallow-tailed Kite			X	X	X
BI	<i>Euphagus carolinus</i>	Rusty Blackbird	X	X	X	X	X
BI	<i>Falco peregrinus</i>	Peregrine Falcon			X		X
BI	<i>Falco sparverius paulus</i>	Southeastern American Kestrel				X	X
BI	<i>Gelochelidon nilotica</i>	Gull-billed Tern					X
BI	<i>Grus americana</i>	Whooping Crane	X		X	X	
BI	<i>Grus canadensis pratensis</i>	Florida Sandhill Crane					X
BI	<i>Haematopus palliatus</i>	American Oystercatcher					X
BI	<i>Haliaeetus leucocephalus</i>	Bald Eagle	X	X	X	X	X
BI	<i>Himantopus mexicanus</i>	Black-necked Stilt					X
BI	<i>Ixobrychus exilis</i>	Least Bittern	X		X	X	X
BI	<i>Lanius ludovicianus</i>	Loggerhead Shrike	X		X	X	X
BI	<i>Laterallus jamaicensis</i>	Black Rail			X	X	X
BI	<i>Limnothlypis swainsonii</i>	Swainson's Warbler	X	X	X	X	X
BI	<i>Mycteria americana</i>	Wood Stork				X	X
BI	<i>Numenius phaeopus</i>	Whimbrel					X
BI	<i>Passerina ciris</i>	Painted Bunting				X	X
BI	<i>Peucaea aestivalis</i>	Bachman's Sparrow	X		X	X	X

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## Distribution of High Priority Animals by Ecoregion

A-4

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
BI	<i>Picoides borealis</i>	Red-cockaded Woodpecker			X	X	X
BI	<i>Protonotaria citrea</i>	Prothonotary Warbler	X		X	X	X
BI	<i>Rallus elegans</i>	King Rail			X	X	X
BI	<i>Rynchops niger</i>	Black Skimmer					X
BI	<i>Setophaga cerulea</i>	Cerulean Warbler		X			
BI	<i>Setophaga kirtlandii</i>	Kirtland's Warbler		X	X		X
BI	<i>Sphyrapicus varius appalachiensis</i>	Appalachian Yellow-bellied Sapsucker		X			
BI	<i>Sternula antillarum</i>	Least Tern					X
BI	<i>Tyto alba</i>	Barn Owl	X	X	X	X	X
BI	<i>Vermivora chrysoptera</i>	Golden-winged Warbler		X			
FI	<i>Acipenser brevirostrum</i>	Shortnose Sturgeon				X	X
FI	<i>Acipenser fulvescens</i>	Lake Sturgeon	X	X			
FI	<i>Acipenser oxyrinchus desotoi</i>	Gulf Sturgeon				X	
FI	<i>Acipenser oxyrinchus oxyrinchus</i>	Atlantic Sturgeon			X	X	X
FI	<i>Alosa alabamae</i>	Alabama Shad				X	
FI	<i>Alosa sapidissima</i>	American Shad			X	X	X
FI	<i>Ameiurus serracanthus</i>	Spotted Bullhead			X	X	
FI	<i>Carpoides velifer</i>	Highfin Carpsucker			X	X	X
FI	<i>Chologaster cornuta</i>	Swampfish				X	X
FI	<i>Cynoscion nebulosus</i>	Spotted Seatrout					X
FI	<i>Cyprinella caerulea</i>	Blue Shiner	X	X			
FI	<i>Cyprinella callitaenia</i>	Bluestripe Shiner		X	X	X	
FI	<i>Cyprinella gibbsi</i>	Tallapoosa Shiner			X		
FI	<i>Cyprinella xaenura</i>	Altamaha Shiner			X		
FI	<i>Elassoma gilberti</i>	Gulf Coast Pygmy Sunfish				X	
FI	<i>Elassoma okatie</i>	Bluebarred Pygmy Sunfish				X	X
FI	<i>Enneacanthus chaetodon</i>	Blackbanded Sunfish				X	X
FI	<i>Erimonax monachus</i>	Spotfin Chub	X				
FI	<i>Erimystax insignis</i>	Blotched Chub		X			
FI	<i>Etheostoma brevirostrum</i>	Holiday Darter		X	X		
FI	<i>Etheostoma chlorbranchium</i>	Greenfin Darter		X			
FI	<i>Etheostoma chuckwachatte</i>	Lipstick Darter			X		
FI	<i>Etheostoma cinereum</i>	Ashy Darter	X				
FI	<i>Etheostoma ditrema</i>	Coldwater Darter	X				
FI	<i>Etheostoma duryi</i>	Blackside Snubnose Darter	X				
FI	<i>Etheostoma etowahae</i>	Etowah Darter	X	X	X		
FI	<i>Etheostoma gutselli</i>	Tuckasegee Darter		X			
FI	<i>Etheostoma parvipinne</i>	Goldstripe Darter			X	X	
FI	<i>Etheostoma rufilineatum</i>	Redline Darter	X	X			
FI	<i>Etheostoma rupestre</i>	Rock Darter	X	X	X		
FI	<i>Etheostoma scotti</i>	Cherokee Darter	X	X	X		
FI	<i>Etheostoma trisella</i>	Trispot Darter	X				
FI	<i>Etheostoma vulneratum</i>	Wounded Darter		X			

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## Distribution of High Priority Animals by Ecoregion

A-5

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
FI	<i>Fundulus bifax</i>	Stippled Studfish			X		
FI	<i>Fundulus catenatus</i>	Northern Studfish	X				
FI	<i>Hemitremia flammea</i>	Flame Chub	X				
FI	<i>Hiodon tergisus</i>	Mooneye	X				
FI	<i>Hybopsis lineapunctata</i>	Lined Chub	X	X	X		
FI	<i>Hybopsis</i> sp. 9	Etowah Chub	X		X		
FI	<i>Ichthyomyzon bdellium</i>	Ohio Lamprey	X				
FI	<i>Lampetra aepyptera</i>	Least Brook Lamprey	X	X			
FI	<i>Lucania goodei</i>	Bluefin Killifish				X	X
FI	<i>Lythrurus lirus</i>	Mountain Shiner	X	X			
FI	<i>Macrhybopsis</i> sp. 1	Coosa Chub	X	X	X		
FI	<i>Micropterus cataractae</i>	Shoal Bass			X		X
FI	<i>Micropterus chattahoochee</i>	Chattahoochee Bass		X	X		
FI	<i>Micropterus notius</i>	Suwannee Bass				X	
FI	<i>Micropterus</i> sp. cf <i>coosae</i> "Altamaha/Ogeechee"	Undescribed Redeye Bass			X	X	
FI	<i>Micropterus</i> sp. cf <i>coosae</i> "Savannah"	Bartrams Bass		X	X	X	
FI	<i>Moxostoma carinatum</i>	River Redhorse	X	X			
FI	<i>Moxostoma robustum</i>	Robust Redhorse			X	X	X
FI	<i>Moxostoma</i> sp. 2	Sicklefin Redhorse		X			
FI	<i>Notropis ariommus</i>	Popeye Shiner	X				
FI	<i>Notropis asperifrons</i>	Burrhead Shiner	X	X			
FI	<i>Notropis hypsilepis</i>	Highscale Shiner		X	X	X	
FI	<i>Notropis photogenis</i>	Silver Shiner		X			
FI	<i>Notropis scepticus</i>	Sandbar Shiner		X	X		
FI	<i>Noturus eleutherus</i>	Mountain Madtom	X				
FI	<i>Noturus flavipinnis</i>	Yellowfin Madtom	X				
FI	<i>Noturus munitus</i>	Frecklebelly Madtom	X	X	X		
FI	<i>Percina antesella</i>	Amber Darter	X	X	X		
FI	<i>Percina aurantiaca</i>	Tangerine Darter		X			
FI	<i>Percina aurolineata</i>	Goldline Darter		X			
FI	<i>Percina crypta</i>	Halloween Darter		X	X	X	
FI	<i>Percina jenkinsi</i>	Conasauga Logperch	X	X			
FI	<i>Percina kusha</i>	Bridled Darter	X	X	X		
FI	<i>Percina lenticula</i>	Freckled Darter	X	X			
FI	<i>Percina sciera</i>	Dusky Darter	X	X			
FI	<i>Percina smithvanizi</i>	Muscadine Darter			X		
FI	<i>Percina squamata</i>	Olive Darter		X			
FI	<i>Percina tanasi</i>	Snail Darter	X				
FI	<i>Phenacobius crassilabrum</i>	Fatlips Minnow		X			
FI	<i>Phenacobius uranops</i>	Stargazing Minnow	X				
FI	<i>Phoxinus tennesseensis</i>	Tennessee Dace	X				
FI	<i>Pteronotropis euryzonus</i>	Broadstripe Shiner				X	

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## Distribution of High Priority Animals by Ecoregion

A-6

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
FI	<i>Pteronotropsis welaka</i>	Bluenose Shiner				X	
FI	<i>Sphryna lewini</i>	Scalloped Hammerhead					X
FI	<i>Typhlichthys subterraneus</i>	Southern Cavefish	X				
MA	<i>Corynorhinus rafinesquii</i>	Rafinesque's Big-eared Bat	X	X		X	X
MA	<i>Eubalaena glacialis</i>	Northern Atlantic Right Whale					X
MA	<i>Geomys pinetis</i>	Southeastern Pocket Gopher				X	X
MA	<i>Lasiurus intermedius</i>	Northern Yellow Bat				X	X
MA	<i>Megaptera novaeangliae</i>	Humpback Whale					X
MA	<i>Mustela nivalis</i>	Least Weasel		X			
MA	<i>Myotis austroriparius</i>	Southeastern Myotis			X	X	X
MA	<i>Myotis grisescens</i>	Gray Myotis	X		X		
MA	<i>Myotis leibii</i>	Eastern Small-footed Myotis	X	X			
MA	<i>Myotis lucifugus</i>	Little Brown Myotis	X	X			
MA	<i>Myotis septentrionalis</i>	Northern Myotis	X	X	X		
MA	<i>Myotis sodalis</i>	Indiana Myotis	X	X			
MA	<i>Neofiber alleni</i>	Round-tailed Muskrat				X	X
MA	<i>Parascalops breweri</i>	Hairy-tailed Mole		X			
MA	<i>Perimyotis subflavus</i>	Tri-colored Bat	X	X	X	X	X
MA	<i>Puma concolor coryi</i>	Florida Panther					
MA	<i>Sciurus niger shermani</i>	Sherman's Fox Squirrel					X
MA	<i>Sorex dispar</i>	Long-tailed or Rock Shrew		X			
MA	<i>Sorex palustris</i>	Water Shrew		X			
MA	<i>Spilogale putorius</i>	Eastern Spotted Skunk	X	X	X	X	
MA	<i>Sylvilagus obscurus</i>	Appalachian Cottontail		X			
MA	<i>Synaptomys cooperi</i>	Southern Bog Lemming		X			
MA	<i>Tamiasciurus hudsonicus</i>	Red Squirrel		X			
MA	<i>Trichechus manatus</i>	Manatee					X
MA	<i>Tursiops truncatus</i>	Atlantic Bottle-nose Dolphin					X
MO	<i>Alasmidonta arcuata</i>	Altamaha Arcmussel			X		X
MO	<i>Alasmidonta triangulata</i>	Southern Elktoe				X	
MO	<i>Amblema neislerii</i>	Fat Threeridge					X
MO	<i>Anodontoides radiatus</i>	Rayed Creekshell			X	X	
MO	<i>Campeloma regulare</i>	Cylinder campeloma	X				
MO	<i>Crassostrea virginica</i>	American Oyster					X
MO	<i>Elimia darwini</i>	Pup Elimia				X	
MO	<i>Elimia inclinans</i>	Slanted Elimia				X	
MO	<i>Elimia induta</i>	Gem Elimia				X	
MO	<i>Elimia mutabilis</i>	Oak Elimia			X		
MO	<i>Elimia ornata</i>	Ornate Elimia	X				
MO	<i>Elimia striatula</i>	File Elimia	X	X			
MO	<i>Elimia timida</i>	Timid Elimia				X	
MO	<i>Elliptio arca</i>	Alabama Spike	X				
MO	<i>Elliptio arcata</i>	Delicate Spike	X				

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## Distribution of High Priority Animals by Ecoregion

A-7

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
MO	<i>Elliptio fraterna</i>	Brother Spike					X
MO	<i>Elliptio nigella</i>	Winged Spike			X		X
MO	<i>Elliptio purpurella</i>	Inflated Spike					X
MO	<i>Elliptio spinosa</i>	Altamaha Spiny mussel				X	
MO	<i>Elliptoideus sloatianus</i>	Purple Bankclimber					X
MO	<i>Fusconaia masoni</i>	Atlantic Pigtoe				X	
MO	<i>Hamiota altilis</i>	Finelined Pocketbook	X		X		
MO	<i>Hamiota subangulata</i>	Shinyrayed Pocketbook			X		X
MO	<i>Lampsilis cariosa</i>	Yellow Lampmussel					X
MO	<i>Lampsilis straminea</i>	Southern Fatmucket	X		X	X	
MO	<i>Lasmigona holstonia</i>	Tennessee Heelsplitter	X				
MO	<i>Leptoxis foremani</i>	Interrupted Rocksnail	X				
MO	<i>Leptoxis praerosa</i>	Onyx Rocksnail	X				
MO	<i>Marstonia agarhecta</i>	Ocmulgee Marstonia				X	
MO	<i>Marstonia castor</i>	Beaverpond Marstonia					X
MO	<i>Marstonia gaddisorum</i>	Emily's Marstonia				X	
MO	<i>Medionidus acutissimus</i>	Alabama Moccasinshell	X				
MO	<i>Medionidus conradicus</i>	Cumberland Moccasinshell	X				
MO	<i>Medionidus parvulus</i>	Coosa Moccasinshell	X				
MO	<i>Medionidus penicillatus</i>	Gulf Moccasinshell			X		X
MO	<i>Medionidus simpsonianus</i>	Ochlockonee Moccasinshell					X
MO	<i>Medionidus walkeri</i>	Suwannee Moccasinshell					X
MO	<i>Pleurobema decisum</i>	Southern Clubshell	X				
MO	<i>Pleurobema georgianum</i>	Southern Pigtoe	X				
MO	<i>Pleurobema hanleyianum</i>	Georgia Pigtoe	X				
MO	<i>Pleurobema hartmanianum</i>	Cherokee Pigtoe	X				
MO	<i>Pleurobema pyriforme</i>	Oval Pigtoe			X		X
MO	<i>Pleurocera pyrenella</i>	Skirted Hornsnail	X				
MO	<i>Pleurocera showalteri</i>	Upland Hornsnail	X				
MO	<i>Pleurocera vestita</i>	Brook hornsnail	X				
MO	<i>Pleuronaia barnesiana</i>	Tennessee Pigtoe	X				
MO	<i>Ptychobranthus fasciolaris</i>	Kidneyshell	X				
MO	<i>Ptychobranthus foremanianus</i>	Rayed Kidneyshell	X				
MO	<i>Quadrula kleiniana</i>	Suwannee Pigtoe				X	
MO	<i>Somatogyrus alcoviensis</i>	Reverse Pebblesnail			X		
MO	<i>Somatogyrus rheophilus</i>	Flint Pebblesnail				X	
MO	<i>Somatogyrus tenax</i>	Savannah Pebblesnail			X		
MO	<i>Strophitus connasaugaensis</i>	Alabama Creekmussel	X	X			
MO	<i>Toxolasma corvunculus</i>	Southern Purple Lilliput	X				
MO	<i>Toxolasma pullus</i>	Savannah Lilliput					X
MO	<i>Villosa nebulosa</i>	Alabama Rainbow	X	X			
MO	<i>Villosa umbrans</i>	Coosa Creekshell	X				
RE	<i>Caretta caretta</i>	Loggerhead Sea Turtle					X

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## Distribution of High Priority Animals by Ecoregion

A-8

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
RE	<i>Chelonia mydas</i>	Green Sea Turtle					X
RE	<i>Clemmys guttata</i>	Spotted Turtle				X	X
RE	<i>Crotalus adamanteus</i>	Eastern Diamond-backed Rattlesnake				X	X
RE	<i>Dermochelys coriacea</i>	Leatherback Sea Turtle					X
RE	<i>Drymarchon couperi</i>	Eastern Indigo Snake				X	X
RE	<i>Eumeces anthracinus</i>	Coal Skink				X	
RE	<i>Glyptemys muhlenbergii</i>	Bog Turtle		X			
RE	<i>Gopherus polyphemus</i>	Gopher Tortoise				X	X
RE	<i>Graptemys barbouri</i>	Barbour's Map Turtle			X	X	
RE	<i>Graptemys pulchra</i>	Alabama Map Turtle	X				
RE	<i>Heterodon simus</i>	Southern Hognose Snake				X	X
RE	<i>Lepidochelys kempii</i>	Kemp's or Atlantic Ridley					X
RE	<i>Macrochelys temminckii</i>	Alligator Snapping Turtle			X	X	X
RE	<i>Malaclemys terrapin</i>	Diamondback Terrapin					X
RE	<i>Ophisaurus compressus</i>	Island Glass Lizard				X	X
RE	<i>Ophisaurus mimicus</i>	Mimic Glass Lizard				X	X
RE	<i>Pituophis melanoleucus melanoleucus</i>	Northern Pine Snake	X	X	X		
RE	<i>Pituophis melanoleucus mugitus</i>	Florida Pine Snake				X	X
TA	<i>Acronicta albarufa</i>	Albarufan dagger moth				X	
TA	<i>Alloblackburneus troglodytes</i>	Little gopher tortoise scarab beetle				X	X
TA	<i>Amblyomma tuberculatum</i>	Gopher tortoise tick				X	X
TA	<i>Amblyscirtes alternata</i>	Dusky roadside-skipper			X	X	
TA	<i>Amblyscirtes belli</i>	Bell's Roadside-skipper	X		X		
TA	<i>Amblyscirtes carolina</i>	Carolina roadside-skipper	X	X	X		
TA	<i>Amblyscirtes reversa</i>	Reversed roadside-skipper	X	X			
TA	<i>Aphodius aegrotus</i>	A dung beetle				X	X
TA	<i>Aphodius alabama</i>	A dung beetle				X	
TA	<i>Aphodius baileyi</i>	A dung beetle				X	
TA	<i>Aphodius bakeri</i>	A dung beetle				X	
TA	<i>Aphodius dyspistus</i>	A dung beetle				X	X
TA	<i>Aphodius gambrinus</i>	Amber pocket gopher Aphodius beetle				X	
TA	<i>Aphodius hubbelli</i>	A dung beetle				X	X
TA	<i>Aphodius laevigatus</i>	Large pocket gopher Aphodius beetle				X	X
TA	<i>Aphodius pholetus</i>	Rare pocket gopher Aphodius beetle				X	
TA	<i>Aphodius platypleurus</i>	Broad-sided pocket gopher Aphodius beetle				X	
TA	<i>Aphodius tanytarsus</i>	Long-clawed pocket gopher Aphodius beetle				X	

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## Distribution of High Priority Animals by Ecoregion

A-9

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
TA	<i>Aptenopedes apalachee</i>	Apalachee linear-winged grasshopper				X	
TA	<i>Atrytone arogos arogos</i>	Eastern Aragos Skipper				X	
TA	<i>Autochton cellus</i>	Golden-banded skipper	X	X			
TA	<i>Bombus affinis</i>	Rusty-patched bumblebee	X	X	X	X	X
TA	<i>Bombus borealis</i>	Northern amber bumble		X			
TA	<i>Bryophaenocladus chrissichuckorum</i>	Midge (Heggie's Rock)			X		
TA	<i>Callophrys hesselli</i>	Hessell's hairstreak				X	
TA	<i>Callophrys irus</i>	Frosted elfin				X	X
TA	<i>Catocala grisatra</i>	Grisatra underwing moth				X	
TA	<i>Caupolicana electa</i>	Plasterer bee				X	X
TA	<i>Chelyoxenus xerobatis</i>	Gopher tortoise hister beetle				X	X
TA	<i>Chlosyne gorgone gorgone</i>	Gorgone checkerspot				X	
TA	<i>Cicindela nigrior</i>	Autumn tiger beetle				X	
TA	<i>Crossidius grahami</i>	Ohoopie dunes Crossidius beetle				X	
TA	<i>Cyclocosmia torreya</i>	Torreya trap-door spider				X	
TA	<i>Danaus plexippus</i>	Monarch butterfly	X	X	X	X	X
TA	<i>Dorymyrmex bossutus</i>	Sandhills cone ant				X	
TA	<i>Eotettix palustris</i>	Longleaf spur-throated grasshopper				X	
TA	<i>Erora laeta</i>	Early hairstreak	X	X			
TA	<i>Erynnis martialis</i>	Mottled duskywing		X		X	
TA	<i>Euphoria aeusutosa</i>	Pocket gopher flower beetle				X	
TA	<i>Euphydryas phaeton</i>	Baltimore checkerspot	X	X	X		
TA	<i>Euphyes berryi</i>	Berry's Skipper					X
TA	<i>Euphyes bimacula arbogastii</i>	Two-spotted Skipper					X
TA	<i>Euphyes dukesi</i>	Duke's Skipper					X
TA	<i>Euphyes pilatka</i>	Palatka Skipper					X
TA	<i>Fernaldella georgiana</i>	Ohoopie Geometer				X	
TA	<i>Floritettix borealis</i>	A grasshopper				X	
TA	<i>Geopsammodius ohoopie</i>	Ohoopie dunes scarab beetle				X	
TA	<i>Habronattus sabulosus</i>	Jumping spider (Heggie's Rock)			X		
TA	<i>Hesperia attalus slossonae</i>	Dotted skipper				X	
TA	<i>Hesperia meskei</i>	Meske's skipper				X	
TA	<i>Hesperotettix floridensis</i>	A grasshopper				X	
TA	<i>Hypothyce osburni</i>	Osburn's hypothyce				X	
TA	<i>Idia gopheri</i>	Gopher tortoise burrow noctuid moth				X	
TA	<i>Machimus polyphemi</i>	Gopher tortoise robber fly				X	X
TA	<i>Melanoplus acidocercus</i>	A spur-throat grasshopper				X	

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## Distribution of High Priority Animals by Ecoregion

A-10

Group	Scientific Name	Common Name	SA_RV	BR	PD	SP	SCP
TA	Melanoplus clypeatus	Shield-tailed spur-throat Grasshopper				X	
TA	Melanoplus longicornis	A spur-throat grasshopper			X		
TA	Melanoplus nossi	Noss' spur-throat grasshopper				X	
TA	Melanoplus sp nov 1	A spur-throat grasshopper				X	
TA	Melanoplus sp nov 2	A spur-throat grasshopper				X	
TA	Melanoplus stegocercus	A spur-throat grasshopper				X	
TA	Melanoplus tumidicercus	A spur-throat grasshopper				X	
TA	Mycotrupes cartwrighti	Cartwright's burrowing beetle				X	
TA	Mycotrupes lethroides	Large Mycotrupes				X	
TA	Neonympha areolatus	Georgia Satyr					X
TA	Neonympha helicta	Helicta satyr			X		
TA	Onthophagus polyphemi polyphemi	Onthophagus tortoise commensal scarab beetle				X	X
TA	Pheidole davisii	Pine barrens Pheidole				X	
TA	Phyciodes batesii maconensis	Tawny crescent		X			
TA	Pieris virginianensis	West Virginia White	X	X	X		
TA	Poanes aaroni howardi	Aaron's skipper					X
TA	Polites baracoa	Baracoa skipper				X	
TA	Polygona faunus	Green comma		X			
TA	Polyphylla donaldsoni	Donaldson's lined june beetle				X	
TA	Problema bulenta	Rare Skipper					X
TA	Satyrium edwardsii	Edwards hairstreak	X	X	X	X	
TA	Satyrium kingi	King's hairstreak					X
TA	Speyeria diana	Diana fritillary	X	X	X		
TA	Sphodros abbotii	Purse-web spider				X	X
TA	Temnothorax_GA_01	Temnothorax new species		X			
TA	Temnothorax_GA_01	Temnothorax new species	X				
TA	Trimerotropis saxatilis	Lichen or rock grasshopper			X		
TA	Zale perculata	Okefenokee zale moth				X	
		<b>Totals</b>	<b>110</b>	<b>89</b>	<b>90</b>	<b>151</b>	<b>120</b>

## Distribution of High Priority Plants by Ecoregion

A-11

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Acmispon helleri</i>	Carolina Trefoil			X		
<i>Aesculus glabra</i>	Ohio Buckeye	X		X		
<i>Agalinis decemloba</i>	Ten-lobed Purple Foxglove	X	X			
<i>Agalinis georgiana</i>	Georgia Purple Foxglove				X	
<i>Agastache nepetoides</i>	Yellow Giant Hyssop	X				
<i>Agastache scrophulariifolia</i>	Purple Giant Hyssop		X			
<i>Allium speculae</i>	Flatrock Onion			X		
<i>Alnus maritima</i> ssp. <i>georgiensis</i>	Georgia Alder	X				
<i>Amelanchier sanguinea</i>	Roundleaf Serviceberry	X	X			
<i>Amorpha georgiana</i>	Georgia Indigo-Bush					X
<i>Amorpha herbacea</i> var. <i>floridana</i>	Florida Leadbush					X
<i>Amorpha nitens</i>	Shining Indigo-Bush			X		
<i>Amorpha schwerinii</i>	Schwerin's Indigo-Bush			X		
<i>Amphianthus pusillus</i>	Pool Sprite, Snorkelwort			X		
<i>Amsonia ludoviciana</i>	Louisiana Blue Star			X		
<i>Anemone berlandieri</i>	Glade Windflower	X		X		
<i>Anemone caroliniana</i>	Carolina Windflower			X		
<i>Arabis georgiana</i>	Georgia Rockcress	X		X		X
<i>Arnoglossum diversifolium</i>	Variable-Leaf Indian-Plantain					X
<i>Arnoglossum sulcatum</i>	Grooved-Stem Indian-Plantain				X	X
<i>Asclepias purpurascens</i>	Purple Milkweed	X				
<i>Asclepias rubra</i>	Red Milkweed				X	
<i>Asplenium heteroresiliens</i>	Morzenti's Spleenwort				X	X
<i>Astragalus michauxii</i>	Sandhill Milkvetch				X	X
<i>Aureolaria patula</i>	Spreading Yellow Foxglove	X				
<i>Balduina atropurpurea</i>	Purple Honeycomb Head				X	X
<i>Baptisia arachnifera</i>	Hairy Rattleweed					X
<i>Baptisia australis</i> var. <i>aberrans</i>	Glade Blue Wild Indigo	X				
<i>Baptisia megacarpa</i>	Bigpod Wild Indigo			X	X	
<i>Berberis canadensis</i>	American Barberry	X	X	X		
<i>Boechera missouriensis</i>	Missouri Rockcress			X		
<i>Brickellia cordifolia</i>	Heartleaf Brickellia				X	X
<i>Buchnera americana</i>	American Bluehearts	X	X			
<i>Calamintha ashei</i>	Ashe's Wild Savory					
<i>Calamintha</i> sp. nov. (undescribed)	Indian Grave Mountain Wild Savory			X		
<i>Calamovilfa arcuata</i>	Cumberland Sandreed	X				
<i>Calliphysalis carpenteri</i>	Carpenter's Ground-Cherry					
<i>Calystegia catesbiana</i> ssp. <i>Sericata</i>	Catesby's Bindweed				X	
<i>Carex acidicola</i>	Acid-Loving Sedge		X			
<i>Carex baltzellii</i>	Baltzell's Sedge				X	
<i>Carex biltmoreana</i>	Biltmore Sedge		X	X		
<i>Carex calcifugens</i>	Lime-Fleeing Sedge					X
<i>Carex decomposita</i>	Cypress-Knee Sedge				X	X

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## Distribution of High Priority Plants by Ecoregion

A-12

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Carex exilis</i>	Meager Sedge				X	
<i>Carex radfordii</i>	Radford's Sedge			X		
<i>Carex thornei</i>	Thorne's Sedge				X	
<i>Carya laciniosa</i>	Shellbark Hickory	X				
<i>Carya myristiciformis</i>	Nutmeg Hickory	X				
<i>Ceratiola ericoides</i>	Rosemary				X	
<i>Chamaecrista deeringiana</i>	Florida Senna				X	
<i>Chamaecyparis thyoides</i>	Atlantic White-Cedar				X	
<i>Chelone cuthbertii</i>	Cuthbert's Turtlehead		X			
<i>Chelone lyonii</i>	Appalachian Turtlehead	X				
<i>Cirsium virginianum</i>	Virginia Thistle			X		
<i>Clematis fremontii</i>	Fremont's Leatherflower	X				
<i>Clematis socialis</i>	Alabama Leather Flower	X				
<i>Coreopsis integrifolia</i>	Ciliate-Leaf Tickseed				X	X
<i>Coreopsis rosea</i>	Pink Tickseed		X			X
<i>Crataegus aemula</i>	Rome Hawthorn	X		X		
<i>Crataegus aprica</i>	Sunny Hawthorn			X	X	
<i>Crataegus mendosa</i>	Albertville Hawthorn	X			X	
<i>Crataegus mollis</i>	Downy Hawthorn	X				
<i>Crataegus triflora</i>	Three-Flower Hawthorn	X			X	
<i>Crocantemum nashii</i>	Florida Scrub Sunrose					X
<i>Croomia pauciflora</i>	Croomia			X	X	
<i>Croton elliotii</i>	Pondshore Croton				X	
<i>Ctenium floridanum</i>	Florida Orange-Grass					X
<i>Cuscuta harperi</i>	Harper's Dodder			X	X	
<i>Cymophyllus fraserianus</i>	Fraser's Sedge		X			
<i>Cypripedium kentuckiense</i>	Kentucky Ladyslipper				X	
<i>Danthonia epilis</i>	Bog Oat-Grass		X	X		
<i>Delphinium alabamicum</i>	Alabama Larkspur	X				
<i>Desmodium ochroleucum</i>	Cream-Flowered Tick-Trefoil	X			X	
<i>Dicerandra radfordiana</i>	Radford's Dicerandra					X
<i>Dichanthelium hirstii</i>	Hirst Brothers' Panic Grass					
<i>Diplophyllum andrewsii</i>	Andrews' Diplophyllum (Liverwort)		X			
<i>Draba aprica</i>	Open-Ground Whitlow-Grass			X		
<i>Dulichium</i> sp. nov. (unpublished)	Coosa Prairie Threeway Sedge	X				
<i>Ecchremidium floridanum</i>	Florida Pygmy Moss					X
<i>Echinacea laevigata</i>	Smooth Purple Coneflower			X		
<i>Echinacea simulata</i>	Prairie Purple Coneflower	X				
<i>Eleocharis wolfii</i>	Spikerush			X		
<i>Elliottia racemosa</i>	Georgia Plume				X	X
<i>Eriocaulon koernickianum</i>	Dwarf Pipewort			X		
<i>Eriochloa michauxii</i> var. <i>michauxii</i>	Michaux's Longleaf Cupgrass					X
<i>Eriophorum virginicum</i>	Tawny Cottongrass				X	X

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## Distribution of High Priority Plants by Ecoregion

A-13

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Euphorbia purpurea</i>	Glade Spurge		X			
<i>Eurybia avita</i>	Alexander's Rock Aster					
<i>Eurybia jonesiae</i>	Piedmont Bigleaf Aster			X		
<i>Eustachys floridana</i>	Florida Finger Grass				X	
<i>Evolvulus sericeus</i> var. <i>sericeus</i>	Creeping Morning-Glory					X
<i>Fimbristylis brevivaginata</i>	Flatrock Fimbry			X		
<i>Fimbristylis perpusilla</i>	Harper's Fimbry				X	
<i>Forestiera godfreyi</i>	Godfrey's Wild Privet					X
<i>Forestiera segregata</i> var. <i>segregata</i>	Florida Wild Privet					X
<i>Fothergilla gardenii</i>	Dwarf Witch-Alder			X	X	X
<i>Fothergilla major</i>	Large Witch-Alder		X			
<i>Frullania appalachiana</i>	Appalachian Frullania		X			
<i>Gentianopsis crinita</i>	Fringed Gentian		X			
<i>Glandularia bipinnatifida</i> var. <i>bipinnatifida</i>	Dakota Vervain				X	
<i>Gymnoderma lineare</i>	Rock Gnome Lichen		X			
<i>Habenaria quinqueseta</i>	Michaux's Orchid				X	X
<i>Hamamelis ovalis</i>	Bigleaf Witch-Hazel				X	
<i>Hartwrightia floridana</i>	Hartwrightia					X
<i>Helenium brevifolium</i>	Bog Sneezeweed				X	
<i>Helianthus glaucophyllus</i>	Whiteleaf Sunflower		X			
<i>Helianthus smithii</i>	Smith's Sunflower		X	X		
<i>Helianthus verticillatus</i>	Whorled Sunflower	X				
<i>Helodium blandowii</i>	Blandow's Feather Moss		X			
<i>Helonias bullata</i>	Swamp-Pink		X			
<i>Hydrastis canadensis</i>	Goldenseal	X	X	X		
<i>Hymenocallis coronaria</i>	Shoals Spiderlily			X		
<i>Hymenophyllum tayloriae</i>	Taylor's Filmy Fern					
<i>Hypericum adpressum</i>	Bog St. Johnswort				X	
<i>Hypericum erythraeae</i>	Georgia St.-John's-Wort				X	X
<i>Hypnum cupressiforme</i> var. <i>filiforme</i>	Filiform Cypress-Moss		X			
<i>Illicium floridanum</i>	Florida Anise-Tree				X	
<i>Isoetes boomii</i>	Boom's Quillwort				X	
<i>Isoetes flaccida</i>	Florida Quillwort				X	
<i>Isoetes hyemalis</i>	Winter Quillwort				X	
<i>Isoetes junciformis</i>	Rush Quillwort				X	
<i>Isoetes melanospora</i>	Black-Spored Quillwort			X		
<i>Isoetes tegetiformans</i>	Mat-Forming Quillwort			X		
<i>Isotria medeoloides</i>	Small Whorled Pogonia		X			
<i>Jamesianthus alabamensis</i>	Jamesianthus	X				
<i>Juglans cinerea</i>	Butternut	X	X	X		
<i>Juniperus communis</i> var. <i>depressa</i>	Ground Juniper			X		
<i>Justicia angusta</i>	Narrowleaf Water-Willow				X	X
<i>Kalmia carolina</i>	Carolina Bog Myrtle		X		X	

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## Distribution of High Priority Plants by Ecoregion

A-14

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Lachnocaulon beyrichianum</i>	Southern Bog-Button				X	X
<i>Leavenworthia exigua</i> var. <i>exigua</i>	Least Gladecress	X				
<i>Leiophyllum buxifolium</i>	Sand-Myrtle		X			
<i>Leitneria floridana</i>	Corkwood				X	X
<i>Lejeunea blomquistii</i>	Blomquist's Lejeunea		X			
<i>Liatris tenuifolia</i> var. <i>quadriflora</i>	Florida Narrowleaf Blazing Star				X	
<i>Lilium canadense</i>	Canada Lily	X	X	X		
<i>Lilium michiganense</i>	Michigan Lily	X				
<i>Lilium philadelphicum</i>	Wood Lily	X				
<i>Lilium pyrophilum</i>	Pineland Lily				X	
<i>Lindera melissifolia</i>	Pondberry				X	X
<i>Lindera subcoriacea</i>	Bog Spicebush				X	
<i>Liparis loeselii</i>	Fen Orchid		X			
<i>Litsea aestivalis</i>	Pondspice				X	X
<i>Lobelia boykinii</i>	Boykin's Lobelia					
<i>Ludwigia spathulata</i>	Creeping Smallflower Seedbox					
<i>Lycium carolinianum</i>	Carolina Wolfberry					X
<i>Lysimachia fraseri</i>	Fraser's Loosestrife	X	X	X		
<i>Lythrum curtissii</i>	Curtiss' Loosestrife				X	
<i>Macbridea caroliniana</i>	Carolina Bogmint				X	
<i>Macranthera flammea</i>	Bog Flameflower				X	
<i>Malaxis spicata</i>	Florida Adders-Mouth Orchid				X	X
<i>Marshallia mohrii</i>	Coosa Barbara's-Buttons	X				
<i>Marshallia trinervia</i>	Broadleaf Barbara's-Buttons	X				
<i>Matelea alabamensis</i>	Alabama Milkvine				X	X
<i>Matelea floridana</i>	Florida Milkvine				X	
<i>Megaceros aenigmaticus</i>	Headwaters Hornwort		X			
<i>Monotropsis odorata</i>	Sweet Pinesap		X	X		
<i>Morella inodora</i>	Odorless Bayberry				X	
<i>Najas filifolia</i>	Narrowleaf Naiad				X	
<i>Nestronia umbellula</i>	Indian Olive			X	X	
<i>Nevusia alabamensis</i>	Alabama Snow-Wreath	X				
<i>Oncophorus raii</i>	Rau's Oncophorus Moss		X			
<i>Onosmodium molle</i> ssp. <i>occidentale</i>	Western Marble-Seed	X				
<i>Oxypolis canbyi</i>	Canby's Dropwort				X	
<i>Oxypolis ternata</i>	Savanna Cowbane				X	X
<i>Packera millefolia</i>	Blue Ridge Golden Ragwort		X			
<i>Panax quinquefolius</i>	American Ginseng	X	X	X	X	
<i>Panax trifolius</i>	Dwarf Ginseng		X			
<i>Paronychia virginica</i>	Yellow Nailwort			X		
<i>Pedicularis lanceolata</i>	Swamp Lousewort		X			
<i>Pediomelum piedmontanum</i>	Dixie Mountain Breadroot			X		
<i>Philadelphus pubescens</i>	Hairy Mockorange	X				

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## Distribution of High Priority Plants by Ecoregion

A-15

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Pinguicula primuliflora</i>	Clearwater Butterwort				X	
<i>Pityopsis oligantha</i>	Few-Flowered Golden-Aster				X	
<i>Plagiochila caduciloba</i>	Brittle-Lobed Leafy Liverwort		X			
<i>Plagiochila floridana</i>	Florida Leafy Liverwort				X	
<i>Plagiochila sharpii</i>	Sharp's Leafy Liverwort		X			
<i>Plagiomnium carolinianum</i>	Carolina Wavy-Leaf Moss		X			
<i>Plantago sparsiflora</i>	Pineland Plantain				X	X
<i>Platanthera blephariglottis</i>	Small White Fringed Orchid					X
<i>Platanthera chapmanii</i>	Chapman's Fringed Orchid					X
<i>Platanthera conspicua</i>	Large White Fringed Orchid				X	X
<i>Platanthera flava</i> var. <i>herbiola</i>	Pale Green Orchid		X			
<i>Platanthera grandiflora</i>	Large Purple Fringed Orchid		X			
<i>Platanthera integra</i>	Yellow Fringeless Orchid				X	X
<i>Platanthera integrilabia</i>	Monkeyface Orchid	X	X	X		
<i>Platanthera peramoena</i>	Purple Fringeless Orchid		X			
<i>Platyhypnidium pringlei</i>	Pringle's Platyhypnidium		X			
<i>Pohlia rabunbaldensis</i>	Rabun Bald Feather-Moss		X			
<i>Polymnia laevigata</i>	Tennessee Leafcup	X				
<i>Portulaca biloba</i>	Grit Portulaca				X	X
<i>Portulaca umbraticola</i> ssp. <i>coronata</i>	Wingpod Purslane			X		
<i>Pteroglossaspis ecristata</i>	Wild Coco				X	X
<i>Ptilimnium ahlesii</i>	Coastal Bishopweed					X
<i>Ptilimnium nodosum</i>	Harperella			X	X	
<i>Quercus oglethorpensis</i>	Oglethorpe Oak			X		
<i>Quercus similis</i>	Swamp Post Oak	X	X			X
<i>Rhexia aristosa</i>	Awned Meadowbeauty				X	
<i>Rhexia salicifolia</i>	Willowleaf Meadowbeauty				X	
<i>Rhododendron eastmanii</i>	May Pink Azalea				X	
<i>Rhododendron prunifolium</i>	Plumleaf Azalea				X	
<i>Rhus michauxii</i>	Dwarf Sumac			X		
<i>Rhynchospora breviseta</i>	Short-Bristle Beakrush				X	X
<i>Rhynchospora crinipes</i>	Bearded Beakrush				X	
<i>Rhynchospora culixa</i>	Georgia Beakrush				X	
<i>Rhynchospora decurrens</i>	Decurrent Beakrush				X	X
<i>Rhynchospora fernaldii</i>	Fernald's Beakrush					X
<i>Rhynchospora harperi</i>	Harper's Beakrush					
<i>Rhynchospora macra</i>	Many-Bristled Beakrush					X
<i>Rhynchospora pleiantha</i>	Clonal Thread-Leaved Beakrush				X	X
<i>Rhynchospora punctata</i>	Spotted Beakrush				X	X
<i>Rhynchospora solitaria</i>	Solitary Beakrush				X	
<i>Rhynchospora thornei</i>	Thorne's Beakrush	X			X	
<i>Rudbeckia auriculata</i>	Swamp Black-Eyed Susan					
<i>Rudbeckia heliopsisidis</i>	Little River Black-Eyed Susan	X				

SA/RV = SW Appalachians/Ridge & Valley, BR = Blue Ridge, PD = Piedmont, SP = Southeastern Plains, SCP = Southern Coastal Plain

## Distribution of High Priority Plants by Ecoregion

A-16

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Ruellia noctiflora</i>	Night-Blooming Wild Petunia					X
<i>Sabatia capitata</i>	Cumberland Rose Gentian	X		X		
<i>Sageretia minutiflora</i>	Climbing Buckthorn				X	X
<i>Sagittaria secundifolia</i>	Little River Water-Plantain	X				
<i>Salix floridana</i>	Florida Willow				X	
<i>Sanguisorba canadensis</i>	Canada Burnet		X			
<i>Sapindus saponaria</i> var. <i>marginatus</i>	Soapberry					X
<i>Sarracenia leucophylla</i>	Whitetop Pitcherplant				X	
<i>Sarracenia oreophila</i>	Green Pitcherplant		X			
<i>Sarracenia psittacina</i>	Parrot Pitcherplant				X	X
<i>Sarracenia purpurea</i> var. <i>montana</i>	Mountain Purple Pitcherplant		X			
<i>Sarracenia purpurea</i> var. <i>venosa</i>	Lowland Purple Pitcherplant				X	
<i>Sarracenia rubra</i> aff. <i>gulfensis</i>	Sweet Pitcherplant				X	
<i>Sarracenia rubra</i> ssp. <i>rubra</i>	Sweet Pitcherplant					X
<i>Schisandra glabra</i>	Bay Starvine			X	X	
<i>Schoenolirion albiflorum</i>	White Sunnysbell					X
<i>Schoenoplectus erectus</i> ssp. <i>raynalii</i>	Raynal's Bulrush				X	
<i>Schoenoplectus etuberculatus</i>	Clearwater Bulrush				X	
<i>Schwalbea americana</i>	Chaffseed			X	X	
<i>Scutellaria altamaha</i>	Altamaha Skullcap				X	X
<i>Scutellaria mellichampii</i>	Mellichamp's Skullcap				X	X
<i>Scutellaria montana</i>	Large-Flower Skullcap	X				
<i>Scutellaria ocmulgee</i>	Ocmulgee Skullcap					
<i>Sedum nevii</i>	Nevius' Stonecrop			X		
<i>Sedum pusillum</i>	Granite Stonecrop, Puck's Orpine			X		
<i>Shortia galacifolia</i>	Oconee Bells		X			
<i>Sibbaldiopsis tridentata</i>	Three-Toothed Cinquefoil		X			
<i>Sideroxylon macrocarpum</i>	Ohoopée Bumelia				X	X
<i>Sideroxylon thornei</i>	Swamp Buckthorn					X
<i>Silene ovata</i>	Mountain Catchfly		X		X	
<i>Silene polypetala</i>	Fringed Campion			X	X	
<i>Silene regia</i>	Royal Catchfly	X				
<i>Silphium mohrii</i>	Cumberland Rosinweed	X				
<i>Sium floridanum</i>	Florida Water-Parsnip				X	
<i>Solidago arenicola</i>	Black Warrior Goldenrod	X				
<i>Solidago simulans</i>	Cliffside Goldenrod		X			
<i>Spiraea latifolia</i>	Broadleaf Bog Meadowsweet		X			
<i>Spiraea virginiana</i>	Virginia Spirea	X				
<i>Spiranthes floridana</i>	Florida Ladies-Tresses					X
<i>Spiranthes longilabris</i>	Giant Spiral Ladies-Tresses				X	
<i>Spiranthes magnicamporum</i>	Great Plains Ladies-Tresses	X				
<i>Sporobolus pinetorum</i>	Pineland Dropseed					X
<i>Sporobolus teretifolius</i>	Wire-Leaf Dropseed				X	X

SA/RV = SW Appalachians/Ridge & Valley, BR = Blue Ridge, PD = Piedmont, SP = Southeastern Plains, SCP = Southern Coastal Plain

## Distribution of High Priority Plants by Ecoregion

A-17

Name	Common Name	SA_RV	BR	PD	SP	SCP
<i>Stachys hyssoifolia</i> var. <i>lythroides</i>	Tallahassee Hedge-Nettle				X	
<i>Stewartia malacodendron</i>	Silky Camellia			X	X	X
<i>Stokesia laevis</i>	Stokes Aster				X	
<i>Streptopus lanceolatus</i> var. <i>lanceolatus</i>	Rosy Twisted-Stalk		X			
<i>Symphyotrichum georgianum</i>	Georgia Aster	X	X	X	X	
<i>Teloschistes exilis</i>	Slender Orange Bush Lichen				X	
<i>Tephrosia mohrii</i>	Dwarf Goat's-Rue				X	
<i>Thalictrum cooleyi</i>	Cooley's Meadowrue				X	
<i>Thalictrum coriaceum</i>	Appalachian Meadowrue		X			
<i>Thalictrum debile</i>	Trailing Meadowrue	X				
<i>Thaspium pinnatifidum</i>	Cutleaf Meadow-Parsnip	X				
<i>Thermopsis fraxinifolia</i>	Ash-Leaved Bush-Pea	X	X			
<i>Thermopsis villosa</i>	Carolina Golden Banner	X	X			
<i>Torreya taxifolia</i>	Florida Torreya				X	
<i>Tridens carolinianus</i>	Carolina Redtop				X	
<i>Trillium decipiens</i>	Mimic Trillium				X	
<i>Trillium persistens</i>	Persistent Trillium		X	X		
<i>Trillium pusillum</i>	Least Trillium	X				
<i>Trillium reliquum</i>	Relict Trillium			X	X	
<i>Trillium</i> sp. nov. (unpublished)	Amicalola Trillium		X			
<i>Trillium</i> sp. nov. (unpublished)	Lookout Mountain Toadshade	X				
<i>Trillium</i> sp. nov. (unpublished)	Southern Decumbent Trillium			X	X	
<i>Triphora trianthophora</i>	Three-Birds Orchid		X	X		
<i>Tsuga caroliniana</i>	Carolina Hemlock		X			
<i>Veratrum woodii</i>	Ozark Bunchflower	X		X	X	
<i>Verbesina walteri</i>	Carolina Crownbeard				X	
<i>Viburnum bracteatum</i>	Limerock Arrowwood	X				
<i>Viburnum rafinesquianum</i> var. <i>affine</i>	Downy Arrowwood			X		
<i>Waldsteinia lobata</i>	Piedmont Barren Strawberry		X	X	X	
<i>Xerophyllum asphodeloides</i>	Eastern Turkeybeard	X		X		
<i>Xyris drummondii</i>	Drummond's Yellow-Eyed Grass				X	X
<i>Xyris scabrifolia</i>	Harper's Yellow-Eyed Grass			X	X	X
<i>Xyris tennesseensis</i>	Tennessee Yellow-Eyed Grass	X		X		
	<b>Totals</b>	<b>65</b>	<b>66</b>	<b>66</b>	<b>118</b>	<b>68</b>

## **HIGH PRIORITY HABITATS BY ECOREGION**

The following definitions are based on input from the habitat restoration & historic vegetation technical teams, members of the ecosystem and species technical teams, and information from Wharton (1978) and Mirarchi et al. (2004).

### **SOUTHWESTERN APPALACHIANS/RIDGE & VALLEY ECOREGIONS**

#### **Acidic Meadows Over Sandstone or Shale**

Open, grassy habitats over shallow acidic soils; edaphic factors control species composition and diversity. May be moist or dry, depending on topographic setting. These small patch habitats are relatively rare in Georgia.

#### **Calcareous Flatwoods (Hardwood Flats)**

Relatively open, flat, shallowly and seasonally wet forested habitats dominated by hardwoods and including rare or uncommon species such as nutmeg hickory and Alabama leatherflower. Shrub and herb diversity is high. A small patch habitat restricted to low-lying areas with clayey calcareous soils.

#### **Calcareous Prairies (Coosa Valley Prairies)**

Open grass- and forb-dominated communities over clayey calcareous soils that inhibit growth of woody species. Groundlayer plant species diversity is high, and includes disjunct from midwestern prairies. Includes wet and dry prairie subtypes. These habitats require periodic fire for maintenance.

#### **Canebrakes**

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

#### **Caves, Rock Shelters, Talus Slopes**

These habitats share certain structural characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. They are typically embedded in a larger matrix of forest habitats. Caves are unique in their lack of sunlight and vegetation and dependence on outside materials for energy flows. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes.

#### **Forested Limestone Slopes and Terraces**

This forest type is found at middle elevations along Lookout and Pigeon Mountain. Characterized by submesic hardwood forest, with species composition dependent on aspect and slope position. Includes partially forested limestone ledges along streams.

#### **High Gradient First- and Second-Order Streams**

Small, clear, cold, tumbling streams with bedrock riffles and sandy pools. Found at higher elevations and upper ends of steep ravines and slopes. These streams typically experience wide seasonal variations in flow; some receive substantial input from groundwater.

#### **Limestone Glades and Barrens (Cedar Glades)**

Open habitats dominated by grasses or forbs, with scattered eastern redcedars and other trees. These habitats contain a large number of endemic plant species. Glades occur on thin, rocky soils, and are

typically dominated by forbs; barrens are in areas with deeper soils and are dominated by grasses. The largest and most important area of cedar glades/barrens in Georgia is centered on Chickamauga-Chattanooga National Military Park.

### **Mesic Hardwood Forests**

Mesic forests of bluffs, ravines, and colluvial flats, characterized by a diverse canopy of hardwood species such as yellow poplar, black cherry, white oak, shagbark hickory, northern red oak, bigleaf magnolia, sugar maple, and American beech. Hemlock and loblolly pine may be minor components in some areas. Mature examples are characterized by a rich understory of shrubs and herbaceous plants. This large patch habitat includes a rich mesic hardwood forest subtype found on calcareous soils.

### **Medium to Large Rivers**

Lower gradient streams of valley bottoms, characterized by sandy, silty, or gravelly substrates. Typically surrounded by agricultural lands on the broad, fertile floodplains. Nearly all examples of large river floodplain forest in the Ridge & Valley region have been converted to other types of land cover.

### **Montane Longleaf Pine-Hardwood Forests**

Dry forests composed of longleaf pine and mixed hardwood species, including mountain chestnut oak, southern red oak, and various scrub oaks. Significant examples occur in the Ridge & Valley region near Rome. Many Georgia examples are fire-suppressed and exhibit depressed species diversity relative to more frequently burned sites.

### **Oak Woodlands**

An uncommon subxeric vegetation type found at higher elevations, oak woodlands are usually surrounded by xeric pine or pine-oak forest. Canopy dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, with persimmon, blackgum, and other hardwood species. Probably maintained by a combination of infrequent fire and edaphic factors. Pigeon and Lookout Mountain contain good but narrow ecotonal examples.

### **Pine-Oak Woodlands and Forest**

Relatively open subxeric to xeric forest or woodland, typically dominated by shortleaf pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. May also include chestnut oak, scarlet oak, and other dry-site hardwood species. Includes typical shortleaf pine-post oak woodlands as well as mixed pine-oak scrub and dry pine-oak forest.

### **Red Maple/Blackgum Swamps**

Nonalluvial or small stream swamp forests dominated by red maple and swamp blackgum. Often found along small low-gradient streams, in shallow depressions, or on wet flats. Often boggy, with a layer of peat, these wetlands have been impacted by construction of drainage ditches.

### **Sagponds (Isolated Depressional Wetlands)**

Depressions formed by subsidence of soil due to groundwater percolation in the underlying rock. Contain a variety of vegetation types from freshwater emergents to swamp forest, depending on hydroperiod and other factors. Forested types are usually dominated by willow oak, swamp blackgum, and red maple. May include disjunct coastal plain species.

### **Sandstone Barrens and Outcrops**

This edaphic habitat type includes sandstone boulders and outcrops of the Appalachian (Cumberland) Plateau as well as scoured sandstone ledges near streams. These open, rocky habitats are typically bordered by Virginia and shortleaf pine, chestnut oak, and a variety of shrubs.

### **Springs and Spring Runs; Gravelly Seeps**

Springs are highly localized points of groundwater discharge that typically feed spring runs, while seeps may be broader or less defined areas of perennial or seasonal flows. The Ridge & Valley region contains a number of high-discharge springs. The waters of springs and associated habitats can be highly variable, depending on hydrology. These perennially cool and clear waters provide important habitat to a number of animal species, particularly salamanders and fish such as the coldwater darter.

### **Streams**

Moderate to low gradient streams running through lower coves and valleys. Riffle, pool, and shoal habitats may be present. Substrates include gravel, pebbles, boulders, and bedrock. Aquatic plants may also be present. Pools are often silt-bottomed. These streams become turbid after rain. These are generally more productive than headwater streams because of limestone valley bottoms.

### **Underground Streams**

Includes streams of all sizes flowing through caves and other underground passages. These aquatic systems are important for rare species such as the Southern cavefish and Tennessee cave salamander.

## **BLUE RIDGE ECOREGION**

### **Boulderfield Forests**

High elevation mesic hardwood forest; dominated by broadleaf deciduous trees, occupying north-facing areas with angular rocks or blocks of rock and little visible soil. Includes rich flora with northern affinities. Typically very mesic, with trees such as yellow buckeye, sweet birch, yellow birch, rosebay rhododendron. A rare community of the Blue Ridge; only a few examples are known.

### **Canebrakes**

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most examples in this ecoregion are small and fire-suppressed.

### **Caves, Rock Shelters, Talus Slopes**

These habitats share characteristics, such as a bedrock component with a variety of microhabitats that provide cover for priority animal species. These habitats are usually embedded in a larger matrix of forest habitats. The Blue Ridge contains relatively few caves; these are typically fracture-type caves rather than solution caves. Rock shelters can be found under cliffs (vertical exposures of rock). Talus slopes are accumulations of rock beneath cliffs and steep slopes.

### **Floodplain Hardwood Forests**

Forested wetlands characterized by a diverse association of deciduous hardwood trees, including both montane and low-elevation species. Generally lacking in the more flood-adapted oaks and hickories

prevalent in Piedmont bottomland hardwood forests. Many of these floodplain forests were converted to agricultural uses early in the history of settlement of this region.

### **Hemlock-Hardwood-White Pine Forests**

Mesic and submesic forests dominated by a mixed canopy of hardwoods and hemlock and/or white pine. Hemlock forests are typically found along small to medium streams, in sheltered valleys and ravines. Thickets of rhododendron and mountain laurel frequently form a dense understory, which is important for many neotropical migratory birds. White pine may share dominance with oak-dominated forests in low- to mid-elevation slopes and sheltered low ridges. A serious threat to this forest type is the hemlock wooly adelgid, which is spreading from east to west across the region. A rare subtype of this forest type containing Carolina hemlock is found in scattered locations in the lower Blue Ridge.

### **High-Elevation Early Successional Habitats**

Includes a variety of vegetation types found at high elevations that are maintained by periodic natural or anthropogenic disturbance. Many high priority species are dependent on this habitat type, including the golden-winged warbler, Appalachian Bewick's wren, star-nosed mole, pygmy shrew, and fringed gentian.

### **High Elevation Forested Heath Thickets**

High elevation habitats characterized by dense thickets of ericaceous shrubs under an open canopy of hardwood trees. Herbaceous layer is sparse to patchy. Typical shrubs include huckleberry, mountain laurel, and rosebay rhododendron.

### **High Elevation Rocky Summits and Shrub Balds**

These are small patch habitats typically found only on the highest peaks of the Blue Ridge in association with northern hardwood forest. Characterized by a mosaic of exposed rock and patches of shrub or herb-dominated vegetation. Trees are mostly dwarfed northern red oak. Shrubs may include Catawba rhododendron, mountain laurel, huckleberry, mountain ash, viburnum, and hawthorn.

### **Low Elevation Seepy Thickets and Wet Woods**

Seasonally inundated or spring-fed wetland habitats. Thickets are dominated by a variety of shrubs. Includes forested habitats along seepage slopes and at the edge of mountain bogs, some of which are maintained by the actions of beaver.

### **Medium to Large Rivers**

Moderate to high gradient rivers with cold, clear riffles, pools, and runs. Substrates may include boulders, bedrock, gravel, and pebbles. Many of these rivers traverse steep gorges. These aquatic habitats are low in productivity compared to streams of the Southwestern Appalachians/Ridge & Valley.

### **Mixed Pine-Hardwood Forests**

Mesic to submesic forests of hardwoods and pines, typically at middle to low elevations over a broad range of topographic conditions. A large patch habitat that comprises a major forest type of the Blue Ridge. Dominants may include yellow-poplar, sweetgum, various oaks, and loblolly, white, and/or shortleaf pine.

### **Moist Cliff Faces and Spray Cliffs**

Vertical to gently sloping rock faces located adjacent to waterfalls or seepage zones. These are wetlands dominated by mosses, liverworts, vascular herbs, and sparse shrubs or scrubby trees adapted to thin soils and high humidity. These small patch habitats represent unusually stable environments, where temperatures are moderated by the constant spray or seepage. Include many bryophytes and ferns representing disjunct occurrences from tropical regions as well as Southern Appalachian endemics.

### **Mountain Bogs and Wet Meadows**

A mosaic of wetland communities usually dominated by shrubs or emergent herbs, with scattered trees. May occur as elongate bands along stream valleys, or in much smaller and more compact patches on flats or slopes. Includes wetlands maintained by beaver activity as well as small, sheltered seepage areas along the headwaters of mountain creeks.

### **Northern Hardwood Forests**

High elevation mesic forests found in upper coves, flats and slopes with northerly aspects, usually at elevations above 3,500 ft. Dominant canopy species include American beech, yellow birch, sugar maple, and yellow buckeye, with white basswood, northern red oak, white ash, and black cherry also present. These forests are subject to broad scale disturbances such as ice storms. Old growth examples are rare and usually restricted to steeply sloped, inaccessible areas.

### **Oak Forest and Woodlands**

This vegetation type includes a wide variety of upland forests dominated by Appalachian oaks. Composition and complexity of oak forests vary with elevation, slope and moisture. In more mesic sites, canopy dominants may include red oak, white oak, and black oak, along with hickories and mesophytic hardwoods. Canopy dominants of more xeric sites may include mountain chestnut oak, scarlet oak, southern red oak, and northern red oak. Also includes subxeric or xeric oak woodlands found on ridges and upper slopes at high elevations. These oak-dominated forests and woodlands represent the most extensive upland vegetation type of the Blue Ridge.

### **Pine-Oak Woodlands and Forest**

Relatively open subxeric forest to xeric woodland, typically dominated by shortleaf pine, pitch pine, Virginia pine, and post and blackjack oaks, often with a diverse grass and shrub layer. A rare subtype is found on serpentine soils. Pitch pine, Virginia pine, red maple and post oak are the dominant canopy trees in this rare community; understory trees of sourwood, dogwood and sassafras are usually thinly scattered and shrubs are sparse to dense.

### **Rich Mesic Hardwood Forests (Cove Hardwoods)**

The mixed mesophytic hardwood forests of the Southern Appalachians are the most biologically diverse habitats in the United States. Variations of this forest type can be found in the Blue Ridge at elevations from 1,000 to 3,800 ft. They are typically found in mesic sites on concave landforms and ravines, or on protected north and east-facing slopes at low elevations. A diverse mixture of mesophytic trees dominates the canopy, including yellow poplar, white basswood, sugar maple, yellow and sweet birch, cucumber magnolia, yellow buckeye, black cherry, eastern hemlock, white ash, blackgum, American beech, red maple, and various oaks and hickories.

### **Rocky Bluffs and Streambanks**

Plant composition of these rocky streamside habitats is variable, depending on stream size, amount of rock, and extent of flooding. These periodically scoured rocky habitats typically support few trees

and sparse to moderate shrubs (sometimes thickets). A diverse stratum of light-loving herbs may be present.

### **Springs and Spring Runs; Gravelly Seeps**

Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. These cool clean waters provide important habitat to a number of animal species, particularly salamanders.

### **Streams**

Cold, clear, high gradient streams typically containing riffles, plunge-pools, cascades, and waterfalls. Substrata dominated by bedrock and boulders, but sand and gravel may also be present in depositional areas. These streams have low productivity and aquatic vegetation is rarely present.

### **Xeric Pine Woodlands**

A heterogeneous group of xeric pine-dominated woodlands found on ridges and steep slopes with southerly aspects, knobs, and low-elevation peaks. Below 2,400 ft. shortleaf pine is a dominant, with Virginia pine a common associate. From 2,400 to 2,800 ft. on the driest ridges pitch pine dominates. Above 2,800 ft. on slopes and ridges, Table Mountain pine dominates. All of these habitats require periodic fire for maintenance.

## **PIEDMONT ECOREGION**

### **Beaver Ponds; Freshwater Marsh**

Beaver ponds are temporary impoundments created by beaver on small to medium sized streams. Freshwater marshes develop in shallow beaver ponds and along the edges of larger lakes and ponds. Dominants include a variety of sedges, rushes, grasses, and forbs, with scattered buttonbush, red maple, swamp dogwood, and tag alder. Few Georgia examples exist that are not invaded by the exotic weed, *Murdannia*. These wetlands provide habitat for a wide variety of wildlife species.

### **Bottomland Hardwood Forests**

Forested wetlands of alluvial river floodplains, characterized by a diverse association of deciduous hardwood trees. Canopy dominants vary, but may include water oak, willow oak, overcup oak, cherrybark oak, swamp chestnut oak, green ash, sweetgum, bitternut hickory, and pignut hickory. Shrub layer may be dense or relatively sparse, containing a variety of mesophytic or hydrophytic woody plants and often a significant woody vine component. Many of these habitats have been impacted by invasive exotic species such as Chinese privet and Nepalese browntop.

### **Canebrakes**

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require fire or other form of periodic disturbance for maintenance. Most canebrakes in this region are relatively small and fire-suppressed, often occurring along the edges of fields and other clearings.

### **Granite Outcrops**

Diverse mosaics of exposed granitic rock, herb and shrub dominated patches, and wetland microhabitats. Most have shallow solution pits that collect soil and support various stages of plant

succession. These environments support rare or endemic species of plants and animals. The most important of these habitats contain a variety of solution pits, seepage zones, and bare rock exposures. Some outcrops are monadnocks (rise above the ground) while others are flat rock exposures. The Georgia Piedmont is the center of granite outcrop species diversity.

### **Medium to Large Rivers**

Low to moderate gradient meandering rivers, typically with heavy sediment loads. Floodplains are relatively narrow compared to similar rivers in the Coastal Plain. Extensive shoal habitats may occur, especially along the Fall Line. Dominant habitats include runs, pools, and shoals. Substrate is variable, but is dominated by sand in runs and pools and by bedrock in shoals. Aquatic vegetation may be present.

### **Mesic Hardwood Forests**

Non-wetland forests of floodplains, ravines, and north-facing slopes in the Piedmont. These may include species such as American beech, white oak, northern red oak, bitternut hickory, pignut hickory, shagbark hickory, bigleaf magnolia, yellow poplar, blackgum, dogwood, black cherry, and loblolly pine. Typical shrubs include spicebush, sweetshrub, pawpaw, Oconee azalea, rusty viburnum, and pinxter-flower.

### **Montane Longleaf Pine-Hardwood Forest**

A subxeric or xeric mixed forest with longleaf pine, oaks, and hickories. Georgia examples are typically fire-suppressed. Pine Mountain contains notable examples; others can be found along Dugdown and Hightower Mountain and in Paulding Forest and Sheffield WMAs. Includes a rare longleaf pine/Georgia oak subtype found on Hollis quartzite along the main Pine Mountain ridge.

### **Oak Woodlands and Savannas**

Rare upland hardwood habitats found in scattered locations in the Piedmont. These xeric or subxeric oak-dominated woodland are influenced by edaphic conditions (i.e. thin soils, mafic rocks) and periodic fire. Dominants may include southern red oak, scarlet oak, post oak, and blackjack oak, sometimes with shortleaf pine. Sparkleberry and hawbushes are common shrub components. A particularly rare type, the post oak-blackjack oak savanna, was apparently much more common in pre-settlement times; only small, fire-suppressed remnants of these habitats exist today.

### **Oak-Hickory-Pine Forest**

Considered the climax forest of the Piedmont, this forest type formerly covered 50% to 75% of the region; most examples on fertile soils were eliminated by conversion to agricultural uses. Remaining examples are often found in rocky areas that were difficult to convert to agricultural fields. Typically include a variety of hardwood species such as white oak, black oak, southern red oak, pignut hickory, shagbark hickory, mockernut hickory, red maple, blackgum, shortleaf pine, and loblolly pine, with dogwood, rusty viburnum, hog plum, dwarf pawpaw, and various hawbushes in the understory. American chestnut was formerly a major component of the canopy. Examples over circumneutral soils influenced by mafic or ultramafic bedrock are often floristically richer, and may contain species such as Oglethorpe oak, basswood, red mulberry, redbud, and fringetree.

### **Rocky or Cobbly River Shoals**

Shallow, high gradient reaches with swift water and rocky substrates. These habitats are important spawning areas for fish, including darters, shiners, and suckers (such as the extremely rare robust redhorse). In addition, shoals provide foraging areas for wading birds, and sunning areas for turtles. May contain dense growths of riverweed (*Podostemum ceratophyllum*). The shoals spiderlily

(*Hymenocallis coronaria*), a State-protected plant, is found on rocky shoals in the middle reaches of the Savannah, Flint, and Chattahoochee rivers. Many shoals have been degraded by stream impoundments, altered water quality, and excessive silt deposition.

### **Rocky/Sandy River Bluffs**

Exposed rocky or sandy bluffs along rivers in the Piedmont are often characterized by mixed pine-oak vegetation with shortleaf pine, loblolly pine post oak, eastern redcedar, southern red oak, blackjack oak, and white oak. Small trees and shrubs may include hornbeam, winged elm, sparkleberry, winged sumac, yucca, and century plant. More sheltered or east-facing bluffs may have mountain laurel and rosebay rhododendron.

### **Serpentine Outcrops/Woodland/Savanna**

This rare habitat represents a complex mosaic of woodlands and savannas with scattered outcropping of serpentine rocks. The pine-mixed hardwood vegetation includes longleaf pine as a dominant. This type is maintained by fire and edaphic conditions. The only known Georgia examples are fire-suppressed. These habitats include disjunct coastal plain species such as pineland Barbara-buttons and Georgia plume.

### **Springs and Spring Runs**

Springs are highly localized groundwater expressions. The waters of springs and associated habitats can be highly variable, depending on hydrology (hydroperiod and volume) and edaphic factors. Springs of the Piedmont have varying mineral content, chemical properties, and temperatures. Includes spring pools and first order streams immediately below springs where rare fish and invertebrates may occur.

### **Streams**

In the upper Piedmont, streams are low to moderate gradient and typically contain well-defined riffles and pools. Substrate consists of gravel, pebble, sand, and silt; some bedrock may also be present. Lower Piedmont streams are lower gradient, have fewer riffles and pools, and their substrates have a higher proportion of silt, clay, and detritus than upper Piedmont streams. Turbidity is highly variable, but most of these streams become highly turbid after rain.

### **Upland Depression Swamp**

A non-alluvial open swamp with water oak, southern shagbark hickory, Oglethorpe oak, and loblolly and shortleaf pine. Coastal plain elements in the understory include swamp palmetto and parsley haw. Usually found on Iredell or Enon soils in the lower Piedmont. These sticky, plastic soils pond water in the spring, resulting in swampy conditions for a portion of the year.

### **Xeric Pine Woodlands**

Pine-dominated habitats of dry, rocky ridgetops and granitic outcrops. Dominants are loblolly, shortleaf, and Virginia pine. These woodland habitats are maintained by a combination of edaphic factors and periodic fire.

## **SOUTHEASTERN PLAINS ECOREGION**

### **Alluvial (Brownwater) Rivers and Swamps**

Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the

dominant substrata and these rivers typically carry heavy sediment loads. Extensive cypress-gum swamps can be found on all major alluvial rivers in the upper portion of the Southeastern Plains. These systems have been impacted by altered flows from upstream dams.

### **Altamaha Grit Outcrops**

These small patch habitats represent mosaics of indurated sandstone outcrops (vertical and horizontal surfaces) interspersed with rock-influenced pine woodland, bogs, and bottomlands. Characterized by several endemic species and plant association.

### **Atlantic Whitecedar Swamps; Clearwater Stream Swamps**

Narrow, linear forested systems along cold, clear streams of the Fall Line sandhills. Characterized by a fairly dense canopy of Atlantic whitecedar, with pond pine, red maple, sweetbay, and other mesic-hydric site species. Clearwater stream swamps are similar but without Atlantic whitecedar in the canopy. The shrub layer is usually well developed and diverse, while the groundlayer herbaceous vegetation is often sparse. These systems are thought to be maintained by periodic fire, beaver activity, and possibly other forms of disturbance.

### **Bayheads and Titi Swamps**

Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). Considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain

### **Beech-Magnolia Slope Forests**

These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

### **Black Belt Prairies**

Small-patch prairie habitats occurring over alkaline Oktibbeha soils. These soils are adhesive when wet and hard when dry, limiting the growth of woody plants. Black Belt prairies consist of herb-dominated patches interspersed with woody scrub component. These habitats are maintained by a combination of soil conditions and periodic fire.

### **Bottomland Hardwood Forests**

Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

### **Calcareous Swamps**

Hardwood dominated swamp forests that are influenced by calcareous soils. Examples include Spring Creek in the Dougherty Plain. These spring-fed swamps may contain rare plants such as

variable-leaved water plantain. Similar habitats are found along tributaries of the Ocmulgee and Ogeechee rivers.

### **Canebreaks**

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

### **Caves**

Found primarily along the Pelham Escarpment in the southwestern portion of the ecoregion. A few caves are also found in karst environments near Cochran and Sandersville. These Coastal Plain caves provide habitat for high priority species such as the southeastern myotis and Georgia blind salamander.

### **Evergreen Hammocks and Mesic Hardwood Forests**

Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

### **Flint Kaolin Outcrops**

Unusual rock outcrops composed of flint kaolin, a hard, flinty conglomerate of metamorphosed sediments. Outcrops are surrounded by xeric mixed oak/pine forest. The plant communities of the outcrops resemble Altamaha Grit. Known only from Columbia County.

### **Forested Depressional Wetlands**

Seasonally or semi-permanently flooded forests of depressional features, including Carolina bays, limesinks, and Grady ponds. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish populations are very important breeding habitats for amphibians such as the flatwoods salamander.

### **Freshwater “Prairies”**

Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is Grand Bay, possibly the largest Carolina bay known. Other examples can be found in the Tallahassee Hills/Valdosta Limesink region. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

### **Hillside Seeps**

Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

### **Limestone and Marl Outcrops; Calcareous Bluffs**

Rich riparian or ravine habitats influenced by limestone substrate. Marl gorges and bluffs are restricted to tributaries of the Chattahoochee River (Town Creek, Kolomoki Creek) near Fort Gaines. These “blue marl gorges” have diverse mesic hardwood forests and unusual seepage cliffs. Mesic calcareous bluffs are also found along the Savannah River and contain plant species of northern affinities.

### **Longleaf Pine-Scrub Oak Woodlands**

Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

### **Longleaf Pine-Wiregrass Savannas**

Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. Can range from mesic to dry, depending on topographic position and soils. Transitions downslope into wet pine savanna. These habitats are heavily dependent on frequent fire for maintenance.

### **Nonalluvial (Blackwater) Rivers and Swamps**

Large, meandering rivers with tea-stained, but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form extensive bars in larger systems. Runs and pools are dominant habitats. Large snags are a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers.

### **Open-Water Ponds and Lakes (Carolina Bays, Limesinks and Beaver Ponds)**

Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. Many wildlife species are dependent on these habitats. Limesinks are generally round, formed by the collapse of underground caverns, and are found primarily in the Dougherty Plain. Carolina bays are characterized by an elliptical shape, NW-SE axis, and a deep sandy rim on the east and south edges. Beaver activity along small branches may semi-permanently inundate areas, creating open wetlands.

### **Pine Flatwoods**

Seasonally wet forests with open to closed pine canopy, often with an ericaceous shrub understory. Canopy dominants may include slash, longleaf, and occasionally pond pine. These habitats generally occur on nonalluvial flats and low terraces, and have a strong herbaceous component (although not as diverse as the longleaf pine savanna). Maintained by periodic fire.

### **Rocky/Sandy River Bluffs**

Subxeric mixed pine-hardwood forest on river bluffs. May contain species such as white oak, southern red oak, post oak, laurel oak, mockernut hickory, shortleaf pine, loblolly pine and spruce pine. The woody understory may include red buckeye, blueberry, and possumhaw. The herb layer is typically sparse, but may include rare species such as Alabama milkvine.

### **Springs and Spring Runs**

Clear, flowing systems with circumneutral pH and stable temperature and flow regimes. Limestone, detritus, and woody debris are dominant substrata. Floodplains of these systems are poorly

developed. Mostly confined to the Dougherty Plain. Many of the larger springs in this ecoregion serve as important cool-water refuges for species such as striped bass.

### **Steephead Ravines**

Rich mesic ravine forests characterized by a diverse canopy of hardwood trees, including American beech, southern sugar maple, southern magnolia, pyramid magnolia, basswood, and sugarberry. The most significant examples are the “Torreya Ravines” of the lower Pelham Escarpment near Lake Seminole. Similar habitats are found in the upper ends of narrow ravines in the Fall Line Sandhills and along the edges of deep limesinks in the Dougherty Plain.

### **Streams (Blackwater)**

Meandering acidic streams with tea-stained, translucent waters and small to moderate-sized floodplains. Blackwater streams are highly acidic, high in dissolved organic materials, and low in suspended materials. Streambeds are characterized by sandy substrates, often with extensive woody debris and live plant roots are often interspersed. Pools and runs are the dominant microhabitats, but these are occasionally interspersed with beaver ponds and limestone outcroppings. These aquatic systems have been impacted by channelization, impoundment, and encroachment by agricultural and silvicultural uses.

### **Wet Pine Savannas, Herb and Shrub Bogs**

Open pine savanna dominated by longleaf or slash pine, with interspersed bogs. Herb bogs are found in low swales or depressions. Herb bogs are often characterized by pitcherplants and a high diversity of forbs. Shrub bogs occur in the ecotones of Carolina bays or cypress ponds and along the drier edges of bay swamps. Dominated by shrubs with a few (usually stunted) scattered pines and a sparse herb layer.

### **Xeric Aeolian Dunes**

Wind-formed deep well-drained dunes found mostly along the eastern side of rivers such as the Ochopee, Little Ochopee, Canoochee, and Little Ocmulgee. These unusual xeric habitats are dominated by deciduous or evergreen scrub oaks and scattered pines, with little groundcover other than patches of wiregrass and lichens. A number of rare plants are associated with these habitats, including sandhills rosemary and Ashe’s savory.

## **SOUTHERN COASTAL PLAIN ECOREGION**

### **Alluvial (Brownwater) Rivers and Swamps**

Large, low-gradient, meandering rivers with sandbars, sloughs and extensive floodplain swamps. Floodplains of these systems may remain inundated for extensive periods. Sand and silt are the dominant substrata and these rivers typically carry heavy sediment loads. Dominant canopy trees are baldcypress and tupelo gum; the understory tree/shrub vegetation may be patchy, often consisting of swamp priet, water elm, swamp dogwood, red maple, and Carolina ash. Cypress and gum-dominated swamps can be found along the Altamaha, Savannah, and Ogeechee rivers. These systems have been impacted by altered flows from upstream dams.

### **Barrier Island Freshwater Wetlands and Ponds**

Usually found in broad flats or in elliptical to linear interdune depressions on Georgia’s coastal barrier islands. These wetland habitats are variable in physiognomy and species composition; deeper, more permanently flooded ponds often have a large extent of open water; shallower ponds are usually

dominated by a combination of submergent, emergent and/or floating macrophytes. Trees or shrubs are present mainly along the edges of the ponds. These habitats have been impacted by groundwater withdrawals, fire suppression, and invasive exotic plants such as Chinese tallow tree.

### **Bayheads and Titi Swamps**

Forested wetlands dominated by broad-leaved evergreen trees: sweetbay, redbay, and loblolly bay. Usually found in domed peatlands, broad interstream flats, or shallow drainageways. Includes shrubby areas dominated by titi (*Cyrilla racemiflora*). Considered a late successional community in a variety of hydrogeomorphic settings in the Coastal Plain

### **Beech-Magnolia Slope Forests**

These are uncommon Coastal Plain hardwood forests, typically found on very mesic river bluffs, and occasionally on gentle slopes that are naturally protected from fire by topographic setting. In addition to American beech and southern magnolia, may contain water oak, water hickory, American holly, and other fire-intolerant species. Often small in extent and occupying a narrow zone between wetland and fire-maintained upland forests. May contain epiphytic species such as green-fly orchid. Often associated with and in close proximity to hillside seeps.

### **Bottomland Hardwood Forests**

Diverse hardwood-dominated forests found on natural levees, upper floodplain flats and terraces along brownwater and blackwater rivers. Characterized by a diverse canopy of hardwood species dominated by various oaks, green ash, sweetgum, red maple, water hickory, and other mesic species. These extensive forested systems provide habitat for a wide variety of wildlife species, and are especially important for wide-ranging forest interior species. Bottomland hardwood forests have been impacted by altered hydrologic conditions, forest conversion, and invasive exotic species.

### **Brackish Marsh and Salt Marsh**

Salt marshes are salt-tolerant grasslands, dominated by cordgrasses and rushes, over soils with circumneutral pH. Extremely productive habitats. Brackish marshes occupy a wide ecotonal zone in the vicinity of river mouths.

### **Canebreaks**

Thickets of native river cane found along rivers and creeks under sparse to full tree cover. Canebrakes represent important wildlife habitat for a variety of neotropical birds and insects. These habitats require periodic fire or other form of disturbance for maintenance.

### **Coastal Beaches and Sand Bars**

Beaches and sand bars are dynamic, high-energy intertidal systems that represent important habitat for shorebirds and sea turtles. Longshore movement of sand on barrier islands results in erosion at the north end and building up at the south end. These unvegetated habitats are important foraging areas for coastal shorebirds; sea turtles nest in the foredunes at the upper ends of sandy beaches.

### **Coastal Dunes and Bluffs**

These habitats consist of sparsely vegetated sandy interdunes, rear dunes, and bluffs. They constitute important habitats for a number of high priority species adapted to harsh temperatures and salt spray. Coastal dune habitats include a number of important microhabitats such as interdune meadows and depressions, shrub thickets, and dune scrub forests. Similar vegetation can be found along eroded or exposed coastal bluffs.

### **Coastal Scrub-Shrub Wetlands**

Shrub dominated estuarine communities found along the upper border of salt marsh or brackish marsh. These habitats are infrequently flooded by tidal action and form ecotones between wetland and terrestrial environments. Typical shrubs include groundsel tree, marsh elder, yaupon holly, wax myrtle, Florida privet, and false willow. Wind-pruned redcedar may also be present.

### **Estuarine and Inshore Marine Waters**

Estuaries (brackish water between barrier islands and mainland) and near-shore ocean waters. Estuaries serve as nurseries for many species of fish and shellfish as well as habitats for manatees and other marine mammals. Plant composition is influenced by tidal regime and salinity.

### **Evergreen Hammocks and Mesic Hardwood Forests**

Evergreen hammocks are typically associated with small isolated uplands within a floodplain or depressional wetland. Protected from frequent fire, these habitats are characterized by a canopy of submesic oaks and hickories, with southern magnolia, American holly, ironwood, flowering dogwood and spruce pine. Mesic hardwood forests are similar, and may occur in terraces above bottomland hardwood forests, ravines, or nonalluvial flats protected from frequent fire.

### **Forested Depressional Wetlands**

Seasonally or semi-permanently flooded forests of depressional features in broad interstream flats. Soils range from mineral to organic and canopy dominants may include bays, pondcypress, and/or pond pine. Fire plays a role in maintaining some of these systems. Isolated wetlands that do not support fish populations are very important breeding habitats for amphibians such as the flatwoods salamander.

### **Freshwater “Prairies”**

Semipermanently flooded freshwater wetlands dominated by emergent vegetation and floating macrophytes, with scattered cypress, buttonbush, and swamp blackgum. The primary example in this region is the Okefenokee Swamp. Fluctuations in water levels and/or periodic fire are required for maintenance. Many of these habitats have been impacted by altered hydrology (impoundment with dams or drainage) and/or fire suppression.

### **Hillside Seeps**

Small patch habitats found on moist to wet lower slopes in sandy terrain. These seeps represent natural groundwater discharge points. May be dominated by shrubs or herbs (including pitcherplants), with scattered trees such as pond, slash, or longleaf pine. Most Georgia examples are fire-suppressed.

### **Longleaf Pine-Scrub Oak Woodlands**

Sparse-canopied xeric longleaf pine system with patchy oak understory composed of turkey oak, sand post oak, bluejack oak, blackjack oak and other scrub oak species. Typically found on deep sand soils, on ridges and upper slopes. Contains a fairly diverse groundlayer of xerophytic grasses and forbs and scattered shrubs.

### **Longleaf Pine-Wiregrass Savannas**

Large patch or matrix upland habitats characterized by a sparse canopy of longleaf pine (sometimes with slash pine) and a diverse herb layer dominated by wiregrass. Can range from mesic to dry, depending on topographic position and soils. Transition downslope into wet pine savannas, pine flatwoods, or other wetlands. These habitats are heavily dependent on frequent fire for maintenance.

**Maritime Forest and Coastal Hammocks**

Coastal forests dominated by live oak and palmetto; hammocks are small islands of maritime forest usually surrounded by brackish water and/or salt marsh. These are restricted to a narrow band of shoreline and barrier islands. Characterized by sandy soils and wind-pruned canopy trees. Provide important habitat for neotropical migrant birds.

**Mud and Sand Flats**

Periodically inundated mud and sand deposits located in estuarine or inshore marine waters. These unvegetated habitats are generally covered at high tide and exposed at low tide. They serve as important feeding areas for a number of coastal shorebirds such as plovers, sandpipers, and dowitchers.

**Nonalluvial (Blackwater) Rivers and Swamps**

Large, meandering rivers with tea-stained, but translucent waters and narrow to wide floodplains. Dominant substrate is sand, which may form extensive bars in larger systems. Runs and pools are dominant habitats. Large snags are a significant component of habitat heterogeneity. Limestone shoals occur on some of these rivers.

**Offshore Marine Waters**

Georgia's offshore marine waters provide habitat for a number of high priority species, including loggerhead, green, Kemp's ridley, and leatherback turtles, North Atlantic right whales, and bottlenose dolphins. Hard-bottom areas are especially important habitats for marine fish and sessile organisms.

**Open-Water Ponds and Lakes**

Open water aquatic habitats ranging from isolated depressions to impoundments created by beaver. Vegetation is sparse and consists primarily of emergent and floating macrophytes. These habitats are relatively uncommon in this region. Maintained by periodic fire and fluctuating water levels.

**Pine Flatwoods**

Mesic or wet forests on flat, poorly-drained areas of the lower Coastal Plain. Dominated formerly by longleaf pine, now typically by slash pine, occasionally with loblolly or pond pine. Contains a well-developed shrub layer consisting of saw palmetto, gallberry, lowbush blueberry, and other ericaceous species. One of the most extensive and prevalent habitats of this ecoregion.

**Tidal Rivers and Freshwater Tidal Marsh**

Includes the tidally influenced portions of rivers and creeks and associated wetlands. Freshwater tidal marshes are wetlands found along the margins of tidal rivers and creeks above the brackish water zone, typically dominated by giant cutgrass, sawgrass, pickerel weed, wild rice, cattail, rushes, and a variety of other herbs.

**Wet Oak Flats**

These forested habitats occur on fluvial terraces and interstream divides in the Southern Coastal Plain. The soils of this vegetation are saturated by rainfall and seasonally high water tables with little influence from river or tidal flooding. Wet oak flats contain a unique mix of upland and wetland species, including live oak, willow oak, southern magnolia, bottomland post oak, red maple, cherrybark oak, swamp chestnut oak, diamondleaf oak, and loblolly pine. Calcareous examples can be quite diverse in the herbaceous layer.

**Wet Pine Savannas, Herb and Shrub Bogs**

Wet pine savannas are poorly drained wetlands with open to sparse canopies dominated by longleaf, slash, and/or pond pine. The shrub layer may be sparse, consisting mainly of gallberry, wax myrtle, and blueberries. The herbaceous layer is often diverse and dense, dominated by grasses, sedges, composites, orchids, and lilies. May include small peat-filled depressions dominated by titi and other shrubs or by herbaceous bog plants.

## **Appendix B. Birds Technical Team Report**

**Prepared by Todd Schneider and Tim Keyes, Team Leaders**

### **Technical Team Members**

#### *Team Leaders*

Todd Schneider, WRD, Nongame Conservation Section – Wildlife Biologist

Tim Keyes, WRD, Nongame Conservation Section – Wildlife Biologist

#### *Team Members participating at Bird Technical Committee Meetings*

Jim Bates, U.S. Fish and Wildlife Service, Ecological Services, Ft. Benning - Biologist

Rebecca Byrd, Georgia Department of Transportation - Ecologist

Larry Carlile, Ft. Stewart, Fish and Wildlife Branch - Chief of Planning and Monitoring

Scott Coleman, Little St. Simons Island - Natural Resources Manager

Chris Coppola, U.S. Fish and Wildlife Service, Ecological Services, Townsend - Biologist

Dean Demarest, U.S. Fish and Wildlife Service – Region 4, Nongame Bird Coordinator

Jenifer Hilburn, St. Catherines Island Foundation, Altamaha Riverkeeper - Biologist

Malcolm Hodges, The Nature Conservancy - Ornithologist, Land Steward

Elizabeth Hunter, University of Georgia – Ph.D. Candidate

Nathan Klaus, WRD, Nongame Conservation Section – Wildlife Biologist

Charlie Muise, Atlanta Audubon Society, Important Bird Areas Program - Biologist

Jim Ozier, WRD, Nongame Conservation Section - Program Manager, Wildlife Biologist

Carrie Straight, U.S. Fish and Wildlife Service, Ecological Services, Athens - Biologist

Reggie Thackston, WRD, Game Management Section – Private Lands Program Supervisor

Jim Wentworth, U.S. Forest Service – Wildlife Biologist

Troy Wilson, U.S. Fish and Wildlife Service - Region 4, Assistant Nongame Bird Coordinator

#### *Team Members participating through email and correspondence*

Giff Beaton, Independent Ornithologist, bird records expert

Richard Chandler, University of Georgia – Ornithologist, Assistant Professor

Bob Cooper, University of Georgia – Ornithologist, Professor

Bob Sargent, Warner Robins Air Force Base/Georgia Ornithological Society – Wildlife Biologist

Terry Johnson, WRD, Nongame Conservation Section - Program Manager (Retired)

John Parrish, Georgia Southern University – Ornithologist, Professor (Emeritus)

Jim Cox, Tall Timbers Research Station – Ornithologist, Researcher

#### *Invited but unable to participate:*

Ray Chandler, Georgia Southern University - Ornithologist, Professor

Ellie Covington, U.S. Army Corps of Engineers - Biologist

Joe Meyers, U.S. Geologic Survey, Patuxent Wildlife Research Center – Researcher (Retired)

Greg Balkcom, WRD, Game Management Section - State Waterfowl Biologist

## Approach

On January 8, 2014 a one-day meeting was convened at Charlie Elliott Wildlife Education Center near Mansfield to update and revise the SWAP bird species list. Those invited to attend represented a broad range of expertise both geographically and taxonomically. Many of these people had participated in development of the original SWAP bird list (2005), although a significant number of people new to the process also attended. Prior to the meeting participants were provided with the 2005 SWAP bird list for review, as well as a summary of the revision process and expectations for the meeting. During the meeting participants discussed individual species on the list at length and determined whether information for a particular species needed to be revised or added. They also discussed whether a species should remain on the list or be removed, as well as possible new species that should be added. While this process was relatively efficient, we were only able to get through a portion of the species on the list and decided that another meeting would be necessary to complete the task. A second one-day meeting was convened on July 8, 2014 at the Nongame Conservation Section Office in Forsyth. At this meeting species not previously discussed were reviewed and new species proposed for the list were discussed and approved or rejected by the group. While working on the bird list we also discussed updates and changes to the status of species on the Georgia Protected Species List and the Georgia Special Concern Species Tracking List. These suggested changes were documented in the bird list spreadsheet. Later we sent out the updated bird list from this meeting to everyone on our mailing list to seek any additional input and to allow everyone to vote on the species suggested for addition or deletion.

Decisions on all species discussed at these two meetings were made based on expert opinion that was supported by peer reviewed scientific literature, technical reports, ornithological records, other databases, and conservation plans including, but not limited to, the Partners in Flight North American Landbird Conservation Plan, the North American Waterbird Conservation Plan, United States Shorebird Conservation Plan, the North American Waterfowl Management Plan, and the North American Bird Conservation Initiative. Determination of species to include on the list was based primarily on the species' population status, trends, habitat status and threats, rarity, vulnerability, and ability to serve as an indicator of ecological integrity of specific habitats or habitat conditions. Species included on the list are those species known, or thought to be, most critically in need of immediate conservation action. In a few cases the species included on this list serve as umbrella species that represent a guild of species, habitat type(s), or habitat condition(s) that is significantly declining (e.g., Northern Bobwhite, Prothonotary Warbler). While this list is fairly comprehensive it should be considered a work in progress and modified as needed to best address conservation concerns in the future.

## Assessment Results

The SWAP bird committee reviewed the original 33 species on the 2005 SWAP list, and proposed the removal of one species and the addition of 8 species. In addition, 2 species were recommended for addition to the Georgia Special Concern Species Tracking List.

*Removal:* Bicknell's Thrush was recommended for removal based upon the fact that it is a transient through the state, virtually impossible to distinguish from the ubiquitous Gray-cheeked Thrush (even in the hand), and the consensus that there is no meaningful management activity

that we could undertake that would have any direct impact on the species. The only other species on the SWAP list that is strictly a transient is Kirtland's Warbler, which was maintained on the list due to its federal endangered species status and other considerations.

*Additions:* The group agreed that the following species should be added to the list; Seaside Sparrow, Saltmarsh Sparrow, Nelson's Sparrow, Rusty Blackbird, Whooping Crane, Little Blue Heron, Prothonotary Warbler, and Yellow Rail. Seaside, Saltmarsh, and Nelson's Sparrows use coastal saltmarshes for all or part of their life cycle and are threatened by sea level rise, development, and possibly excessive predation. The Rusty Blackbird has declined by 90% or more over the last few decades, the causes for this decline are not well understood. Georgia bottomland forests provide potentially important habitat for overwintering birds. Whooping Cranes now regularly migrate through the state led by ultralight aircraft, or on their own, as they travel between their wintering site in Florida and breeding site in Wisconsin. Some also overwinter in Georgia, and there have even been cases of Whooping Cranes being illegally shot in the state in recent years. Little Blue Heron remains a species of concern and appears to be undergoing a range-wide decline. The Prothonotary Warbler was suggested as another species that should be included on the list based upon both a declining population trend (BBS data) and its suitability as an umbrella species for birds of bottomland and swamp forest habitats. One other species on our SWAP list, the Northern Bobwhite, is similarly used as an umbrella species for grassland and pine savanna habitats. Yellow Rail was added to the list despite very little knowledge of its status in the state. It is considered a high conservation priority throughout its range and clearly winters here in unknown numbers. The broader concern for the species warrants additional survey effort in Georgia.

*Discussed:* The committee discussed whether several high priority pelagic species (e.g., Bermuda Petrel, Black-capped Petrel) should be added to the list. While there was no disagreement regarding the status of these imperiled pelagic species, it was determined that since these birds virtually never come into state waters (within 3 miles of shore), there would be no direct management actions we could take that would meaningfully affect these species.

*Tracked List:* The group discussed the possible addition of the Roseate Spoonbill, which has been documented nesting in the state since the 2005 SWAP list was completed, and the Reddish Egret. It was determined that both species warrant tracking at a state level (Georgia Special Concern Species Tracking List) but do not rise to the level of concern needed for inclusion on the SWAP list.

The status of Loggerhead Shrike was expanded to include both breeding and wintering subspecies.

### High Priority Bird Species in Georgia

Common Name	Species
Saltmarsh Sparrow	<i>Ammodramus caudacutus</i>
Henslow's Sparrow	<i>Ammodramus henslowii</i>
Seaside Sparrow (MacGillivray's)	<i>Ammodramus maritimus macgillivraii</i>
Nelson's Sparrow	<i>Ammodramus nelsoni</i>
Grasshopper Sparrow	<i>Ammodramus savannarum</i>
Red Knot	<i>Calidris canutus</i>
Piping Plover	<i>Charadrius melodus</i>
Wilson's Plover	<i>Charadrius wilsonia</i>

Northern Bobwhite	<i>Colinus virginianus</i>
Yellow Rail	<i>Coturnicops noveboracensis</i>
Little Blue Heron	<i>Egretta caerulea</i>
Tricolored Heron	<i>Egretta tricolor</i>
Swallow-tailed Kite	<i>Elanoides forficatus</i>
Rusty Blackbird	<i>Euphagus carolinus</i>
Peregrine Falcon	<i>Falco peregrinus</i>
Southeastern American Kestrel	<i>Falco sparverius paulus</i>
Gull-billed Tern	<i>Gelochelidon nilotica</i>
Whooping Crane	<i>Grus americana</i>
Florida Sandhill Crane	<i>Grus canadensis pratensis</i>
American Oystercatcher	<i>Haematopus palliatus</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Black-necked Stilt	<i>Himantopus mexicanus</i>
Least Bittern	<i>Ixobrychus exilis</i>
Loggerhead Shrike	<i>Lanius ludovicianus</i>
Black Rail	<i>Laterallus jamaicensis</i>
Swainson's Warbler	<i>Limnothlypis swainsonii</i>
Wood Stork	<i>Mycteria americana</i>
Whimbrel	<i>Numenius phaeopus</i>
Painted Bunting	<i>Passerina ciris</i>
Bachman's Sparrow	<i>Peucaea aestivalis</i>
Red-cockaded Woodpecker	<i>Picoides borealis</i>
Prothonotary Warbler	<i>Protonaria citrea</i>
King Rail	<i>Rallus elegans</i>
Black Skimmer	<i>Rynchops niger</i>
Cerulean Warbler	<i>Setophaga cerulea</i>
Kirtland's Warbler	<i>Setophaga kirtlandii</i>
Appalachian Yellow-bellied Sapsucker	<i>Sphyrapicus varius appalachiensis</i>
Least Tern	<i>Sternula antillarum</i>
Barn Owl	<i>Tyto alba</i>
Golden-winged Warbler	<i>Vermivora chrysoptera</i>

### Examples of High Priority Species

#### Pine Savanna/Grassland Specialists

Much of South Georgia was in pine savanna habitat prior to European colonization of the state. Pine savanna also occurred locally in the Piedmont and portions of the mountains, although generally on a much smaller scale. The Red-cockaded Woodpecker, Bachman's Sparrow, Henslow's Sparrow, Loggerhead Shrike, Southeastern American Kestrel, and Northern Bobwhite thrived in these savanna habitats, particularly in the Coastal Plain. Starting in the 1700s longleaf pine savanna was converted to agriculture, harvested for lumber, and lost due to fire suppression, human development, and as a result of injuries trees sustained during pine sap extraction for turpentine and naval stores. More open grasslands were scattered throughout portions of the state

where soils, geology, micro-climate, frequent fire, and other physical or ecological forces shaped vegetative communities by inhibiting or preventing woody vegetation from growing. Many of these areas were lost due to fire suppression, but plowing for agriculture, overgrazing, and attempts to grow trees in these “wastelands” also reduced the number of functional grasslands remaining.

The result of this onslaught of human activity today is a landscape devoid of expansive areas of pine savanna and very few remaining open grasslands. However, some larger areas of pine savanna survived these assaults, artifacts of unique historical occurrences. Two good examples of these are the Red Hills quail plantations, saved by wealthy industrialists as personal recreation lands, and the two largest military bases, Ft. Stewart and Ft. Benning, whose military mission over several decades led to the conservation on hundreds of thousands of acres of pine savanna habitat. Today these areas hold significant numbers of Red-cockaded Woodpeckers and Bachman’s Sparrows, and likely substantial numbers of some of the other species mentioned previously. In the case of the Red-cockaded Woodpecker, Ft. Stewart has served as a source for reintroduction efforts to other sites. Conservation efforts for several pine savanna species are building and expanding off these core areas.

#### Beach-nesting Birds

This group of birds includes the solitary nesting species - Wilson’s Plover and American Oystercatcher - and colonial nesters such as Gull-billed Tern, Black Skimmer, and Least Tern. The factors that result in their inclusion as high priorities for conservation in Georgia are extremely limited and vulnerable breeding habitat, historic reductions in populations, and reduction in the number of extant, low disturbance, nesting locations. The species listed above represent a partial list of species in need of conservation action.

Beach nesting birds are dependent on similar, specific, beach attributes to fulfill nesting and chick rearing requirements. The attributes include wide accretional beach, adequate beach elevation to thwart normal tidal inundation, a degree of isolation from uplands, and proximity to quality feeding sites. These attributes rarely combine on the Georgia Coast, especially for the colonial birds dependent on the greatest level of isolation. When the attributes do combine, the resulting beach is frequently also favored by recreationists, ensuring frequent disturbance during incubation and chick rearing in spring and early summer. The primary threats to these species are 1) increasing access to historically isolated areas of coastal Georgia by recreational users and their dogs, 2) vehicular use of beaches for travel, recreating, law enforcement, and sea turtle nest patrols, 3) reductions in the number of nesting locations due to sea level rise, 4) contaminants including dioxin, mercury, PCBs, and toxaphene, 5) physical loss of emergent sands due to beach nourishment projects, and 6) feral, introduced, and invasive animals, including cats, pigs, horses, bobcats, donkeys, coyotes, and fire ants.

Immediate conservation actions are needed and include; 1) Developing a state legislative mechanism that automatically provides protection for newly developing, persistent, emergent, sand bars on the outer coast. Currently only five sand bar islands, including Little Egg Island Bar, St. Catherine Island Bar, Pelican Spit, Satilla Marsh Island, and Williamson Island, are covered under the Georgia Natural Resources Board, Shorebird and Sea Bird Habitat Protection Rule; 391-4-7-.03 (also known as the Bird Island Rule), which protects seabird and shorebird

nesting and roosting at these sites. Since sand bar habitats are highly dynamic and ephemeral protected seabird nesting locations can easily be lost to storms, erosion, or other factors. A legal mechanism is needed to protect recently formed or created sand bar habitats as well as future sand bars as they are established and become valuable to seabirds for nesting. The recently created dredge spoil island in Brunswick Harbor has become one of the most important sea bird colonies in the state, but since its creation post-dates the Bird Island Rule, which became effective on May 20, 1998, there is no specific protection for the site, making it difficult for Law Enforcement to enforce posted closure. This, and similar sites, should be included within the Bird Island Rule to assist with enforcement. 2) Continue to work with island managers to recognize and protect higher value shorebird nesting locations through signage and symbolic fencing where appropriate, 3) Limit or eliminate vehicular use of beach areas recognized for high beach-nesting values. Examples include the south end of Middle Beach on Ossabaw Island, all of Little St. Simons Island, the south end of Sea and Jekyll islands, Little Cumberland Island, and the South end of Cumberland Island. Limit or eliminate night patrols for sea turtle nesting projects, 4) Identify and control the source of contaminants that could negatively impact the health and reproductive ability of waterbirds, 5) Restrict use of nearshore sand sources for beach nourishment projects, opting for deeper water locations, 6) Eradicate feral hogs, cats, and coyotes on islands where they are found. Reduce feral horse populations on Cumberland Island. Continue to control fire ants as needed on Little Egg Island Bar and Satilla Marsh Island, 7) Continue to educate recreationists frequenting sensitive beach nesting locations and, 8) continue to build regional coordination with monitoring and management. Many colonial seabirds move significantly year to year, and in order to accurately assess their population numbers and trends, it is imperative that states within the Southeast coordinate their efforts.

#### Isolated Wetlands Dependent Birds

Some of the most at risk species are those dependent on isolated wetlands including Tricolored Heron, Little Blue Heron, Wood Stork, King Rail, Least Bittern, and Black-necked Stilt. These birds represent a much larger group of species that include all of our wading birds, most of our rails, many migrant shorebirds, resident and migratory passerines, waterfowl, and grebes. Wading birds in particular require specific flooded woodland habitats in which to nest. Most wading bird rookeries in Georgia are located within 20 miles of the coast. Even along the immediate coast, freshwater wetlands are used not only for nesting, but also heavily as feeding locations.

Primary threats include; 1) lack of state or federal protection for isolated freshwater wetlands in Georgia, unless a specific location is recognized as a Wood Stork rookery with Endangered Species Act implications, 2) direct loss of isolated wetlands due to increased residential and industrial development and intensive silvicultural practices, 3) environmental contaminants particularly mercury, PCBs, and toxaphene, 4) agricultural and industrial groundwater withdrawal which dries wetlands, 5) climate change scenarios with predicted increases in the variability of rainfall, leading to increased drought conditions punctuated with more extreme rainfall events. This altered rainfall pattern may present new challenges at both ends of the rainfall spectrum, from drought conditions where nesting is not possible, to flood conditions where nests are lost and foraging areas are flooded making them unsuitable for feeding.

These species are in need of immediate management action and recommended conservation actions are; 1) promote state legislation that protects isolated wetlands and non-flowing waters. This will help safeguard and stabilize waterbird populations as well as those of other dependent wildlife, 2) use GIS and remote sensing to determine locations for all freshwater wetlands in regions experiencing heavy development, 3) contact landowners of the most valuable sites to discuss important wildlife values of wetlands and long-term conservation options, 4) pursue acquisition or easements for the highest valued locations, and 5) make development of a regional survey/monitoring protocol for wading birds a priority. Our most recent statewide wading bird survey is 20 years old.

## **High Priority Habitats and Associated Species**

### ***Southwestern Appalachians/Ridge & Valley***

#### Hardwood Forests

The greatest bird conservation issue in this region is conversion of hardwood and mixed pine/hardwood forest to monocultures of loblolly pine, urbanization, and agriculture. A large percentage of natural vegetation has been cleared for other uses, and mature forest and the birds dependent on mature forest are less secure here than in any other physiographic area in the Southern Appalachians. The long-term health of populations of priority birds including Acadian Flycatcher, Wood Thrush, and Yellow-throated Warbler will depend on maintenance and management of remnant forest as well as aggressive restoration efforts. It is recommended that at least eight upland hardwood forest patches greater than 4,000 hectares be sustained and that the number of such patches in the 4,000 to 40,000 hectare range be increased. More than 80% of the mixed mesophytic hardwood acreage within these patches should be managed for long rotation or old growth.

#### Southern Yellow Pine

Existing short-rotation pine, while of less benefit to birds than mature forest, is nevertheless much more valuable than more intensive land uses, and it is recommended that the current percentage of land in this cover type be retained. All existing southern yellow pine and mixed pine hardwood habitats should be actively and appropriately managed with fire, and current acreage should be increased where possible. Priority species associated with mature pine forests in the Ridge and Valley include Brown-headed Nuthatch and Bachman's Sparrow.

#### Scrub-Shrub and Early Succession

Suppression of natural disturbance regimes has depleted scrub-shrub and woodland habitats and birds adapted to those conditions such as Prairie Warbler, Orchard Oriole, and Red-headed Woodpecker persist largely in the early succession phases of actively managed forests. The needs of these birds, including game species such as American Woodcock and Northern Bobwhite, should be considered within the context of forest habitat objectives.

## ***Blue Ridge***

### Mature Forests

This remains the most heavily forested physiographic area in the Southeast. Species of conservation concern in this habitat include Black-throated Blue Warbler, Yellow-throated Vireo, and Cerulean Warbler. The amount of land in agriculture has decreased in the last century, being replaced by forest. Nevertheless, BBS data indicate bird population declines in the Southern Blue Ridge in excess of those in any other areas in the region. Declines are seen in long-distance migrants, short-distance migrants, and permanent residents. However, this information should be interpreted with some caution since BBS routes are situated along roads, and most roads in the Southern Blue Ridge are in valleys where there has been a great deal of development and habitat loss in recent years. These perceived trends may not be representative of population conditions in the bulk of the forested area in this region. This, however, is not necessarily a safe assumption, and there is cause for concern in at least some of the forest types and conditions.

Although some forest types, such as Appalachian oak, remain widespread, most of the area is in a mid-successional stage of closed canopy with a poorly developed understory and ground cover. Many mature forest birds including Wood Thrush, Worm-eating Warbler, and Canada Warbler may be suffering from this deficiency in structure. This will correct itself over time, although perhaps not soon enough to conserve some declining species such as Cerulean Warbler; therefore, some conservationists advocate hastening the process through management. In fact, selective logging was used to improve habitat for Cerulean Warblers in an area where they occur on the Chattahoochee National Forest. In any case, a much greater extent of old-growth conditions in general is desirable for mature forest birds. Much of the mature forest in the Blue Ridge occurs on National Forest lands that are classified as unsuitable for commercial harvest activities, and it is likely that these areas will eventually provide substantial blocks of old-growth habitat. Although largely in USFS ownership, mature forest habitat and associated bird species may also be threatened by several exotic pest species including the Hemlock Woolly Adelgid, Gypsy Moth, and Asian Long-horned Beetle, which are advancing down the Appalachians. Upon arrival in other areas, these species dramatically altered forest structure and bird populations, and the Hemlock Woolly Adelgid has already caused considerable loss of streamside hemlock habitats in the Chattahoochee National Forest.

### Early Successional Forest

Other high priority birds inhabit early successional conditions, which also have decreased in extent in recent years. Indeed, the Appalachian subspecies of Bewick's Wren may have become extinct in the past two decades because of loss of this type of habitat. Maintenance of a suitable amount of mid- and high elevation early successional or woodland habitat is a priority conservation need particularly for species such as Golden-winged Warbler, Ruffed Grouse, and Appalachian Yellow-bellied Sapsucker.

### Riparian Forests

The lowest elevation riparian forests are most affected by forest loss and fragmentation in recent years. Management of riparian zones and retention or restoration of fragments of suitable size is

another conservation need in the Southern Blue Ridge and of particular importance for Swainson's Warbler, Louisiana Waterthrush, and Kentucky Warbler.

## *Piedmont*

### Grasslands and Scrub-Shrub

Open woodlands, grasslands, and savannas were common as late as the 1800s in the Piedmont, and because Native American settlements were apparently common in the area, agricultural fields and other large openings were historically part of the landscape. The three greatest challenges facing the conservation of habitat in the Piedmont today are unchecked urbanization, intensification of agriculture and forest management, and suppression of natural disturbance regimes. Of these, the former is of much greater concern because its effects are essentially permanent. Urban sprawl is an increasingly important issue nationwide and the human population in the Southern Piedmont is growing rapidly. However, no comprehensive planning for growth is in place. Agriculture and forestry are significant land uses in the Southern Piedmont. The general decline in abundance of grassland species is mostly related to changing land use patterns from agriculture to intensive forestry. Remaining agricultural lands are intensively managed, often consisting of frequently harvested or grazed pastures of exotic grass species. The result is a loss of stable, grassland habitats with associated influences on species of conservation concern including Blue Grosbeak, Northern Bobwhite, Grasshopper Sparrow, and Red-headed Woodpecker.

### Mature Forests of Southern Pine and Upland Hardwood

Although overall increasing forest acreage and maturity in the Piedmont would suggest greater security for vulnerable bird species, many species' populations have shown declines in patches of protected mature forests embedded within suburban settings where they were once common. Conservation opportunities to manage and maintain bird habitats will require significant involvement from public land managers, public agencies, and private industrial and non-industrial landowners. Public lands are an important component of the Southern Piedmont and may serve as core areas from which to manage or expand habitat. Timber companies are the largest private landowner in the Piedmont, creating tremendous opportunity for increased cooperative management strategies to accomplish bird conservation objectives. Private, non-industrial landowner incentive programs can be increased in key areas as well, further adding to core habitat acreage. Priority species dependent on Southern Pine forests include Red-cockaded Woodpecker, Brown-headed Nuthatch, and Bachman's Sparrow. Upland Hardwood forests are needed to support Wood Thrush and Kentucky Warbler.

### Bottomland Hardwood Forests

Encroachment from urbanization, industrialization, and intensive pine management influence both the extent and connectivity of riparian forests in the Piedmont. In addition, closed canopy forests that lack a diverse understory and degradation of water quality due to development and sedimentation and chemical run-off from roads can negatively influence species such as Swainson's Warbler and Louisiana Waterthrush. Altered hydrology can also influence habitat quality for these species as well as Prothonotary Warbler. Consideration must be given to connecting large blocks of riparian forest, management prescriptions to improve understory structure, and appropriate management activities in streamside areas.

## *Southeastern Plains and Southern Coastal Plain*

### Pine Forests

As in other pine-dominated uplands of the Southeast, fire suppression, conversion to other land uses, and short-rotation pine plantations have significantly altered the nature of the South Atlantic Coastal Plain. Maintenance and restoration of large tracts of fire maintained pine savanna are the keys to health of high priority pine and pine-grassland bird species including Red-cockaded Woodpecker, Southeastern American Kestrel, Bachman's Sparrow, and Brown-headed Nuthatch. Pine plantations have some wildlife value, and maintenance of a diversity of age classes over landscapes can help maintain many bird species, including some that are of reasonably high priority.

### Bottomland Hardwood

The bottomland hardwood bird community requires large tracts of forest in river systems including the Savannah, Altamaha, Ogeechee and Satilla. These areas are needed to support significant numbers of breeding Swallow-tailed Kite, Northern Parula, Prothonotary Warbler, and Swainson's Warbler. Maintenance and restoration of large patches of bottomland forest ranging in size from 2,000 to 40,000 hectares in this physiographic area should assure the health of these birds.

### Maritime Forest and Scrub-Shrub

Coastal maritime forest and scrub-shrub habitats not only support much of the eastern population of Painted Bunting but also are extremely important for in-transit migrants. Much of this forest has been developed for intensive human use, and what remains should be maintained. Although likely secure on several barrier islands, on the mainland, birds occupying these habitats may face additional challenges from parasitism by Brown-headed Cowbirds and increased predation by feral and domestic cats as well as avian predators such as crows and jays.

### Coast and Islands

About eighty species of waterbirds and several species of rails and songbirds use the coastal environs of Georgia during some part of their annual cycle. Some of these birds are coastal specialists, dependent on habitats found only on, or primarily within the coastal zone for all of their life-sustaining needs. Due to their specialization, many coastal dependent waterbirds are experiencing population stresses, or biological bottlenecks as a result of direct habitat loss or indirect loss due to disturbance. As breeding and feeding sites are increasingly restricted in scope and number, the flexibility needed by our priority species to respond to natural changes in their nesting and feeding habitats is eliminated. These coastal specialists are included on our High Priority Species List. High priority habitats critical to some of our most threatened bird species are described.

### Beach/Dune/Tidal Flats, Pools, and Creeks

These tidally influenced habitats form a particularly diverse and rich waterbird area. High priority species including all of our seabirds, and our highest ranked shorebirds such as Piping Plover, Red Knot, Wilson's Plover, American Oystercatcher, Marbled Godwit, and Whimbrel are all obligate tidal lands species. Of our priority wading birds, Tricolored Herons are restricted

to our coastal zone, and roughly half of the state's Wood Storks depend, in part, on the tidal pools and feeder creeks for foraging.

The most pressing waterbird conservation issues on Georgia's tidally influenced habitats include sea level rise and human disturbance of nesting areas by day-use recreation. Two of Georgia's shorebirds, and virtually all of Georgia's resident seabirds, including Brown Pelican, Royal Tern, Gull-billed Tern, Sandwich Tern, Laughing Gull, Least Tern, and Black Skimmer, nest directly on the ground on terrace and dune habitats that are only a few feet above mean sea level. These sites are increasingly under threat of the effects of tidal inundation from rising water level and possibly increased tidal amplitudes. Additionally, these species depend on disturbance-free beaches and Georgia's barrier beaches have been discovered by a rapidly increasing human population interested in shoreline recreational activities. The state needs a long-term mechanism to ensure disturbance-free nesting areas in this highly dynamic, ephemeral landscape. All of our waterbirds depend on healthy abundant live food resources. Water quality will play a major role in the future of the migrant, wintering, and resident breeding birds on the Georgia Coast. Development of uplands, including hammocks, is impacting estuarine water quality with siltation and contaminant loading. Increased dock and marina development will deliver petroleum residues from increased numbers of boats. All of the water flowing down our five major Atlantic drainage rivers mixes with seawater to create the rich estuarine waters of the coastal marshes. Everything put into the watersheds of the Savannah, Ogeechee, Altamaha, Satilla, and St. Mary's rivers eventually ends up on the coast, influencing the quality and quantity of invertebrate and vertebrate foods for waterbirds. River born contaminants will end up in waterbird food resources, eventually influencing their health and reproductive potential. Contaminant control and monitoring will be an important aspect of waterbird conservation efforts.

### Saltmarsh

The expanse of saltmarsh between Georgia's barrier islands and mainland comprises about one third of all saltmarsh habitat on the U.S. Atlantic Coast. This area harbors a number of obligate saltmarsh bird species and subspecies including the Seaside Sparrow, Saltmarsh Sparrow, Clapper Rail, and Worthington's Marsh Wren, as well as other species dependent upon saltmarsh habitats including Nelson's Sparrow and possibly the Black Rail. Sea level rise is the greatest threat to saltmarsh habitats, although contaminants, siltation, dredging, filling, petroleum residues, and predation by upland mammals may also be significant threats.

### Isolated Freshwater Wetlands

All of our wading birds are either entirely dependent, or primarily dependent upon isolated freshwater wetlands for nesting. Wading birds nest above the freshwaters of Carolina bays, gum swamps, flooded interdune swales, cypress domes, and temporary depressional wetlands; anywhere shrubs and trees are sitting in standing water throughout the spring and early summer. Our high priority wading bird species also feed regularly in freshwater wetlands throughout the year. There are no state or federal laws currently protecting isolated freshwater wetlands in Georgia. Dewatering is eliminating freshwater wetlands throughout the Coastal Plain, particularly on interior timberlands, and on the coast where development pressures are highest. To successfully manage our priority wading bird populations, we need to adequately address the loss of isolated freshwater wetlands, seeking a mechanism to protect the sites of highest current and future value.

## High Priority Areas

1. Chattahoochee National Forest – Particularly Brawley Mountain and the Ivy Log/Gum Log area. The last site where nesting Golden-winged Warblers still occur in Georgia is at the Brawley Mountain site. About 200 acres of habitat for Golden-wings was created here recently by logging and prescribed burning, although numbers have dwindled due to the delay in finally getting this habitat on the ground. Ivy Log/Gum Log is the only nesting site for Cerulean Warblers in the state and habitat maintenance work was done here recently.
2. Piedmont NWR and Oconee National Forest – Breeding Red-cockaded Woodpeckers and Bachman's Sparrows occur at these sites as well as many other bird species of lower conservation concern.
3. Bond Swamp NWR – This national refuge and the surrounding Ocmulgee River corridor are home to one of the larger populations of Swainson's Warbler.
4. Altamaha River Delta – This is an important area for shorebirds and waterbirds including Whimbrels, Red Knots, Piping Plovers, Wilson's Plovers, American Oystercatchers, Least Terns, Gull-billed Terns, Black Skimmers and many more. It provides breeding habitat as well as migration stop-over and wintering habitat.
5. Barrier Islands – Most provide nesting, stop-over, and wintering habitat. Those particularly important to shorebird stop-over and wintering are Little St. Simons, middle beach on Ossabaw, Sapelo, the south ends of St. Simons and Jekyll, Little Cumberland, and the south end of Cumberland. Several of the less developed islands, particularly Wassaw, Blackbeard, Sapelo, and St. Catherines, provide substantial habitat for Painted Buntings as well.
6. Little Egg Island Bar, St. Catherines Island Bar, Pelican Spit, Satilla Marsh Island, and Brunswick Harbor Dredge Spoil Island – These isolated islands provide the best waterbird nesting sites in the state. Species that nest here include Brown Pelican, Gull-billed Tern, Sandwich Tern, Least Tern, Royal Tern, American Oystercatcher, Black Skimmer, and Wilson's Plover. These areas are also heavily used by birds during migration stop-over and in winter.
7. Altamaha WMA – This management area provides a significant amount of habitat for high priority marsh birds such as the King Rail and Least Bittern. Wood Storks also occasionally feed here as do Gull-billed Terns.
8. Okefenokee NWR – This is the only site in the state known to have breeding Florida Sandhill Cranes. This refuge may also harbor a significant number of King Rails, although that is unknown at present. Pine uplands here support Red-cockaded Woodpeckers and Bachman's Sparrows.
9. Savannah, Ogeechee, Altamaha, Satilla, and St. Marys Rivers – The flood plains and adjacent uplands are the stronghold for nesting Swallow-tailed Kites in the state. The Altamaha and Satilla Rivers appear to be the most important of these.

10. Ft. Stewart, Ft. Benning, the Red Hills region – These are our most expansive areas of pine savanna habitat and harbor the largest populations of Red-cockaded Woodpeckers and Bachman’s Sparrow in the state. Other high priority birds that occur here in numbers are Southeastern American Kestrel, Loggerhead Shrike, and Henslow’s Sparrow. Silver Lake WMA and Joseph Jones Ecological Research Center also have significant number of Red-cockaded Woodpeckers and Bachman’s Sparrows.
11. Paulk’s Pasture, Townsend, and Moody Forest WMAs – Henslow’s Sparrows winter here in good numbers. These are our best known and studied sites for this species.
12. Coastal Saltmarsh – Substantial numbers of nesting MacGillivray’s Seaside Sparrows occur throughout low marsh areas of the saltmarsh. Other high priority species including the Nelson’s Sparrow and Saltmarsh Sparrow winter here in significant numbers. Black Rails may nest in high marsh areas, although this has not been confirmed.

### **Problems Affecting High Priority Species and Habitats**

The overwhelming threat to high priority species is loss of suitable habitat and this loss is caused by a variety of factors. Urban and suburban expansion causes both direct loss of habitat and degradation of habitat quality, exposing birds to increased risk of predation from domesticated and natural predators and parasitism by brown-headed cowbirds. Coastal development, including an explosion of dock construction and a push to build bridges to many marsh hammocks is a significant problem for many species. Habitat fragmentation is also a significant threat resulting in loss of some species as breeding birds in remnant patches of habitat and reduced productivity of those that remain. Chemical, and possibly bacterial and viral, contamination of habitats and food resources impacts some high priority species, particularly on the coast. Recently it has become clear that climate change will likely be one of the most significant threats to wildlife and their habitats in the future. Some of its potential impacts in Georgia are listed below.

A large suite of birds and other wildlife species are threatened by the loss of the longleaf pine ecosystem or other mature, frequently burned pine forests. Restrictions on the management of forests and wetland habitats including thinning and harvest, prescribed fire, and manipulation of water levels threaten the health of habitats and associated species. Human disturbance stresses numerous high priority species including beach nesting birds, migrating and wintering shorebirds, birds utilizing rookeries for nesting, and birds using pre-migration staging areas. Poorly understood threats include anthropogenic causes of mortality including collisions with lighted buildings, communications towers, and wind turbines. Recent changes in federal Clean Water Act protections for small wetlands could also negatively affect many wetland-dependent species. For migratory species, threats may occur outside of Georgia’s physical boundaries such as loss of winter or migratory stopover habitat, poisoning or shooting in countries with fewer protections, collection for the pet trade, or, in the case of pelagic species, conflicts with fishing gear and lighted navigational aids, masts, and other structures on ships.

#### ***Climate Change:***

While there is a significant amount of uncertainty surrounding the impacts climate change will have on our native species, there are several broad areas of concern. It is likely that a warming

climate will cause the ranges of many species to shift northward, possibly leading to negative interactions with other species or less favorably environmental conditions that affect reproduction and survival. Some species will likely lose a significant amount of habitat because there are spatial and temporal impediments to habitat migration. This may result in dramatic population declines, extirpations, or even extinctions of species. A number of species including, Seaside Sparrow, Saltmarsh Sparrow, and Nelson's Sparrow, have been added to this SWAP bird list specifically because of the threats posed by climate change.

### Sea Level Rise

The fact that Georgia's coast is relatively undeveloped and has limited shoreline hardening should allow the coast to migrate and adjust better than the more developed shorelines of other states as sea level continues to increase. However, portions of our coast with beach development and shoreline hardening will likely lose their beaches and developed areas inland may serve as barriers to saltmarsh migration. Another concern is the rapidity with which sea level rise is predicted to occur. Establishment of new beaches and saltmarsh may not be able to keep pace with net loss of these habitats, thereby significantly reducing the amount of habitat available for these highly specialized birds.

*Direct impacts:* The overall impact on beach nesting birds will depend on the balance between erosion and accretion, and the relative frequency of high tide events. There is evidence that the amplitude of high tide events is increasing at a greater rate than mean sea level rise. This may pose a serious threat to many coastal nesting species, from the seabirds and shorebirds that nest on our beaches to the rails, sparrows, and wrens that nest in our coastal marshes. Tidal inundation already causes numerous nest failures each year among all of these coastal species.

Fresh water impoundments on the immediate coast provide critical fresh water resources to a wide range of species from waterfowl and marsh birds to shorebirds and wading birds. It will be more difficult to maintain these impoundments structurally as sea level continues to rise, and to maintain fresh water in them as salt water invades the river systems.

*Indirect Impacts:* As sea level rises, and salt water pushes further up our rivers, there will be alterations in coastal habitats that will likely impact breeding and migratory species. A number of priority wading birds, including the Federally Threatened Wood Stork, regularly forage in the intertidal marshes that will likely be impacted as sea level rises. There will also be a retreat upriver of tidal forests as salinity increases.

### Trophic asynchrony

Many species of migratory songbirds have been documented returning to their breeding grounds and nesting earlier in the season as the climate continues to warm. There is a concern that the timing of peak bird nesting, and the flush of insects that feed their young, will become asynchronous, leading to lower productivity rates.

Trophic asynchrony is likely much more of a problem in the Arctic, where climate change has been occurring more rapidly than in temperate regions. This would potentially influence several arctic nesting shorebirds that are on Georgia's SWAP bird list, particularly the red knot and

whimbrel. Arctic warming may influence breeding habitat, prey availability, quality, and timing, and potentially shift or alter other ecological interactions.

### Range Shifts

As climate warms, it is likely that there will be a northward shift of the range of some species where suitable habitat is available. Georgia's Blue Ridge Mountains provide the southernmost breeding range for a number of species and it is quite plausible that we may lose some of these nesting populations if they shift their breeding grounds northward. SWAP listed species that may move north out of Georgia include Golden-winged Warbler and Cerulean Warbler. Others include Blue-winged Warbler, Canada Warbler, Winter Wren, Veery, Red-breasted Nuthatch, and Brown Creeper.

### Ocean Warming

As oceans warm, there is the risk of altering the prey base that supports our coastal birds. Fish die-offs and related seabird colony collapse in the North Pacific have been linked to warming ocean waters. Most evidence on the Atlantic coast at this point is fairly speculative however.

Addressing all of these conservation issues will require a combination of regulatory enforcement, protection through acquisition and easement, appropriate management through management plans, agreements and incentives, technical assistance and advisement to land managers, and outreach to the public. Landowners, land managers, and Georgia's citizens must appreciate not only the value of our natural resources, including birds and other wildlife, but must also be educated as to the threats facing these species and protections and management actions required to preserve these valuable resources.

## **Research and Survey Needs**

Several areas of research and survey have been identified to assist in the conservation of priority bird species in Georgia. These needs fall into several broad categories.

### Secretive Species

Some groups of birds, particularly secretive marsh birds and nocturnal species, are poorly understood. Inventory and monitoring protocols for these species should be developed and implemented, and should be compatible with similar efforts in other parts of the Southeast or the species' range. Since the original SWAP was completed in 2005, several survey and monitoring efforts have been initiated for secretive or difficult to detect species. In recent years the Standardize North American Marsh Bird Monitoring Protocols have been used to survey King Rails and Least Bitterns (as well as other species) at several sites. Data from these surveys are compatible with those collected across the U.S. and Canada and can be aggregated with other data to look at population trends at local, regional, national, or continental scales. Surveys for Black Rails are being conducted using protocol developed in the Chesapeake Bay region of Virginia and Maryland. These surveys fit into a larger effort to monitor this species across the Atlantic and Gulf Coasts. Surveys of nightjars, songbirds, and other species are also using standardized protocols which allow the data to be used at regional or national levels.

### Productivity

Although distribution and perhaps abundance of many species is fairly well known, productivity in various habitat types and conditions needs further study. The influence of external agents including contaminants, toxins, and pathogens on both survival and productivity are poorly understood for most species. Recent research and survey work in Georgia has addressed issues of nesting success and productivity of Wood Storks at some nest sites, and very recently work on nesting success and productivity was started for MacGillivray's Seaside Sparrow in our saltmarshes.

### Management

Management issues in need of further study include the use of fire and the frequency, intensity, and timing of burning to benefit specific bird species. We must also conduct research and monitor responses to determine the influence of management strategies targeting particular species or groups of species such as game birds or endangered species on other high priority species. For example, do frequent burning and use of restrictor plates on cavities, common management techniques for Red-cockaded Woodpecker, affect the habitat quality of mature pine forests for Southeastern American Kestrel and Brown-headed Nuthatch? Do management practices promoted in agricultural landscapes for Northern Bobwhite also provide habitats for breeding and wintering songbirds? How effective are predator control efforts at key beach nesting waterbird sites?

Permitting for offshore energy exploration has already begun. This includes both offshore wind energy development as well as oil and gas exploration. For birds the risks are several. Any offshore infrastructure, especially with lighting that attracts birds, may become a collision hazard. Any spill would affect pelagic as well as near-shore coastal species. Colonial seabirds would be particularly vulnerable to a spill. The coastal support and transport infrastructure required to support offshore energy extraction may also seriously impact coastal habitat.

While the development of renewable energy sources in Georgia, such as solar and wind farms, should be encouraged, there are potentially negative impacts to wildlife from these developments. Siting issues must be very carefully considered to minimize any impacts to birds. Primarily, physiographic features that concentrate migratory birds and bats should be avoided entirely. Other sensitive sites such as wading bird colonies and Bald Eagle nests should be considered in any siting decision as well.

### Winter Distribution and Ecology

Surveys of the winter distribution, habitat use, and ecology of high priority birds are needed for Georgia, because our state serves as an important wintering area for resident species and for many species that breed far north of our borders.

### Migration

Perhaps one of the most difficult periods to study in the annual cycle of migratory birds, migration is no less important. A statewide survey of spring and fall migrant occurrence, distribution and abundance is needed. In addition, the distribution, quality and spatial characteristics of migration stopover habitat are poorly understood. For migratory species of

birds breeding in Georgia, such as Swallow-tailed Kite, understanding extent and causes of mortality during migration are critical to the long-term health and stability of the population.

### Taxonomy

The taxonomy of some bird species needs additional scrutiny and in many cases Georgia may provide significant habitats for distinctive or geographically isolated subspecies such as the Appalachian Yellow-bellied Sapsucker, Southeastern American Kestrel, and Florida Sandhill Crane.

### Influences Beyond Georgia

We must also be involved in efforts to understand the population effects of influences that occur outside of our state boundaries and in assisting our international conservation counterparts in seeking solutions for any limiting factors, regardless of where they occur.

### **Monitoring**

It is imperative that we better communicate, coordinate, and share information with other agencies, organizations, and institutions working to conserve our birds. This needs to be done at the state, regional, national, and international levels. Presently some of the national/international coordinated efforts we are participating in include the Breeding Bird Survey, U.S. Nightjar Survey, and International Shorebird Survey. These programs offer central data storage, retrieval, and analysis. We also participate in several other national and regional conservation efforts; however, these are more loosely coordinated and most do not offer a mechanism for central data handling. Coordinated monitoring and data storage for seabirds across the Southeast states should be pursued, since colonial seabirds often move dramatically from year to year, and this would enable us to better understand their status and trends. In cases such as this a shared database would be the best option. The Avian Knowledge Network offers collaborative databases and this network could be used as a central clearinghouse for data storage and dissemination for many of our bird conservation efforts.

### **Land Conservation**

The Satilla River corridor provides some of the most important Swallow-tailed Kite nesting sites in the state, almost all of which are on private lands. Based on the colonial nature of the species, and their site fidelity, protecting known nesting clusters must be one of the highest priorities for the species. This can be achieved through easements, WRP program enrollment, or fee simple purchase. An enormous long-term land conservation need is providing corridors and areas for beach and saltmarsh habitats to mitigate to as sea level rises. This will be one of our greatest conservation challenges in the coming decades.

### **Outreach and Education**

Most wading bird colony sites are on private lands and as such it will be necessary to increase our outreach and education efforts aimed at landowners so that we can effectively work with the landowners to manage these sites. This is also true for Swallow-tailed Kite nesting aggregations as well as for other species. Outreach and education efforts need to also reach out to boaters and beachgoers to aid in protecting beach nesting birds from human disturbance. Campaigns like the

American Bird Conservancy's "Swim, fish, and play from 50 yards away" could be used effectively in these efforts.

### **Significant 2005 SWAP priority action item accomplishments for birds**

#### **GOAL • Assess status of high priority species**

1. Assess populations of high priority terrestrial birds in the Coastal Plain (e.g., Swallow-tailed Kite, Southeastern American Kestrel, Painted Bunting, grassland species).

Work with swallow-tailed kites is ongoing. We have been monitoring nests in the Atlantic drainage rivers and expanded survey work westward in the state, which has led to documentation of kite nesting further west and north than previously known. Have participated in multi-state roost surveys to better estimate population numbers and tested use of nesting platforms and vocal and visual lures as a possible way to establish new nesting sites. This was very successful. Initiated nest monitoring program for Southeastern American Kestrels using power poles and nest boxes along major power line corridors. This effort is ongoing. Tracked kestrels using radio-telemetry to define home range and habitat use along these power line corridors and at other sites with nest boxes. Completed a 3-year multi-state breeding season survey of Painted Buntings to assess population size of the Southeast Atlantic population. This survey led to a population estimate that was several times larger than the previous estimate. Used radio-telemetry to define home range and habitat use of breeding Loggerhead Shrikes. Have conducted surveys for Henslow's Sparrows for several years at several sites. At three of these sites we have intensively monitored populations for 5 years including banding birds to aid in developing a population index or estimate as well as other demographics. Conducted surveys for Bachman's Sparrows and Swainson's Warblers on state-owned and leased properties to determine presence/absence as well as numbers on occupied sites. Assessed the effects of clearcut size on use of clearcuts by Bachman's Sparrows during the breeding season on private industrial forest lands.

2. Conduct aerial surveys for federally listed birds (Bald Eagle nesting surveys; Wood Stork nesting and roosting surveys).

We have conducted annual Wood Stork nest colony flights at least once, and often twice, each year to determine numbers. Several colonies (usually 9-12) are monitored for productivity. Low altitude photography is used in conjunction with visual counts to estimate numbers. Annual nest surveys for Bald Eagles have been conducted every year. Surveys include a flight in January to determine whether nests are active and to locate new nests. The second survey, flown in March, documents nesting success and productivity. Since Bald Eagles are no longer federally listed and have been increasing in number every year since the surveys started we may consider down-scaling these survey efforts in the future.

3. Conduct midwinter waterbird survey and Piping Plover winter survey; conduct research and surveys on Southeastern Red Knot and Whimbrels; investigate American Oystercatcher ecology and demographics

Continue to conduct mid-winter waterbird and Piping Plover survey annually. Have expanded shorebird efforts to include the International Shorebird Survey. Support Virginia Tech with

more frequent Piping Plover surveys. Conducted or supported 2 intensive Red Knot band resighting efforts, with more planned. Satellite tagged 8 Whimbrels in Georgia to track movements to breeding grounds. Most used Hudson Bay, but we did confirm a link to the Mackenzie River Basin population. Also documented routes traveled by birds in fall to wintering areas, including some interesting interactions with severe weather (e.g. hurricanes) and some key wintering sites were discovered. Discovered that some Whimbrels were killed by hunters in the Caribbean, a source of mortality not widely recognized previously. Continue to conduct annual nesting population survey of American Oystercatchers. Studies of incubation and effects of predator control are being conducted on oystercatchers as well. In addition, counts of wintering oystercatchers have been done as a part of a larger Atlantic Coast effort.

#### 4. Expand Breeding Bird Survey routes

The number of breeding bird survey routes has been increased to 96, with approximately 72-75 being run annually. Significant effort has been made to recruit new observers and this effort will continue in the future.

### **GOAL • Conserve high priority habitats**

5. Continue cooperative management for Golden-winged Warbler and other species requiring mid- to high-elevation early successional habitats in the Blue Ridge

A substantial amount of habitat for Golden-winged Warblers was created at Brawley Mountain on the Chattahoochee National Forest by the U.S. Forest Service, with DNR assistance, using logging and prescribed fire. Unfortunately, this habitat creation was delayed for several years due to an environmental group's concerns and few Golden-winged Warblers remain at this site.

### **GOAL • Conserve high priority species**

6. Continue Waterbird Conservation Initiative

Have been heavily engaged in this initiative conducting surveys, monitoring, research, and habitat management related to seabirds, shorebirds, and wading birds. Managed vegetation encroaching on sand spit islands and other beach habitats using prescribed fire, herbicides, dredge spoil deposition, and other tools to create or preserve and enhance nesting and roosting habitat for colonial waterbirds and shorebirds including Least and Gull-billed Terns, American Oystercatchers, and many other species. Worked cooperatively with the Game Management Section to create and maintain shorebird habitat at Altamaha WMA. Have implemented predator control to eliminate coyotes on barrier islands, where they can essentially reduce most beach nesting bird productivity to zero, as well as control of other predators that affect productivity such as feral hogs and raccoons. Worked with the U.S. Army Corps of Engineers to construct and manage an artificial island in Brunswick Harbor for waterbird and shorebird nesting.

7. Implement Red-cockaded Woodpecker conservation on private lands

Have successfully translocated Red-cockaded Woodpeckers to Joseph Jones Ecological Research Center, a private research facility, and to The Nature Conservancy's lands at Moody Forest WMA. Worked with quail plantation owners in the Red Hills region using Safe Harbor to assure these private lands are properly managed to provide habitat for RCWs.

8. Update State-protected species list and work with partners to improve management for these species.

State Protected Species List was updated in 2008. Have been working with numerous partners to improve management of these species. Recommendations on status changes for some species on this list were developed during our SWAP bird list revision meetings.

### **GOAL • Improve environmental education and outreach**

9. Develop technical educational materials (e.g., Georgia Breeding Bird Atlas, revised natural community classification system)

Georgia Breeding Bird Atlas published in 2010. Species accounts for birds on the state protected species list placed on the Wildlife Resources Division website for use by biologists, consultants, researchers, and the general public.

### **GOAL • Improve public land management**

10. Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands (Red-cockaded Woodpecker is mentioned in description, but not specifically in the conservation action).

Have translocated 116 Red-cockaded Woodpeckers from lands with surplus birds to Joseph Jones Ecological Research Center, Moody Forest WMA, and Silver Lake WMA. The Red-cockaded population at the Jones Center had been extirpated. With translocation effort there are now approximately 29 active RCW clusters. Moody Forest was down to a single bird prior to translocation efforts there. Now there are several birds in one or two clusters. The number on Silver Lake went from five family groups (clusters) to 25 clusters with translocation efforts.

11. Manage and monitor coastal bird islands to conserve populations of beach-nesting birds.

Regularly monitor all of these sites for nesting seabirds and shorebirds. Managed vegetation on sand spit islands and other beach habitats, control predators where needed.

### **GOAL • Increase capacity for wildlife conservation**

12. Improve biodiversity databases and increase data-sharing with conservation partners

Have shared Breeding Bird Atlas database with Patuxent Wildlife Research Center in their effort to assemble a database containing as many breeding bird atlas datasets as possible. Continue to add bird records to the Biotics conservation database.

## **Appendix C. Mammals Technical Team Report**

**Prepared by Jim Ozier,\* Katrina Morris,\* and Clay George, Nongame Conservation Section, Georgia Department of Natural Resources**

### **Technical Team Members and Approach**

Because of their recognized expertise, the following individuals were invited to participate on the SWAP revision mammal team via email on September 20, 2013, and specifically invited to the mammal team meeting via email on November 5, 2013; seven of these were also involved with the initial 2005 mammal team:

Dr. Michael Bender, Department of Biology, Gordon State College  
 Dr. Brad Bergstrom, Department of Biology, Valdosta State University  
 Bobby Bond\*, Game Management Section, Georgia Department of Natural Resources  
 Dr. Steven Castleberry\*, Warnell School of Forestry and Natural Resources, University of Georgia  
 Nikki Castleberry\*, Museum of Natural History, University of Georgia  
 Dr. Mike Chamberlain, Warnell School of Forestry and Natural Resources, University of Georgia  
 Doug Chamblin\*, Office of Environmental Services, Georgia Department of Transportation  
 Dr. Michael Conner, Joseph W. Jones Ecological Research Center  
 Dr. Tara Cox, Department of Marine and Environmental Science, Savannah State University  
 Dr. Mark Ford, Virginia Cooperative Fish and Wildlife Research Unit, Virginia Tech  
 Dr. Greg Hartman\*, Department of Biology, Gordon State College  
 Dennis Krusac, Southern Regional Office, U. S. Forest Service  
 Dr. Susan Loeb, U. S. Forest Service Southern Research Station, Clemson University  
 Pete Pattavina\*, Ecological Services, U. S. Fish and Wildlife Service  
 Carol Ruckdeschel, Cumberland Island Museum  
 Dr. Jason Scott, Forest Resources Department, Abraham Baldwin Agricultural College  
 Dr. Doug Waid (ret), Forest Resources Department, Abraham Baldwin Agricultural College  
 Greg Waters, Game Management Section, Georgia Department of Natural Resources  
 Dr. Jim Wentworth\*, Chattahoochee National Forest, U. S. Forest Service

Each invitee received the report and other products from the 2005 mammal team, our current working priority species table, and a link to the full online 2005 SWAP. Available participants (\*) met December 16, 2013 at the Rum Creek Nongame Conservation Section office near Forsyth where they reviewed and discussed priority mammal (except bats and marine species) conservation needs. Katrina Morris helped coordinate a review of priority bat conservation needs the following day (December 17, 2013) as part of the Georgia Bat Working Group meeting at Gordon State College, Barnesville. Most of those present at the December 16 meeting were present, as well as the following additional participants:

Cecilia Ball, Habitat for Bats  
 Robert Ball, Habitat for Bats  
 Dr. Jackie Belwood, Georgia Highlands College

Chris Brookshire, Golder Associates, Inc.  
 Dottie Brown, Ecological Solutions, Inc.  
 Dr. Stephen Burnett, Clayton State University  
 Jim Candler, Georgia Power Company  
 Laci Coleman, Eco-Tech Consultants  
 Brian Davis, Office of Environmental Services, Georgia Department of Transportation  
 Ben Dickerson, Georgia Power Company  
 Lee Droppelman, Eco-Tech Consultants  
 Dennis Krusac, Southern Regional Office, U. S. Forest Service  
 Alton Owens, Eco-Tech Consultants  
 Dr. William Paschal, LaGrange College  
 Jimmy Rickard, Ecological Services, U. S. Fish and Wildlife Service  
 Kim Romano, Ecological Solutions, Inc.  
 Vicky B. Smith, A-Z Animals  
 Vanessa Terrell, University of Georgia  
 Dr. Mark Yates, LaGrange College

Additionally, Clay George and Dr. Tara Cox worked separately on the coast to address marine species.

Participants reviewed the draft table of 23 priority species, discussed and updated all data fields, and made the following recommendations:

Add humpback whale (*Megaptera novaeangliae*) – These whales are sighted occasionally in Georgia state and federal ocean waters, they are listed as endangered under the ESA and Georgia Endangered Wildlife Act, and they are threatened by human activities such as shipstrikes and fishery entanglement.

Add northern long-eared bat (*Myotis septentrionalis*) – This species is proposed for listing by the US Fish and Wildlife Service due to impacts from WNS.

Add little brown bat (*Myotis lucifugus*) and eastern pipistrelle (Tri-colored Bat) (*Perimyotis subflavus*) – These are being considered for listing by the US Fish and Wildlife Service due to impacts from WNS.

Add spotted skunk (*Spilogale putorius*) – There are very few records of this species in Georgia and they are apparently in decline throughout much of their range.

Drop star-nosed mole (*Condylura cristata*), masked shrew (*Sorex cinereus*), and Florida black bear (*Ursus americanus floridanus*) from the list. The group felt that these species were sufficiently secure for the short-term. The Florida black bear population in the vicinity of the Okefenokee Swamp is hunted and appears to be doing fine.

## Conservation Priorities

Bats – Sixteen species of bats are known to occur in Georgia. During the development of the initial SWAP, six species were considered at risk and in need of additional protection and further research; three additional species are included this time. Work funded by State Wildlife Grants provided a great deal of new information on all of our SWAP species of concern.

Since the development of the initial SWAP bats in the eastern U.S. have been subjected to a new and very serious threat. White-nose Syndrome (WNS) was first documented in New York in the winter of 2006-2007. The disease is caused by a newly discovered fungus (*Pseudogymnoascus destructans*) and has killed millions of cave-dwelling bats in the eastern U.S. ([www.whitenosesyndrome.org](http://www.whitenosesyndrome.org)). WNS was detected in Georgia in 2013 and is now known from 7 counties in the northern part of the state; it continues to spread across the U.S. and Canada. Because of this disease, the U.S. Fish and Wildlife Service has proposed one species for listing under the Endangered Species Act (ESA) and is currently reviewing several others. Georgia has been active completing WNS surveys, participating in research projects and completing education activities across the state. Georgia will continue to monitor the spread of the disease across the state and document the impacts to our bat populations. We will also continue to participate in research projects both to better understand the disease and also to test potential treatment options for WNS. Education has been a critical component of the battle against WNS, helping the caving community and general public to better understand bats, their benefits and the things that threaten their existence. The SWG programs and other federal funding sources have been critical to provide biologists in Georgia with the resources to complete this work in the state.

Another relatively new threat to bats is development of facilities for wind-generated electricity. A recent report estimated that 650,000 to more than 1,300,000 bats were killed between 2000–2011 in the U.S. and Canada. Another study estimated that more than 600,000 bats may have died at wind energy facilities in the U.S. in 2012. The majority of these bats are tree roosting species so far, thus they are not directly impacted by WNS. However, threats from white-nose syndrome, wind energy development, and habitat modification and loss all combine to put several species of bats at risk of serious declines and possibly extinction in the foreseeable future.

Because of the recent declines in bat populations across the eastern use, Beneficial Management Practices (BMPs) for public, private and industrial forests have become a critical need. Currently, BMPs are being developed as part of the Conservation and Recovery Working Group organized during the White-nose Syndrome workshops. This group includes individuals from federal and state agencies, universities, non-profits, industrial forestry and other interested individuals. Sub-groups are currently working on BMP development and these guidelines will be reviewed and revised before being released and implemented. Georgia will continue to work on development and revision of these BMPs. We will implement BMPs for bats on state lands and continue current beneficial practices that are already in action. We will also advise federal agencies and private companies and individuals on implementation of these practices. Many of the BMPs already in place for other species benefit bats as well. Future bat BMPs will be

designed to be a part of overall healthy forest management and will benefit a variety of other high priority species.

Another critical issue includes working with Nuisance Wildlife Control Operators (NWCOs). Bats cause widespread nuisance problems when they occupy buildings, sometimes in large numbers. We need to continue to work to see that nuisance bat situations are handled promptly and in a manner that avoids harm to the bats. Exclusions should be conducted outside the season when non-volant young are present if possible, and the provision of alternate roost structures should be encouraged.

Indiana (*Myotis sodalis*), gray (*Myotis grisescens*) and small-footed (*Myotis leibii*) bats were identified as high priority species in the initial SWAP. All have been impacted by WNS, though gray bats appear to be less susceptible; little mortality has been detected at sites that have shown positive for the disease. We should continue using emergence counts at summer roosts and winter counts at hibernacula to monitor this species. Most historically occupied caves have been heavily disturbed and are no longer used, but it is likely that additional occupied caves remain to be discovered. Identifying and protecting all important sites is critical for the protection of this species in Georgia.

The Indiana bat has been heavily impacted by WNS in the Northeastern U.S. We have no current records of this species in caves in Georgia, but a maternity site was recently discovered in some snags in Gilmer County through radio telemetry, and almost certainly there are other summer sites in northern Georgia. We need to continue to attempt to identify any summer maternity areas using banding, radio-telemetry, Anabat (or other bat detector) surveys and mist netting. Though differentiating between Myotid species using bat detectors is difficult, positive *Myotis* calls can be used to target mist-net surveys to determine species presence.

The small-footed bat has also been impacted by WNS in the northeastern US, however to a lesser degree than the Indiana bat. These bats often go undetected in winter hibernacula surveys either because they roost in areas difficult to survey or they use sites other than caves in winter. Further work to determine important winter and summer sites for this species is critical to better understanding the range and critical habitats for this bat in Georgia. Work should include visual outcrop surveys, radio-telemetry, cave surveys, Anabat (or other bat detector) surveys, harp trapping and mist netting. Banding is a concern for this species because of its use of crevices. Many feel that this bat is more likely to become injured by bands impeding movement or getting stuck in rock crevices. We currently do not recommend banding this species in Georgia.

The little brown bat was not considered a high priority species during the initial SWAP development. Though the range in Georgia is limited geographically, it was thought that this species was common across the Eastern U.S. and north Georgia. However, WNS syndrome has caused major declines in little brown bats in the Northeastern U.S. Because of declines from WNS, the little brown bat will be added as a high priority species in the SWAP revision. Very few of these bats are found in hibernacula in Georgia so it is likely that most of the bats captured in summer hibernate further north. However, these sites are likely already impacted by WNS and we expect to see declines in summer captures of this species in the future. Future work should include banding, radio-telemetry, Anabat (or other bat detector) surveys, cave surveys,

harp trapping and mist netting. Though differentiating between Myotid species using bat detectors is difficult, positive *Myotis* calls can be used to target mist-net surveys to determine species presence.

During the development of the initial SWAP, the tri-colored bat (formerly Eastern pipistrelle) was considered to be a very common bat in Georgia. It has been found in low numbers in most caves and in some of the highest numbers known in a few winter sites in Georgia. It is also detected during summer mist-net and Anabat surveys across the state. However, WNS is impacting populations of this species in the Eastern U.S. including Georgia. Because of declines from WNS, the tri-colored bat will be added as a high priority species in the SWAP revision. The vast majority of hibernating bats in Georgia are tri-colored bats. It was thought that these bats may be able to survive WNS infection better in the Southern states because of shorter, milder winters and the availability of some food almost year-round. However, surveys during the first years of WNS infection detected a decline of about one-third at known sites. This suggests that this species may be vulnerable to WNS across the range. Future work should include banding, radio-telemetry, Anabat (or other bat detector) surveys, cave surveys, harp trapping and mist netting. In addition, work to determine if coastal populations of this species do not migrate to caves during winter is critical. Efforts to implement conservation measures for this species outside of caves will be especially difficult because of its use of a variety of habitat types and its widespread geographic distribution.

Surveys revealed many new locations for Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) and gave us a much better idea of the important habitat factors that make an area suitable for this species. As was our initial suspicion, we discovered this secretive species was more common than indicated by known occurrence records, though it is still rare throughout the state and suitable habitat is limited. We identified important conservation areas for "Raf bats," the most critical being the Altamaha River corridor; this species was used as an example of one that would benefit from protection of the Altamaha corridor and other floodplain forests. During recent drought years, more mature bottomland hardwood forests were lost that likely provided habitat for this species. Identifying these critical areas and protecting and managing them to promote the growth of bottomland hardwood forests is critical. In the northern portion of the range of this species, the threat of WNS was a concern. However, it does not appear that they are susceptible to the disease. It is still important to identify the best sites for them in northern Georgia and continue to monitor them as the disease spreads through the Southeast.

Southeastern myotis (*Myotis austroriparius*) also rely on bottomland hardwood forests and can use the same trees as Rafinesque's big-eared bats. However, this species also relies on cave habitats, especially for large maternity roosts in the summer. Continuing to monitor these sites using thermal imagery or the best available technology is important to track population changes over time. Gathering additional information on the most important sites for this species and their seasonal movements is also very important. The southeastern myotis in SW Georgia may also use sites in Florida and Alabama. None of the three states understand the movements or best sites for this species in the region. Multi-state projects research and survey projects could help answer some of these questions and inform an effective conservation strategy. This species is not known to be affected by WNS yet, but continued monitoring of the southward spread of the disease is needed.

We now have a better understanding of northern yellow bat (*Lasiurus intermedius*) roosting habitat following recent work on Sapelo and Little St. Simons Islands. Interestingly, only two females were captured during this project. Large scale movements of this bat are completely unknown and it is possible that they occupy different areas during different seasons. We continue to collect Anabat calls along the coast, which should also help to identify the best sites for this species; it is likely that urban areas provide suitable habitat. Research and survey projects to better understand the movements and critical habitats for this species are needed across its range.

Marine species -- Seven species of baleen whales, at least 22 species of toothed whales and dolphins, and one sirenian occur in Atlantic Ocean waters offshore of Georgia. Most of these species occur well offshore, are transient, or only enter Georgia state waters when they are ill, stranded or otherwise outside of their normal habitat. Four marine mammal species are known to occur regularly within the U.S. Territorial Sea offshore of Georgia (i.e., within 12 nautical miles of shore): the West Indian manatee (*Trichechus manatus*), North Atlantic right whale (*Eubalaena glacialis*), humpback whale, and bottlenose dolphin (*Tursiops truncatus*). Manatees, right whales and humpback whales are each listed as endangered under federal and state law. Bottlenose dolphin stocks that occur in Georgia waters are listed as “strategic” stocks under the Marine Mammal Protection Act (MMPA) due to their small population sizes and/or depleted status. All four species are directly impacted by human activities that occur in Georgia waters and have been included in this plan accordingly.

North Atlantic right whales are among the most endangered whale species with a population numbering approximately 450 whales. Waters along the South Carolina, Georgia and northeast Florida coast are an important wintering ground and only known calving ground for this species. Right whales are present from November to April and are most frequently observed 10-45 km east of the Georgia shoreline. The most immediate threats to right whales are mortality and injury from ship strikes and entanglement in commercial fishing gear. Coastal and marine development (including recreational, commercial and military activities) poses a growing threat to whales and their habitat. Climate change may negatively impact forage availability in Northeast U.S. and Canada, and the suitability of Southeast wintering habitat (whale distribution in the Southeast is strongly correlated with water temperature). DNR conducts a wide variety of right whale conservation activities in accordance with the North Atlantic Right Whale Recovery Plan (NMFS 2005) using funds primarily from NMFS. This project is implemented in cooperation with Florida Fish and Wildlife Conservation Commission (FWC), NMFS and other partners. Right whales are the highest priority marine mammal species in Georgia because of their small population size and the importance of Georgia waters to the population’s recovery.

Approximately 11,500 humpback whales inhabit waters throughout the North Atlantic Ocean. Humpbacks migrate between high latitude summer foraging grounds and winter mating/calving grounds in the West Indies. Small numbers of humpback whales, primarily juveniles, have been sighted within 30 km of the Southeast U.S. coast during winter and spring in recent decades. It is unknown whether these whales are wayward migrants, winter residents, or a combination. Like right whales, the primary threats to humpback whales are ship strikes, commercial fishing entanglements, and coastal and marine development. As such, efforts to conserve right whales will indirectly benefit humpback whales. DNR monitors humpback whales opportunistically

during right whale monitoring efforts. Additional data on humpback whale distribution and abundance are needed, especially during April and May after right whale monitoring has concluded.

Bottlenose dolphins are the only marine mammal species found year-round in Georgia waters. Georgia dolphins can be categorized into “estuarine” and “coastal” stocks. Estuarine stocks are non-migratory resident groups that inhabit estuaries, brackish tidal rivers and ocean waters within 1 km of shore. Estuarine stocks are geographically constrained, and have relatively small population sizes accordingly (perhaps 200-300 individuals per sound system). Coastal stocks inhabit near-shore ocean waters year-round and move into estuarine habitats at various times of year. The coastal stock along the Georgia and South Carolina coast likely numbers at least 4,000 dolphins. Coastal and estuarine stocks overlap spatially near the beaches and ocean inlets, but genetic research indicates that there is limited interbreeding between stocks. Entanglement in fishing gear and habitat degradation are threats to all dolphin stocks. Harassment and behavioral changes from dolphin feeding may be growing problems in some areas in Georgia. Estuarine dolphins in the Brunswick, GA area have been impacted negatively by high concentrations of persistent environmental contaminants. DNR, NMFS, NOAA’s National Ocean Service and local cooperators monitor bottlenose dolphins using the Georgia Marine Mammal Stranding Network, by conducting photo-identification studies, and through other targeted research. Funding has been provided by NMFS, the Nongame Conservation Fund and private groups.

Manatees inhabit all tidal and near-shore ocean waters along the Georgia coast from April to October. The number of manatees that migrate into coastal Georgia is unknown, but is probably a small fraction of the Florida Atlantic subpopulation, which numbers at least 2,000 manatees. Aerial surveys at Cumberland Sound (along the Georgia/Florida border) found that abundance varies widely within and among seasons, with more than 50 manatees during summer in peak years, to less than 10 manatees during early spring and fall, and during lower years. Manatees disperse widely into coastal Georgia and northward into the Carolinas each summer. They forage on marsh cordgrass (*Spartina alterniflora*) and other emergent vegetation which is abundant throughout coastal Georgia. Threats to manatees in Georgia include watercraft collisions, attraction to artificial freshwater and warm-water sources, and coastal development. Harmful algal blooms (e.g., “red-tides”) and abnormally cold winters regularly cause mass mortalities in Florida waters. Climate-change may exacerbate these impacts in the future, which could impact the number of manatees inhabiting Georgia waters. DNR conducts a wide variety of manatee conservation activities in accordance with the Florida Manatee Recovery Plan (USFWS 2001) using funds primarily from the USFWS and Navy. Recovery efforts are conducted in close cooperation with USFWS, the U.S. Geological Survey, FWC and other partners.

Coastal plain pine savanna species – The extensive, open pine savannas of the southeastern coastal plain have disappeared from the vast majority of this community’s former range. Conversion to agricultural fields, pasture, tree farms, residential areas, roads, etc., has eliminated and fragmented this habitat type, and lack of fire on the landscape has reduced the suitability of many areas.

Although the taxonomy and ranges of fox squirrel subspecies are in question, we consider Sherman's fox squirrel (*Sciurus niger shermani*), which is the large subspecies found in the upper peninsula of Florida and the Okefenokee Swamp region of Georgia, to be of conservation concern because of its rareness and apparent close relationship with declining open longleaf pine habitat. A recent study, funded through a State Wildlife Grant did not find genetic evidence to support subspecific designations, but the results are inconclusive due primarily to small sample sizes. Management to restore suitable savanna-type habitat should benefit this iconic animal and many others of conservation concern.

Southeastern pocket gophers (*Geomys pinetis*) need soft, sandy soil with a grassy/herbaceous groundcover. Loss of longleaf pine savannas has apparently heavily impacted populations, and where they are still found they are often treated as pests because of their burrows. These burrows, however, provide crucial habitat for several other species of wildlife, some invertebrates of which are rarely if ever found elsewhere. DNR needs to work with landowners who still have suitable habitat for these species to promote proper management with frequent fire and responsible timber harvest. Restoration of degraded habitat could also play an important role in building populations of these species eventually. A 2006 roadside survey for Southeastern pocket gophers (*Geomys pinetis*) confirmed suspected recent declines. Of 272 historical locations in 41 counties, gophers were found at only 65 locations in 18 counties. However, the survey did not include known sites in Thomas County on large tracts of private land. Addition of these and other opportunistically discovered sites brought the total to 106 sites in 20 counties. Relatively high densities were identified at 5 locations in Burke, Taylor, Baker, Early, and Camden counties; the population in Thomas County could be added to this list as well. Although pocket gophers appear to do well in some disturbed habitats, such as hay fields, habitat and population fragmentation are significant obstacles to recovery for this species. Reintroduction to suitable sites appears to be a useful management approach; however, opportunistic attempts to trap gophers at sites in Marion and Schley counties for potential relocation to Sand Hills WMA in Taylor County have not been successful so far.

High elevation forest species – The mountains of northeastern Georgia represent the extreme southern limits of the ranges of several species of mammals, including the long-tailed shrew (*Sorex dispar*), water shrew (*Sorex aquaticus*), hairy-tailed mole (*Parascalops breweri*), Appalachian cottontail (*Sylvilagus obscurus*), red squirrel (*Tamiasciurus hudsonicus*), southern bog lemming (*Synaptomys cooperi*), and least weasel (*Mustela nivalis*). Many of these probably represent relict populations left isolated in high elevation sites as the boreal forests retreated northward following the last ice age. Though Georgia provides only a very small amount of the total occupied habitat and supports only a very small portion of the entire population for these species, maintenance of these range extremes could conserve a disproportionate amount of the species' genetic diversity because of isolation and adaptation. In general, these species need high quality forested habitat, with accompanying clean streams, rich soils, and rocky outcrops. In Georgia, much of this habitat occurs on national forest land and is under no immediate threat. However, DNR should work with the Forest Service and private landowners to avoid alteration of these important habitats. The ranges of these species might be particularly vulnerable to climate change. A small increase in average temperature would likely result in a northward retreat, reducing or eliminating occupied habitat in Georgia.

## Appendix D. Reptiles and Amphibians Technical Team Report

Prepared by John B. Jensen, Team Leader

### Technical Team Members

Dr. Kimberly Andrews, Georgia Sea Turtle Center – Herpetologist  
 Dr. Bill Birkhead, Columbus State University - Professor  
 Dr. Carlos Camp, Piedmont College – Professor  
 Larry Carlisle, D.O.D./Ft. Stewart Military Reservation – Wildlife Biologist  
 Nikki Castleberry, University of Georgia Museum of Natural History - Curator  
 Christopher Coppola, U. S. Fish and Wildlife Service – Wildlife Biologist  
 Mark Dodd, WRD – Wildlife Biologist  
 Matt Elliott, WRD – Program Manager  
 Dr. Zach Felix, Reinhardt College - Professor  
 Thomas Floyd, WRD – Wildlife Biologist  
 Greg Greer, Greg Greer Enterprises - Herpetologist  
 Dr. Bob Herrington, Georgia Southwestern University - Professor  
 Robert Hill, Zoo Atlanta - Herpetologist  
 Robert Horan, WRD – Wildlife Technician  
 Jen Howze, Joseph W. Jones Ecological Research Center – Herpetologist  
 Dr. Chris Jenkins, The Orianne Society - Director  
 John Jensen, WRD – Wildlife Biologist  
 Dr. Joyce Klaus, WRD – Wildlife Technician  
 Dr. Brad Lock, Zoo Atlanta – Veterinarian  
 John Macey, D.O.D./Ft. Stewart Military Reservation – Wildlife Biologist  
 Dr. John Maerz, University of Georgia – Professor  
 Mark Mandica, Atlanta Botanical Garden – Herpetologist  
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 Dr. Jessica McGuire, WRD – Wildlife Biologist  
 Dr. Joe Mendelson, Zoo Atlanta – Herpetologist  
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 Dr. Dennis Parmley, Georgia College and State University – Professor  
 Todd Pierson, University of Georgia – Student  
 Ashley Raybould, WRD – Wildlife Technician  
 Ashley Rich-Robertson, Georgia Department of Transportation - Biologist  
 Dr. Lora Smith, Joseph W. Jones Ecological Research Center – Herpetologist  
 Dirk Stevenson, The Orianne Society – Herpetologist  
 Kevin Stohlgren, The Orianne Society – Herpetologist  
 Vanessa Terrell, University of Georgia - Researcher

### *Invited but unable to participate:*

Dr. Michael Black, Georgia State University – Professor  
 Dr. Lance McBrayer, Georgia Southern University – Professor/Curator  
 Robert Moulis, Chatham County – Herpetologist  
 Dr. Mark Patterson, Gwinnett County Parks and Recreation – Conservation District Coordinator

Dr. David Rostal, Georgia Southern University – Professor  
Dr. Adam Safer, Georgia State University – Professor

## **Approach**

Two one-day herp team workshops were held: Georgia Wildlife Federation Headquarters on 15 November 2013; Little Ocmulgee State Park 14 January 2014. The first meeting began with a progress report on amphibian and reptile action items identified in the 2005 SWAP to inform the team on accomplishments and continued needs (summary of accomplishments provided below). Following this report and continuing through the remainder of both meeting dates, the team was presented with the 2005 spreadsheet of high priority species to amend based on information learned since the previous effort. This spreadsheet identifies each species' abundance, range, population trend, threats, protection needs, inventory needs, monitoring needs, research needs, and importance in Georgia as it relates to global conservation of the species. This effort required the knowledge of professionals who work closely with reptiles and amphibians in Georgia and their conservation, and the team assembled for this evaluation certainly represented that need. In addition to expert opinion provided by team members, information on conservation concerns and needs was gleaned from peer-reviewed scientific literature, technical reports, and natural history museum databases.

Thirteen species from the 2005 priority list (*Graptemys geographica*, *Desmognathus aeneus*, *Desmognathus folkertsi*, *Necturus maculosus*, *Plestiodon* [formerly *Eumeces*] *egregius*, *Plethodon metcalfi*, *Plethodon shermani*, *Plethodon teyahalee*, *Plethodon websteri*, *Pseudacris brachyphona*, *Pseudobranchius striatus*, *Stereochilus marginatus*, and *Tantilla relicta*) were not selected by the team for inclusion in the 2015 priority list because they were considered either too peripheral in Georgia or not rare/threatened enough to warrant conservation attention equal to the others. In fact, the status of several of these species was unknown or poorly known in 2005, but studies and observations since then revealed enough stability to consider them of significantly lesser conservation concern. Conversely, six that were not on the 2005 list species (*Ambystoma tigrinum*, *Eurycea aquatica*, *Eurycea chamberlaini*, *Ophisaurus compressus*, *Plethodon savannah*, and *Urospelerpes brucei*) were added to the new one. The full 2015 high priority species list is shown below in Table 1.

The team also discussed the current list of state protected reptiles and amphibians and recommended changes based on current status and threats (this information is not presented here, but will be used when the state protected list is formally reviewed). Following the meeting, the team leader “cleaned-up” the spreadsheet and resubmitted to the team for final review. This finalized spreadsheet was used by the team leader as an important tool for recommending top priorities for conservation action.

## **Significant 2005 SWAP Priority Action Items Accomplishments**

1. Conduct status survey for hellbender.

A 2005 survey by Jeff Humphries checked stream segments in proximity to historical occurrence records in 21 areas. This contracted survey established a baseline for a long-term, landscape-level survey and population monitoring effort initiated in 2011. Primary

objectives include monitoring known populations over time and documenting additional populations from stream basins that had not been sampled before. From 2011-2014, hellbender surveys of 57 streams totaling 47.8 km of stream habitat were conducted by snorkeling and flipping rocks. Researchers caught, weighed, measured, photographed, and individually marked 350 hellbenders. Tissue samples were collected from 305 hellbenders for museum archival and for use in genetics research. Each hellbender was sampled for chytrid fungus (*Bd*) and Ranavirus. Results from the analysis of these and future samples will help in a range-wide assessment of the health of the species. A Georgia hellbender species status assessment was submitted to USFWS to assist in a range-wide assessment in response to a petition to list the hellbender under the federal Endangered Species Act. In cooperation with The Orianne Society, WRD also conducted a hellbender survey throughout much of the north Georgia mountains using environmental DNA (eDNA). In 2013, 150 water samples were collected from 98 streams, including some that had not been sampled before, plus streams with known hellbender populations, streams with historical occurrences and several streams outside of the species' known distribution in Georgia (the Tennessee River drainage). Hellbender DNA was not detected in any of the sampled streams in northwestern Georgia or any of the streams outside of the Tennessee River drainage, with the exception of one previously documented site. However, DNA was detected in 12 streams where hellbenders had not been previously documented.

2. Conduct surveys of potential habitat for bog turtle and associated species and evaluate methodology for use in other habitats in North Georgia.

In an effort to monitor known populations and identify new bog turtle populations, an average of 150 traps per year have been set in 33 different mountain bog sites for a total of over 71,000 trap days since 2007. In 2005, the Natural Resources Spatial Analysis Laboratory (NARSAL) of UGA was contracted to conduct a GIS-based bog habitat survey of an 11 county area encompassing the Blue Ridge Physiographic Province and adjacent areas. 330 sites were initially identified in the NARSAL survey. In collaboration with the University of Georgia and Clemson University a species distribution model was built in MaxEnt software by creating a relative suitability map based on relationships between known bog turtle occurrences and the ten selected environmental characteristics typical of suitable bog turtle habitat. As a result of these two mapping efforts, over 300 sites have been ground-truthed or otherwise excluded as potential habitat for rare bog flora and fauna in Georgia; 18 separate wetland sites have been selected for bog turtle trapping surveys resulting in the discovery of 4 new bog turtle occurrences, increasing the number of known occurrences in Georgia by 40%. An additional 80 wetland sites identified through GIS, remain to be assessed for potential suitability

3. Identify potential habitat for flatwoods salamander and other high priority Coastal Plain species; survey habitats for populations of high priority species.

Areas of suitable habitat on public and on private lands within the historical range of the flatwoods salamander, striped newt, and gopher frog were identified through numerous sources including the analysis of topographic and soil survey maps, aerial imagery, a digital elevation model, GIS-based habitat modeling, and information provided by local resource

managers, biologists, and agency staff. Surveys for pond breeding amphibians were conducted by dip-netting wetlands following ground-truthing of potential sites on the ground or by helicopter survey. Thirty-five tracts of private land were surveyed primarily for flatwoods salamanders, as well as suitable wetlands on Chickasawhatchee, Mayhaw, and Grand Bay WMAs, Dixon Memorial Forest, and Okefenokee NWR. Survey efforts failed to identify new populations of flatwoods salamanders. Opportunistic surveys for gopher frogs and striped newts detected the former at two previously unknown sites. No new striped newt sites were discovered during this period, but continued persistence was documented at previously known, extant sites.

Sean Graham conducted a WRD-sponsored status survey for the southern dusky salamander in Georgia. Only seven individuals from two sites were found in Georgia, despite widespread historical occurrences. Additional information resulting from this survey can be found in the following publication:

Graham, S. P., E. K. Timpe, and L. R. Laurencio. 2010. Status and possible decline of the southern dusky salamander (*Desmognathus auriculatus*) in Georgia and Alabama, USA. *Herpetological Conservation and Biology* 5:360-373.

4. Develop private landowner incentives for conservation of flatwoods salamanders.

An analysis of the feasibility of implementing the Safe Harbor Policy as a conservation strategy for flatwoods salamander was conducted. Through interaction with private landowners while conducting flatwoods salamander surveys, it became clear that in order to gain access to many private landholdings some form of legal assurances or conservation incentives must be available. Following a thorough policy analysis, recommendations were made to the US Fish and Wildlife Service for a unique application of the Safe Harbor Policy for the flatwoods salamander that would require no additional regulative mechanism. These policy recommendations would allow for “A Priori Zero Baseline” Safe Harbor Agreements in exchange for access to a particular private property to conduct flatwoods salamander surveys. Extensive drought from 1998 to 2009, coupled with disruption of metapopulation dynamics through extensive habitat fragmentation on the landscape are thought to be the primary factors in the presumed extirpation of *A. bishopi* and near extirpation of *A. cingulatum* in Georgia, thus making the implementation of conservation incentives for this species in Georgia moot. However, recommendations resulting from this policy analysis are applicable to any plant or reclusive animal species requiring direct access to private lands to survey for species presence and may still show promise in the conservation of such species.

5. Assess status of diamondback terrapin populations and determine impact of vehicle-induced mortality and incidental captures on populations.

Dr. John Maerz, UGA Warnell School of Forest Resources, conducted a statewide survey of Georgia’s tidal creeks to assess diamondback terrapin abundance. Single-year mark-recapture estimates of terrapin abundance were obtained for 29 randomly chosen tidal creeks. Researchers estimated that 88% of Georgia’s tidal creeks were occupied with an abundance estimate of approximately 92,000 sub-adult and adult terrapins. Terrapin density was found to decline with increasing commercial crabbing activity and there was no measurable impact

on abundance with proximity to roads. The overall conclusion of the study was that terrapins were relatively widespread and moderately abundant in Georgia with some notable areas of high density.

6. Continue long-term monitoring of Pigeon Mountain salamander populations; conduct surveys for other high priority cave and outcrop species.

Carlos Camp of Piedmont College and WRD staff seasonally (once per season) monitored cave-dwelling salamanders at six caves on Pigeon and Lookout mountains every year during this period and observed stable populations of Pigeon Mountain salamanders and other salamander species for which enough encounters were made to assess trends. Additional information resulting from this monitoring effort can be found in the following publications: Camp, C. D., and J. B. Jensen. 2007. Seasonal patterns of lipid storage in two salamander species in northwestern Georgia. *Journal of the North Carolina Academy of Sciences* 123:110-118.

Camp, C. D., and J. B. Jensen. 2007. Use of twilight zones of caves by plethodontid salamanders. *Copeia* 2007:594-694.

Camp, C. D., J. A. Wooten, J. B. Jensen, and D. F. Bartek. 2014. Role of temperature in determining relative abundance in cave twilight zones by two species of lungless salamanders (family Plethodontidae). *Canadian Journal of Zoology* 92:119-127.

Numerous caves were surveyed for Tennessee cave salamanders but no new populations were discovered.

The discovery of green salamanders on Rocky Mountain in the Ridge and Valley (previously unknown from this province) prompted further staff surveys throughout the Georgia portion of this province and resulted in numerous new occurrences.

7. Conduct genetic, taxonomic, and reproductive studies of high priority species. (e.g., bog turtle reproduction; loggerhead genetics; parameters of healthy alligator snapping turtle population).

Although genetic dependent sex determination (GSD) is the likely mode of sex determination in the bog turtle, discovery of temperature dependent sex determination (TSD) in this species would have significant implications for headstarting methods used in the conservation of the southern bog turtle population. Eggs collected from Georgia's wild turtles in 2011 were used in the initiation of a multi-year cooperative study between the Chattahoochee Nature Center and WRD intended to determine GSD/TSD. However, temperature-controlled incubation of eggs for this experiment was suspended in 2012 due to limited egg availability and lack of egg variability or survival. Funding was granted in 2014 for a study intended to identify sex chromosomes in bog turtles, which would demonstrate GSD without risking the health or future reproduction of any individuals.

Georgia DNR collaborated with Dr. Joe Nairn and Dr. Brian Shamblin, UGA Warnell School of Forest Resources, to conduct a statewide genetic mark-recapture estimate of adult female loggerhead sea turtle abundance from 2008 to 2014. A single viable egg was taken from each

nest in Georgia. Maternal DNA was extracted from egg samples, and nesting females were identified using 18 novel microsatellite loci. To date, 2,242 individual females have been identified nesting on Georgia beaches. Estimates of annual adult female abundance ranged from 288 to 733 females. Other important reproductive parameters were also estimated including site fidelity, clutch frequency, and remigration interval.

WRD conducted a long-term capture-mark-recapture study of alligator snapping turtles in Spring Creek in southwest Georgia. Because a previous survey by staff had shown that this population had the highest capture rate of surveyed populations in Georgia – suggesting it may be among the state’s healthiest populations surveyed – we sought to characterize demographics here as a reference for evaluating recovery in other populations. The study ended in 2014, totaling 163 captures of 71 individual turtles in a 2.5-mile stretch of the creek. WRD and Auburn University researchers are analyzing capture-mark-recapture data from the 16-year period to examine population demographics, growth rates and longevity.

8. Investigate site fidelity and habitat use by eastern indigo snakes.

UGA–Warnell School was contracted to conduct this work and served as PhD dissertation research for Natalie Hyslop. A radiotelemetry study from 2002-2004 investigated the habitat use, survival, movements, and home ranges of the species in southeastern Georgia. 32 snakes (19 M, 13 F) at sites on Fort Stewart and adjacent private property were tracked. Annual home ranges were found to be large (male = 510 ha; female = 101 ha). Models for annual home range size estimates suggested a positive correlation with body size, negative influence of sex (being female), and negative association with habitat undergoing restoration opposed to areas used commercially. Snakes used the highest diversity of habitats in late spring and summer as they moved from their dry upland winter and early spring habitats to wetter, lowland summer ranges; however, snakes continued to periodically use upland xeric habitats throughout the warmer months. Snakes in this study maintained close association with underground shelters, especially throughout the winter. Most fall and winter locations were recorded at gopher tortoise burrows. Snakes relied less on these burrows in spring and summer. Additional information resulting from this study can be found in the following publications:

N. L. Hyslop, R. J. Cooper, and J. M. Meyers. 2009. Seasonal shifts in shelter and microhabitat use of *Drymarchon couperi* (eastern indigo snake) in Georgia. *Copeia* 2009:458-464.

N. L. Hyslop, J. M. Meyers, R. J. Cooper, and T. M. Norton. 2009. Survival of radio-implanted *Drymarchon couperi* (eastern indigo snake) in relation to body size and sex. *Herpetologica* 65:199-206.

N. L. Hyslop, D. J. Stevenson, J. N. Macey, L. C. Carlile, C. L. Jenkins, J. A. Hosteetler, and M. K. Oli. 2011. Survival and population growth of a long-lived threatened snake species, *Drymarchon couperi* (eastern indigo snake). *Population Ecology* DOI 10.1007/s10144-011-0292-3.

9. Restore mountain bogs; continue bog turtle headstart and population establishment efforts and use non-releasable turtles for education/outreach efforts.

A robust field experiment was initiated in 2007: “The Efficacy of Prescribed Fire, Mechanical Woody Stem Removal, and Herbicide Application in the Restoration and Maintenance of Southern Appalachian Mountain Bog Habitats in an Early Seral State by Mimicking Natural Disturbance.” The final round of data collection was completed in 2013. A manuscript analyzing the results of this study is in preparation. Vegetative composition of 20 mountain bogs (10 with documented bog turtle occurrences, 10 previously trapped without detection) has been mapped and vegetation classified according to National Wetland Inventory standards. Changes to vegetative composition and hydrologic functionality of these same sites over time are being determined through historical aerial photographic interpretation. All of these data are being collected in an effort to determine subtle environmental variables affecting habitat suitability for the bog turtle over time. A total 17 captive-reared bog turtles were released within a restored mountain bog on the Chattahoochee NF in 2004 and 2005. These turtles are progeny of a captive breeding colony of 7 wild bog turtles from 3 separate Georgia bogs. The sudden loss of all 7 turtles has severely affected Georgia’s ability to produce captive-reared turtles for release. Fortunately much of the 2006 cohort of captively-reared hatchlings make up a captive breeding colony today. An effort to breed these captives was initiated in 2011. Since 2007, no viable eggs have been produced in captivity nor have any hatchlings from wild-caught gravid females survived. An outdoor bog turtle enclosure is currently under construction and a cooperatively developed standardized protocol for bog turtle headstarting has been initiated among conservation partners, both of which are expected to improve headstarting results in Georgia in the future with the ultimate objective of additional releases of headstarted bog turtles into restored habitat.

10. Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of freshwater turtles, and develop appropriate regulations.

A stakeholder’s group was formed and met several times to develop appropriate regulations. The Board of Natural Resources approved the recommended regulations which became official in January 2012 (O.C.G.A. 391-4-16). In summary, anyone wishing to possess more than 10 freshwater turtles in Georgia is required to obtain a commercial turtle permit and annually report details of their harvest. Commercial turtlers will be subject to annual quota limits of 100 to 1000 turtles, depending on the species. We believe that these limits are strict enough to prevent overharvest while being generous enough to allow limited commercial enterprise. And, because we now have harvest data made available to us, if these limits prove inadequate to sustain turtle populations, we will have the supportive information necessary to adjust the rules.

11. Address venomous snake exception in state law (O.C.G.A. 27-1-30) prohibiting disturbing or destroying wildlife habitats.

Senate Bill 322, which simply struck the venomous snake exception language, passed and was signed into law making it illegal to use gasoline or other chemicals to drive rattlesnakes from gopher tortoise burrows.

12. Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of eastern diamondback rattlesnakes, and develop appropriate regulations.

This action item was not addressed, but remains a priority in the 2015 SWAP revision.

13. Continue sea turtle stranding and salvage network. Monitor impacts of coastal fisheries on sea turtles and effectiveness of nest protection efforts. Consider construction of a Georgia SeaTurtle Center on Jekyll Island.

Georgia DNR maintained a network of volunteers, managers, and researchers to monitor beaches for stranded sea turtles. Stranded sea turtles were identified by species and morphometric measurements were collected. Gross necropsies are conducted on approximately 65% of carcasses to determine sex and probable cause of death. The number of stranded sea turtles ranges from 84 to 804 annually. Major threats to sea turtles based on necropsies included incidental capture and drowning in the shrimp trawl fishery and watercraft related injuries. In order to further assess the effects of the shrimp trawl fishery on sea turtles, Georgia DNR conducted bi-monthly aerial surveys to document trawler abundance and distribution. Trawler distributions were correlated with stranding patterns to assist law enforcement personnel in planning TED compliance boardings.

Georgia DNR maintained a network of volunteers, managers, and researchers to monitor beaches for sea turtle nesting activity. Approximately 85 % of Georgia's barrier island beaches were monitored daily from 1 May through 1 October for sea turtle nesting activity. Nests deposited at low beach elevations were relocated to minimize embryo mortality from tidal inundation. Nest screening and predator control were used to minimize nest loss to predators. Nests were inventoried following hatchling emergence to assess reproductive success. Loggerhead nesting data shows a significant increasing trend in nesting in Georgia since comprehensive surveys were initiated in 1989 (n=25 years).

Georgia DNR assisted with fund-raising and design of the Georgia Sea Turtle Center. The Georgia Sea Turtle Center opened to the public in 2007 and is the centerpiece of the sea turtle conservation program on Jekyll Island. The GSTC is an integrated conservation program that includes research, education and rehabilitation.

14. Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands.

In 2007, in partnership with Atlanta Botanical Garden, University of Georgia, The Nature Conservancy, Zoo Atlanta, U.S. Department of Defense, Joseph W. Jones Ecological

Research Center, and Bear Hollow Zoo, WRD began a project that involved collecting gopher frog eggs from healthy populations, rearing them to late-stage tadpoles or post-metamorphic froglets, and releasing them at an unoccupied but high-quality protected site at Williams Bluffs Preserve in Early County, which is within the species' historical range. The goal: Establish a self-sustaining breeding population of gopher frogs at a protected site. 5,621 gopher frogs, mostly metamorphs, have been reared and released during this period. While previous years of drought prevented mature gopher frogs the opportunity to breed in the release pond – and biologists' ability to assess the success of the project – in 2013 we were provided sufficient rainfall to fill the wetland basin. Multiple male gopher frogs were heard calling in the pond that year and a single egg mass was discovered. Males were also heard calling in 2014. Camera surveys of gopher tortoise burrows in the uplands surrounding the wetland showed juvenile and adult gopher frogs using the burrows. Together, these discoveries indicate that released juveniles are surviving to adulthood in the uplands and successfully breeding in the wetland.

Yuchi WMA, a DNR tract identified as having an unsustainably low gopher tortoise population size in its current state, was established as a recipient site for tortoises displaced by development. Thirty-six adult tortoises have been released, and radio telemetry conducted on 10 of them has shown strong fidelity to the release site. Beginning in 2014, juvenile tortoises hatched and head-started from eggs collected at stable populations are being used to further augment the population. Twelve juvenile tortoises with attached radio-transmitters were released in soft-release pens for a three-week period, then allowed free roam once they became well-acclimated to the site. Researchers with UGA are tracking the free-ranging juveniles to evaluate growth, habitat use, home range and survivorship. 20 nests collected from the stable donor sites in 2014 resulted in 142 hatchlings being raised in captivity for release in spring 2015.

Although repatriation of striped newts did not occur in Georgia during this period, Georgia striped newts and WRD staff contributed significantly to efforts in Florida. A small number of striped newts collected from the Fall Line Sandhills WMA breeding pond by staff and others established captive breeding populations at Jacksonville and Memphis zoos. 490 larvae have been produced at these two zoos and were released in an Apalachicola National Forest wetland in 2013 and 2014. Researchers have documented emigration of 36 fully developed land-bound newts from the recipient wetland.

#### 15. Develop technical educational materials.

WRD funded and led the effort to produce the state's only comprehensive guide book to amphibians and reptiles:

Jensen, J. B., C. D. Camp, W. Gibbons, and M. J. Elliott. 2008. *Amphibians and Reptiles of Georgia*. University of Georgia Press, Athens, GA. 575 pp.

Brochures include:

Forest Management Practices to Enhance Habitat for the Gopher Tortoise

Venomous Snakes of Georgia

Is it a Water Moccasin? (revision/reprint)

## High Priority Amphibians and Reptiles

Common Name	Scientific Name
Reticulated Flatwoods Salamander	<i>Ambystoma bishopi</i>
Frosted Flatwoods Salamander	<i>Ambystoma cingulatum</i>
Eastern Tiger Salamander*	<i>Ambystoma tigrinum</i>
One-toed Amphiuma	<i>Amphiuma pholeter</i>
Green Salamander	<i>Aneides aeneus</i>
Loggerhead Sea Turtle	<i>Caretta caretta</i>
Green Sea Turtle	<i>Chelonia mydas</i>
Spotted Turtle	<i>Clemmys guttata</i>
Eastern Diamond-backed Rattlesnake	<i>Crotalus adamanteus</i>
Hellbender	<i>Cryptobranchus alleganiensis</i>
Leatherback Sea Turtle	<i>Dermochelys coriacea</i>
Southern Dusky Salamander	<i>Desmognathus auriculatus</i>
Eastern Indigo Snake	<i>Drymarchon couperi</i>
Brown-backed Salamander*	<i>Eurycea aquatica</i>
Chamberlain's Dwarf Salamander*	<i>Eurycea chamberlaini</i>
Georgia Blind Salamander	<i>Eurycea wallacei</i>
Bog Turtle	<i>Glyptemys muhlenbergii</i>
Gopher Tortoise	<i>Gopherus polyphemus</i>
Barbour's Map Turtle	<i>Graptemys barbouri</i>
Alabama Map Turtle	<i>Graptemys pulchra</i>
Tennessee Cave Salamander	<i>Gyrinophilus palleucus</i>
Southern Hognose Snake	<i>Heterodon simus</i>
Kemp's or Atlantic Ridley	<i>Lepidochelys kempii</i>
Gopher Frog	<i>Lithobates capito</i>
Alligator Snapping Turtle	<i>Macrochelys temminckii</i>
Diamondback Terrapin	<i>Malaclemys terrapin</i>
Dwarf Waterdog	<i>Necturus punctatus</i>
Striped Newt	<i>Notophthalmus perstriatus</i>
Island Glass Lizard*	<i>Ophisaurus compressus</i>
Mimic Glass Lizard	<i>Ophisaurus mimicus</i>
Pine Snake	<i>Pituophis melanoleucus</i>
Southern Coal Skink	<i>Plestiodon anthracinus pluvialis</i>
Pigeon Mountain Salamander	<i>Plethodon petraeus</i>
Savannah Slimy Salamander*	<i>Plethodon savannah</i>
Patch-nosed Salamander*	<i>Urspelerpes brucei</i>
* = species not on 2005 SWAP	

## **Examples of High Priority Habitats**

### ***Southwestern Appalachians/Ridge & Valley***

#### Caves, springs, and rock outcrops

A great diversity of salamanders, including three of high conservation concern (green, Pigeon Mountain, and Tennessee cave salamanders), depend on these habitats. Caves and rock outcrops can obviously be impacted by mining operations, a continued threat in this region. Forest moisture required by terrestrial salamanders may be compromised by land alteration. Water quality of springs and subterranean streams is threatened by septic tanks and other sources of toxins from upslope developments.

#### Sag ponds

Fishless, temporary wetlands are critical breeding habitats for a number of amphibians, yet they are frequently deepened and stocked with fish, or drained.

### ***Blue Ridge***

#### Cove hardwood forests

Salamanders reach their highest worldwide diversity in the Southern Blue Ridge, and cove hardwood habitats harbor much of this diversity. Maintenance of mesic forest conditions and low silt loads in embedded seeps and small streams is threatened by development and forestry activities that do not follow Best Management Practices (BMPs).

#### Mountain bogs

Primarily of concern because of the dependence on this habitat by the endangered bog turtle, although numerous other reptiles and amphibians can be found here. The majority of these habitats are formed in low mountain valleys, mostly in private ownership. Streams within mountain bogs are often channelized, diverted, or impounded, rendering them unsuitable for bog turtles. Beavers may be the primary force behind creation of these habitats, but their activities are rarely tolerated by most landowners. Maintaining these naturally successional habitats requires active management in the form of hand-clearing shrubs and hardwoods, prescribed fire, and targeted herbicide application.

#### Medium to large streams

Those found in the Tennessee River drainage are home to the hellbender, a huge, fully aquatic salamander that is very sensitive to stream perturbations. Siltation from improper erosion control during land clearing activities and inadequate forested buffers is perhaps the greatest threat. Accumulations of silt reduce or eliminate space between critical rock shelters, and suffocate eggs and larvae. Forestry activities should follow industry-approved BMPs to avoid impacts to streams.

## ***Piedmont***

### Spring seeps

The recently discovered patch-nosed salamander is only known to occur in a few headwater streams or seeps in the upper Piedmont of eastern Georgia and adjacent South Carolina, thus protection of the surrounding forests is critical to maintaining suitable water quality.

Otherwise, the Piedmont does not contain habitats uniquely important to herps of conservation concern, and with the notable exception above, few of these species range into this province.

## ***Southeastern Plains and Southern Coastal Plain***

### Isolated wetlands

Includes Carolina bays, sinkhole ponds, cypress domes, and other depressional wetlands. A number of high priority herps (gopher frog, frosted flatwoods salamander, reticulated flatwoods salamander, eastern tiger salamander, and striped newt) depend on the fishless (or lacking of large, predatory fish), temporary conditions provided by isolated wetlands. However, most of these species spend considerably more time burrowed in adjacent uplands. Conservation of these species requires attention to both wetland and upland habitat needs. These wetlands are exempt from any protection under the Clean Water Act, thus they can be filled, drained, or deepened for permanency. The adjacent uplands are often impacted by conversion to silviculture, agriculture, residential and industrial development, or are neglected, fire-suppressed, and overgrown with hardwoods. Prescribed fires in surrounding uplands should be allowed to burn into isolated wetlands, which often necessitates that burning be periodically conducted during the summer when these ponds are most often dry.

### Longleaf pine-wiregrass habitats

Includes pine flatwoods, sandhills, and upland pine forest. Many species of reptiles and amphibians are endemic, or nearly so, to this broad habitat type. Thus, it is not surprising that the 97% loss of this habitat range-wide has led to drastic declines of closely associated herpetofauna. Priority species include those above that breed in isolated wetlands, plus mimic glass lizard, eastern indigo snake, southern hognose snake, pine snake, eastern diamond-backed rattlesnake, and gopher tortoise. Silviculture, agriculture, residential and industrial development, and fire suppression have all contributed to loss and alteration of longleaf-wiregrass habitats, and ultimately to declines of the aforementioned herp species. Prescribed burning on an appropriate rotation is the single best tool for maintaining these habitats, but mechanical and chemical means may be necessary to restore some sites before fire alone can be effective. Removal of longleaf pine stumps for the resin and rosin industry significantly reduces important refugia available to numerous snake species, including eastern indigo snake, eastern diamond-backed rattlesnake, and Florida pine snake. This practice should be prohibited on state lands and discouraged elsewhere.

### Hammocks and other high ground within and adjacent to salt marshes

Georgia's extensive salt marshes are home to a unique and very specialized turtle of conservation concern, the diamondback terrapin. Terrapins must nest in sandy soil above the high tide level. Unfortunately, these higher grounds are premium land for developments and roads, which

reduces the available nesting sites for terrapins and leads to high mortality of females and hatchlings while crossing roads. Early successional habitats on hammocks and in secondary dune systems are also favored habitats for eastern diamond-backed rattlesnakes and island glass lizards.

#### Ocean beach/dunes

Georgia's ocean beach/dune habitat is critical for the recovery and maintenance of threatened loggerhead turtle populations. Loggerheads typically nest on ocean beaches between the high tide line and the front of the primary dune. Beachfront property is also perhaps the most highly prized real estate in Georgia for residential development and recreation. Human activities have resulted in a wide variety of direct and indirect impacts to this important habitat. Indirect effects include reduced sediment input to the coastal sand-sharing system as a result of the impoundment of Georgia's major river systems. In addition, the construction of jetties and shipping channels has altered natural sand movement patterns increasing erosion on some beaches. Direct impacts to beach dune habitats include coastal development and construction activities such as beach nourishment projects, shoreline stabilization (rock armoring), home construction, artificial lighting, and increased recreational use. Disallowing the construction of structures in the dynamic dunefield will reduce the need to install shoreline stabilization structures and resulting loss in available nesting habitat.

#### **High Priority Areas**

Partners in Amphibian and Reptile Conservation (PARC) developed a Priority Amphibian and Reptile Conservation Areas (PARCAs) project. PARCAs are a non-regulatory designation whose purpose is to raise public awareness and spark voluntary action by landowners and conservation partners to benefit amphibians and/or reptiles. Areas are nominated using scientific criteria and expert review, drawing on the concepts of species rarity, richness, regional responsibility, and landscape integrity. Modeled in part after the Important Bird Areas program developed by BirdLife International, PARCAs are intended to be coordinated nationally but implemented locally at state or regional scales. Importantly, PARCAs are not designed to compete with existing landscape biodiversity initiatives, but to complement them – providing an additional spatially explicit layer for conservation consideration.

PARCAs are intended to be established in areas:

- capable of supporting viable amphibian and reptile populations
- occupied by rare, imperiled, or at-risk species, and
- rich in species diversity or endemism

A meeting of amphibian and reptile experts in Georgia (listed below), most of which were also on the SWAP revision herp technical team, was hosted by WRD and convened on 12 June 2012 to determine Georgia's PARCAs. More information on the process can be found in: Apodaca, J.J., S., Spear, and C.L. Jenkins. 2014. Determining Priority Amphibian and Reptile Conservation Areas in the south Atlantic landscape, and assessing their efficacy for cross-taxa conservation. Final Report for the South Atlantic Landscape Conservation Cooperative.

Georgia PARCAs Meeting attendees (\* = denotes SWAP herp team member):

Dr. J.J. Apodaca, Warren Wilson College - Professor

Dr. Lora Smith, Joseph W. Jones Ecological Research Center – Herpetologist \*

Thomas Floyd, WRD – Wildlife Biologist \*

Malcolm Hodges, The Nature Conservancy - Ecologist

Matt Elliott, WRD – Program Manager \*

Dr. Bill Birkhead, Columbus State University - Professor \*

John Jensen, WRD – Wildlife Biologist \*

Dirk Stevenson, The Orianne Society – Herpetologist \*

Dr. Carlos Camp, Piedmont College – Professor \*

Javan Bauder, The Orianne Society – Herpetologist

Dr. Chris Jenkins, The Orianne Society - Director \*

Georgia PARCAs (refer to Figure 1)

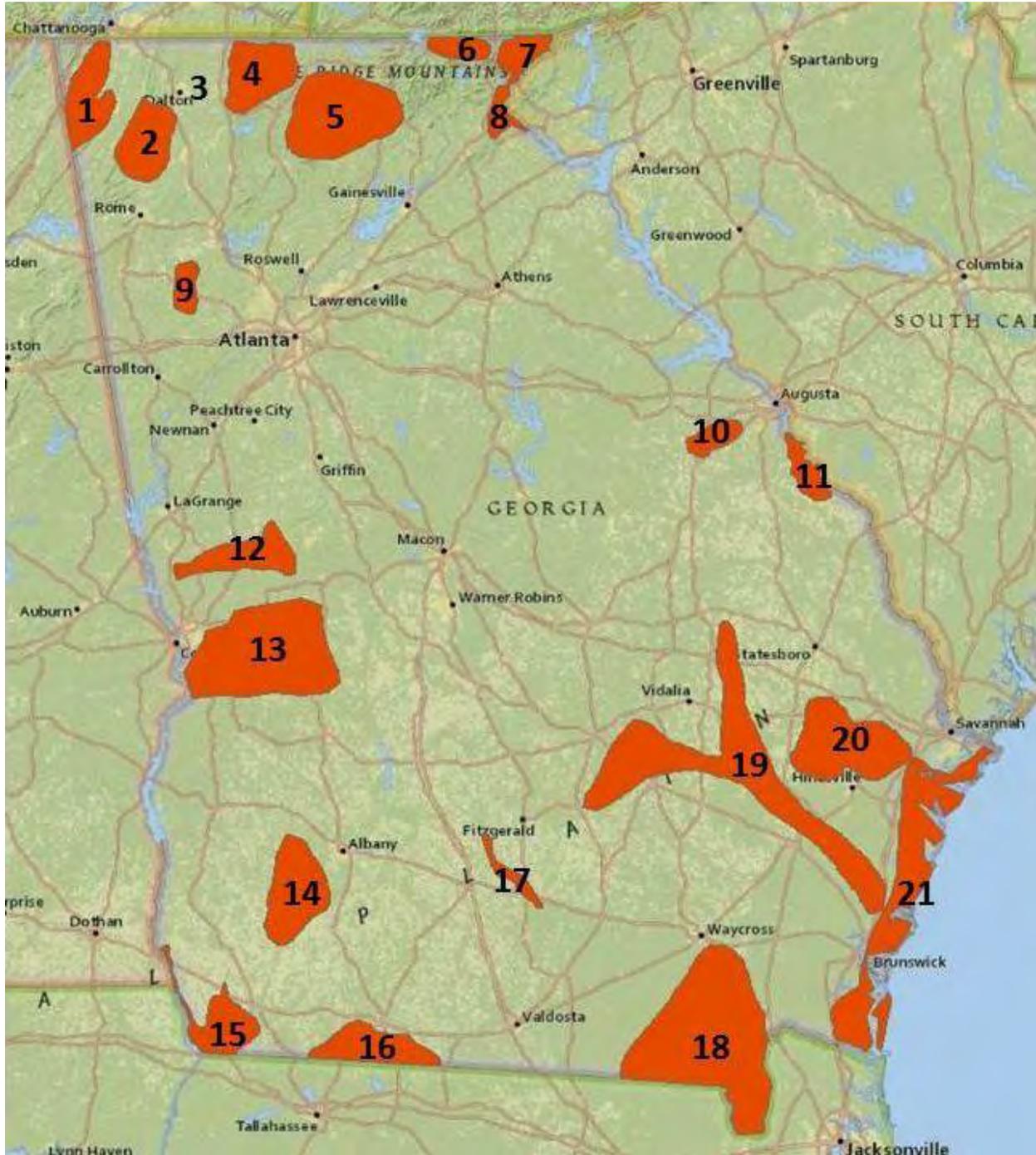
1. Lookout/Pigeon Mountains - Highest salamander species richness in GA, and only place with four species of *Plethodon*. Includes entire range of the Georgia endemic Pigeon Mountain salamander and only known Georgia site(s) for Tennessee cave salamander. Green salamanders are commonly found in rock outcrops in this area. Species endemic to karst regions such as cave salamander and southern zigzag salamander thrive here. Also includes amphibian species normally associated with Coastal Plain such as tiger salamander and southern cricket frog. Mountain chorus frogs and the one of the largest breeding populations of four-toed salamanders range-wide use sag ponds on the mountain tops.
2. Armuchee Ridges – This Ridge and Valley Province PARCA includes species endemic to karst regions, such as the cave salamander. Green salamanders occur in the rocky outcrops and brown-backed salamanders are found in artesian springs and their outflow streams.
3. Conasauga River – A high quality stream with populations of both Alabama and northern map turtles.
4. Cohutta Mountains – Perhaps the largest contiguously forested region in the state, with attendant, high salamander diversity. Also contains headwaters of Conasauga River on the western side; the eastern side contains headwaters for streams that contain hellbenders and possibly mudpuppies.
5. Rich Mountain/ Snake Nation - High salamander diversity including a genetically unique form of Chattahoochee slimy salamander. Contains headwaters for streams that contain hellbenders and possibly mudpuppies.
6. Nantahala Mountains - High salamander diversity (e.g., 6 species of *Desmognathus*). Includes salamanders having strong genetic influence from the red-legged salamander, a North Carolina endemic. Possible occurrence of pigmy salamander. Streams of the Tennessee River drainage harbor hellbenders. Includes populations of eastern milk snakes and coal skinks.

7. Upper Chattooga Basin - High salamander diversity, especially *Desmognathus* (at least 5 spp.). Only place in Georgia with southern Appalachian and southern gray-cheeked salamanders. Green salamanders occur in forested areas with rock-outcroppings.
8. Tugaloo Basin - Second highest salamander species richness in Georgia, especially genus *Desmognathus* (5 spp.). Includes all but one (in SC) known population of the locally endemic patch-nosed salamander, as well as green salamanders.
9. Paulding Forest – A uniquely intact Piedmont region with ridge-tops characterized by montane longleaf habitats, and the only Georgia PARCA representing true Piedmont ecoregion. Locally occurring mountain chorus frogs are among the interesting herps here.
10. Ft. Gordon – Uplands support gopher tortoises and southern hognose snakes, as well as the Georgia endemic Savannah slimy salamander. Streams contain excellent populations of dwarf waterdogs. Spotted turtles and pine snakes are also likely to occur here.
11. Yuchi WMA/Plant Vogtle – Contains Pleistocene beach dune-origin sandhills that are a stronghold for southern hognose and pine snakes. Gopher tortoises also present, though depleted from past human collection for food. Dwarf waterdogs, Chamberlain’s dwarf salamanders, and spotted turtles are likely in the blackwater streams and riparian zones. The Savannah slimy salamander, a Georgia endemic, may occur in the uplands.
12. Pine Mountain/ Upper Flint River - An isolated Appalachian-origin ridge in the lower Piedmont that harbors species more characteristic of montane regions, such as wood frogs and spring and seepage salamanders, as well as species typically found in the coastal plain, such as eastern coral snakes. The largest populations known for Webster’s salamander are found here. High priority species, Barbour’s map turtle and alligator snapping turtle, are found in the river.
13. Ft. Benning/ Western Fall Line Hills – Straddling the Fall Line, Ft. Benning and the surrounding lands are a significant herp diversity hotspot. High priority species in this area include gopher tortoise, Barbour’s map turtle, alligator snapping turtle, eastern diamond-backed rattlesnake, pine snake, southern hognose snake, southern coal skink, gopher frog, tiger salamander, Chamberlain’s dwarf salamander, and striped newt.
14. Chickasawhatchee Swamp/Ichauway Plantation – Chickasawhatchee Swamp, a.k.a the Swamp of Toa, is the second largest wetland in Georgia and boasts populations of Florida green watersnakes (not a high priority species, but rare in GA) and alligator snapping turtles, and the larger streams in this region have Barbour’s map turtles in abundance. Upland communities of longleaf pine support gopher tortoises, eastern diamond-backed rattlesnakes, pine snakes, southern hognose snakes, and non-breeding habitat for reticulated flatwoods salamanders, gopher frogs, tiger salamanders, and striped newts, all of which breed in nearby isolated wetlands. This area is underlain by the Floridan Aquifer which is home to the Georgia blind salamander.

15. Lake Seminole Region – Longleaf pine communities and embedded isolated wetlands provide habitat for gopher tortoises and eastern diamond-backed rattlesnakes. A small, remnant population of eastern indigo snakes also is found here, the only known remaining population in SW Georgia. Lower Chattahoochee and Flint rivers, as well as Spring Creek, are inhabited by good populations of Barbour's map and alligator snapping turtles. Chamberlain's dwarf salamanders are found in seepages in this region. This area is underlain by the Floridan Aquifer which is home to the Georgia blind salamander.
16. Georgia Red Hills – Premier longleaf pine-wiregrass region of GA, some of which contains virgin forest. Well-managed, primarily for the benefit of bobwhite quail and red-cockaded woodpeckers, but benefits all longleaf pine herp specialists. High priority species include gopher tortoise, eastern diamond-backed rattlesnake, pine snake, one-toed amphiuma, and tiger salamander. Included Ochlocknee River contains a healthy alligator snapping turtle population.
17. Alapaha River and Sandhills – Aeolian sandhills on east side of the river offer habitat for the following high priority species: Gopher tortoise, eastern indigo snake, pine snake, and eastern diamond-backed rattlesnake. Embedded isolated wetlands serve as breeding habitat for striped newt, gopher frog, and tiger salamander. Alapaha River is inhabited by the Suwannee River alligator snapping turtle, a distinct, newly described species that is rarer in Georgia than the species found in other drainages. Spotted turtles also occur in wetlands here.
18. Okefenokee Swamp – This is the largest wetland in Georgia and includes both embedded (islands) and adjacent upland habitats. Striped crayfish snakes and Florida red-bellied turtles are found at very few other places in Georgia. Frosted flatwoods salamander, striped newt, gopher frogs, gopher tortoises, eastern indigo snakes, eastern diamond-backed rattlesnakes, and perhaps mimic and island glass lizards all occur here.
19. Altamaha-Ocmulgee-Ochoopee River Corridors – Aeolian sandhills on north and east sides of these rivers and adjacent summer habitat retreats harbor the best remaining populations of eastern indigo snakes in the state, if not in their entire range. Gopher tortoises, spotted turtles, pine snakes, and eastern diamond-backed rattlesnakes also thrive here. Isolated wetlands serve as breeding habitat for striped newt, gopher frog, and tiger salamander. Dwarf waterdogs likely occur in the streams.
20. Ft. Stewart – Largest contiguous old-growth longleaf pine-dominated ecosystem in the state, harboring the only known extant population of frosted flatwoods salamanders in Georgia. Many other rare or unique herps thrive here including gopher tortoise, spotted turtle, eastern diamond-backed rattlesnake, pine snake, southern hognose snake, gopher frog, tiger salamander, southern dusky salamander, and striped newt. The most recently documented mimic glass lizard was found at Ft. Stewart.
21. Barrier Islands and Salt Marshes – Nesting (island beaches) and/or foraging habitat (estuaries and nearshore waters) for four marine turtles (green, loggerhead, Kemp's ridley, and leatherback sea turtles). Estuaries and imbedded marsh islands are habitat for diamondback

terrapins. Other rare species found in upland areas in this region include island glass lizards and dense populations of eastern diamond-backed rattlesnakes.

Figure 1 – Georgia PARCAs



## High Priority Conservation Actions

### Surveys

Because most amphibians and reptiles are very cryptic in behavior, currently known occurrences of many species in the state are likely unrepresentative of their full distribution. Surveys for new populations of priority species will remain an important conservation action. A new technique that may be especially useful for our most cryptic high priority amphibians involves filtering water from aquatic habitats to detect environmental DNA (eDNA) of targeted species. This has been used successfully in Georgia for hellbenders, patch-nosed-salamanders, flatwoods salamanders, striped newts, and gopher frogs. eDNA surveys for some of these species may be expanded and we will explore the utility of this technique for other good candidates, such as Tennessee cave and brown-backed salamanders. Trained detection dogs have proved effective for detecting difficult to find reptiles and may be useful for such priority species as southern hognose snakes and mimic glass lizards. Georgia is home to 18 amphibian and reptile species that are under federal review by USFWS as candidate species or species that have been formally petitioned for listing, and we will be assisting the Service by conducting status surveys or providing status reports. Most of these status surveys are underway, some being funded by a Section 6 grant. Federal candidate species: Striped newt, gopher tortoise. Petitioned species: Gopher frog, one-toed amphiuma, hellbender, green salamander, Chamberlain's dwarf salamander, Tennessee cave salamander, Georgia blind salamander, Pigeon Mountain salamander, patch-nosed salamander, southern hognose snake, Florida pine snake, eastern diamond-backed rattlesnake, alligator snapping turtle, spotted turtle, Barbour's map turtle, Alabama map turtle.

### Population Monitoring

A critical component of successful conservation efforts involves monitoring to evaluate the population stability of the target organism(s). Monitoring priority species will be done at different scales and use various methods. Some species, such as flatwoods salamander, striped newt, and gopher frog, will continue to be annually monitored for breeding activity at known, recently extant ponds. Eastern indigo snake occupancy monitoring has been employed at selected sites in the sandhills of the lower Altamaha River basin and will be periodically (every 2-3 years) continued here and expanded to other areas (likely Alapaha and Satilla river sandhills). Similarly, occupancy modeling has been used to monitor eastern hellbender populations in select mountain streams and will be continued every three years. A statewide index of abundance for diamondback terrapins, perhaps also using occupancy models, will be developed and designed to assess their trends in abundance over time. Trends in adult female sea turtle abundance will be assessed through nest monitoring programs and genetic mark-recapture sampling. Sea turtle strandings will be monitored (and necropsies performed to determine cause of death) as an index of threats in coastal marine waters. WRD is a signatory to the Gopher Tortoise Candidate Conservation Agreement, and through this has committed to monitoring tortoise population sizes and age classes of state and select private lands harboring the species every 7-10 years using line-transect distance sampling. We may also develop monitoring approaches and implementation for other priority species, such as green salamanders, spotted turtles, and one-toed amphiumas. WRD will continue to administer the North American Amphibian and Monitoring Program (NAAMP) in Georgia. This citizen science-based effort utilizes volunteers

to monitor calling activity of frogs along 73 stratified-random driving routes across the state during three survey periods each year.

#### Disease Screening and Monitoring

Newly emerging diseases are a growing conservation concern for many of our priority species, some of which are known to be highly susceptible while others have been unchallenged thus far but are potentially vulnerable. Diseases and disease-causing pathogens include Snake Fungal Disease (potentially harmful to all snake species), Upper Respiratory Tract Disease (affects gopher tortoises and box turtles), ranavirus (affects many amphibians and some turtles; gopher frogs are highly vulnerable based on laboratory trials), and amphibian chytrid fungi (*Batrachochytrium dendrobatidis* and *B. salamandrivorans*). Potentially or known-to-be vulnerable high priority amphibians and reptiles will be sampled for these and other emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.

#### Translocation, Captive Rearing, and Head-starting

Habitat loss and the resulting fragmentation it causes have left many populations of amphibians and reptiles severely isolated. Because most of these species have very limited dispersal abilities, restoring them in areas where they have been heavily reduced (augmentation) or eliminated (repatriation) often requires translocations or captive breeding/rearing and release programs. WRD has been actively working to establish a new gopher frog population using wild-collected eggs, tadpole rearing, and releases of metamorphs. This will be continued and likely expanded to other sites. Similarly, juvenile gopher tortoises head-started from wild-collected eggs are being used to augment the small resident population on Yuchi WMA, a project that will also be continued and perhaps expanded to other sites. Augmentation of the Yuchi WMA tortoise population has also involved translocations of tortoises displaced by development elsewhere. While the cause of the displacement is a concern for this and other species, we will opportunistically salvage vulnerable tortoises and strategically use them to augment Yuchi WMA and other tortoise-depleted, but protected state lands. Captive breeding/rearing, head-starting and releases of bog turtles will also continue. Other priority species that may be future candidates for captive breeding/rearing and head-starting efforts include flatwoods salamanders, striped newts, and southern hognose snakes.

#### Research

Research is an integral part of many amphibian and reptile conservation efforts, in-part because for many of these species we still have more questions than answers about aspects of their life history, natural history, taxonomic status, etc. High priority species for which basic natural history remains poorly known include Chamberlain's dwarf salamander, patch-nosed salamander, Georgia blind salamander, Tennessee cave salamander, southern dusky salamander, brown-backed salamander, dwarf waterdog, one-toed amphiuma, spotted turtle, southern hognose snake, and southern coal skink. Taxonomic questions exist for green salamander (are those found in three different and widely separated physiographic provinces genetically unique?), southern coal skink (are the isolated coastal plain populations actually representative of a distinct species rather than subspecies?), and Florida pine snake (similar question as coal skink). Determining the demographic patterns and habitat use of juvenile sea turtles in coastal waters will be important to understanding patterns in seasonal abundance, and is critical for

assessing the impacts of coastal offshore development projects and other activities such as vessel interactions.

#### Legislation/Regulation/Enforcement

Changing existing laws and regulations, or developing new legislative or regulatory recommendations, may be necessary to ensure conservation of certain exploited amphibians and reptiles. Adding to the state list of protected species is one avenue for conservation, but that alone is not always sufficient. Concerns voiced during the technical team meetings that would require legislative or regulatory attention to adequately address include prohibiting the shooting of basking turtles (which is done indiscriminately and is a threat to map turtles), regulating the attendance of set lines (“bush-hooks”), their placement, and their immediate removal after a fishing effort (these incidentally capture and kill certain reptiles including map turtles and alligator snappers), and prohibiting or limiting commercialization (primarily for skin and venom trade) of eastern diamond-backed rattlesnakes. To further address concerns for that latter species, we will continue dialogue with the Whigham Community Club in hopes of reforming the last remaining Georgia rattlesnake roundup into a wildlife-friendly festival, as was successfully done in Fitzgerald and Claxton. The shrimp trawl fishery is the primary source of mortality for sea turtles in Georgia. Shrimpers are required to use Turtle Excluder Devices (TEDs) in all trawl nets to reduce incidental capture and drowning of sea turtles. Poor TED compliance rates have hampered sea turtle recovery efforts in Georgia. Assuring high compliance with TED regulations is necessary for population recovery. In addition, a limited-entry system for the shrimp trawl fishery should be developed to reduce overall trawling effort and interactions with sea turtles. All other trawl fisheries should be monitored for sea turtle mortality (whelk, jellyfish) and conservation measures should be put in place if mortality is observed. Applying the North American Model of Wildlife Conservation to all of our amphibians and reptiles, an idea formally approved at the 2014 AFWA Business Meeting, should be pursued in Georgia to ensure sustainable use of herpetofaunal resources.

#### Conservation Planning

One of the greatest threats to diamondback terrapins is drowning in commercial and recreational crab pots. To address this, a terrapin conservation plan for these crab pot fisheries will be developed and implemented. The terrapin conservation plan should include the use of Terrapin Excluder Devices (TEDs), pot soak time requirements, closure areas, removal of abandoned pots, and the monitoring of the effectiveness of conservation efforts. Another significant threat to terrapins is mortality of nesting females on coastal roadways. To address this we will continue to experimentally assess methods and develop management guidelines for reducing terrapin mortality on coastal roadways, including techniques for installing seasonal barrier fences.

#### Addressing/Monitoring Climate Change Impacts

Warmer average temperatures, increased drought frequency and intensity, and sea level rise are predicted outcomes of climate change in the southeastern United States that are likely to have adverse effects on herpetofauna. Effects on habitat suitability are the most wide-ranging, but in the case of most of our turtle species and the American alligator, species that exhibit temperature-dependent sex determination, warming temperatures may skew sex ratios adversely. WRD cooperators will continue to monitor the length of incubation for all sea turtle nests in the

state, which is significantly correlated with incubation temperature and sex ratio. Additionally, WRD will continue periodic qualitative surveys of sea turtle nesting habitat on all barrier island beaches, categorizing each 100 m section as erosional or depositional based on beach and dune morphological characteristics. Annual surveys are compared to determine changes in the erosional state of sea turtle nesting habitat. Researchers at UGA conducted an “Amphibian and Reptile Climate Change Vulnerability Assessment” (Barrett, K., J.C. Maerz, and N. P. Nibbelink. 2012. Amphibian and Reptile Climate Vulnerability Assessment. Attachment A In Missouri Department of Conservation (Ed.), State Wildlife Action Plan Implementation Resources and Capacity Building Tools for Amphibian & Reptile Conservation, Final Report to US Fish & Wildlife Service. Competitive State Wildlife Grant No. U-3-R-1. FBMS No. F09AP00202. Jefferson City, MO) for select southeastern species, including ten (flatwoods salamander, tiger salamander, one-toed amphiuma, green salamander, hellbender, striped newt, gopher frog, eastern indigo snake, bog turtle, and gopher tortoise) that we consider high priority in Georgia. The predictions are dire for all high priority Georgia species in showing significant reductions in climatically suitable habitat. The assessment maps indicate where climatically suitable habitat is predicted to remain in 2050, and for the striped newt and flatwoods salamander, no habitat is predicted to remain. Several of the high priority species assessed (striped newt, flatwoods salamander, hellbender, eastern indigo snake, gopher tortoise) are part of continuing population monitoring efforts in Georgia, and over time we will be able to compare observations of them from the field with the predictive models. For pond-breeding amphibians such as striped newts, tiger salamanders, and gopher frogs, creating permanent fishless wetlands by installing flexible plastic liners in natural or excavated depressions is one method to mitigate for climate change impacts that may be explored.

## **Appendix E. Fishes and Aquatic Invertebrates Technical Team Report**

**Prepared by Brett Albanese, Jason M. Wisniewski and Andrew GaschoLandis**

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\*Team member participated via email correspondence

## Executive Summary

As part of the 2015 revision of Georgia's State Wildlife Action Plan (SWAP), the SWAP aquatic species technical team assessed the conservation status and needs of 251 rare aquatic species (fishes, mollusks, crayfishes, insects, and other aquatic invertebrates). The assessment was completed using expert opinion, published reports, and range maps that depicted watersheds categorized by the date of the species' last known occurrence as well as locations of occurrences and recent survey sites. While many species persist in all or most of their historically-occupied watersheds, an alarming proportion of fishes (42%), mollusks (43%) and crayfishes (25%) have been documented from half or fewer of their Georgia historic watersheds within the last decade. Lack of recent watershed occurrences can be attributed to either lack of sampling or population declines. Information gaps were particularly evident for aquatic insects and other arthropod species, which were frequently categorized as "unknown" for assessment criteria.

Overall, a significant number of Georgia's aquatic species can be considered imperiled. Eighty-six species are globally imperiled (G1-G2), half of which are mollusks. Within the state, 152 species are considered imperiled (S1-S2) and four dozen more are historic (SH—not seen in 20-40 years, but could still be extant) or considered extirpated (SX). Based on their degree of imperilment, information needs, and need for conservation within the next 5-10 years of SWAP implementation, the technical team identified 165 high priority species. The high priority species list includes 22 federally-listed species, a single candidate species, 46 species that are petitioned for federal listing (some additional petitioned species were not high priority because they are considered stable or extirpated from the state), and 109 species that are currently state-listed or merit state listing according to the species technical team (numbers do not add up because some species occur in multiple categories). Altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction were identified as significant threats to the greatest number of high priority aquatic species. While these results are sobering and indicate the magnitude of the aquatic conservation problem in Georgia, there have been some improvements since the first SWAP plan was completed in 2005. For example, seven species have been proposed for removal from the state-protected species list and an additional eight state-listed species were downgraded to a less imperiled listing category. Additionally, the status of some species proposed for listing under the U.S. Endangered Species Act (ESA), such as the Altamaha Arcmussel and the Apalachicola Floater, has improved since the first assessment due to the discovery of new populations.

In addition to numerous species-specific actions, the aquatic technical team identified 53 high priority conservation actions to be addressed during SWAP implementation. Proposed actions include distributional surveys and monitoring, research and conservation planning that will improve the effectiveness of conservation efforts, on the ground conservation actions, and environmental education and outreach. Meeting the conservation needs of SWAP high priority species is a daunting task and will require increased capacity and coordination, as well as the implementation of conservation actions with the potential to simultaneously benefit multiple species. The identification of watersheds that protect the greatest number of high priority aquatic species should help identify the places where a multi-species approach will be most effective.

## Introduction

Like other southeastern states, Georgia occurs within one of the most diverse regions for aquatic species richness in the temperate world (Abell et al. 2000). Georgia is among the top five states in the number of native species of mussels (127 species), fishes (265 species), and crayfishes (70 species). Unfortunately, Georgia is also ranked among the top states in the number of imperiled aquatic species (Taylor et al. 2007; Jelks et al. 2008; Johnson et al. 2013). Threats to Georgia's aquatic diversity and habitats are representative of the threats contributing to the global freshwater biodiversity crisis (Dudgeon et al. 2005) and include water pollution, flow alteration, habitat degradation and fragmentation, invasive species, and climate change. These threats are associated with urbanization, agricultural runoff and irrigation, dams and water withdrawals, riparian alteration, historic land use, and other human activities.

In an effort to prioritize conservation actions to conserve and restore Georgia's aquatic diversity, Georgia assessed the conservation needs of 376 aquatic taxa as part of the development of a [State Wildlife Action Plan \(SWAP\) in 2005](#). Completing the SWAP plan was necessary for funding under the State Wildlife Grants (SWG) program, but also provided an opportunity to systematically assess the status and conservation needs of Georgia's species and habitats. The SWAP 2005 assessment identified 74 fishes, 75 mollusks, 47 aquatic arthropods, and 212 waterbodies as high priority for conservation efforts. It also resulted in the addition of 42 aquatic species to Georgia's protected species list, the development of an online guide to rare species ([Georgia Department of Natural Resources 2010](#)), and provided guidance for many of the aquatic conservation projects that have been completed by GADNR and its partners since that time (Table 1).

**Table 1.** Examples of aquatic conservation projects initiated since completion of Georgia's State Wildlife Action Plan in 2005. Almost all of these projects address high priority species, habitats, or conservation actions identified in the 2005 SWAP Plan. Projects were completed by a variety of agencies, organizations, and other conservation partners. ACF = Apalachicola, Chattahoochee, and Flint drainage.

<u>Project Title</u>	<u>Year Completed</u>
ACF (Sawhatchee Creek) Mussel Monitoring	Ongoing
ACF (Spring Creek) Mussel Monitoring	Ongoing
ACF Crayfish Surveys	2007
ACF Dam Removals (Eagle & Phoenix and City Mills Dams)	2013
ACF Mussel Identification Workshops	Ongoing
ACF Reservoir/Flow Management Alternatives Study	2014
ACF Sheffields Mill Creek (Sawhatchee System) Stabilization Project	Ongoing
Alabama Shad Management Plan-ACF basin	2013
Altamaha River Mussel Monitoring	2008
Altamaha River Mussel Population Genetics Study	2010
Amber Darter Genetics Study	2011

<b><u>Project Title</u></b>	<b><u>Year Completed</u></b>
American Shad Management Plan for Altamaha River	2012
Blackbanded Sunfish Survey	2014
Blue Shiner Genetics Study	2008
Bluenose Shiner Survey	2007
Captive Propagation Techniques for Several Rare GA Aquatic Species	Ongoing
Cherokee Darter Genetics Study	2006
Conasagua Fishes Monitoring	Ongoing
Conasauga (Dill Creek) Fish Passage Removal	2011
Conasauga (Holly Creek) Mussel Monitoring	Ongoing
Conasauga (Holly Creek) Restoration Project (0.7 mile)	Need Date
Conasauga (Petty Farm) Stream Corridor Protection	2009
Conasauga Conservation Area	Ongoing
Conasauga Intersex Fishes/Human Health Study	Ongoing
Conasauga Nitrate/Estrogen/Glyphosate and Agricultural Runoff Studies	Ongoing
Conasauga Riparian Restoration (Alaculsey Valley)	2006
Conasauga Snorkel Hole Fish Education Program	Ongoing
Conasauga Spring Restoration (Colvard Springs)	Ongoing
Conasauga Sub-basin Prioritization	2009
Coosa Fish Passage Barriers –Priority Removal Evaluation	Ongoing
Coosa Mussel Reintroduction Study	Ongoing
Coosawattee Fishes Survey (Goldline, Bridled and Holiday darters)	2013
Coosawattee Flow Habitat Relationship Study	2010
Corps Permit Requirements for Culverts and Utility Crossings	2010
Crayfishes of Georgia Website	2012
Edmund's Snaketail and Cherokee Clubtail Dragonfly Surveys	2008
Etowah (Raccoon Creek) Restoration Monitoring	Ongoing
Etowah (Raccoon Creek) Basin Land Acquisition and Restoration	Ongoing
Etowah (Raccoon Creek) Fish Passage Project, Braswell Mtn. Rd	2013
Etowah (Shoal Creek) Preservation	Ongoing
Etowah (Smithwick Creek) Preservation and Restoration	Ongoing
Etowah Darter Genetics Study	2006
Etowah Fishes Monitoring	Ongoing
Etowah Fishes Stressors Study	2007
Etowah Habitat Conservation Plan Management Strategies	Ongoing
Etowah Mainstem Riparian Buffer Corridor Establishment	Ongoing
Fishes of Georgia Website	2008
Flint Mussel Age, Growth and Physiology Study	2014
Flint River Habitat Conservation Planning Project	Ongoing

<b><u>Project Title</u></b>	<b><u>Year Completed</u></b>
Flint River Mussel Monitoring	Ongoing
Goldline Darter Genetics Study	2012
Interagency Mussel Survey Protocol	2008
Lake Blackshear/Lake Harding Downstream Dissolved Oxygen Improvements	2008, 2011
Lake Sturgeon Reintroduction Program	Ongoing
Livestock Riparian Fencing Program (Partners for Fish and Wildlife)	2012
Multistate Prioritization of Small Barriers for Removal	Ongoing
Piedmont Blue Burrower Crayfish Survey	2010
Robust Redhorse Gravel Bar Monitoring	Ongoing
Robust Redhorse-Broad River Population Assessment	2013
Robust Redhorse-Ocmulgee River Population Assessment	2014
Robust Redhorse-Oconee River Telemetry Study	2012
Robust Redhorse-Ogeechee River Population Assessment	2013
Savannah Ecosystem Flows Alternatives Study	Ongoing
Say's Spiketail Dragonfly Survey	2008
Shoal Bass Genetic Integrity, Population Status, and Viability Studies	Ongoing
Sicklefin Redhorse Monitoring	Ongoing
Stream Fish Occurrence in Response to Impervious Surface Study	2008
Tennessee (South Chickamauga Creek) Fish Community/Passage Study	Ongoing
Tennessee (Toccoa River) Rare Fishes Survey and Riparian Assessment	2011
Tennessee Basin Mussels Survey	2014

Almost a decade has passed since the conservation needs of Georgia's aquatic species have been systematically assessed. In addition to the large number of conservation projects completed or initiated since 2005 ([Table 1](#)), substantial efforts have been made to update the GADNR Rare Species Database (also known as the NatureServe Biotics database) as well as databases maintained by the [GADNR Stream Survey Team](#), the [Georgia Museum of Natural History](#) and the U.S. Fish and Wildlife Service (FWS), Georgia Ecological Services Office. In addition, the need for up-to-date status information has been amplified because of the large number of Georgia aquatic species that have been petitioned for listing under the ESA. Petitioned species must undergo an intensive 12 month review to determine if listing under the ESA is warranted. Because of the limited resources available for the conservation of ESA listed species, it is important that the 12-month finding is based on the best available information.

The purpose of this assessment is to identify the current conservation status, conservation needs (e.g., surveys, monitoring, management) and high priority conservation actions for Georgia's rare aquatic species. A companion report has identified high priority watersheds for conservation (Albanese et al. 2015).

## Assessment Methods

We initially included 196 species in the assessment because they were designated as high priority for conservation in our SWAP plan in 2005. We added additional species because they had been formally petitioned for listing under the ESA or because of some concern or uncertainty about their current conservation status. Ultimately, 251 species were included in the current assessment, including 103 fishes, 28 crayfishes, 24 aquatic insects, 9 “other” arthropods (isopods, amphipods, shrimps, etc.), 56 mussels, and 31 snails. With the exception of three estuarine species, all species occur within freshwater or use freshwater habitats for some portion of their life cycle. We generally did not include historic or extirpated species in the assessment, unless there was uncertainty about their status or a realistic expectation for reintroduction or rediscovery.

The species assessment was carried out by technical team members during three single-day meetings held at the Georgia Wildlife Federation’s Alcovy Conservation Center in Covington, Georgia. We held separate meetings for freshwater fishes, freshwater mollusks (mussels and snails), and aquatic arthropods (crayfishes, insects, and cave invertebrates) during January and February 2014. Technical team members were split into groups, with each group assessing different groups of species based on their faunal and regional expertise. The following groups were identified: crayfishes, aquatic insects and cave invertebrates, Gulf/Atlantic Slope Basin mussels, Mobile Basin mussels, Tennessee Basin mussels, snails (all basins), Atlantic Slope Basin fishes, Mobile Basin fishes, Gulf Slope Basin fishes, and Tennessee Basin fishes.

We created an Access database (Microsoft Corp., Redmond WA, USA) to record the results of the species assessment. Assessment data fields were grouped into the following seven categories: current status, habitat, range, trends and threats, conservation needs, recommendations, and documentation. Definitions for some fields were slightly modified for relevance to aquatic species, as shown in Appendix 1. For each species, technical team members assigned qualitative categorical rankings to range size, the importance of Georgia protection efforts to global conservation, population trends, and degree of threat. Selecting from a list of 25 standardized threat descriptions, they also selected the three most significant threats to each species. The database included long comment boxes for specific recommendations for protection, inventory, monitoring, management, and research needs. Technical team members were asked to recommend changes to the State Rarity Rank (SRANK), status under Georgia’s Endangered Wildlife Act, whether the species should be identified as high priority in the revised SWAP, and whether the species should be tracked as a special concern species in Georgia’s Rare Species Database (i.e., NatureServe Biotics database). The hierarchical relationship between these different conservation status categories is shown in [Figure 1](#). Finally, for species designated as a high priority, we asked team members to identify up to four important watersheds for the conservation of each species, as described in our Georgia SWAP High Priority Watershed report (Albanese et. al 2015). The technical team spent approximately 5-20 minutes discussing each species while GADNR staff recorded their comments in the database. In addition, technical team members were provided an opportunity to review and edit draft assessment results in May 2014 and the draft assessment report in September 2014.

Key reference materials (e.g., taxonomic and distribution guides, reports), Georgia landcover maps and conservation status assessment maps were provided to technical team members to facilitate assessment completion. Conservation status assessment maps categorize USGS 10 digit Hydrologic Unit Code (HUC 10) watersheds by the year of the most recent occurrence of the species and also include locations of known occurrences and recent survey sites. These maps were used to help identify high priority watersheds for conservation, but also helped inform assessments of range size, trends, and areas in need of survey. We chose the HUC 10 spatial scale because we believe it provides a practical scale for the conservation of high priority watersheds (McGurrin and Forsgren 1997). In addition, mapping at finer spatial scales (HUC 12) was not prudent because many have not been surveyed. Using the maps, we determined the total number of HUC10 watersheds known for each species as well as the number of watersheds where the species has been documented within the last 10 years. A more detailed description of our conservation status assessment maps, along with conservation status maps for 193 species included in our SWAP assessment is found on the following web page: [http://www.georgiawildlife.com/conservation\\_status\\_assessment\\_maps](http://www.georgiawildlife.com/conservation_status_assessment_maps). We were not able to make maps for the remaining 58 species (primarily invertebrates) because of insufficient distributional data.

Species occurrence records used to make the conservation status assessment maps were compiled from the following sources: 1) GADNR Rare Species Database. This dataset includes records from research projects carried out by GADNR or its contractors, publications, consultant reports, and scientific collection permit reports, 2) GADNR Stream Survey Team Database. This dataset includes records collected from wadeable streams throughout Georgia between 1998-2011, 3) GADNR Fisheries Standardized Sampling Database. This dataset includes records collected from large rivers and reservoirs throughout Georgia between 1984-2013, but focuses primarily on game fishes and large-bodied species (<http://www.georgiawildlife.com/fishing/fisheries-management>), and 4) Records from the Georgia Museum of Natural History (<http://museum.nhm.uga.edu/>). These records are a compilation of historic and recent surveys performed by independent researchers as well as research staff of the University of Georgia. Additional species occurrence records provided by assessment team members were added to the databases as needed after technical team meetings.

## Hierarchy of Conservation Statuses In Georgia

**Special Concern**—Species (and natural communities) that are monitored or tracked in the Georgia DNR Rare Species Database. This category includes high priority, state listed, ESA listed, and other species that warrant long-term monitoring. Special concern status does not provide any legal protections. All special concern species are assigned a state rarity rank (SRANK) to indicate their conservation status.

**High Priority**—Species that are officially designated in Georgia’s State Wildlife Action Plan (SWAP). This category includes state listed, ESA listed, and other species that merit conservation during SWAP implementation. Some high priority species may not actually be declining, but were identified because of survey or information needs. This category is equivalent to Species of Greatest Conservation Need (SGCN) identified in other State Wildlife Action Plans. By itself, high priority status does not provide any legal protections.



**State Listed**—Species that are legally protected under Georgia’s Endangered Wildlife Act or Wildflower Preservation Act. This status includes all ESA listed species that occur in Georgia, as well as other species that are at risk of extinction within our state boundaries. Species can be listed as Endangered, Rare, Threatened or Unusual.

**ESA Listed**—Species that are federally protected under the U.S. Endangered Species Act (ESA) as threatened or endangered with extinction. Candidate species meet the requirements for ESA listing, but have not been officially listed. Petitioned species have been legally petitioned for listing under the ESA, but have not yet been evaluated to determine if they meet the requirements for listing.

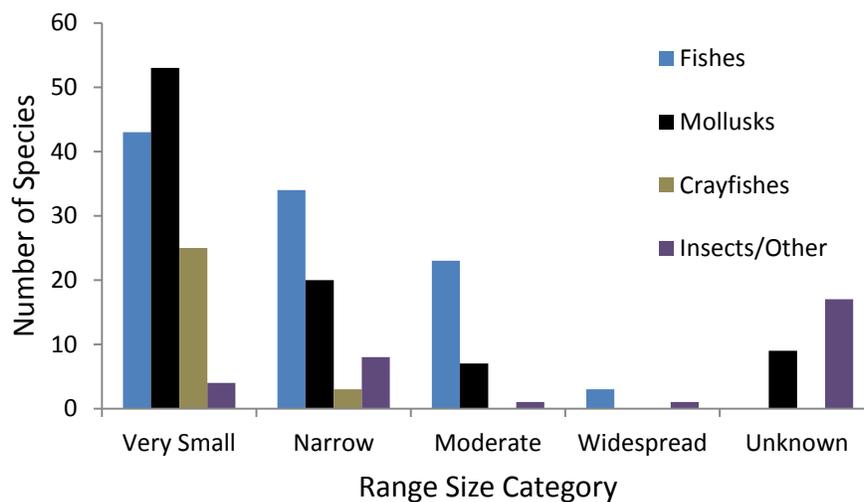
**Figure 1.** Hierarchy of frequently used conservation status categories in Georgia. Although there are rare exceptions (e.g., an ESA listed species that is not state-listed because it is considered extirpated), the figure shows how the more restrictive categories containing fewer species are nested within the larger, less restrictive categories. Thus an ESA listed species is almost always designated as state listed, high priority and special concern.

### Assessment Results

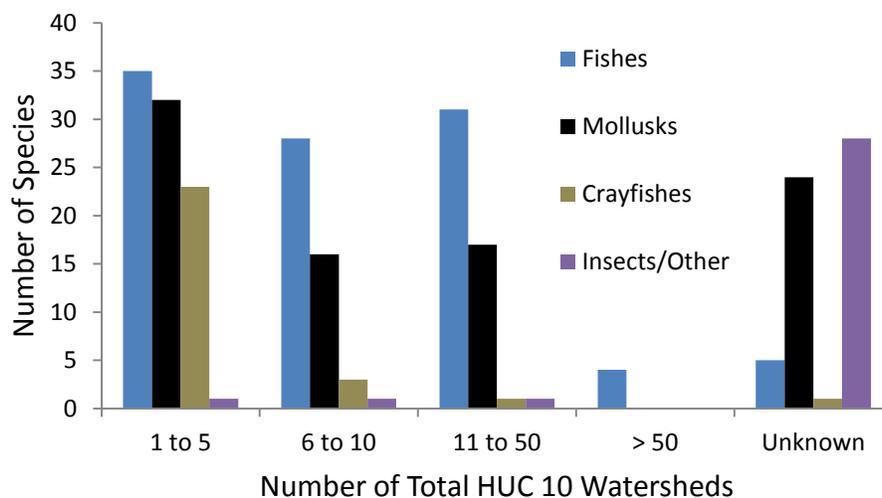
#### Categorical Assessment Criteria: Range, Georgia Importance, and Trends

The majority of fishes and mollusks and all of the crayfishes included in the assessment were categorized as having a very small to narrow geographic range ([Figure 2](#)). To put this in perspective, the majority of fishes (61%) and mollusks (54%) are known from fewer than 10 HUC 10 watersheds and 82% of the crayfishes assessed are known from five or fewer watersheds ([Figure 3](#)). Protection efforts in Georgia were considered critical or very important to the global conservation of the majority of mollusks and crayfishes included in the assessment and almost half of the fishes ([Figure 4](#)). Population trends were categorized as unknown for the vast majority of species included in the assessment largely due to the technical team’s unwillingness to speculate without detailed trend data ([Figure 5](#)). Several species that have been monitored periodically in the past (e.g., Altamaha Spinymussel, Robust Redhorse) were

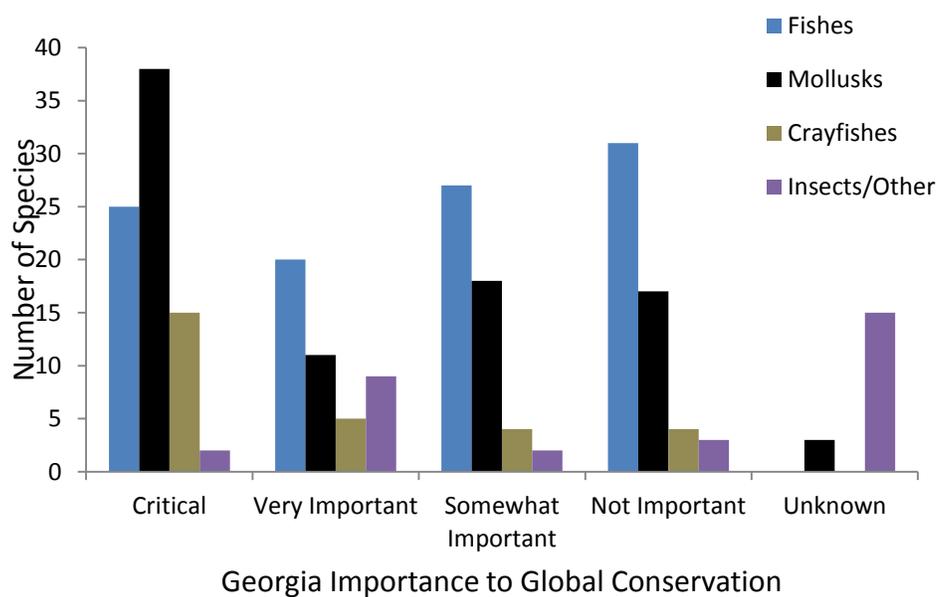
categorized as rapidly declining or declining but many crayfish species were categorized as stable. While some species are persisting in all or most of their historically-occupied watersheds, an alarming proportion of fishes (42%), mollusks (43%) and crayfishes (25%) have been documented from half or fewer of their Georgia historic watersheds within the last decade ([Figure 6](#)). These results stem from lack of recent, targeted surveys for some species, but also suggest that some populations have likely declined or have become extirpated. For example, examination of the [conservation status map](#) for the Frecklebelly Madtom (*Noturus munitus*) illustrates that this species has not been detected in the Conasauga River system in over 10 years despite extensive survey efforts. Due to lack of information, the majority of insects and other invertebrates were categorized as unknown for range size, Georgia importance to conservation, and population trends.



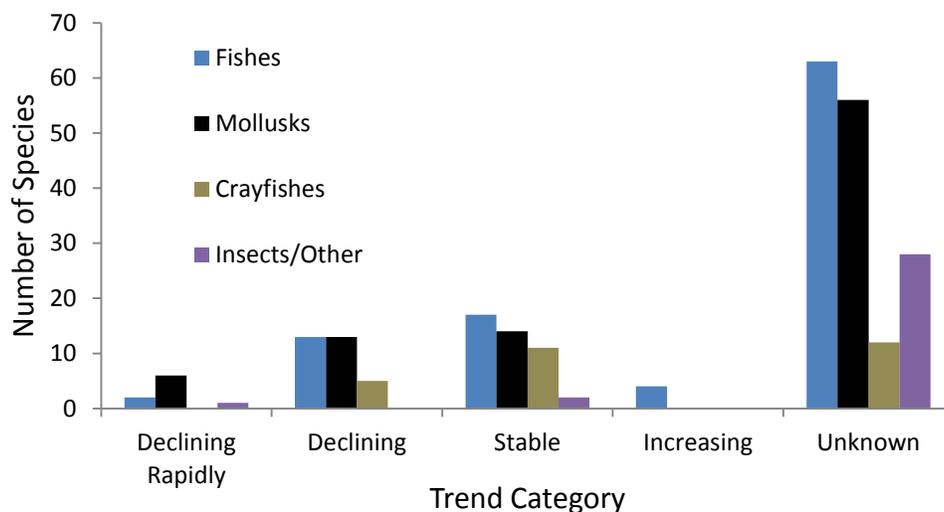
**Figure 2.** Range size category by taxonomic group as determined for Georgia’s 2015 SWAP revision.



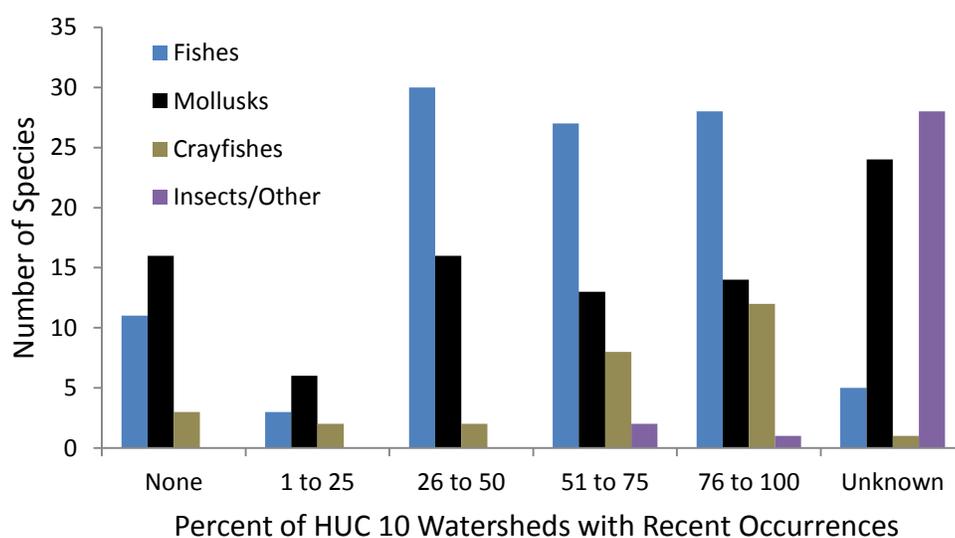
**Figure 3.** Total number of HUC 10 watersheds species have been documented from, summarized by taxonomic group for all species assessed during Georgia's 2015 SWAP revision.



**Figure 4.** Importance of Georgia populations to global conservation for all species considered in Georgia's 2015 SWAP revision, summarized by taxonomic group.



**Figure 5.** Trend category by taxonomic group as determined for all species assessed during Georgia’s 2015 SWAP revision.



**Figure 6.** Percent of historic HUC 10 watersheds with recent occurrences (within the past decade) of species assessed during Georgia’s 2015 SWAP revision, summarized by taxonomic group. This figure does not include species that were considered extirpated when the assessment was initiated.

## Special Concern, High Priority, and State Protection Status Recommendations

The technical team recommended a significant increase (n=28) in the number of special concern species, mostly due to the addition of several globally rare snail species with no or very few occurrences in our database ([Table 2](#)). In contrast, the number of species designated as high priority declined by 33 species, which reflects a desire to focus our limited resources. Nonetheless, there are still 165 high priority aquatic species recognized in Georgia. Finally, in contrast to the first SWAP plan which resulted in the addition of 42 aquatic species to Georgia's protected species list, changes proposed by the current technical team would not result in a net increase in the number of state-listed species. Proposed changes include the removal of five fishes and five mollusks and the addition of one fish, five mollusks, three crayfishes, and one insect (Note: three of the mollusks are proposed for removal because they are extirpated or no longer recognized from Georgia). These are only proposed changes and will have to be formally considered and approved by the Board of Natural Resources as specified in DNR Rule 391-4-10. The technical teams also changed the status category (e.g., Threatened to Endangered) for 10 state-protected species to better reflect their current biological status. Eight of these species were downlisted to a less imperiled status category (e.g, Endangered to Threatened), while two species were elevated to a more imperiled category. [Table 3](#) lists the current and proposed status of all species considered in the assessment.

Overall, a significant proportion of Georgia's aquatic species can be considered imperiled ([Table 4](#)). Eighty-six species are considered imperiled globally, half of which are mollusks. Almost twice as many species (n=152) are considered imperiled within the state of Georgia and dozens of species (n=48) are historic or considered extirpated from the state. Over half of the 41 federally-listed animal species currently occurring in Georgia are aquatic species. Similarly, an additional 48 extant aquatic species have been petitioned for listing under the ESA. However, our assessment results suggest that the status of some of these petitioned species may be improving. For example, the Apalachicola Floater was changed from S1 (critically imperiled) to S4 (apparently secure) and proposed for removal from the state-protected species list due to the discovery of new populations.

**Table 2.** Number of species that are special concern (SC), designated as high priority (HP) and state-protected (SP) as recommended during the 2005 SWAP plan and the 2015 revision.

<b>Group</b>	<b>SC2005</b>	<b>SC2015</b>	<b>HP2005</b>	<b>HP2015</b>	<b>SP2005</b>	<b>SP2015</b>
Fishes	80	89	74	78	58	54
Mollusks	62	79	75	57	28	28
Crayfishes	27	26	20	24	20	23
Insects/Other	26	29	27	7	3	4
Total	195	223	196	166	109	109

**Table 3.** Global rarity rank (GR, as determined by NatureServe), current status under the ESA, whether or not it is petitioned for ESA listing (PETIT.), state rarity rank (SR), state protection status (SP), high priority status (HP) and special concern status (SC) as recommended in the 2005 SWAP Plan or in the current (2015) revision. See Appendix I for status definitions.

SCIENTIFIC NAME/Group	COMMON NAME	GR	ESA	PETIT.	SR2005	SR2015	SP2005	SP2015	HP2005	HP2015	SC2005	SC2015
<b>Fishes</b>												
<i>Acipenser brevirostrum</i>	Shortnose Sturgeon	G3	LE	NO	S2	S2	E	E	YES	YES	YES	YES
<i>Acipenser fulvescens</i>	Lake Sturgeon	G3G4		NO	S1	S3			YES	YES	YES	YES
<i>Acipenser oxyrinchus desotoi</i>	Gulf Sturgeon	G3T2	LT	NO	SX	SX			YES	YES	YES	YES
<i>Acipenser oxyrinchus oxyrinchus</i>	Atlantic Sturgeon	G3T3	LE	NO	S3	S3	E	E	NO	YES	YES	YES
<i>Alosa aestivalis</i>	Blueback Herring	G3G4		NO	SNR	S3			NO	NO	NO	NO
<i>Alosa alabamae</i>	Alabama Shad	G2G3		YES	S1	S1	T	T	YES	YES	YES	YES
<i>Alosa sapidissima</i>	American Shad	G5		NO	S5	S5			NO	YES	NO	NO
<i>Ameiurus serracanthus</i>	Spotted Bullhead	G3		NO	S2	S3	R	R	YES	YES	YES	YES
<i>Anguilla rostrata</i>	American Eel	G4		YES	S3S4	S4			NO	NO	NO	NO
<i>Carpoides velifer</i>	Highfin Carpsucker	G4G5		NO	SNR	S2S3			NO	YES	NO	YES
<i>Chologaster cornuta</i>	Swampfish	G5		NO	S2S3	S2S3			NO	YES	YES	YES
<i>Clinostomus funduloides</i>	Rosyside Dace	G5		NO	S1S3	S4			NO	NO	YES	NO
<i>Clinostomus funduloides</i> ssp. 1	Smoky Dace	G5T3Q		NO	S2S3	S3			NO	NO	NO	YES
<i>Cynoscion nebulosus</i>	Spotted Seatrout	G5		NO		S5			NO	YES	NO	NO
<i>Cyprinella caerulea</i>	Blue Shiner	G2	LT	NO	S1	S2	E	E	YES	YES	YES	YES
<i>Cyprinella callitaenia</i>	Bluestripe Shiner	G2G3		YES	S2	S2	R	R	YES	YES	YES	YES
<i>Cyprinella gibbsi</i>	Tallapoosa Shiner	G4		NO	S2S3	S3			YES	YES	YES	YES
<i>Cyprinella xaenura</i>	Altamaha Shiner	G2G3		YES	S2S3	S2S3	T	T	YES	YES	YES	YES
<i>Elassoma gilberti</i>	Gulf Coast Pygmy Sunfish	G4G5		NO	S1S3	S2S3			NO	YES	YES	YES
<i>Elassoma okatie</i>	Bluebarred Pygmy Sunfish	G2G3		NO	S1S2	S1	E	E	YES	YES	YES	YES
<i>Enneacanthus chaetodon</i>	Blackbanded Sunfish	G3G4		NO	S1	S1	E	E	YES	YES	YES	YES
<i>Erimonax monachus</i>	Spotfin Chub	G2	LT	NO	SX	SX			YES	YES	YES	YES
<i>Erimystax insignis</i>	Blotched Chub	G4		NO	S2	S2	E	T	YES	YES	YES	YES
<i>Etheostoma brevirostrum</i>	Holiday Darter	G2		YES	S2	S1	E	E	YES	YES	YES	YES
<i>Etheostoma chlorobranchium</i>	Greenfin Darter	G4		NO	S1	S2	T	R	YES	YES	YES	YES
<i>Etheostoma chuckwachatte</i>	Lipstick Darter	G3		NO	S1S2	S2	E	E	YES	YES	YES	YES
<i>Etheostoma cinereum</i>	Ashy Darter	G2G3		YES	SH	SX			YES	YES	YES	YES
<i>Etheostoma ditrema</i>	Coldwater Darter	G2		NO	S1	S1	E	E	YES	YES	YES	YES

<u>SCIENTIFIC NAME/Group</u>	<u>COMMON NAME</u>	<u>GR</u>	<u>ESA</u>	<u>PETIT.</u>	<u>SR2005</u>	<u>SR2015</u>	<u>SP2005</u>	<u>SP2015</u>	<u>HP2005</u>	<u>HP2015</u>	<u>SC2005</u>	<u>SC2015</u>
Etheostoma duryi	Blackside Snubnose Darter	G4		NO	S1	S1	R		YES	YES	YES	YES
Etheostoma edwini	Brown Darter	G5		NO	S3	S5			NO	NO	NO	NO
Etheostoma etowahae	Etowah Darter	G1	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Etheostoma fricksium	Savannah Darter	G4		NO	S2	S2			NO	NO	YES	YES
Etheostoma gutschelli	Tuckasegee Darter	G3G4		NO	S2	S2			NO	YES	YES	YES
Etheostoma parvipinne	Goldstripe Darter	G4G5		NO	S2S3	S2S3	R	R	YES	YES	YES	YES
Etheostoma rufilineatum	Redline Darter	G5		NO	S1S3	S1S3			YES	YES	YES	YES
Etheostoma rupestre	Rock Darter	G4		NO	S2	S2	R	R	YES	YES	YES	YES
Etheostoma scotti	Cherokee Darter	G2	LT	NO	S2	S2	T	T	YES	YES	YES	YES
Etheostoma serrifer	Sawcheek Darter	G5		NO	S2	S2			NO	NO	YES	YES
Etheostoma tallapoosae	Tallapoosa Darter	G4		NO	S2S3	S3	R		YES	NO	YES	YES
Etheostoma trisella	Trispot Darter	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Etheostoma vulneratum	Wounded Darter	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Etheostoma zonale	Banded Darter	G5		NO	S1S2	S3			YES	NO	YES	NO
Fundulus bifax	Stippled Studfish	G2G3		NO	S1	S1	E	E	YES	YES	YES	YES
Fundulus catenatus	Northern Studfish	G5		NO	S1S2	S2	R	R	YES	YES	YES	YES
Fundulus cingulatus	Banded Topminnow	G4		NO	S1	S1			YES	NO	NO	YES
Fundulus luciae	Spotfin Killifish	G4		NO	S1S3	SU			NO	NO	NO	YES
Fundulus rubrifrons	Redfaced Topminnow	G4		NO	SU	SU			NO	NO	YES	YES
Hemiremia flammea	Flame Chub	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Hiodon tergisus	Mooneye	G5		NO	S1	S1		T	YES	YES	YES	YES
Hybopsis amblops	Bigeye Chub	G5		NO	S2	S3			YES	NO	NO	NO
Hybopsis lineapunctata	Lined Chub	G3G4		NO	S2	S2	R	R	YES	YES	YES	YES
Hybopsis sp. 9	Etowah Chub	G1Q		NO	S1	S1S2			YES	YES	NO	YES
Ichthyomyzon bdellium	Ohio Lamprey	G3G4		NO	S1S2	S1	R	R	YES	YES	YES	YES
Lampetra aepyptera	Least Brook Lamprey	G5		NO	S3	S2			NO	YES	NO	YES
Lethenteron appendix	American Brook Lamprey	G4		NO	SNA	S1			NO	NO	NO	YES
Lucania goodei	Bluefin Killifish	G5		NO	S1	S1	R	R	YES	YES	YES	YES
Lythrurus bellus	Pretty Shiner	G5		NO	S2	S3			YES	NO	YES	YES
Lythrurus lirus	Mountain Shiner	G4		NO	S3	S3			YES	YES	YES	YES
Macrhybopsis sp. 1	Coosa Chub	G3G4		NO	S2	S1	E	E	YES	YES	YES	YES
Micropterus cataractae	Shoal Bass	G3		NO	S3	S2			NO	YES	YES	YES
Micropterus chattahoochee	Chattahoochee Bass	GNR		NO		S1			NO	YES	NO	YES
Micropterus notius	Suwannee Bass	G3		NO	S2	S2	R	R	YES	YES	YES	YES

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Micropterus sp. cf coosae "Alt."	Undescribed Redeye Bass	GNR		NO		S3			NO	YES	NO	YES
Micropterus sp. cf coosae "Sav."	Bartrams Bass	GNR		NO		S3			NO	YES	NO	YES
Moxostoma carinatum	River Redhorse	G4		NO	S2	S3	R	R	YES	YES	YES	YES
Moxostoma lachneri	Greater Jumprock	G4		NO	S3	S3			NO	NO	NO	NO
Moxostoma robustum	Robust Redhorse	G1		YES	S1	S1	E	E	YES	YES	YES	YES
Moxostoma sp. 1	Apalachicola Redhorse	G3		NO	S3	S3			NO	NO	YES	YES
Moxostoma sp. 2	Sicklefin Redhorse	G2Q	C	NO	S1	S1	E	E	YES	YES	YES	YES
Moxostoma sp. 4	Brassy Jumprock	G4		NO	S3S4	S3			NO	NO	NO	YES
Notropis ariommus	Popeye Shiner	G3		YES	S1	S1	E	E	YES	YES	YES	YES
Notropis asperifrons	Burrhead Shiner	G4		NO	S2	S2	T	T	YES	YES	YES	YES
Notropis chalybaeus	Ironcolor Shiner	G4		NO	S2S3	S3			NO	NO	YES	YES
Notropis harperi	Redeye Chub	G4		NO	S3	S3			YES	NO	NO	NO
Notropis hypsilepis	Highscale Shiner	G3		NO	S3	S3	R	R	YES	YES	YES	YES
Notropis photogenis	Silver Shiner	G5		NO	S1	S1	E		YES	YES	YES	YES
Notropis scepticus	Sandbar Shiner	G4		NO	S2	S2	R	R	YES	YES	YES	YES
Noturus eleutherus	Mountain Madtom	G4		NO	S1	S1	E	E	YES	YES	YES	YES
Noturus flavipinnis	Yellowfin Madtom	G1	LT	NO	SX	SX			YES	YES	YES	YES
Noturus munitus	Frecklebelly Madtom	G3		YES	S1	S1	E	E	YES	YES	YES	YES
Percina antesella	Amber Darter	G1G2	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Percina aurantiaca	Tangerine Darter	G4		NO	S1	S2	E	T	YES	YES	YES	YES
Percina aurolineata	Goldline Darter	G2	LT	NO	S1	S2	E	E	YES	YES	YES	YES
Percina crypta	Halloween Darter	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Percina jenkinsi	Conasauga Logperch	G1	LE	NO	S1	S1	E	E	YES	YES	YES	YES
Percina kusha	Bridled Darter	G2		YES	S1	S1	E	E	YES	YES	YES	YES
Percina lenticula	Freckled Darter	G3		NO	S1	S2	E	T	YES	YES	YES	YES
Percina sciera	Dusky Darter	G5		NO	S1S2	S3	R		YES	YES	YES	YES
Percina shumardi	River Darter	G5		NO	S1	SX	E		YES	NO	YES	YES
Percina smithvanizi	Muscadine Darter	G3		NO	S2	S3	R	R	YES	YES	YES	YES
Percina squamata	Olive Darter	G3		NO	S1	S1	E	E	YES	YES	YES	YES
Percina tanasi	Snail Darter	G2G3	LT	NO	S1	S1	E	E	YES	YES	YES	YES
Phenacobius crassilabrum	Fatlips Minnow	G3G4		NO	S1	S2	E	T	YES	YES	YES	YES
Phenacobius uranops	Stargazing Minnow	G4		NO	S1	S1	T	T	YES	YES	YES	YES
Phoxinus tennesseensis	Tennessee Dace	G3		NO	S1	S1	E	E	YES	YES	YES	YES

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<i>Pteronotropis euryzonus</i>	Broadstripe Shiner	G3		YES	S2	S3	R	R	YES	YES	YES	YES
<i>Pteronotropis metallicus</i>	Metallic Shiner	G4		NO	S2?	S3			NO	NO	YES	YES
<i>Pteronotropis stonei</i>	Lowland Shiner	G5		NO	S3S4	S4			NO	NO	NO	NO
<i>Pteronotropis welaka</i>	Bluenose Shiner	G3G4		NO	S1	S1	T	T	YES	YES	YES	YES
<i>Salvelinus fontinalis</i>	Brook Trout	G5		NO	S5	S3			NO	NO	NO	NO
<i>Sphryna lewini</i>	Scalloped Hammerhead	GNR		NO		S2S3			NO	YES	NO	NO
<i>Typhlichthys subterraneus</i>	Southern Cavefish	G4		NO	S1	S1	E	E	YES	YES	YES	YES
<i>Umbra pygmaea</i>	Eastern Mudminnow	G5		NO	S2S3	S3S4			NO	NO	NO	NO
<b>Mollusks (Mussels and Snails)</b>												
<i>Alasmidonta arcula</i>	Altamaha Arcmussel	G2		YES	S2	S3	T		NO	YES	YES	YES
<i>Alasmidonta triangulata</i>	Southern Elktoe	G1Q		YES	S1	S1	E	E	NO	YES	YES	YES
<i>Alasmidonta varicosa</i>	Brook Floater	G3		YES	S2	S2			NO	NO	YES	YES
<i>Amblema elliottii</i>	Coosa Fiveridge	G3		NO	S2	S3			NO	NO	YES	YES
<i>Amblema neislerii</i>	Fat Threeridge	G1	LE	NO	S1	S1	E	E	NO	YES	YES	YES
<i>Anodonta couperiana</i>	Barrel Floater	G4		NO	SNR	S4			NO	NO	NO	YES
<i>Anodonta heardi</i>	Apalachicola Floater	G1G2		YES	S1	S4	R		NO	NO	YES	YES
<i>Anodontoides radiatus</i>	Rayed Creekshell	G3		YES	S2	S2	T	T	NO	YES	YES	YES
<i>Athearnia anthonyi</i>	Anthony's River Snail	G1	LE	NO	SH	SH			NO	NO	YES	NO
<i>Athearnia crassa</i>	Boulder Snail	GX		NO		SNA			NO	NO	NO	NO
<i>Campeloma regulare</i>	Cylinder campeloma	G4		NO	S2	S2		T	NO	YES	YES	YES
<i>Crassostrea virginica</i>	American Oyster	G5		NO		S4			NO	YES	NO	NO
<i>Elimia albanyensis</i>	Black-crest Elimia	G3Q		NO	S5	S5			NO	NO	NO	NO
<i>Elimia boykiniana</i>	Flaxen Elimia	G2Q		NO	SH	SH			NO	NO	YES	YES
<i>Elimia caelatura</i>	Savannah Elimia	G3		NO		S3			NO	NO	NO	YES
<i>Elimia capillaris</i>	Spindle Elimia	GX		NO	SU	SX			NO	NO	YES	NO
<i>Elimia darwini</i>	Pup Elimia	G1		NO		S1			NO	YES	NO	YES
<i>Elimia inclinans</i>	Slanted Elimia	G1G2		NO		S1S2			NO	YES	NO	YES
<i>Elimia induta</i>	Gem Elimia	G2		NO		S2			NO	YES	NO	YES
<i>Elimia lecontiana</i>	Rippled Snail	G2G3		NO		S3			NO	NO	NO	YES
<i>Elimia mutabilis</i>	Oak Elimia	G2Q		NO		S2			NO	YES	NO	YES
<i>Elimia ornata</i>	Ornate Elimia	G1		NO	S1	S1			NO	YES	YES	YES
<i>Elimia striatula</i>	File Elimia	G2		NO	S1	S1			NO	YES	YES	YES
<i>Elimia timida</i>	Timid Elimia	G1		NO		S1			NO	YES	NO	YES
<i>Elliptio ahenea</i>	Southern Lance	G3		NO	SNR	S2			NO	NO	NO	YES

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Elliptio arca	Alabama Spike	G2G3Q		YES	S1	S1	E	E	NO	YES	YES	YES
Elliptio arctata	Delicate Spike	G2G3Q		YES	S1S3	S2	E	E	NO	YES	YES	YES
Elliptio fraterna	Brother Spike	G1		YES	S1	S1			NO	YES	YES	YES
Elliptio monroensis	St. John's Elephantear	G2G3		NO		S2			NO	NO	NO	YES
Elliptio nigella	Winged Spike	G1		NO	S1	S2		T	NO	YES	YES	YES
Elliptio occulta	Hidden Spike	GNR		NO		S4			NO	NO	NO	YES
Elliptio purpurella	Inflated Spike	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Elliptio roanokensis	Roanoke Slabshell	G3		NO	S2	S2			NO	NO	YES	YES
Elliptio spinosa	Altamaha Spiny mussel	G1G2	LE	NO	S1S2	S1	E	E	NO	YES	YES	YES
Elliptoideus sloatianus	Purple Bankclimber	G2	LT	NO	S2	S2	T	T	NO	YES	YES	YES
Fusconaia masoni	Atlantic Pigtoe	G2		YES	S1	S1	E	E	NO	YES	YES	YES
Hamiota altilis	Finelined Pocketbook	G2G3	LT	NO	S1S2	S2	T	T	NO	YES	YES	YES
Hamiota subangulata	Shinyrayed Pocketbook	G2	LE	NO	S2	S2	E	E	NO	YES	YES	YES
Lampsilis binominata	Lined Pocketbook	GX		NO	SX	SX			NO	NO	YES	YES
Lampsilis cariosa	Yellow Lampmussel	G3G4		NO	S2	S3			NO	YES	YES	YES
Lampsilis straminea	Southern Fatmucket	G5T		NO	S3	S2		R	NO	YES	NO	YES
Lasmigona alabamensis	Alabama Heelsplitter	G3		NO	S1	S1			NO	NO	YES	YES
Lasmigona etowaensis	Etowah Heelsplitter	G3		NO	S3	S3			NO	NO	YES	YES
Lasmigona holstonia	Tennessee Heelsplitter	G3		YES	S1	S1			NO	YES	YES	YES
Leptodea ochracea	Tidewater Mucket	G3G4		NO		S3			NO	NO	NO	YES
Leptoxis foremani	Interrupted Rocksnail	G1	E	NO	S1	S1	E	E	NO	YES	YES	YES
Leptoxis praerosa	Onyx Rocksnail	G5		NO	S1	S1			NO	YES	YES	YES
Marstonia agarhecta	Ocmulgee Marstonia	G1		YES	S1	S1			NO	YES	YES	YES
Marstonia castor	Beaverpond Marstonia	G1		YES	S1	S1			NO	YES	YES	YES
Marstonia gaddisorum	Emily's Marstonia	G1		NO		S1			NO	YES	NO	YES
Marstonia halcyon	Halcyon Marstonia	G4		NO		S3			NO	NO	NO	YES
Medionidus acutissimus	Alabama Moccasinshell	G2	LT	NO	S1	S1	T	E	NO	YES	YES	YES
Medionidus conradicus	Cumberland Moccasinshell	G3G4		YES	SH	S1			NO	YES	YES	YES
Medionidus parvulus	Coosa Moccasinshell	G1Q	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Medionidus penicillatus	Gulf Moccasinshell	G2	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Medionidus simpsonianus	Ochlockonee Moccasinshell	G1	LE	NO	SH	SH	E	E	NO	YES	YES	YES
Medionidus walkeri	Suwannee Moccasinshell	GNR		YES		SX			NO	YES	NO	YES
Notogillia sathon	Satyr Siltsnail	G5		NO		S3			NO	NO	NO	YES
Pleurobema decisum	Southern Clubshell	G2	LE	NO	S1	S1	E	E	NO	YES	YES	YES

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Pleurobema georgianum	Southern Pigtoe	G1	LE	NO	S1	S1	E	E	NO	YES	YES	YES
Pleurobema hanleyianum	Georgia Pigtoe	G1	E	NO	S1	S1	E	E	NO	YES	YES	YES
Pleurobema hartmanianum	Cherokee Pigtoe	G1		NO	SNR	S1			NO	YES	NO	YES
Pleurobema pyriforme	Oval Pigtoe	G2	LE	NO	S2	S1	E	E	NO	YES	YES	YES
Pleurocera foremani	Rough Hornsnail	G1	E	NO	SNA	SX			NO	NO	YES	NO
Pleurocera pyrenella	Skirted Hornsnail	G2		YES	SH	S2			NO	YES	YES	YES
Pleurocera showalteri	Upland Hornsnail	G2Q		NO	S1	S1		E	NO	YES	YES	YES
Pleurocera trochiformis	Sulcate Hornsnail	G2		NO	SH	SH			NO	NO	YES	NO
Pleurocera vestita	Brook hornsnail	G3		NO	S2	S2			NO	YES	YES	YES
Pleuroaia barnesiana	Tennessee Pigtoe	G2G3		YES	SNR	S1		R	NO	YES	YES	YES
Potamilus purpuratus	Bleufer	G5		NO	S1	S1?			NO	NO	YES	YES
Ptychobranchus fasciolaris	Kidneyshell	G4G5		NO	SH	S1			NO	YES	YES	YES
Ptychobranchus foremanianus	Rayed Kidneyshell	G1		NO	S1	S1	E	E	NO	YES	YES	YES
Quadrula asperata	Alabama Orb	G4		NO	S4	S3			NO	NO	NO	YES
Quadrula kleiniana	Suwannee Pigtoe	G2G3		NO	SNR	S2			NO	YES	NO	YES
Quadrula rumphiana	Ridged Mapleleaf	G4		NO	S3	S3			NO	NO	YES	YES
Somatogyrus alcoviensis	Reverse Pebblesnail	G1Q		YES	S1	S1			NO	YES	YES	YES
Somatogyrus rheophilus	Flint Pebblesnail	G1		NO		S1			NO	YES	NO	YES
Somatogyrus tenax	Savannah Pebblesnail	G2G3Q		NO	S2S3	S2S3			NO	YES	YES	YES
Spilochlamys turgida	Pumpkin Siltsnail	G5		NO		S4			NO	NO	NO	YES
Strophitus connasaugaensis	Alabama Creekmussel	G3		NO	S1	S1	E	E	NO	YES	YES	YES
Toxolasma corvunculus	Southern Purple Lilliput	G1		NO	S1	S1?			NO	YES	YES	YES
Toxolasma lividum	Purple Lilliput	G3Q		YES	SH	SX			NO	NO	YES	NO
Toxolasma parvum	Lilliput	G5		NO	SH	S4			NO	NO	NO	NO
Toxolasma pullus	Savannah Lilliput	G2		YES	S2	S2	T	T	NO	YES	YES	YES
Truncilla donaciformis	Fawnsfoot	G5		NO	S1	S1?			NO	NO	YES	YES
Villosa nebulosa	Alabama Rainbow	G3		YES	S2	S2			NO	YES	YES	YES
Villosa umbrans	Coosa Creekshell	G2		YES	S1S2	S2			NO	YES	YES	YES
Villosa vanuxemensis	Mountain Creekshell	G4		NO	S1S2	S3			NO	NO	YES	YES
<b>Crayfishes</b>												
Cambarus chaugaensis	Chauga River Crayfish	G2		YES	S1	SNA			YES	NO	YES	NO
Cambarus coosawattae	Coosawattee Crayfish	G2		YES	S1	S2	E	T	YES	YES	YES	YES
Cambarus cryptodytes	Dougherty Plain Cave Crayfish	G2		YES	S1S2	S2	T	T	YES	YES	YES	YES

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<i>Cambarus cymatilis</i>	Conasauga Blue Burrower	G1		YES	S1	S1	E	E	YES	YES	YES	YES
<i>Cambarus distans</i>	Boxclaw Crayfish	G5		NO	S1	S1		E	YES	YES	YES	YES
<i>Cambarus doughertyensis</i>	Dougherty Burrowing Crayfish	G1		NO	S1	S1	E	E	YES	YES	YES	YES
<i>Cambarus englishi</i>	Tallapoosa Crayfish	G3		NO	S2	S2	R	T	YES	YES	YES	YES
<i>Cambarus extraneus</i>	Chickamauga Crayfish	G2		YES	S2	S2	T	T	YES	YES	YES	YES
<i>Cambarus fasciatus</i>	Etowah Crayfish	G3		YES	S2	S2	T	T	YES	YES	YES	YES
<i>Cambarus georgiae</i>	Little Tennessee Crayfish	G2G3		YES	S1	S1	E	E	YES	YES	YES	YES
<i>Cambarus harti</i>	Piedmont Blue Burrower	G1		YES	S1	S1	E	E	YES	YES	YES	YES
<i>Cambarus howardi</i>	Chattahoochee Crayfish	G3Q		NO	S3	S2	T	T	YES	YES	YES	YES
<i>Cambarus longirostris</i>	Longnose Crayfish	G5Q		NO	S1	S1			YES	NO	YES	YES
<i>Cambarus manningi</i>	Greensaddle Crayfish	G4		NO	S2	S1?			NO	YES	YES	YES
<i>Cambarus parrishi</i>	Hiwassee Headwaters Crayfish	G2		YES	S1	S1	E	E	YES	YES	YES	YES
<i>Cambarus parvovulus</i>	Mountain Midget Crayfish	G5		NO	S1	S3			YES	NO	YES	NO
<i>Cambarus scotti</i>	Chattooga River Crayfish	G3		NO	S2S3	S2	T	T	YES	YES	YES	YES
<i>Cambarus speciosus</i>	Beautiful Crayfish	G2		YES	S2	S2	E	T	YES	YES	YES	YES
<i>Cambarus strigosus</i>	Lean Crayfish	G2		YES	S2	S2	T	T	YES	YES	YES	YES
<i>Cambarus truncatus</i>	Oconee Burrowing Crayfish	G2		NO	S1S2	S2	T	T	YES	YES	YES	YES
<i>Cambarus unestami</i>	Blackbarred Crayfish	G2		NO	S2	S3	T	R	YES	YES	YES	YES
<i>Distocambarus devexus</i>	Broad River Burrowing Crayfish	G1		YES	S1	S1	T	T	YES	YES	YES	YES
<i>Orconectes forceps</i>	Surgeon Crayfish	G5		NO	S1	S1S2			YES	NO	YES	YES
<i>Procambarus acutissimus</i>	Sharpnose Crayfish	G5		NO	S2	S2		R	NO	YES	YES	YES
<i>Procambarus gibbus</i>	Muckalee Crayfish	G3Q		NO	S3	S2	T	T	YES	YES	YES	YES
<i>Procambarus petersi</i>	Ogeechee Crayfish	G3		NO	S3	S2		R	NO	YES	NO	YES
<i>Procambarus verrucosus</i>	Grainy Crayfish	G4		NO	S2	S2	R	R	YES	YES	YES	YES
<i>Procambarus versutus</i>	Sly Crayfish	G5		NO	S1	S1	R	R	YES	YES	YES	YES
<b>Insects/Other Invertebrates</b>												
<i>Acanthametropus pecatonica</i>	Pecatonica River Mayfly	G2G4		NO	S2	SU			YES	NO	YES	YES
<i>Acroneuria arida</i>	Elegant Stone	G3		NO	S3	S3			YES	NO	YES	YES
<i>Acroneuria petersi</i>	Etowah Stonefly	G3		NO	S3	S3			YES	NO	YES	YES
<i>Amerigoniscus curvatus</i>	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
<i>Amerigoniscus georgiensis</i>	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
<i>Anepeorus simplex</i>	Wallace's Deepwater Mayfly	G2G4		NO	SU	SH			YES	NO	YES	YES

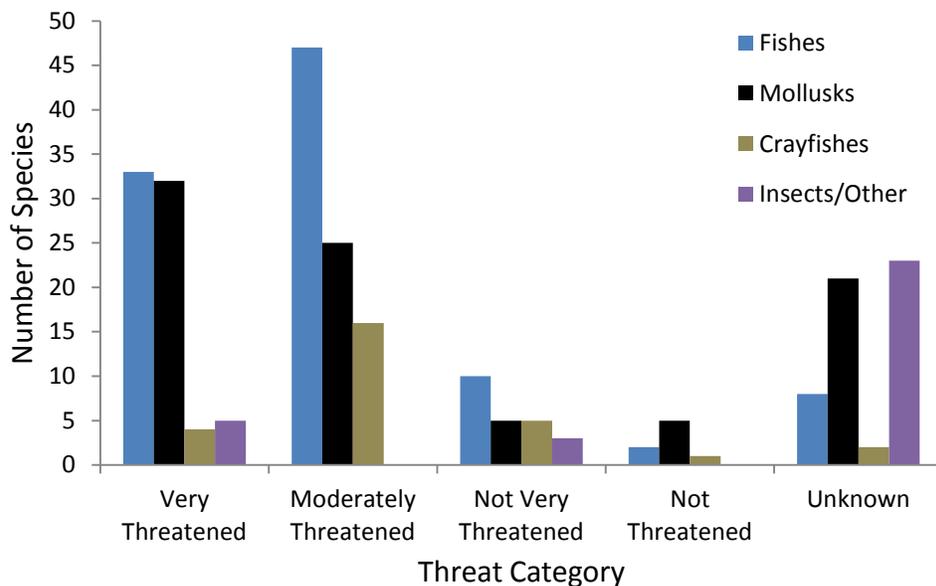
<u>SCIENTIFIC NAME/Group</u>	<u>COMMON NAME</u>	<u>GR</u>	<u>ESA</u>	<u>PETIT.</u>	<u>SR2005</u>	<u>SR2015</u>	<u>SP2005</u>	<u>SP2015</u>	<u>HP2005</u>	<u>HP2015</u>	<u>SC2005</u>	<u>SC2015</u>
Apobaetis etowah	A Mayfly	G5		NO	S1	S1			YES	NO	YES	YES
Beloneuria georgiana	Georgia Beloneurian Stonefly	G2		NO	S2	S2			YES	NO	YES	YES
Caecidotea cyrtorhynchus	A Cave Obligate Isopod	G1		NO	SNR	SU			YES	NO	YES	YES
Callinectes sapidus	Blue Crab	GNR		NO		S4			NO	YES	NO	NO
Cordulegaster sayi	Say's Spiketail	G2		YES	S1S2	S2	T	T	YES	YES	YES	YES
Eubranchipus stegosus	A Fairy Shrimp	G1		NO	SNR	SU			YES	NO	NO	YES
Gomphus consanguis	Cherokee Clubtail	G3		YES	S1S2	S2	T	T	YES	YES	YES	YES
Heterocloeon berneri	Berner's Two-winged Mayfly	G2G3		NO	S1	S1			YES	NO	YES	YES
Homoeoneuria dolani	Blackwater Sand-filtering Mayfly	G3G4		NO	SNR	SU			YES	NO	YES	YES
Leptophlebia cupida	A MAYFLY	G5		NO	SNR	SU			YES	NO	YES	NO
Leuctra moha	Blackwater Needlefly	G3		NO	S3	SU			YES	NO	YES	YES
Macromia margarita	Mountain River Cruiser	G3		YES	S1	S1S2			NO	YES	NO	YES
Neophemera compressa	A Mayfly	G1G3		NO	SNR	SU			YES	NO	YES	YES
Ophiogomphus australis	Southern Snaketail	G1G2		NO	SNR	S1		T	NO	YES	NO	YES
Ophiogomphus edmundo	Edmund's Snaketail	G1G2		YES	S1	S1	E	E	YES	YES	YES	YES
Ophiogomphus incurvatus	Appalachian Snaketail	G3T2T 3		YES	SNR	S2			NO	YES	NO	YES
Paraleptophlebia georgiana	A Mayfly	G1G3		NO	SNR	SH			YES	NO	YES	YES
Paraleptophlebia swannanoa	A Mayfly	G4		NO	SNR	SU			YES	NO	YES	YES
Remenus duffieldi	Georgia Springfly	G2		NO	S2	S2			YES	NO	YES	YES
Rhithrogena fasciata	A Mayfly	G3G4		NO	SNR	SU			YES	NO	YES	YES
Siphloplecton simile	A Mayfly	G1G2Q		NO	SNR	SU			YES	NO	YES	YES
Stygobromus grandis	A Cave Obligate Amphipod	G1		NO	SNR	SU			YES	NO	YES	YES
Stygobromus minutus	A Cave Obligate Amphipod	G2G3		NO	SNR	SU			YES	NO	YES	YES
Stylurus ivae	Shining Clubtail	G4		NO	S3	S2?			NO	NO	NO	YES
Stylurus notatus	Elusive Clubtail	G3		NO	SNR	SNA			YES	NO	YES	NO
Uncinocythere warreni	A Cave Obligate Shrimp	G1		NO	SNR	SU			YES	NO	YES	YES

**Table 4.** Number and percentage of Georgia native species that are imperiled or critically imperiled across their global range (G1-G2), imperiled within the state of Georgia (S1-S2), or are considered historic (SH) or extirpated (SX) from Georgia. The number of species that are currently listed under the ESA (includes one candidate species), as well as the number that have been formally petitioned (PETIT.) for listing under the ESA is also reported. The number of SH and SX species includes 30 species that were not considered in this assessment (and not in Table 3). The number of ESA and petitioned species does not include species that are considered historic or extirpated from Georgia.

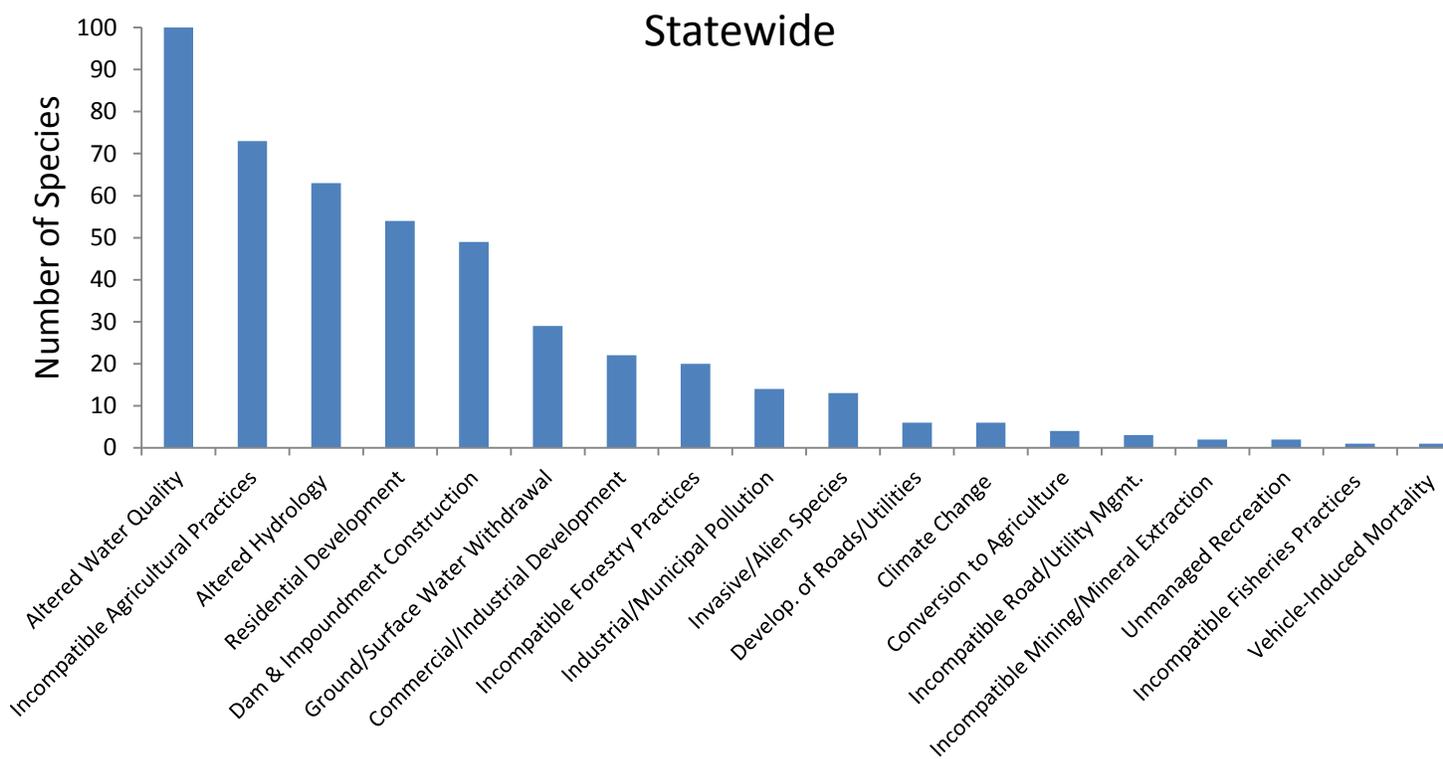
<b>Group</b>	<b>G1-G2 (%)</b>	<b>S1-S2 (%)</b>	<b>SH or SX (%)</b>	<b>ESA</b>	<b>PETIT.</b>
Fishes	16 (6)	58 (21.9)	6 (2.3)	10	12
Mollusks	43 (20.4)	58 (27.5)	38 (18.0)	13	20
Crayfishes	13 (18.6)	25 (35.7)	0 (0.0)	0	11
Insects/Other	14 (?)	11 (?)	4 (?)	0	5
Total	86 (?)	152 (?)	48 (?)	23	48

### Summary of Threats

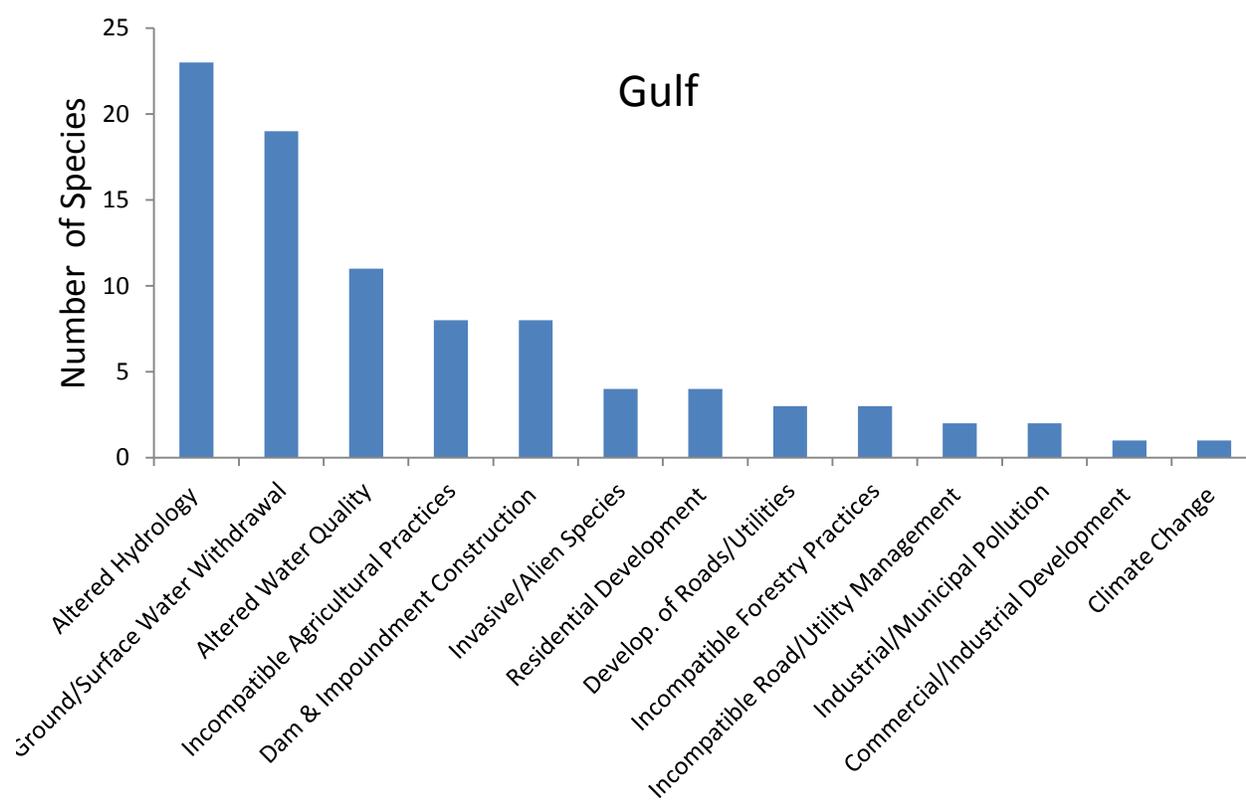
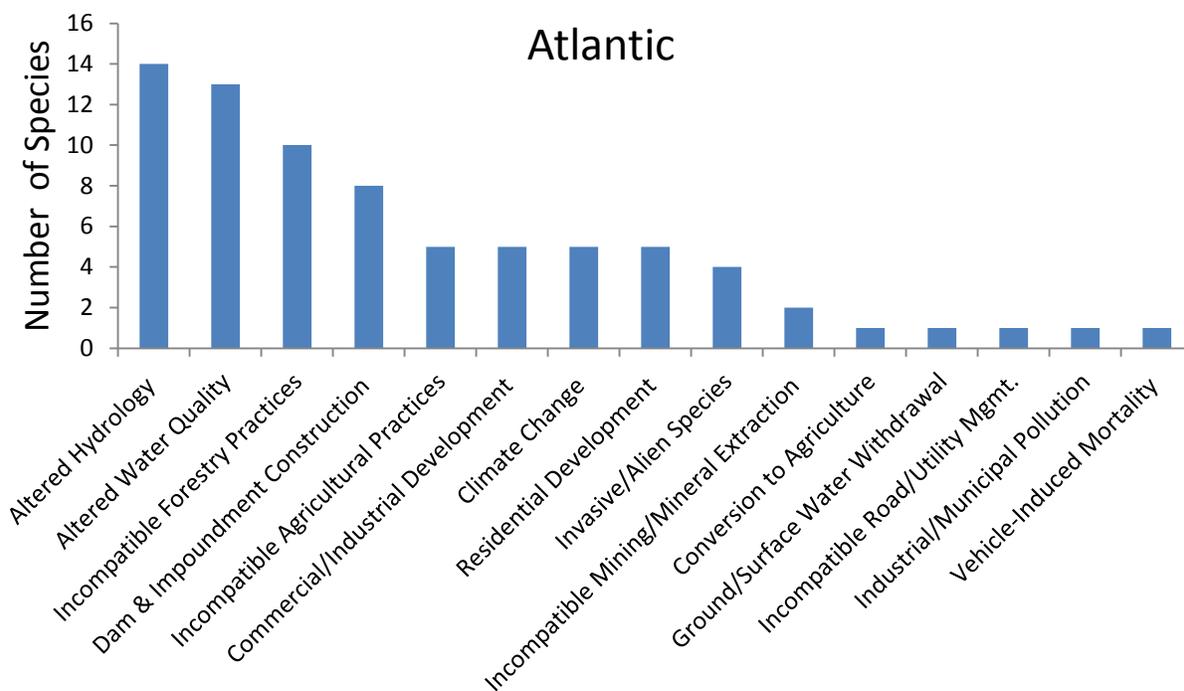
The majority of fishes, mollusks, and crayfishes were categorized as moderately to very threatened ([Figure 7](#)). Altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction were identified as the top five threats to the greatest number of high priority aquatic species ([Figure 8](#)). These same threats generally affected large numbers of high priority species in the different aquatic regions of the state ([Figure 9](#)). However, the threat of residential development emerged as the single-most important threat to Tennessee Basin species, but was less important in other regions. Additionally, excessive groundwater and surface water withdrawal affects a large number of high priority aquatic species in the Gulf drainages of southwestern Georgia.

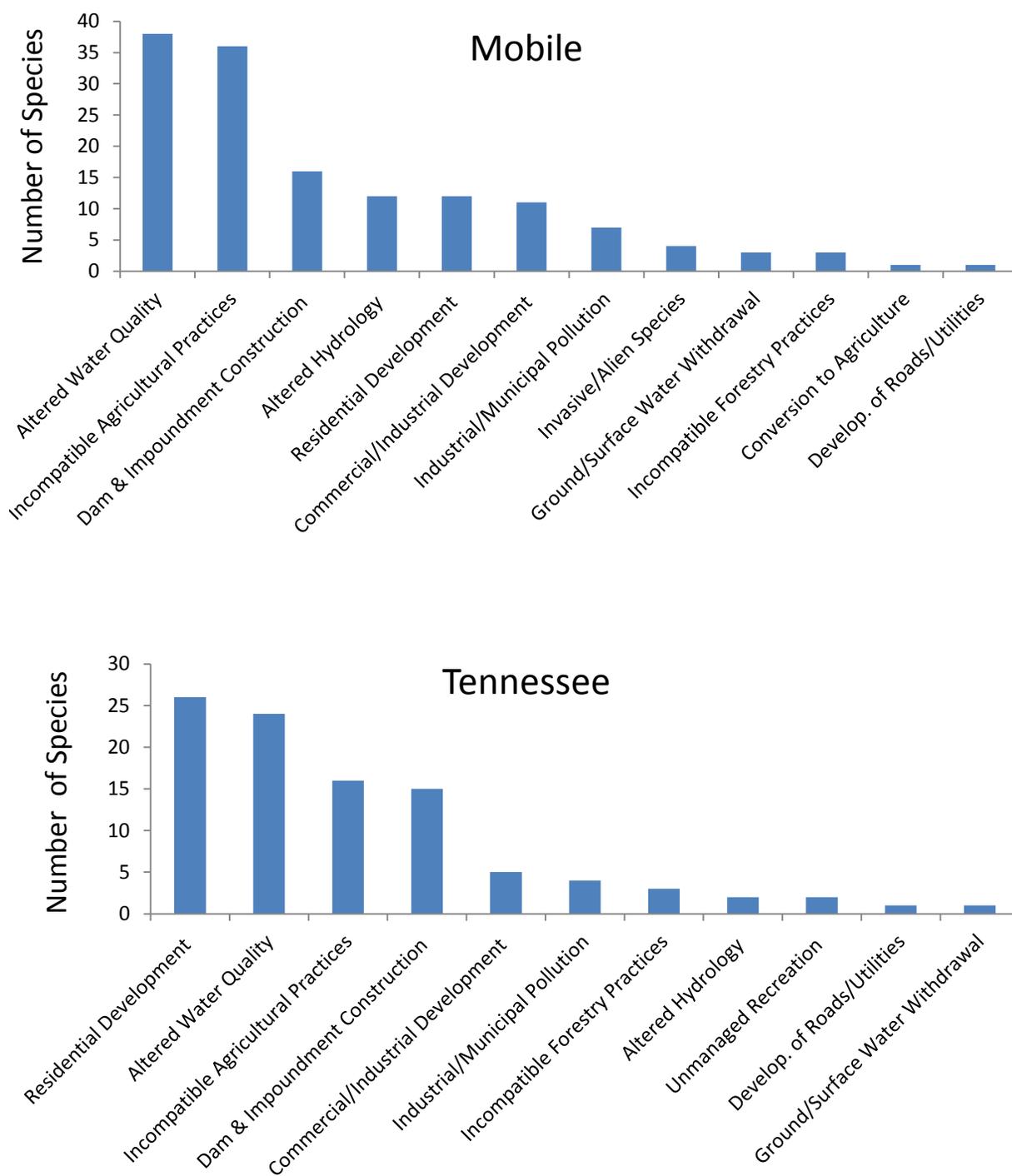


**Figure 7.** Degree of threat affecting species considered in Georgia’s 2015 SWAP revision, summarized by taxonomic group.



**Figure 8.** Number of high priority species affected by each threat identified during the 2015 revision of Georgia’s SWAP. See standardized threat descriptions in Appendix I.





**Figure 9.** Number of high priority species affected by each threat identified during the 2015 revision of Georgia’s SWAP, with data enumerated separately for Atlantic, Gulf, Mobile, and Tennessee basins. See standardized threat descriptions in Appendix I.

## High Priority Conservation Actions

The technical teams identified hundreds of species-specific conservation actions which were recorded in the species assessment database and will be useful for future management. We extracted conservation actions from the database with the potential to benefit multiple species and/or habitats. Our own GADNR biologists also identified additional conservation actions based upon our own vision for improving our aquatic conservation program. We asked technical team members and a handful of other species experts that could not participate in the SWAP revision to rate all 44 conservation actions through an online survey program (Survey Monkey). Fifty-two people completed the survey. All of the ratings averaged 5.8 or higher on a continuous 10 point scale, where 1= a low priority action that should not be completed, 5 = an action that would benefit high priority habitats and or species, but is not critical to complete within the next 5-10 years, and 10 = an action that is likely to benefit multiple high priority species and habitats and should be initiated immediately. After the survey was completed, we received recommendations for 9 additional conservation actions from technical team members. To be consistent with prioritizations carried out by other SWAP technical teams, we used average ratings (score) to place actions into very high (score of 8.0 or higher), high (score of 7.0-7.9), and medium (5.8-6.9) categories. Three of the unrated actions were placed in the very high category because of their potential to benefit a large number of species and habitats; the remaining unrated actions were placed into the high category. All actions categorized as “very high” priority are listed in [Table 5](#). The complete list of conservation actions, along with more detailed action descriptions, potential partners and funding sources, and other information is included in a separate excel file that should **always accompany this document**.

**Table 5.** “Very High” conservation actions identified by SWAP aquatic species technical teams. Score indicates the average rating on a 10 point scale from 52 respondents that completed an online survey. Projects are ranked by score, except for three that were not rated (NR). See excel file for a full list of conservation actions and a more detailed description of each action.

ID	Conservation Action	Type	Score	Rank
3	Protect Aquatic Connectivity in Free-flowing Streams.	Actions and Policies	9.1	1
4	Develop Environmental Flow Recommendations	Actions and Policies	8.8	2
5	Land Acquisition and Easements in High Priority Watersheds.	Actions and Policies	8.7	3
6	Technical Assistance to Local Governments to Protect Streams in High Priority Watersheds	Actions and Policies	8.6	4
7	Invasive Species Outreach and Regulation	Outreach and Education	8.5	5
8	Technical Assistance to Farmers to Protect Streams in High Priority Watersheds	Actions and Policies	8.5	6

ID	Conservation Action	Type	Score	Rank
9	Protect High Priority Species and Habitats through the Statewide Water Planning Process	Conservation Planning	8.4	7
10	Expand GADNR Nongame Conservation Section Aquatic Program	Conservation Planning	8.3	8
11	Targeted Dam and Culvert Removal/Replacement Projects.	Actions and Policies	8.3	9
12	Riparian Forest Restoration	Actions and Policies	8.0	10
13	Aquatic Conservation Planning Meetings for Coosa, Tennessee, Atlantic Slope and Gulf drainages	Conservation Planning	8.0	11
14	Evaluate Status and Distribution of High Priority Snails.	Survey and Monitoring	8.0	12
1	Shoal Creek Watershed Project	Actions and Policies	NR	NR
2	Conasauga River Water Quality and Contaminants Study	Conservation Research	NR	NR
53	Oyster Reef Restoration and Enhancement	Actions and Policies	NR	NR

## Discussion

As in the original plan, the aquatic species assessment for the 2015 revision of Georgia's SWAP identified an enormous list of high priority species, threats, and conservation actions needed to protect and restore Georgia's rich aquatic diversity. Meeting the conservation needs of 165 high priority aquatic species distributed around the state is a daunting task. Compounding this challenge are the 48 aquatic species that are petitioned for listing under the ESA, as these species may require additional assessment to determine if they merit listing and additional monitoring, management, and coordination if they merit formal listing or conservation through other mechanisms (e.g., formal partnerships to conserve species, like the [Robust Redhorse Conservation Committee](#) or [Candidate Conservation Agreements](#) between the U. S Fish and Wildlife Service and stakeholders). We hope that the information contained in this plan can help guide and prioritize the conservation of Georgia's rare aquatic species in the coming years. In pursuit of this goal, we have provided additional recommendations below to consider during SWAP implementation.

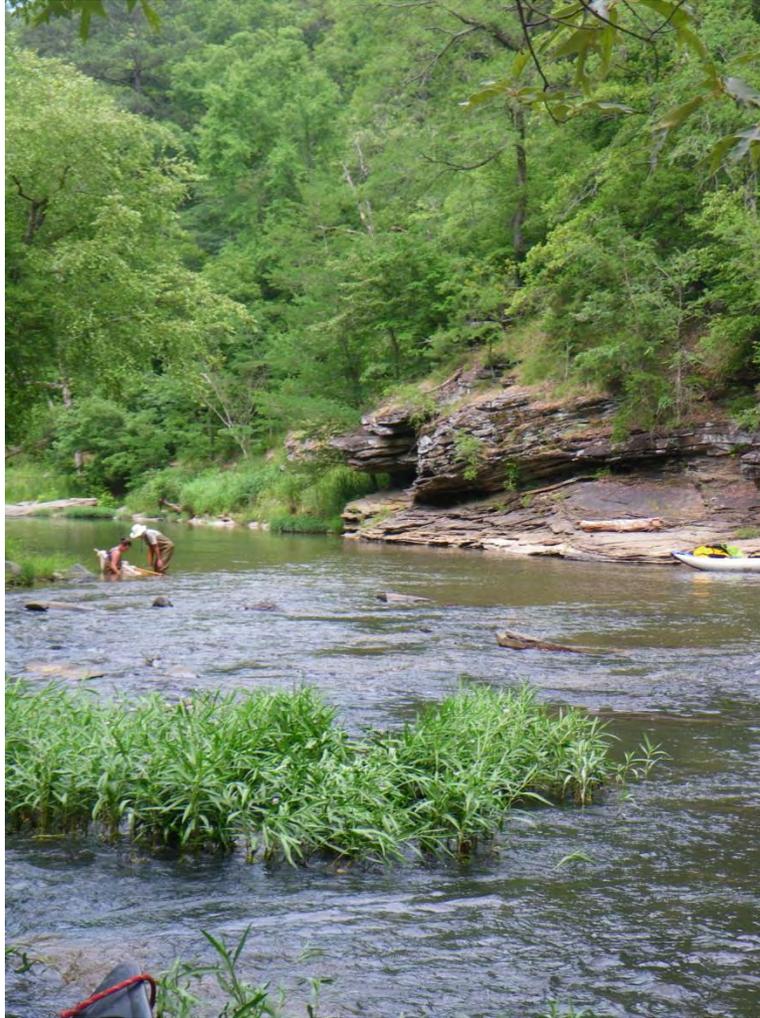
Clearly, there is a need to focus on protection and restoration of aquatic habitats supporting multiple species. To that end, we have attempted to identify conservation actions that would benefit multiple species and habitats. For example, monitoring large river aquatic communities and water quality in the Conasauga and Etowah river systems (actions 28, 29, 2) will allow us to

gauge population health of a large number of high priority species as their supporting watersheds change either positively (e.g., land protection, improved land management) or negatively (e.g., increased urbanization). We have also identified watersheds that protect the greatest number of high priority aquatic species in a separate report (Albanese et al. 2015), which should help identify the places where a multi-species approach will be most appropriate. However, there will still be a need for species-specific conservation (e.g. actions 31, 36).

The top threats facing Georgia aquatic species include altered water quality, altered hydrology, residential development, and dam and impoundment construction. Focusing on threats affecting multiple species can also increase the efficiency of aquatic conservation efforts in Georgia. For example, finding alternatives to the development of new drinking water reservoirs in high priority watersheds would reduce threats to a large number of high priority species around the state and was our top rated conservation action (action 3). Similarly, initiatives to protect instream flows (e.g., [Southern Instream Flow Network](#)) would benefit multiple species, particularly in Gulf drainages where altered hydrology and water withdrawals were considered a threat to dozens of high priority species (action 4).

Conserving Georgia's rare aquatic species and habitats will require greater investments in aquatic conservation as well as improved coordination (e.g., action 18). This is evident from the large number of species that still require protection and restoration almost a decade into the implementation of our first SWAP plan. While much has been accomplished ([Table 1](#)), there are significant information gaps for groups such as aquatic insects, snails, and cave invertebrates. Similarly, there are many HUC10 watersheds without recent occurrences of high priority species, indicating either declines or the need for additional sampling.

Fortunately, there are a large number of agencies, non-profit organizations, and local citizens that are working collaboratively on aquatic conservation in Georgia ([Table 6](#)). Many of these institutions have overlapping responsibilities and geographic scopes, but each group plays a unique and vital role in aquatic conservation. One of the great challenges is coordinating efforts between groups so that limited resources are utilized in the most effective manner possible. While there have been substantial individual and group efforts to coordinate activities (e.g., SWAP, Coosa Summit), there is no established framework for regular aquatic conservation planning in Georgia. Action 13 suggests aquatic conservation planning meetings to be held at least once every five years in different regions of the state. Perhaps these meetings could be integrated with the statewide water planning process, as suggested by action 9. It is not clear what institution would take a lead role in organizing these meetings and it would likely require additional capacity (e.g., action 10).



Shoal habitat in Talking Rock Creek (Coosawattee River system). Several high priority aquatic species, including the Goldline Darter, Bridled Darter, and Beautiful Crayfish have been documented from this stream.

**Table 6.** Organizations that contribute to the conservation of rare aquatic species in Georgia and examples of their conservation activities. This is meant to be a representative, but **not a complete list**.

<u>Institution</u>	<u>Examples of Conservation Activities</u>
Conservation Fisheries Incorporated (CFI)	captive propagation and reintroduction, monitoring
Environmental Consulting Firms	rare species monitoring, mitigation
GADNR, Coastal Resources Division (CRD)	Oyster restoration, conservation, monitoring
GADNR, Environmental Protection Division (EPD)	macroinvertebrate community monitoring, water quality regulations
GADNR, Fisheries Management Section (FM)	fish community monitoring
GADNR, Nongame Conservation Section (NCS)	environmental review, species monitoring, database management, state-listed spp.
Georgia Aquarium	education and outreach, research
Georgia Colleges and Universities	research, professional training, monitoring
Georgia Cooperative Fish and Wildlife Research Unit	research, professional training
Georgia Department of Transportation (GDOT)	mitigate impacts from transportation projects
Georgia Forestry Commission (GFC)	Forestry BMPs for water quality
Georgia Museum of Natural History (GMNH)	database management, fish monitoring, Fishes of Georgia website
Georgia Power	Robust Redhorse, management of regulated rivers
Georgia River Network/Local Watershed Groups	outreach, watershed protection, advocacy
Georgia Wildlife Federation (GWF)	outreach, advocacy
Georgia Water Coalition (GWC)	advocacy
Landtrusts and other Conservation Organizations	Land acquisition and conservation easements
National Marine Fisheries Service (NMFS)	anadromous species
Natural Resources Conservation Service (NRCS)	farm bill programs to protect streams
National Park Service (NPS)	monitoring of NPS resources
North American Native Fishes Association (NANFA)	native fish outreach
River Basin Center	research, technical assistance to communities, professional training
Tennessee Aquarium Conservation Institute (TNACI)	database management, outreach, fish community monitoring, habitat restoration
The Nature Conservancy (TNC)	aquatic habitat restoration, land protection
U. S. Fish and Wildlife Service (FWS)	environmental review, database management, ESA, conservation actions, research
U. S. Geological Survey (USGS)	research, monitoring, technical support to regulatory agencies
U.S. Army Corps of Engineers (USACE)	mitigation program, management of regulated rivers
U.S. Environmental Protection Agency (EPA)	water quality regulations and monitoring, research
U.S. Forest Service (USFS)	watershed management, monitoring

## Acknowledgments

We are grateful to the technical team members for volunteering their time and expertise for the species assessment as well as their helpful comments during the editing of this document. Catherine Reuter, Deb Weiler and Anakela Popp generated the conservation status assessment maps and helped run the three SWAP technical team meetings. Dr. Jon Ambrose presented an overview of the SWAP process at each technical team meeting. Thom Litts helped create the species assessment database and Greg Krakow wrote the GIS algorithm needed to generate the conservation status assessment maps. We thank the staff of the Georgia Wildlife Federation for providing excellent conference facilities.

## Appendices

**Appendix 1.** Description of data fields for aquatic species assessment database.

### Font Color Scheme:

**Black Font**, reference fields that generally do not need updating

**Green Font**, OK to update field, but not absolutely necessary

**Red Font**, Important to update during species assessment meeting.

### Species Info (Banner)

#### Sci. NAME: State Scientific Name

The scientific name of the element (species or natural community) recognized in the state, based on standard scientific nomenclature or terminology accepted by the natural heritage program

Note: Freeze this field during species assessment meeting.

#### SCOMNAME: State Common Name

The common name of the element that is recognized at the state level

#### SRANK: State Rarity Rank

S1 = Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. (Typically 5 or fewer occurrences or very few remaining individuals or acres)

S2 = Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. (Typically 6 to 20 occurrences or few remaining individuals or acres)

S3 = Vulnerable, Rare and uncommon in the state. (Usually 21 to 100 occurrences)

S4 = Widespread, abundant, and apparently secure in state, with many occurrences, but the element is of long-term concern. (Usually more than 100 occurrences)

S5 = Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.

Note: Other factors (e.g., threats and trends) in addition to number of occurrences are considered when assigning a rank, so the numbers of occurrences suggested for each numeric rank above are not absolute guidelines.

S#S# = A range between two numeric ranks. Denotes uncertainty about the exact rarity of the element.

SNR = Unranked: Element is not yet ranked in the state.

SU = Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Possibly in peril in the state, but status uncertain; need more information.

SH = Historical/Possibly extirpated: Element occurred historically in the state (with expectation that it may be rediscovered), perhaps having not been verified in the past 20-40 years, and suspected to be still extant.

SX = Presumed Extirpated: Element is believed to be extirpated from the state

SNA= Not Applicable—A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.<sup>1</sup>

<sup>1</sup> A conservation status rank may be not applicable for some species, including long distance aerial and aquatic migrants, hybrids without conservation value, and non-native species or ecosystems, for several reasons, described below.

#### Qualifiers:

? = Inexact or uncertain: For numeric ranks, denotes inexactness; for SE, denotes uncertainty of exotic status. (should not be used with S#S#, SU, SNR, SNA, SX or SH)

#### SEOTRACK: State Element Tracking

Indicates whether element is currently tracked as a “Special Concern Species” in Biotics.

Y = Yes W = Watch List (plants only) N or blank = No P=partial (part of range)

**STATE STATUS:** State-protected Status under the Georgia Endangered Wildlife Act.

#### Status Page

**GRANK:** Global Rarity Rank (assigned by NatureServe)

G1 = Critically imperiled globally

G2 = Imperiled globally

G3 = Rare or uncommon

G4 = Widespread, abundant, and apparently secure, but with cause for long-term concern

G5 = Demonstrably widespread, abundant, and secure

G#G# = A range between two numeric ranks. Denotes uncertainty about the exact rarity of the element.

G? = Unranked

GU = Unrankable

GH = Historical

GX = Extinct

HYB = Hybrid

Subrank:

T = Taxonomic subdivision (trinomial)

Qualifiers:

? = Inexact numeric rank  
 Q = Questionable taxonomy  
 C = Captive or cultivated only

**IUCN:** IUCN Red List Rank

Rank based on the IUCN Red List of Threatened Species ver. 2013.1 ([www.iucnredlist.org](http://www.iucnredlist.org))

NE = Not evaluated  
 DD = Data deficient  
 LC = Least concern  
 NT = Near threatened  
 VU = Vulnerable  
 EN = Endangered  
 CR = Critically endangered  
 EW = Extinct in the wild  
 EX = Extinct

**OTHERRANK\_AFS\_1:**

This field can be used to specify status under another ranking system used by a particular organization (e.g., Partners in Flight, American Fisheries Society), depending on the taxonomic group under consideration. If used, field can be renamed as appropriate. Use this field for the most recent assessment

**OTHERRANK\_AFS\_2**

This field can be used to specify status under another ranking system used by a particular organization (e.g., Partners in Flight, American Fisheries Society), depending on the taxonomic group under consideration. If used, field can be renamed as appropriate. Use this field for the older assessment

**USESAS:** Status under U.S. Endangered Species Act

The following abbreviations are used to indicate the legal status of federally protected plants and animals or those proposed for listing.

LE	Listed as endangered. The most critically imperiled species. A species that may become extinct or disappear from a significant part of its range if not immediately protected.
LT	Listed as threatened. The next most critical level of threatened species. A species that may become endangered if not protected.
PE or PT	Candidate species currently proposed for listing as endangered or threatened.
C	Candidate species presently under status review for federal listing for which adequate information exists on biological vulnerability and threats to list the taxa as endangered or threatened.
PDL	Proposed for delisting.
E(S/A) or T(S/A)	Listed as endangered or threatened because of similarity of appearance.
(PS)	Indicates "partial status" - status in only a portion of the species' range. Typically indicated in a "full" species record where an infraspecific taxon or population has U.S. ESA status, but the entire species does not.

**USESAS\_PETITIONED**

Checkbox to indicate a species with a significant 90 day finding from FWS, but has not been issued a 12 month finding. Technical Team leader needs to populate this field before meeting.

**SWAP\_HighPriority\_2005**

Check box to indicate that species was recognized as a high priority species during the initial SWAP plan. This field should be checked for all existing high priority species. However, some groups may decide to assess the conservation status of additional species that may be of conservation concern.

**Habitat Page**

**SSHABITAT:** State Short Habitat Description

A brief description of the element's habitat in Georgia (less than 120 characters)

**SHABCOM:** State Habitat Comments

Summarize the habitats and microhabitats commonly used by this organism within Georgia. (This field can be used to expand upon the brief habitat description provided in the SSHABITAT field).

**SENDEMIC:** State Endemic

Enter the appropriate letter code from the list below indicating whether the element is endemic to Georgia. (Leave this field blank if the element is not endemic to the state).

Y = Yes: the element is endemic to the state.

P = Probable: the element is probably endemic to the state.

B = Breeding: the element is endemic to the state as a breeder only.

**SW\_APPALACHIANS**

Check box to indicate that species occurs in Southwestern Appalachians Ecoregion

**RIDGE\_VALLEY**

Check box to indicate that species occurs in Ridge and Valley Ecoregion

**BLUE\_RIDGE**

Check box to indicate that species occurs in Blue Ridge Ecoregion

**PIEDMONT**

Check box to indicate that species occurs in Piedmont Ecoregion

**SOUTHEASTERN PLAINS**

Check box to indicate that species occurs in Southeastern Plains Ecoregion

**SOUTHERN COASTAL PLAIN**

Check box to indicate that species occurs in Southern Coastal Plain Ecoregion

**Range Page**

**SRANGE:** State Range

Enter the code for the present range of the element in Georgia. For aquatic species, we are using the total number of HUC10 watersheds that the species is known from (historic and recent) as an approximation of range size.

A = Very small range, less than 3% of state territory, known from 5 or fewer HUC 10 watersheds

B = Narrow range, less than 10% of state territory. Known from 10 or fewer HUC 10 watersheds

C = Moderately widespread, less than half of state territory. Known from fewer than 50 HUC watersheds

D = Widespread, more than half of state territory. Known from more than 50 HUC 10 watersheds

U = Unknown

#### **HUC10\_TOTALRANGE**

The total number of HUC 10 watersheds with any occurrences, either historical or recent

#### **HUC10\_RECENRANGE**

The number of HUC10 watersheds with documented occurrences during the last 10 years (2004-2013)

#### **SRANGECOM:** State Range Comments

Generally describe the range of the element within the state, using the names of counties, physiographic provinces, ecoregions, etc., as appropriate. For physiographic provinces, use the following abbreviations: CU = Cumberland Plateau; RV = Ridge & Valley; BR = Blue Ridge; PD = Piedmont; CP = Coastal Plain. In the case of disjunct elements, include how distant known occurrences of this element in Georgia are from the nearest populations elsewhere.

#### **GA\_IMP:** Georgia Importance

Assign a code from the list below to indicate the estimated importance of protection efforts in Georgia to global conservation of the element.

A = Protection in Georgia is critical to global conservation of this element.

B = Protection in Georgia very important to global conservation of this element

C = Protection in Georgia somewhat important to global conservation of element.

D = Protection in Georgia not likely to affect global conservation of element.

U = Unknown

For example, if loss of Georgia populations would increase the risk of overall extinction, then the species should get an A for GA\_imp.

#### **GA\_IMPCOM:** Georgia Importance Comments

Provide comments to explain the importance of protection efforts in Georgia to the global conservation of this element.

#### **REGION\_LOOKUP:**

Indicates primary drainage distribution of species. This field may be used to divide your technical team up into basin specific groups.

1= Atlantic, 2 = Gulf, 3 = Mobile (Coosa), 4 = Tennessee

### **Trend/Threats Page**

#### **STREND:** State Trend

Enter the appropriate code from the list below for the description that best characterizes the trend in the element's distribution over its state range:

A = Declining rapidly. Quantitative data (population size, occupancy rate.) showing that the species is currently declining (i.e., within the past decade) across a significant portion of its range in the state (e.g., affecting 1/3 or more of populations). Or any other evidence (expert opinion) suggesting that the species is currently declining in a significant portion of its state range.

B = Declining. Quantitative data (population size, occupancy, etc.etc.) showing that species is currently declining, but that declines are not rapid or are only affecting a limited number of populations. Or any other evidence (expert opinion) suggesting that the species is currently declining gradually or in a limited number of populations.

C = Stable

D = Increasing

U = Unknown

**STRENDCOM:** State Trend Comments

Provide comments concerning trends in the element's distribution in Georgia. Reference data sources used to justify category selected, if any.

**STHREAT:** State Threats

Indicate the degree to which the element is directly or indirectly threatened in Georgia. Threats could include habitat conversion, direct exploitation of the species, influence of disease or predators, etc.

A = Very threatened in the state; species or community severely exploited or threatened by natural or man-made forces.

B = Moderately threatened statewide; habitat or community lends itself to alternate uses.

C = Not very threatened statewide; self-protecting by unsuitability for other uses.

D = Unthreatened on a statewide basis, although it may be threatened in minor portions of the state.

U = Unknown

**STANDTHREAT1:** Drop down box to record first of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

**STANDTHREAT2:** Drop down box to record second of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

**STANDTHREAT3:** Drop down box to record third of the top three threats facing the species. A description of standardized threats, developed as part of the 2005 SWAP Plan is located at the end of this document.

**STHREATCOM:** State Threat Comments

Give examples of actual threats, if known, in the state. Include any specific threat information that is not captured by the standardized threats above

**Standardized Threat Descriptions from 2005 SWAP Plan. Ones that may be particularly relevant to aquatic species are in red font.**

**1. Acidified Rainfall and Other Atmospheric Pollution:**

Includes acid deposition from the atmosphere (both wet and dry) and other air-borne pollutants or nutrients. Acidified rainfall generally has a pH lower than 5.5. It is typically, but not exclusively, related to aerosols, volatile compounds, and semi-liquid pollutants. Impacts include acidifying aquatic systems, impairing plants' ability to evaporate water and exchange gases, and nutrient leaching and toxic accumulation in soil.

**2. Incompatible Agricultural Practices**

Includes agricultural practices that impact the environment well outside the actual agricultural operation through releases of excess nutrients, toxins, or sediments. Includes practices that degrade stream or wetland habitat quality.

### 3. Altered Fire Regimes:

Includes fire exclusion, fire suppression, alteration of habitats through unnatural timing, Frequency, or intensity of prescribed burns, and other incompatible fire management practices. Fire regimes are affected by altered community composition (e.g., increase of non-pyric species such as oak) and habitat fragmentation. Fire is an important ecological process that drives many of the terrestrial habitats in Georgia.

### 4. Altered Hydrology

Includes construction and use of ditches, levees, dikes, and drainage tiles, flow diversion, dredging, channelization, filling of wetlands and headwater streams, destabilization of stream banks or channels, head-cutting, and other alterations to stream morphology or hydrologic regimes. Results in degradation or destruction of aquatic and wetland habitats.

### 5. Altered Water Quality

Includes various forms of point and non-point source pollution, such as herbicides, pesticides, sediments, nutrient loading, and thermal modifications that directly impact water quality. Sources are quite varied and include waste water discharges, excessive soil disturbance near streams, increased impermeable surface area resulting from development, and loss of vegetation in riparian buffers.

### 6. Commercial/Industrial Development

Includes development of structures and infrastructure (buildings, utilities, driveways and roads) for commercial or industrial purposes, usually in an urban setting. Impacts may include direct habitat destruction, fragmentation, altered thermal regimes, and indirect pollution sources that alter water quality.

### 7. Conversion to Agriculture

Includes the conversion of natural habitats to anthropogenic habitats managed for agricultural crops, pasture, horticulture, or silviculture. Usually involves removal of native vegetation, site preparation, and planting of off-site or non-native species. Results in habitat destruction or fragmentation and may impact water quality.

### 8. Dam and Impoundment Construction

Includes the construction of dams and impoundments (from agricultural ponds to large reservoirs) that directly affect stream flows and fragment aquatic habitat. Results in impacts to the impounded portion of the stream as well as habitats above and below the dam.

### 9. Development of Roads or Utilities

Includes construction of new roads (interstate highways, state highways, and county roads) and utility right-of-ways (e.g., electrical transmission lines, water/sewer, gas pipelines) that result in habitat destruction or fragmentation and creation of new avenues for invasion by exotic species.

### 10. Disease

Includes fatal or debilitating disorders resulting from infections, poisons, pathogenic microorganisms, or parasites. The most serious impacts generally result from introduced vectors or pathogens (e.g., sudden oak death, hemlock woolly adelgid, chestnut blight). Impacts can be devastating to the species directly attacked as well as natural communities.

### 11. Excessive Groundwater and Surface Water Withdrawal

Includes direct groundwater and surface water withdrawals for agricultural, industrial, and municipal water supplies. Excessive withdrawal can result in lowered water tables, diminished local aquifer discharges, and reductions in water available to sustain stream base flows, spring discharges, isolated wetlands, karst environments, and seepage communities.

### 12. Excessive Herbivory

Involves high, generally unsustainable rates of herbivory that intensively affect species or entire natural communities. Usually attributed to the impacts of herbivorous species that are either non-native or native but have been released from typical natural population limiters (e.g., white-tailed deer in areas of limited hunting).

#### 13. Excessive Predation

Includes impacts to animal populations caused by predators that extensively and intensively impact the demographics of either a select species or entire species assemblages. These predators may either be non-native species or native species that are released from typical natural population limiters.

#### 14. Incompatible Forestry Practices

Involves poor forestry practices that impact species of concern. This includes failure to follow BMPs and site management activities that result in altered structure and composition of adjacent natural habitats or degraded stream or wetland habitats.

#### 15. Global Warming/Climate Change

Defined as consistent, directed change in climatic conditions at regional scales. Such changes may include increases or decreases in average temperatures, changes in the rates, distribution, frequency, or timing of precipitation, and frequency and intensity of storm events. Local effects are often difficult to quantify.

#### 16. Illegal Dumping

Includes all forms of illegal dumping of by-products, ranging from household trash to light industrial waste, to chemical toxins, as well as the impacts resulting from the movement of these wastes from the original site of dumping. Effects on high-priority habitats may range from minor to serious (e.g. dumping in an ephemeral pool on a granite outcrop).

#### 17. Incompatible Fisheries Practices

Includes harvest or management of fish or shellfish by methods that are destructive to native species or aquatic habitats. Includes forms of harvest that result in heavy rates of by-catch, losses of reproductively critical age classes, or increased mortality of imperiled species.

#### 18. Incompatible Mining/Mineral Extraction

Includes extraction of minerals, oil, or gas or similar activities that result in the disturbance or destruction of natural habitats as well as secondary impacts such as sedimentation or releases of toxins. Impacts may include increased sediment loads, downstream scouring, habitat destruction and disturbance, fragmentation, and creation of migration routes for invasive exotic species.

#### 19. Incompatible Road/Utility Management

Includes management of roads or utility corridors that results in excessive releases of sediment or provides access for non-native species, as well as vegetation management practices that are environmentally “unfriendly” (e.g. indiscriminant use of herbicides).

#### 20. Industrial/Municipal Pollution

Includes toxins and air-borne pollutants, thermally altered effluent, and other point source pollutants derived from industrial/commercial land uses in an urban or suburban setting. Involves direct impacts in the form of chemical or thermal stresses to species or natural communities.

#### 21. Invasive/Alien Species

Includes exotic species as well as native species that have become invasive due to past habitat alterations (e.g. hardwood encroachment of long leaf pine habitats following fire suppression). Impacts include competition, hybridization, and predation as well as long-term alterations of ecological systems and processes (e.g. hydrologic changes, changes in soil attributes, altered fire regimes).

**22. Poaching or Commercial Collecting**

Includes commercial exploitation, poaching, and unscrupulous or excessive collecting of animals or plants by individual or corporate operators. Impacts may include mortality of individuals, population declines, and changes in community composition.

**23. Residential Development**

Includes primary and secondary home construction as well as development of associated infrastructure (e.g. subdivision roads and driveways, sewer and stormwater utilities). Impacts may include habitat destruction, disturbance, fragmentation, and introduction of invasive species.

**24. Unmanaged Recreation**

Includes recreational overuse, particularly by ATVs (all-terrain vehicles), but also hiking, biking, caving, horseback riding, rock climbing, and boating (or use of jet skis) in sensitive areas or at rates considered unsustainable in the environments where they occur. Impacts may include habitat destruction and disturbance as well as impaired water quality.

**25. Vehicle-Induced Mortality**

Includes mortality of animals resulting from collisions with automobiles, boats, or other vehicles. Also includes impacts to plants resulting from vehicular traffic along roadsides, trails, or waterways.

### Needs Page

**SPROTEOS:** State-protected Element Occurrences

Enter the appropriate code (from the list below) for the approximate number of adequately protected occurrences of the element in the state. For an aquatic species population to be considered protected, enough land in the watershed would have to be owned or in easement such that all significant threats to the species are abated (except perhaps for Climate change).

- A = Believed to be none protected.
- B = At least one protected occurrence.
- C = Several protected occurrences.
- D = Many protected occurrences.
- U = Unknown whether any occurrences are protected.

**SPROTNEED:** State Protection Needs

Note the most important protection needs for the element in Georgia. Examples:

"Protect habitat at all three known occurrences."

**SINVENNEED:** State Inventory Needs

Enter comments on the need for additional field inventory work for this element in Georgia. Also enter comments as to the relative completeness of the knowledge of existing element occurrences and where to look for additional occurrences (especially when dealing with poorly known elements where many additional element occurrences are likely to exist). For example,

"Survey Chickamauga Creek population"

"Search for potential population in the Chattahoochee above Lake Lanier"

**MONIT.REQS:** Monitoring Requirements

Reference any monitoring studies that are already ongoing.

Describe recommended monitoring procedures and/or monitoring needs for this element.

Be specific, if possible. Some examples of what we are looking for

"Demographic monitoring ongoing and should be continued"

“Demographic monitoring needed”  
 “Occupancy monitoring ongoing and should be continued”  
 “Occupancy monitoring needed”  
 “CPUE monitoring ongoing and should be continued”  
 “CPUE monitoring needed”  
 “Habitat monitoring ongoing and should be continued”  
 “Habitat monitoring required”  
 “Species-specific monitoring not required for this species.”

**SSTEWNED:** State Stewardship Needs

Enter comments on stewardship (management) needs for this element in Georgia. For example,

“Evaluate potential for reintroduction into Talking Rock Creek”  
 “Stream bank stabilization needed to protect Suches Creek population”  
 “Culvert removal needed in Salacoa Creek system”

**SRSRCHNEED:** State Research Needs

Enter comments on research needs (e.g., taxonomy, reproductive behavior, movement patterns) for this element in Georgia. Results of research should increase our ability to manage or conserve the species.

**Recommendations Page**

**REC\_SRANK:** Drop down box to record S Rank recommended by the Technical Team. S Rank is based upon rarity, trends, and threats.

**REC\_SEOTRACK**

Drop down box to record GADNR Rare Species Database tracking status recommended by Technical Team. Records for this species will be maintained in Biotics and used for environmental review, conservation planning, etc. Species without real conservation needs should not be on this list.

**REC\_SPROT**

Drop down box to record State Protection status recommended by Technical Team.

The following abbreviations are used to indicate the status of state-protected plants and animals or those proposed for state protection in Georgia.

- E Listed as endangered. A species which is in danger of extinction throughout all or part of its range
- T Listed as threatened. A species that is likely to become an endangered species in the foreseeable future throughout all or parts of its range.
- R Listed as rare. A species which may not be endangered or threatened but which should be protected because of its scarcity.
- U Listed as unusual (and thus deserving of special consideration). Plants subject to commercial exploitation would have this status.

**SWAP\_HighPriority\_2014**

Check this box if the species should be kept on the high priority list or added to the high priority list. High priority species are species with conservation needs (e.g., research, monitoring, restoration, protection, etc.) that should be addressed in the next 5-10 years. These are the species that will be used to identify and rank the relative importance of high priority watersheds. At a minimum, all federally protected, state-protected, and candidate species, should be designated as high priority. Petitioned species should also be high priority, unless the committee believes the species is not an important target for conservation. Other species with important

conservation needs should be designated as high priority. GRank and GA\_IMP should be considered when designating high priority species, so that conservation resources are not allocated to peripheral species that are otherwise secure. High priority species are equivalent to Species of Greatest Conservation Need identified by other states.

**HighPriorityShed1-4:** HUC10 watershed selected by technical team to protect best occurrences of the species. Consider date of occurrences, existing protection, existing condition (e.g., landcover), and threats when selecting the watershed. Order designated is not important.

Goals for high priority watershed selection:

- 4 watersheds for G1\* species
- 3 watersheds for G1G2 and G2 species.
- 2 watersheds for G2G3 and higher

Exception: We will not apply this criterion to highly migratory species whose populations do not vary within an individual HUC 10, such as sturgeon, American eels, etc. Also, if the best available science suggests that an individual population of a species could not persist within a single HUC 10, additional watersheds will be selected until a population would have enough habitat to persist (e.g., a sucker species that is known to migrate from a large river into a smaller watershed for reproduction). \*Note: If the technical team disagrees with the GRank, we can base this on what the tech team thinks is an appropriate GRANK. Also, some G1 species may not occur within 4 watersheds, so we may end up selecting all known watersheds for some species. The aquatic habitat team will optimize this list across taxa, so don't consider other species when you identify watersheds independently for each species.

**RECOMMEND:** Recommendations

Summarize recommendations for high-priority actions relating to this element. It is not necessary to repeat information captured by other recommendation fields (e.g., REC\_SPROT). Examples:

“Need updated surveys for this species in the lower Ogeechee River basin”

“Habitat enhancement on existing public lands critical for conservation in Georgia”

**Make sure you delete any recommendations from existing plan that are no longer relevant.**

### **Documentation Page**

**CONTACT:** Contact

Name(s) of primary contact(s) for information on this element (this may be a technical team member, author of a report, or some other source of information).

**REFERENCES:** References

Can be used to provide abbreviated bibliographic references as needed.

**ADDITIONAL\_COMMENTS.** Use this field to record any important information not captured in other parts of the assessment form.

**ASSESSMENT\_COMPLETED**

Check this box when you and technical team members have completed the assessment for this species. Good job

## **Appendix F. Aquatic Habitat Technical Team Report**

**Prepared by Brett Albanese, Catherine McCurdy, and Carrie Straight**

### **Technical Team Members**

Brett Albanese, GADNR, Nongame Conservation Section, Social Circle

Will Duncan, U.S. Fish and Wildlife Service, Athens

Mary Freeman, U.S. Geological Survey, Athens

Robin Goodloe, U.S. Fish and Wildlife Service, Athens

\*Sara Gottlieb, The Nature Conservancy

Greg Krakow, GADNR, Nongame Conservation Section, Social Circle

Patti Lanford, GADNR, Stream Survey Team, Social Circle

\*Jason Lee, GADNR, Nongame Conservation Section, Brunswick

Thom Litts, GADNR, Fisheries Management Section, Social Circle

Catherine McCurdy, U.S. Fish and Wildlife Service, Athens

\*Katie Owens, The Nature Conservancy

Scott Robinson, GADNR, Fisheries Management Section, Social Circle

Carrie Straight, U.S. Fish and Wildlife Service, Athens

\* Member was not able to attend technical team meetings, but participated via email correspondence.

### **Executive Summary**

The 2015 revision of Georgia's State Wildlife Action Plan provided an opportunity to update and improve the existing high priority waters dataset. We chose United States Geological Survey Hydrologic Unit Code 10 digit watersheds (hereafter HUC 10) for the identification of high priority watersheds, because it provides a consistent and practical scale for watershed-level conservation. Based on species occurrence data, land cover, and expert knowledge, the Fishes and Aquatic Invertebrates Species Technical Team identified 165 high priority watersheds to protect the best known populations of 168 high priority aquatic species. These watersheds were then prioritized by calculating a Global Significance Score (GSS), which was based upon the number of species identified in each watershed as well as the global rarity of each species. Watersheds with the highest GSS clustered in the Coosa and Tennessee drainages of northwest Georgia, but also occurred in the Tallapoosa, Chattahoochee, Flint, and Savannah drainages. Watersheds with high and moderate GSS occurred in all of Georgia's five ecological regions and 14 major drainages, except the Satilla. An additional 56 watersheds were designated as "significant" high priority watersheds, but were not further prioritized. Significant watersheds contained important coastal habitats, migratory corridors for anadromous species, recent occurrences or critical habitat for federally listed species, or occurred in a region of the state where high priority watersheds were poorly represented.

We carried out a GIS assessment of all of Georgia's HUC 10 watersheds (n = 366) to characterize their degree of protection, existing condition, recent land cover trends, and future threats. Existing conservation lands are concentrated in the Blue Ridge of northeast Georgia, but there are

significant parcels of protected land scattered throughout the state. Important patterns affecting watershed condition include high forest in northeast Georgia, high cultivated crop agriculture in southwest Georgia, and extensive development within and fringing the Metro Atlanta area and along the I-75 corridor. The density of dams varies across watersheds, but impacts aquatic connectivity in almost every watershed in the state. Trends in land cover between 2001-2011 include significant declines in forest cover in the Piedmont and Southeastern Plains, little change in row crop agriculture, and increases in developed land cover in urban areas throughout the state. Urban growth models predict that extensive urbanization will occur throughout the Piedmont and Blue Ridge provinces and at scattered locations throughout the state between now and 2050.

To provide examples of how the assessment data can be used, we have identified conservation actions for three high priority watersheds: Armuchee Creek, Upper Nottely River, and Spring Creek. Some key conservation actions for these watersheds include the protection of connectivity in free-flowing streams, technical assistance to farmers and local governments, and targeted outreach. While we acknowledge the limitations of our data and the existence of additional data sets that should be considered, the information provided in this report can help guide conservation of Georgia's high priority watersheds. Conserving high priority watersheds is important to the conservation of Georgia's high priority aquatic species as well as southeastern aquatic species diversity overall. In addition, efforts to protect and restore these watersheds may also improve water quality and recreational opportunities for humans.

## **Introduction**

As part of the development of a [State Wildlife Action Plan \(SWAP\) in 2005](#), Georgia identified 212 waterbodies (i.e, rivers, streams, and creeks) as a high priority for conservation efforts. High priority waters were selected to protect important populations of high priority species and also to protect or restore representative aquatic systems throughout the state. High priority waters and their surrounding watersheds are considered a high priority for a broad array of conservation activities, including watershed-level protection efforts, riparian restoration, protection or restoration of natural flow regimes, and other conservation activities. Since the action plan was completed, the protection of high priority waters has been promoted through [GADNR's high priority waters webpage](#), and in [Georgia's SWAP plan](#). In addition, high priority streams are listed along with rare species occurrences when GADNR comments on projects that could potentially impact rare species or habitats.

Changes to the list of high priority species made as part of the current SWAP revision necessitate an update of the high priority waters dataset and also provide an opportunity to make the data more useful for conservation. One of the limitations of the initial data set was the lack of prioritization: streams were designated as high priority or not. With such a large number of high priority waterbodies and watersheds in the state, it is difficult to know where limited conservation resources should be invested. Another limitation was the lack of a GIS assessment of watershed characteristics, which can help identify the most prudent conservation strategies needed in each watershed. For example, an urbanizing watershed with no protected lands would face different threats than one that is dominated by agricultural land uses.

The objective of this report was to identify high priority watersheds for the conservation of SWAP high priority aquatic species and aquatic systems in general. In addition, we have summarized

GIS characteristics that will help identify the most appropriate conservation actions for high priority watersheds.

## **Assessment Methods**

### Selecting High Priority Watersheds for Rare Aquatic Species

We chose United States Geological Survey Hydrologic Unit Code 10 digit watersheds (hereafter HUC 10) as the spatial scale for the identification of high priority watersheds. Georgia has 366 HUC 10 watersheds that occur within or straddle our state boundaries, with an average size of 454 km<sup>2</sup>. While the smaller and more numerous HUC 12 watersheds (mean = 91 km<sup>2</sup>, n =1964) also provide a standard and widely used spatial scale, many have not been adequately surveyed for rare aquatic species in Georgia. In addition, HUC 10 watersheds are typically large enough to include the variety of habitat types (e.g., small streams to large rivers) required by most species for survival and reproduction (Schlosser and Angermeier 1999). In contrast to larger HUC 8 watersheds, HUC 10 watersheds provide a spatial scale in which watershed groups and other stakeholders can work effectively to conserve aquatic species populations (McGurrin and Forsgren 1997). Overall, we believe that the HUC10 scale provides an appropriate framework for the management of aquatic species populations, but note that no single spatial scale will be appropriate for all species. For example, protecting an individual HUC 10 watershed would not protect a population of a highly migratory species.

Species experts selected high priority watersheds during SWAP technical team meetings held in January and February 2014. Watersheds were selected to protect the best occurrences of 165 high priority aquatic species, which are listed in the SWAP Fishes and Aquatic Invertebrates Assessment Report (Albanese et al. 2015). Factors considered included date of species occurrences, watershed condition based on personal knowledge or reference to a 2008 land cover map, and existing watershed protection based on the [Conservation Lands Database](#). [Conservation status assessment maps](#), which show watersheds with the most recent documented occurrences of a species, were used to help guide selection of high priority watersheds. Technical team members attempted to select 4 HUC 10 watersheds for each high priority species. However, for many species it was not possible to identify all four watersheds because: 1) the species occurred in fewer than 4 watersheds in the state (common issue), 2) the species did occur in 4 or more watersheds, but some watersheds were not considered significant to the conservation of the species for a variety of reasons (e.g., the watershed was considered severely degraded, the occurrence was not indicative of an important population or life history function, or old occurrence dates suggest that the species may be extirpated from the watershed). In a few cases, the technical team selected unoccupied watersheds that might be important for reintroduction of a species with few or no extant occurrences in the state.

To focus conservation efforts in watersheds protecting multiple species, we attempted to eliminate watersheds only protecting a single species from the data set. In most cases, we used an alternate high priority watershed selected to protect other high priority species, as long as the new watershed contained recent occurrences of the species and the old watershed was not considered critical for conserving the species. If we could not identify an alternate high priority watershed for a species with an apparently secure (G4) or secure (G5) [NatureServe](#) global rarity rank (i.e. G Rank), we

eliminated it from the data set as long as the species was represented in three other high priority watersheds. If we could not identify an alternate watershed for a G1-G3 species (Critically Imperiled to Vulnerable), we retained the single species watershed in the dataset. Through this editing process, we eliminated 16 watersheds.

The species and aquatic habitat technical teams were given an opportunity to review a draft map of high priority watersheds during May 2014, which resulted in the selection of additional high priority watersheds. Based upon the suggestion of one technical team member, we asked John Jensen (Reptile and Amphibian technical team leader) to designate watersheds for nine high priority reptile and amphibian species that occur in rivers and streams: Apalachicola Alligator Snapping Turtle (*Macrochelys apalachicola*), Alabama Map Turtle (*Graptemys pulchra*), Barbour's Map Turtle (*Graptemys barbouri*), Brown-Back Salamander (*Eurycea aquatica*), Dwarf Waterdog (*Necturus punctatus*), Eastern Hellbender (*Cryptobranchus alleganiensis*), One-Toed Amphiuma (*Amphiuma pholeter*), Patch-nosed Salamander (*Urspeleperpes brucei*), and Suwannee Alligator Snapping Turtle (*Macrochelys suwanniensis*). We also identified additional watersheds for Robust Redhorse (*Moxostoma robustum*) to ensure that important habitats for both Evolutionarily Significant Units (Altamaha and Savannah; see Wirgin et al. 1991) of the species were represented.

#### Prioritizing High Priority Watersheds

Given the large number of high priority watersheds identified by the technical team, it was important to further prioritize them for conservation efforts. For example, a watershed with several globally imperiled species might require substantial investments, such as species monitoring, targeted land acquisition, restoration, and finer scale conservation planning. On the other hand, a high priority watershed may not be significant globally, but might still be significant for proactive conservation of species that have a limited range in the state.

We assigned a global significance score (GSS) for all high priority watersheds in the state, calculated as:

$$GSS = \sum_{i=1}^s SI$$

Where SI = individual species importance score, which is summed across all (s) high priority species in the watershed. The species importance score was based on NatureServe Global Rarity Ranks (lower number means greater imperilment), to place greater emphasis on species that are imperiled globally. We used the following weighting: G1=5 points, G2= 4 points, G3= 3 points, G4 = 2 points, G5 = 1 point. Thus, watersheds with the highest global significance scores will protect many globally rare species. For example, a watershed with five G5 species would have a GSS of 5, whereas a watershed with five G1 species would have a GSS of 25.

#### Selection of Additional High Priority Watersheds

After reviewing the initial map of high priority watersheds, technical team members suggested selection of additional high priority watersheds that did not meet our initial criteria based on rare species occurrences. These additional watersheds were selected because they met at least one of five criteria: 1) they contained [critical habitat](#) for a species listed under the U.S. Endangered Species Act (ESA), 2) they contained important coastal habitats, such as estuaries and marshes, 3) they were part of a migratory corridor for a high priority diadromous species (Alabama Shad *Alosa alabamae*, American Shad *Alosa sapidissima*, Atlantic Sturgeon *Acipenser oxyrinchus*, and Shortnose Sturgeon *Acipenser brevirostrum*), 4) they contained an extant population of an ESA listed species, or 5) they occurred in an ecological region of the state where high priority watersheds were poorly represented. These criteria were only evaluated for watersheds that had not already been designated as high priority because they contained an important population (s) of a high priority species. These additional watersheds were not prioritized as described above and are hereafter designated as “significant” high priority watersheds, regardless of which criterion or criteria they met.

Watersheds with critical habitat for ESA listed aquatic species were identified using a GIS coverage of critical habitat units obtained from the U.S. Fish and Wildlife Service (Athens Ecological Services) in September 2014. All watersheds intersecting the EPA Level 4 ecoregion 75j “Sea Islands/Coastal Marsh” were considered important coastal habitat (Griffith et al. 2001). Migratory corridors included the mainstem Chattahoochee, Flint, Little, Withlacoochee, St. Marys, Satilla, Altamaha, Ocmulgee, Oconee, Ogeechee, and Savannah Rivers up to the first point where passage is blocked by a dam or the most upstream record of the diadromous species in unimpounded systems. Watersheds with extant populations of ESA listed species were identified using GADNR’s Rare Species Database (aka, NatureServe Biotics Database). This database includes records from research projects carried out by GADNR or its contractors, publications, consultant reports, and scientific collection permit reports. It also includes records from the [Georgia Museum of Natural History](#) and GADNR’s [Stream Survey Team](#).

To identify watersheds occurring in an ecological region of the state where high priority watersheds were poorly represented, we identified ecological drainage units by intersecting six Level 3 ecoregions (Griffith et al. 2001) with the [14 major river drainages](#) occurring in the state. This resulted in the identification of 32 ecological drainage units. For example, the Savannah drainage would include separate units for the Blue Ridge, Piedmont, Southeastern Plains, and Southern Coastal Plain. Ecological drainage units serve as a coarse filter to represent aquatic community diversity (see Sowa et al. 2007). We assessed the effectiveness of our species-based approach in capturing aquatic community diversity by overlaying high priority watersheds on a map of ecological drainage units. We then identified additional high priority watersheds for poorly represented ecological drainage units as necessary. Our minimum goal was at least one high priority watershed in each ecological drainage unit.

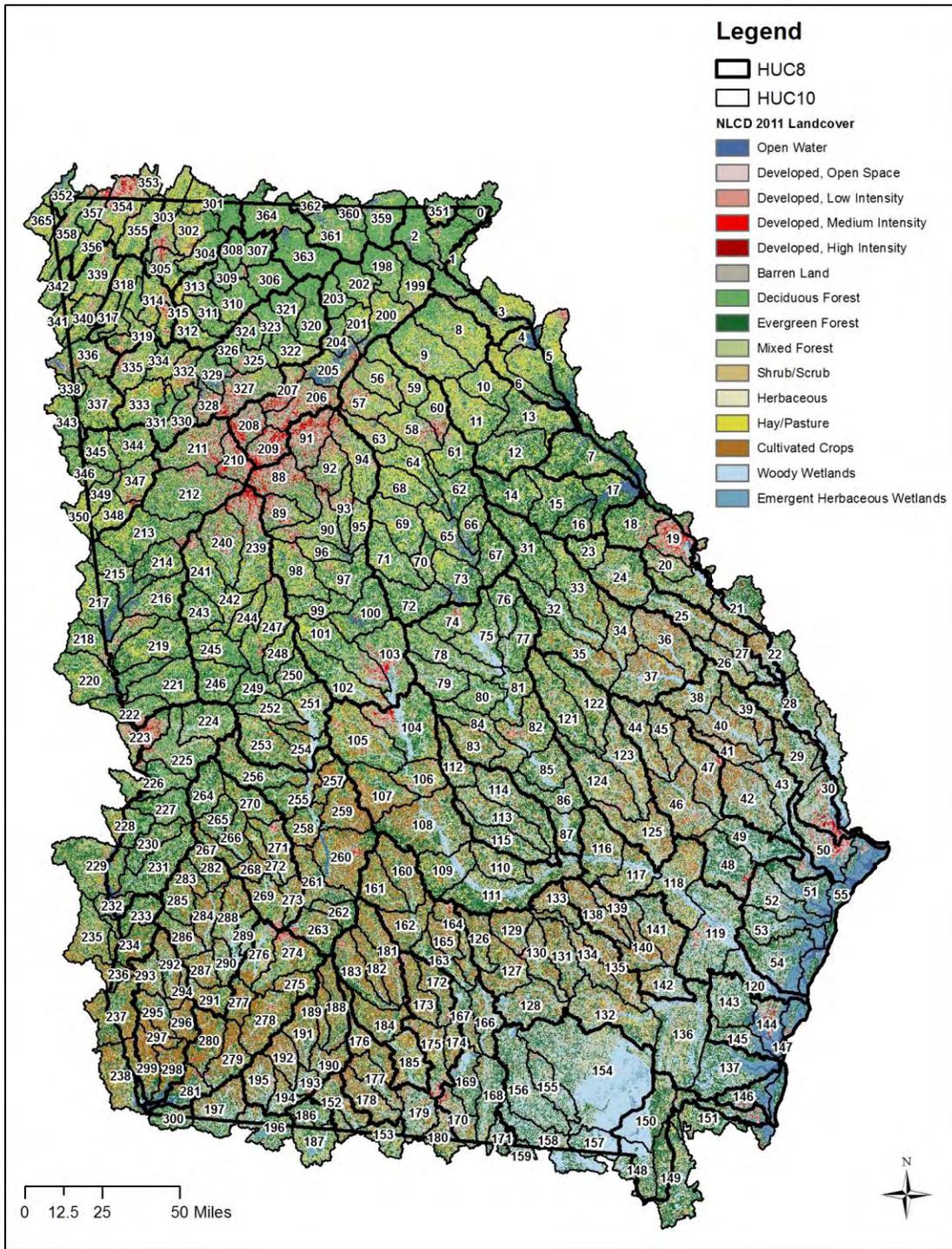
## **Watershed Assessment**

The purpose of the watershed assessment was to assess watershed scale protection, existing condition, and recent trends and threats for all Georgia watersheds at the HUC 10 scale. This information will be used to help identify the most appropriate conservation actions for high priority watersheds. For example, additional land acquisition or easements might be appropriate in

watersheds with existing but insufficient protected areas. Similarly, growth management policies might be the most important conservation action in watersheds threatened by future urbanization.

The aquatic habitat committee met in February 2014 to discuss the merits of different GIS data layers to include in the assessment, which are listed in [Appendix I](#). Individual data layers are categorized to indicate the degree to which they protect aquatic resources, reflect the existing condition of aquatic habitats, or represent a recent trend or future threat to water quality or habitat. Layers were also designated with a + or – to indicate their potential relationship with aquatic species and habitats. Many of the data layers were selected from the most currently available version (2011) of the National Land Cover Dataset (NLCD; Jin et al. 2013; [Figure 1](#)). Descriptions of land cover classes can be found at [http://www.mrlc.gov/nlcd06\\_leg.php](http://www.mrlc.gov/nlcd06_leg.php). We considered a subset of current land cover classes (e.g., % Forest, % Developed, etc.) to be an indicator of the current condition of aquatic habitats within watersheds. We used changes in the proportion of different land cover classes between 2001-2011 to reflect recent watershed trends, with the expectation that similar changes would likely affect aquatic resources in the future.

In addition, each layer was identified as a **potential predictor** or as **exploratory**. Potential predictors could be used in future analyses relating condition variables to attributes of aquatic species. For example, the number of high priority aquatic species in a watershed or reach could be modeled as a function of forest land cover. To be included in our list of potential predictor variables, the data layer had to be available in GIS format for the entire state of Georgia and known to influence aquatic species and habitats in other studies. Exploratory data layers may also impact aquatic species and habitats, but may be difficult to include in analyses for a variety of reasons (e.g., variable not assessed for entire state). Nonetheless, the technical team felt that exploratory data layers were useful for visually representing watershed condition and threats and could also help identify conservation actions within portions of the state. Some additional data layers could not be included in the assessment due to time constraints or because they are not yet available in a GIS format and are listed in [Appendix II](#).



**Figure 1.** National Land Cover Classification (NLCD 2011), with HUC 8 and HUC 10 watershed boundaries. Map numbers correspond to watersheds listed in Tables 1 and 2.

## Assessment Results

### High Priority Watersheds

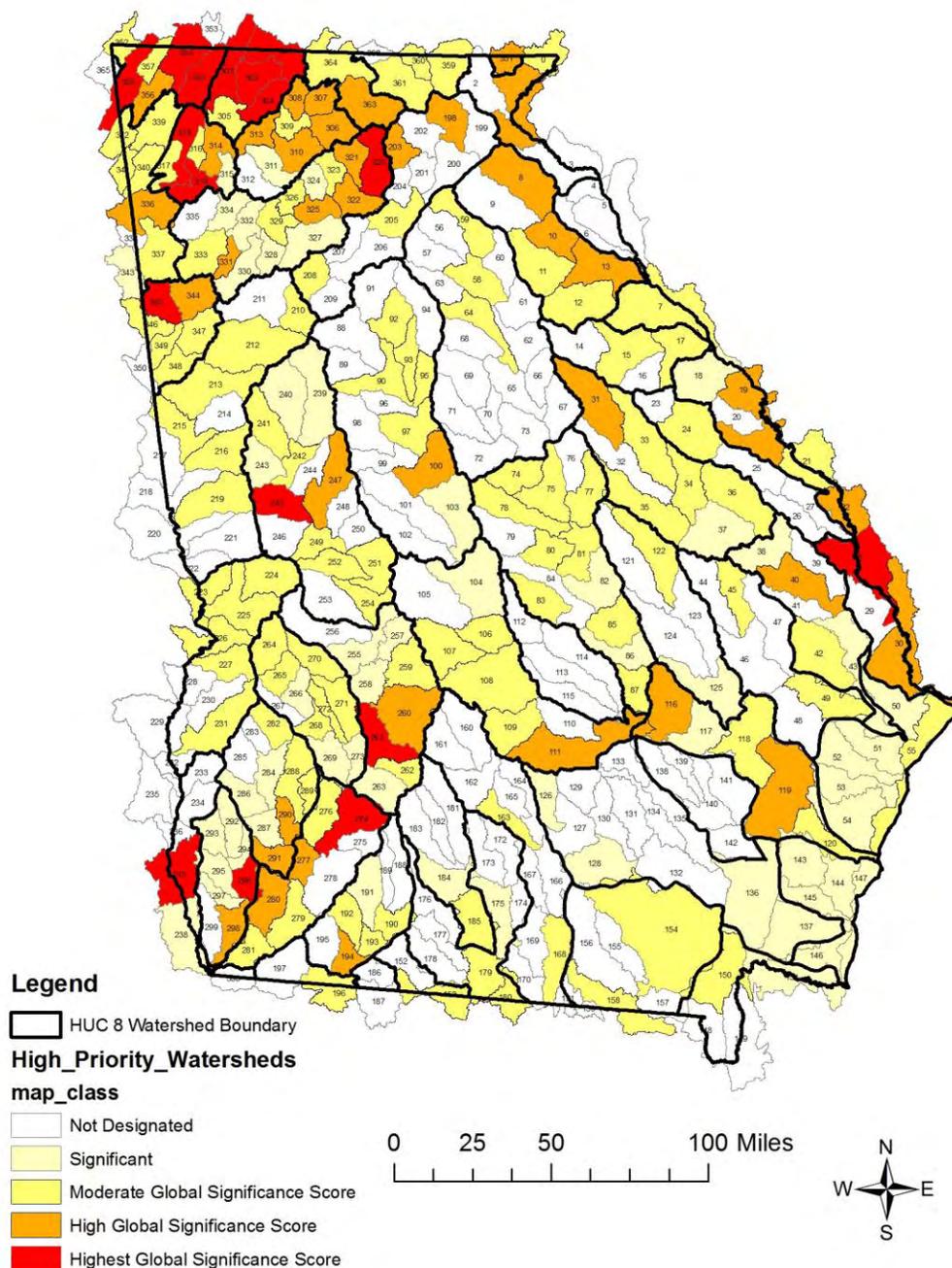
The technical team identified 165 high priority watersheds (45% of watersheds in the state; [Figure 2](#)), which were designated for 168 of 174 high priority aquatic species (including 9 reptile and amphibian species). Lack of distributional data prevented designation of watersheds for the remaining 6 aquatic species.

The number of watersheds selected for each species varied, with one watershed designated for 30 species, two watersheds designated for 20 species, three watersheds designated for 30 species, four watersheds designated for 87 species, and eight watersheds designated for Robust Redhorse. The number of high priority species designated within a single watershed ranged widely, from one species in 58 watersheds to 24 and 26 species in two upper Conasauga River watersheds (units 301 and 302). It is important to realize that the number of high priority species listed for each watershed reflects the number of species that were selected by the technical team as having an important population in the watershed, not necessarily the number of species that may occur or historically occurred within the watershed.

Global significance scores ranged from 95 to 1 for watersheds. For visual representation, we grouped GSS into three categories: moderate 1-10, high 11-19, and highest 20-95 ([Figure 2](#)). Because this represents a somewhat arbitrary categorization of continuous data, we also present actual GSS for each watershed ([Table 1](#)). Watersheds with the highest GSS clustered in the Coosa and Tennessee drainages of northwest Georgia, but also occurred in the Tallapoosa, Chattahoochee, Flint, and Savannah drainages. Watersheds categorized as high GSS were concentrated in the Coosa, lower Flint and Savannah drainages, but also occurred in every other major drainage except the Suwannee, St. Marys, and Satilla. Watersheds with moderate GSS were present in all drainages but the Satilla.

We selected an additional 56 watersheds because they met at least one of our five criteria, increasing the number of high priority watersheds to 221 (60% of watersheds in the state; [Figure 2](#)). This included 15 watersheds that met multiple criteria, 9 with important coastal habitats, 20 containing critical habitat or a recent occurrence of an ESA listed species, 10 that were part of a migratory corridor, and 2 watersheds that were added from ecological drainage units that were poorly represented in the dataset.

The two watersheds added from poorly represented units were both in the Satilla River system. Watershed 128 (Satilla-Southeastern Plains) was added because no watersheds were represented in this ecological drainage unit. We selected this individual watershed because of its relatively low urban cover. Watershed 126 (Satilla-Southern Coastal Plain) was added because of the designation of few high priority watersheds relative to the size of this ecological drainage unit and their clustering along the edge of the coast. This particular watershed was selected based on low urban cover and fish sampling data indicating relatively diverse communities in Guest Mill Pond (a Carolina Bay) and the upper Satilla River. Otherwise, high priority watersheds were well represented in all ecological drainage units ([Figure 3](#)).



**Figure 2.** High priority watersheds identified during the 2015 revision of Georgia’s State Wildlife Action Plan. Watersheds categorized by global significance score were selected because they contain important populations of a high priority aquatic species. Watersheds categorized as “significant” contained one or more of the following: important coastal habitat, a migratory corridor for a high priority diadromous species, critical habitat or a recent occurrence of an ESA listed species, or an aquatic community from an ecological region of the state where high priority watersheds are poorly represented. Map numbers correspond to the watersheds listed in Tables 1 and 2. Zoom in to view map numbers.

**Table 1.** High priority watersheds designated during the 2015 revision of Georgia’s State Wildlife Action Plan. The global significance score (GSS; higher score indicates greater significance) is based upon the number of high priority aquatic species (No. Species) with important populations occurring in the watershed and the global rarity of those species. Additional watersheds were designated as high priority because they contain important coastal habitat (C), a migratory corridor (MC) for a high priority diadromous species, critical habitat (CH) or a recent occurrence of an ESA listed species (LS) or are representative of an aquatic community (AC) from an ecological region of the state where high priority watersheds are poorly represented. Watersheds are sorted by descending global significance score and then by map number.

<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
302	Conasauga River 2	95	26	GSS
301	Conasauga River 3	94	24	GSS
304	Holly Creek	56	14	GSS
354	Chickamauga Creek	41	13	GSS
274	Flint River Lower 4	35	8	GSS
319	Oostanaula River 1	29	8	GSS
355	Little Chickamauga Creek	29	10	GSS
320	Etowah River 7	28	8	GSS
318	Armuchee Creek	27	10	GSS
245	Flint River Upper 4	24	6	GSS
303	Coahulla Creek	24	7	GSS
296	Spring Creek 3, Spring Creek	22	7	GSS
358	Lookout Creek	22	8	GSS
28	Savannah River Lower 2	20	5	GSS
237	Chattahoochee River Lower South 2	20	5	GSS
261	Flint River Middle 2	20	5	GSS
345	Tallapoosa River 2	20	7	GSS
198	Chattahoochee Upper North 5	19	5	GSS
313	Coosawatee River 1	19	6	GSS
325	Etowah River 5	19	6	GSS
13	Broad River 1, Clark Hill	18	5	GSS
277	Flint River Lower 3	18	4	GSS
280	Flint River Lower 2	18	4	GSS
307	Ellijay River	18	5	GSS
356	West Chickamauga Creek	18	6	GSS
290	Chickasawhatchee Creek 1	17	4	GSS
322	Etowah River 6	17	6	GSS
344	Tallapoosa River 3	17	6	GSS
8	Broad River 3	16	5	GSS
10	Broad River 2	16	5	GSS
31	Ogeechee River Upper 4	16	5	GSS

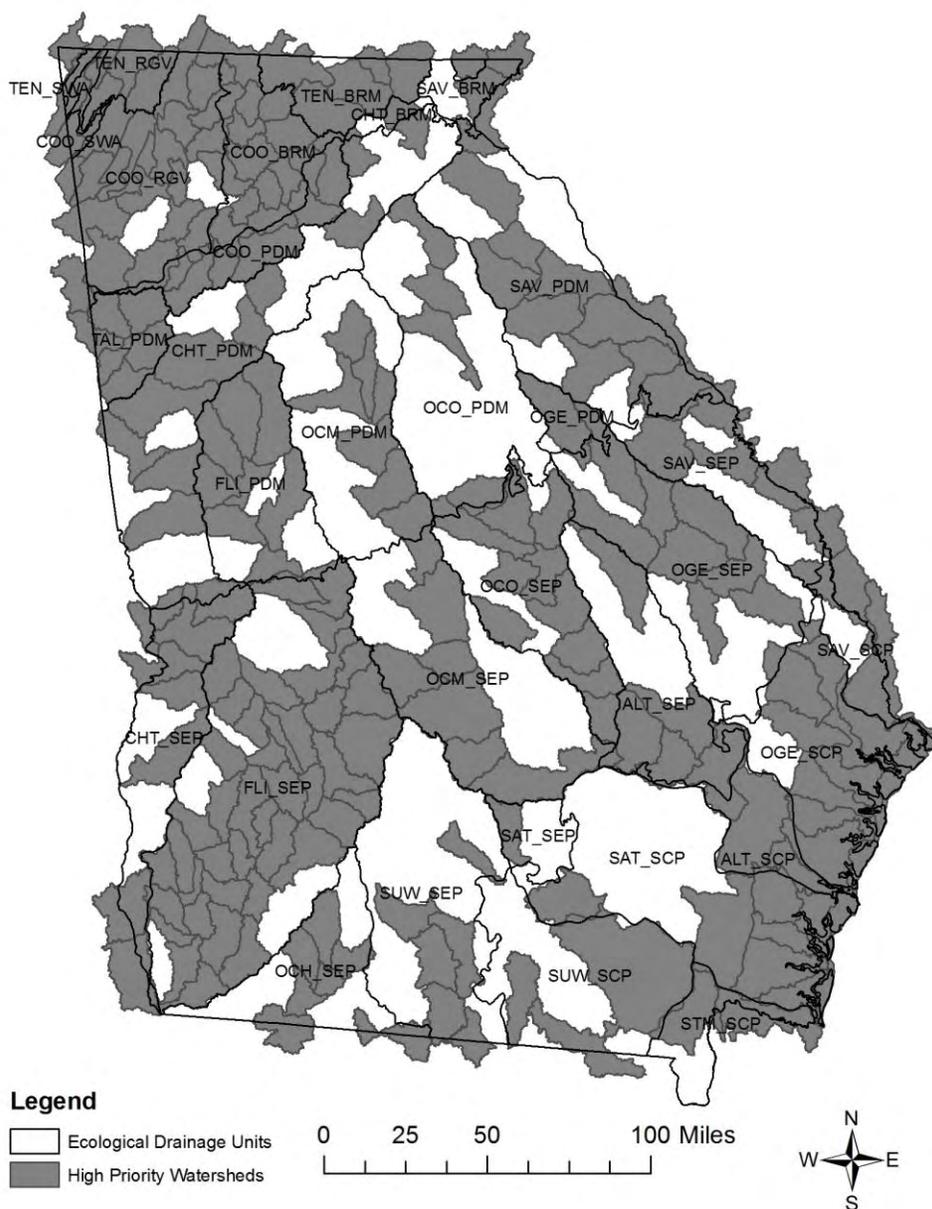
<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
351	Little Tennessee River	16	6	GSS
194	Ochlockonee River Upper 1	15	4	GSS
291	Ichawaynochaway Creek 1	15	4	GSS
314	Oostanaula River 2	15	5	GSS
331	Raccoon Creek, Etowah River	15	4	GSS
100	Ocmulgee River Upper 2	14	5	GSS
203	Chestatee River 2	14	4	GSS
310	Talking Rock Creek	14	4	GSS
363	Toccoa River	14	6	GSS
1	Panther Creek	13	3	GSS
119	Altamaha River 2	13	3	GSS
247	Potato Creek	13	3	GSS
260	Flint River Middle 3, Lake Blackshear	13	3	GSS
111	Ocmulgee River Lower 1	12	4	GSS
298	Spring Creek 1, Spring Creek, Lake Seminole	12	4	GSS
306	Cartecay River	12	3	GSS
308	Mountaintown Creek	12	3	GSS
321	Amicalola Creek	12	3	GSS
19	Savannah River Middle 3	11	3	GSS
22	Savannah River Middle 1	11	3	GSS
30	Savannah River Lower 1	11	4	GSS
40	Ogeechee River Lower 2	11	3	GSS
116	Altamaha River 5	11	3	GSS
336	Coosa River, Wells Reservoir	11	4	GSS
75	Oconee River Lower 6	10	4	GSS
168	Alapaha River 1	10	3	GSS
179	Withlacoochee River 2	10	3	GSS
346	Tallapoosa River 1	10	4	GSS
349	Big Indian Creek, Tallapoosa River	10	4	GSS
12	Long Creek	9	2	GSS
81	Oconee River Lower 5	9	2	GSS
93	Yellow River 1, Jackson Lake	9	2	GSS
95	Alcovy River 1, Jackson Lake	9	2	GSS
118	Altamaha River 3	9	2	GSS
339	Teloga Creek	9	3	GSS
360	Brasstown Creek	9	4	GSS
21	Savannah River Middle 2	8	2	GSS
34	Ogeechee River Upper 2	8	2	GSS
180	Withlacoochee River 1	8	3	GSS
196	Ochlockonee River Lower	8	2	GSS

<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
249	Flint River Upper 3	8	2	GSS
251	Flint River Upper 2	8	2	GSS
281	Flint River Lower 1, Lake Seminole	8	3	GSS
288	Chickasawhatchee Creek 2	8	2	GSS
305	Conasauga River 1	8	2	GSS
309	Coosawatee River 2, Carters Lake	8	2	GSS
317	Little Armuchee	8	3	GSS
326	Shoal Creek, Etowah River	8	3	GSS
11	South Fork Broad River	7	2	GSS
35	Williamson Swamp Creek	7	2	GSS
36	Buckhead Creek	7	2	GSS
64	Apalachee River 1, Lake Oconee	7	2	GSS
163	Alapaha River 3	7	2	GSS
224	Upatoi Creek 2	7	4	GSS
225	Upatoi Creek 1	7	4	GSS
231	Pataula Creek	7	3	GSS
259	Turkey Creek, Flint River Middle	7	2	GSS
289	Kiokee Creek	7	2	GSS
359	Hiawassee River, Chatuge Lake	7	2	GSS
120	Altamaha River 1	6	2	GSS
213	Chattahoochee River Lower North 6	6	2	GSS
254	Flint River Upper 1	6	2	GSS
333	Euharlee Creek	6	2	GSS
340	Chattooga River	6	2	GSS
0	West Fork	5	2	GSS
7	Savannah River Upper 1, Clark Hill	5	1	GSS
17	Little River 1, Little R, Clark Hill	5	1	GSS
24	Brier Creek 3	5	2	GSS
83	Rocky Creek	5	1	GSS
85	Oconee River Lower 3	5	1	GSS
97	Ocmulgee River Upper 3	5	1	GSS
106	Ocmulgee River Lower 4	5	1	GSS
107	Big Creek, Ocmulgee River Lower	5	1	GSS
108	Ocmulgee River Lower 3	5	1	GSS
109	Ocmulgee River Lower 2	5	1	GSS
153	Aucilla River 1	5	2	GSS
216	Yellowjacket Creek, West Point Lake	5	1	GSS
219	House Creek, Chattahoochee River Lower North	5	1	GSS
227	Hannahatchee Creek	5	2	GSS
241	White Oak Creek	5	1	GSS

<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
252	Patsiliga Creek	5	1	GSS
323	Long Swamp Creek	5	1	GSS
352	Cole City Creek	5	2	GSS
357	Chattanooga Creek	5	2	GSS
361	Upper Nottely River	5	2	GSS
15	Little River 2, Little R	4	1	GSS
49	Canoochee River 1	4	1	GSS
58	Middle Oconee River 1	4	1	GSS
74	Oconee River Lower 7	4	2	GSS
77	Sandy Hill Creek	4	1	GSS
78	Commissioner Creek	4	1	GSS
80	Big Sandy Creek 1	4	1	GSS
87	Oconee River Lower 1	4	1	GSS
90	South River 1, Jackson Lake	4	1	GSS
92	Yellow River 2	4	1	GSS
122	Little Ohoopie River	4	1	GSS
190	Ochlockonee River Upper 3	4	1	GSS
192	Barretts Creek	4	1	GSS
223	Chattahoochee River Upper South 5	4	2	GSS
262	Abrams Creek	4	1	GSS
268	Kinchafoonee Creek 2	4	1	GSS
279	Big Slough 1	4	1	GSS
329	Etowah River 4, Allatoona Lake	4	2	GSS
342	Middle Fork Little River	4	1	GSS
347	Little Tallapoosa River 2	4	1	GSS
364	Fightingtown Creek/Lower Toccoa	4	2	GSS
33	Rocky Comfort Creek	3	1	GSS
59	North Oconee River 2	3	1	GSS
150	St. Marys River 2	3	1	GSS
154	Suwannee River 3	3	1	GSS
158	Suwannee River 2	3	1	GSS
185	Little River 1, Little River	3	1	GSS
193	Ochlockonee River Upper 2	3	1	GSS
205	Chattahoochee Upper North 3, Lake Lanier	3	1	GSS
208	Chattahoochee Upper North 1	3	1	GSS
210	Chattahoochee River Lower North 8	3	1	GSS
212	Chattahoochee River Lower North 7	3	1	GSS
215	Chattahoochee River Lower North 5, West Point Lake	3	1	GSS
226	Chattahoochee River Upper South 4, Eufaula Lake	3	2	GSS
242	Flint River Upper 5	3	1	GSS

<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
264	Kinchafoonee Creek 5	3	1	GSS
265	Kinchafoonee Creek 4	3	1	GSS
270	Muckalee Creek 3	3	1	GSS
271	Muckalee Creek 2	3	1	GSS
272	Muckaloochee Creek	3	1	GSS
276	Cooleewahee Creek	3	1	GSS
282	Ichawaynochaway Creek 4	3	1	GSS
316	Johns Creek	3	1	GSS
341	Alpine Creek	3	1	GSS
348	Little Tallapoosa River 1	3	1	GSS
337	Cedar Creek	2	1	GSS
42	Black Creek	1	1	GSS
45	Fifteenmile Creek	1	1	GSS
55	Ogeechee River, Coast	1	1	GSS
18	Savannah River Middle 4	0	0	MC
37	Ogeechee River Upper 1	0	0	MC
38	Ogeechee River Lower 3	0	0	MC
43	Ogeechee River Lower 1	0	0	C, LS, MC
50	Little Ogeechee River	0	0	C
51	Medway River	0	0	C, LS
52	North Newport River	0	0	C
53	South Newport River	0	0	C
54	Sapelo River	0	0	C
82	Oconee River Lower 4	0	0	MC
86	Oconee River Lower 2	0	0	MC
103	Ocmulgee River Upper 1	0	0	MC, LS
104	Ocmulgee River Lower 5	0	0	MC
117	Altamaha River 4	0	0	CH, LS, MC
125	Ohoopsee River 1	0	0	CH
126	Satilla River 6	0	0	AC
128	Satilla River 4	0	0	AC
136	Satilla River 2	0	0	MC
137	Satilla River 1	0	0	C, LS, MC
143	Turtle River	0	0	C
144	Brunswick River	0	0	C
145	Satilla River Coast 2	0	0	C
146	Crooked River	0	0	C
147	Satilla River Coast 1	0	0	C
151	St. Marys River 1	0	0	C, LS
175	Withlacoochee River 3	0	0	MC

<b>Map Number</b>	<b>HUC 10 Watershed Name</b>	<b>GSS</b>	<b>No. Species</b>	<b>Criteria</b>
184	Little River 2, Little River	0	0	MC
191	Little Ochlockonee River	0	0	CH
238	Chattahoochee River Lower South 1, Lake Seminole	0	0	MC
239	Flint River Upper 6	0	0	CH
240	Line Creek	0	0	CH, LS
243	Red Oak Creek	0	0	CH
255	Flint River Middle 5	0	0	CH, LS
257	Hogcrawl Creek	0	0	CH
258	Flint River Middle 4	0	0	CH
263	Flint River Middle 1	0	0	CH, LS
266	Kinchafoonee Creek 3	0	0	CH, LS
269	Kinchafoonee Creek 1	0	0	CH, LS
273	Muckalee Creek 1	0	0	CH, LS
284	Ichawaynochaway Creek 3	0	0	CH
286	Pachitla Creek 1	0	0	CH
287	Ichawaynochaway Creek 2	0	0	CH, LS
292	Spring Creek 5, Spring Creek	0	0	CH
293	Dry Creek	0	0	CH
294	Spring Creek 4, Spring Creek	0	0	CH, LS
295	Aycocks Creek	0	0	CH
297	Spring Creek 2, Spring Creek	0	0	CH, LS
311	Salacoa Creek	0	0	LS
315	Oothkalooga Creek	0	0	LS
324	Sharp Mountain Creek	0	0	LS
327	Little River, Etowah River, Allatoona Lake	0	0	LS
328	Allatoona Creek, Allatoona Lake	0	0	LS
330	Pumpkinvine Creek	0	0	LS
332	Etowah River 3	0	0	LS
334	Etowah River 2	0	0	LS
343	Terrapin Creek	0	0	CH



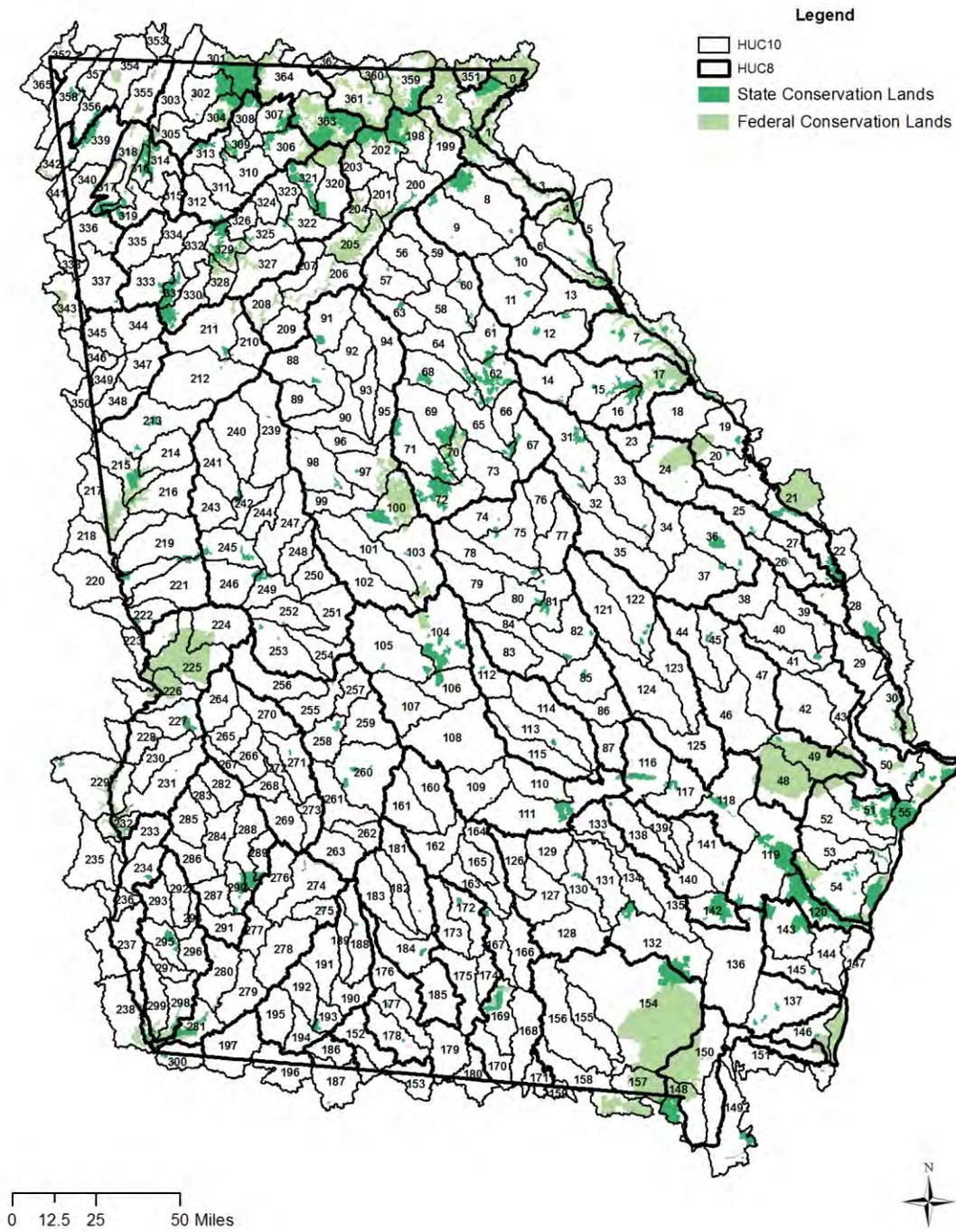
**Figure 3.** High priority watersheds designated within each of 32 ecological drainage units. Ecological drainage units (EDU) were formed by intersecting Georgia's 14 major river drainages with six ecoregions. Each EDU unit is labeled as drainage\_ecoregion abbreviations: CHT = Chattahoochee, FLI = Flint, OCH = Ochlockonee, SUW = Suwannee, STM = St. Marys, SAT = Satilla, ALT = Altamaha, OCM = Ocmulgee, OCO = Oconee, OGE = Ogeechee, SAV = Savannah, COO = Coosa, TAL = Tallapoosa, TEN = Tennessee, SWA = Southwestern Appalachians, RGV = Ridge and Valley, BRM = Blue Ridge Mountains, PDM = Piedmont, SEP = Southeastern Plains, and SCP = Southern Coastal Plain.

## Watershed Assessment

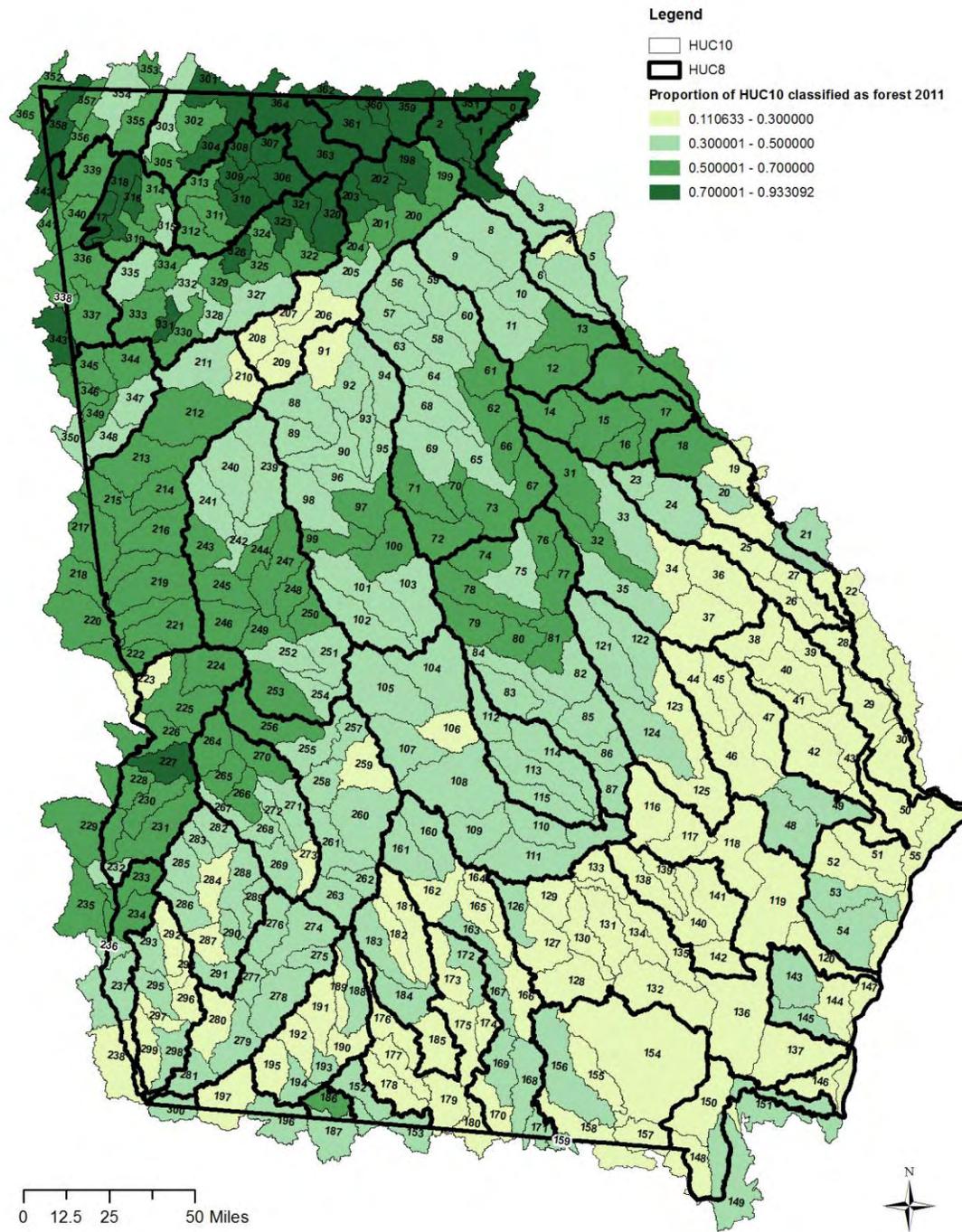
Maps were created to summarize the degree of protection, existing condition, and recent trends and future threats to all of Georgia's HUC 10 watersheds. Here we briefly summarize major patterns across the state. Detailed information for all watersheds is provided in Table 2, which is available as a separate excel file that should always accompany this report.

### Degree of Protection and Existing Condition

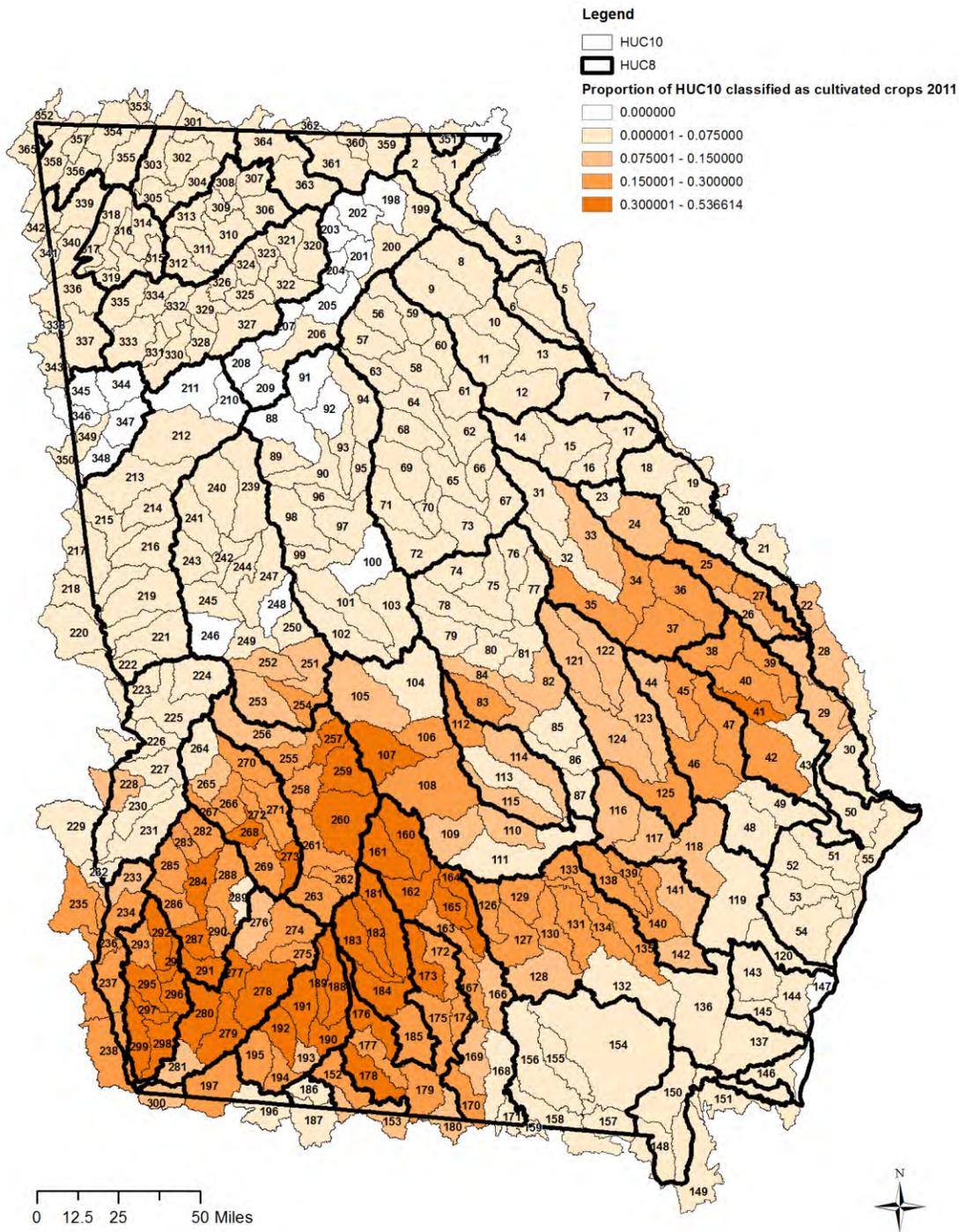
Existing conservation lands are concentrated in the Blue Ridge of northeast Georgia ([Figure 4](#)), but there are significant parcels of protected land scattered throughout the state. Similarly, the proportion of watersheds classified as forest is highest in northeast Georgia, exceeding 70% in most watersheds ([Figure 5](#)) and providing important headwater protection for several high priority watersheds. The lowest forest cover (<30%) occurs in watersheds in the Metro Atlanta area and within the Southeastern Plains and Southern Coastal Plain ecoregions. Cultivated crop agriculture is present throughout the state, but reaches its highest coverage (>30%) in southwest Georgia ([Figure 6](#)). Developed land ([Figure 7](#)) exhibits peak levels (> 50%) in the metro Atlanta area and in the I-75 corridor north into Tennessee. In addition, watersheds throughout the upper Piedmont and Ridge and Valley have levels ranging from 10-50% developed. A similar pattern is exhibited when Developed Open Space (e.g., parks, golf courses, athletic fields) is included in the classification ([Figure 8](#)) and when examining the proportion of individual 30 m landscape cells that are impervious (e.g., paved surfaces that promote runoff as opposed to infiltration of precipitation; [Figure 9](#)). Relatively high numbers of dams per kilometer of stream occur in watersheds scattered throughout the state, with the highest levels in watersheds within and fringing the Metro Atlanta area ([Figure 10](#)). To put these levels in perspective, the two highest categories mapped represent one dam for every 6 to 25 km of stream or river. Road crossing densities are greatest in Metro Atlanta and relatively high throughout north Georgia ([Figure 11](#)). Clean Water Act impairment designations, based on Index of Biotic Integrity fish community sampling in 1094 stream reaches sampled between 1998-2011, show a large proportion of impaired streams (42.8%) scattered throughout the state ([Figure 12](#)). The proportion of stream length listed as impaired under the Clean Water Act (i.e., 303d listed streams) is relatively high in Metro Atlanta, north Georgia in general, and in southeast Georgia ([Figure 13](#)). Habitat condition index values indicate a very high risk of habitat degradation in the Metro Atlanta area, in the I-75 corridor near Tennessee, and in other urban areas around the state. Stream reaches with a moderate to high risk of degradation are concentrated in the upper Piedmont and throughout the Southeastern Plains ([Figure 14](#)).



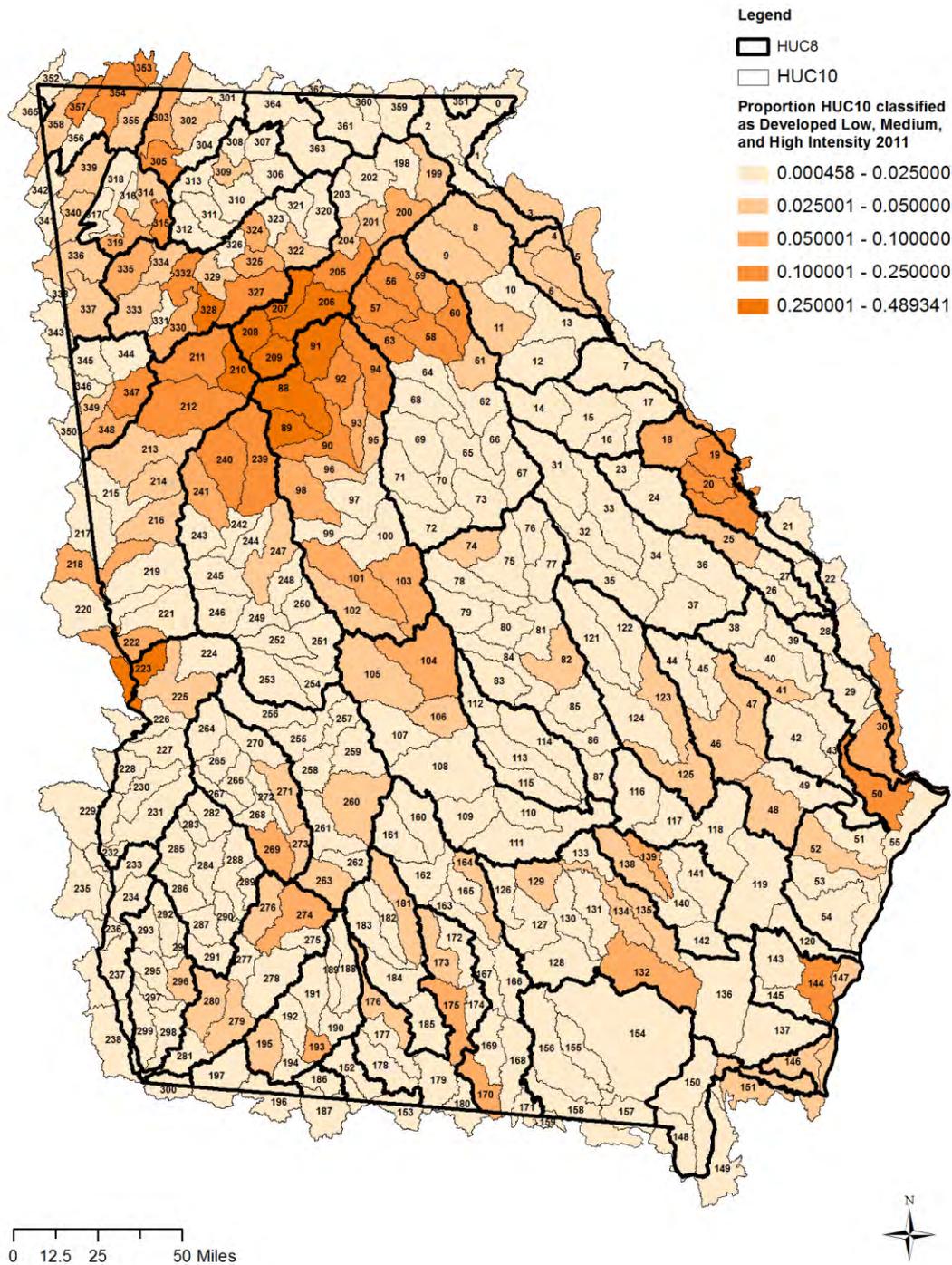
**Figure 4.** State and federal conservation lands, with HUC 8 and HUC 10 boundaries. Map numbers correspond to watersheds listed in Tables 1 and 2.



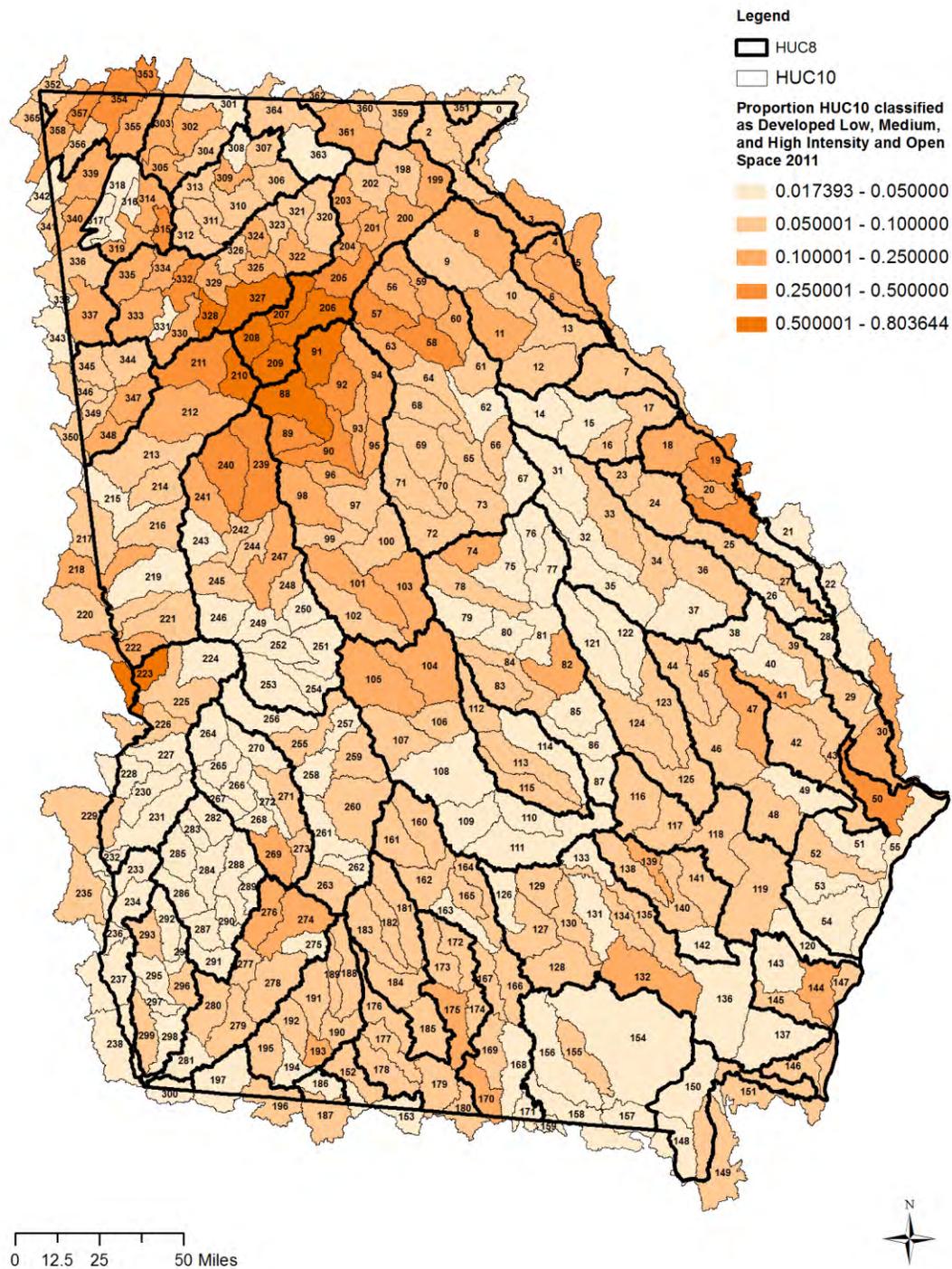
**Figure 5.** Proportion of HUC 10 watersheds classified as forest in 2011, based on the National Land Cover Classification Dataset. Forest cover includes deciduous, evergreen, and mixed forest classes. HUC 8 watershed boundaries are also shown.



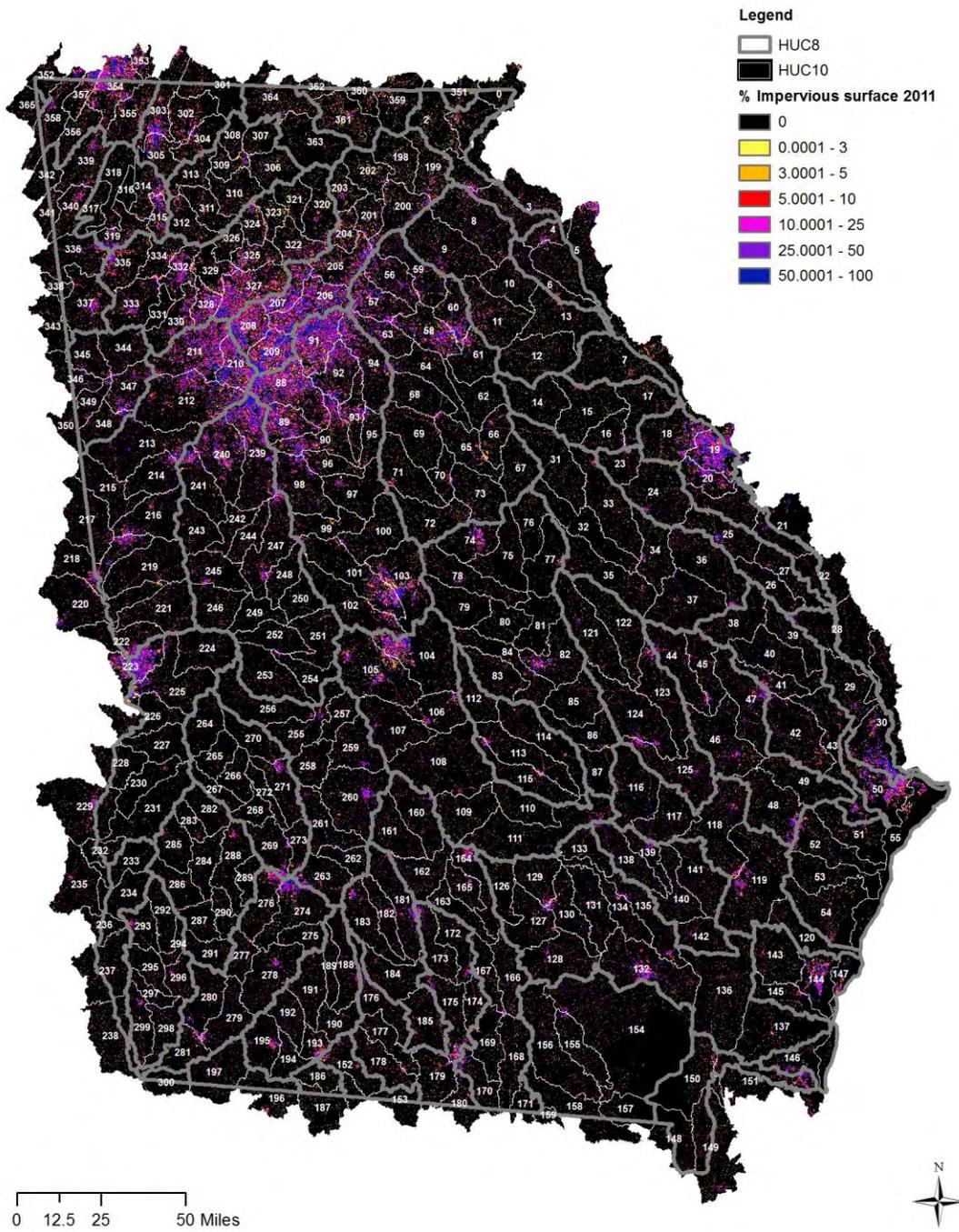
**Figure 6.** Proportion of HUC 10 watersheds classified as cultivated crops in 2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



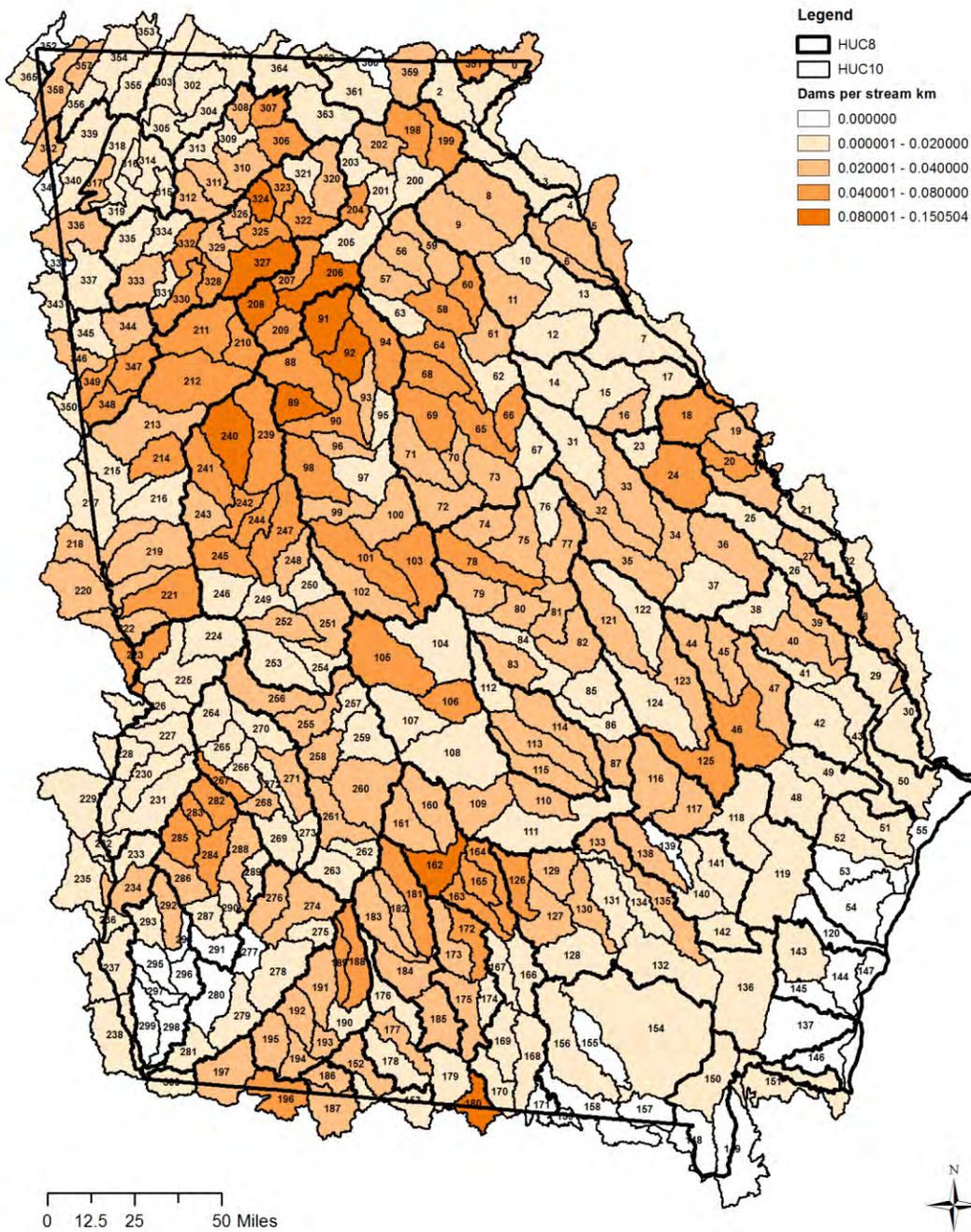
**Figure 7.** Proportion of HUC 10 watersheds classified as low, medium, or high intensity development in 2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



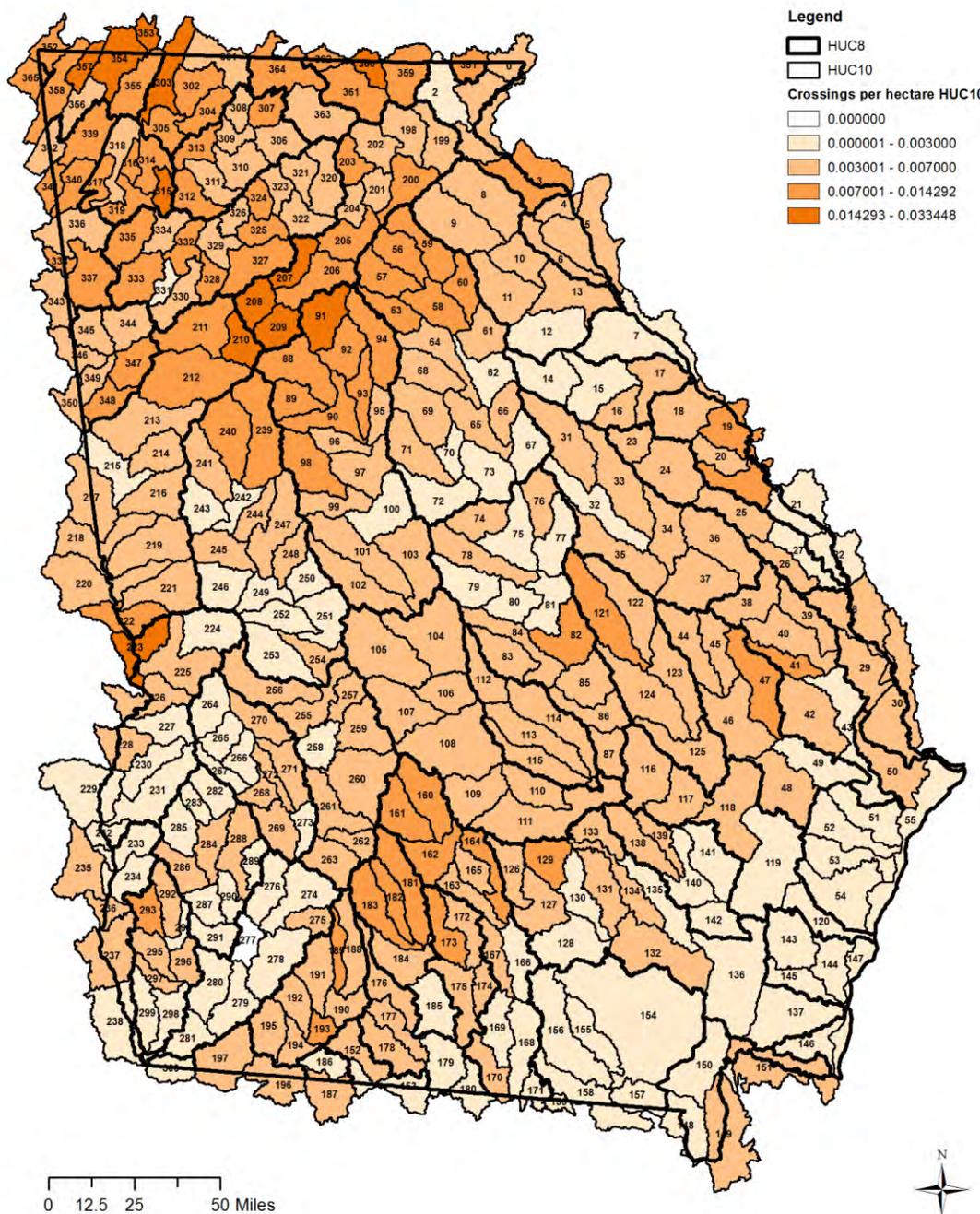
**Figure 8.** Proportion of HUC 10 watershed classified as low, medium, or high intensity development or developed open space in 2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



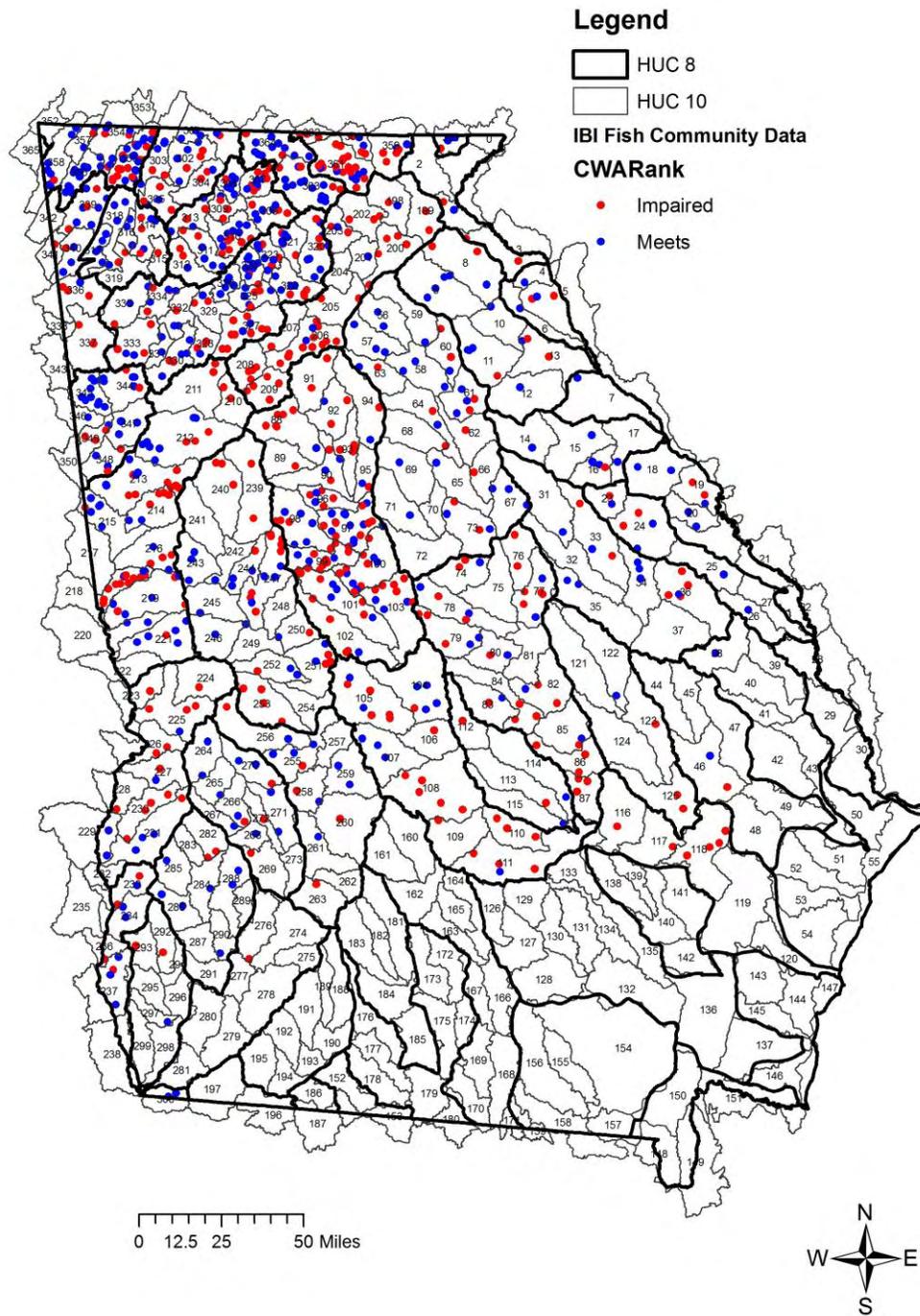
**Figure 9.** Percent imperviousness of 30 m landscape cells within HUC 10 watersheds in 2011, based on the National Land Cover Classification Dataset. Additional impervious cells are visible as you zoom into the figure. HUC 8 watershed boundaries are also shown.



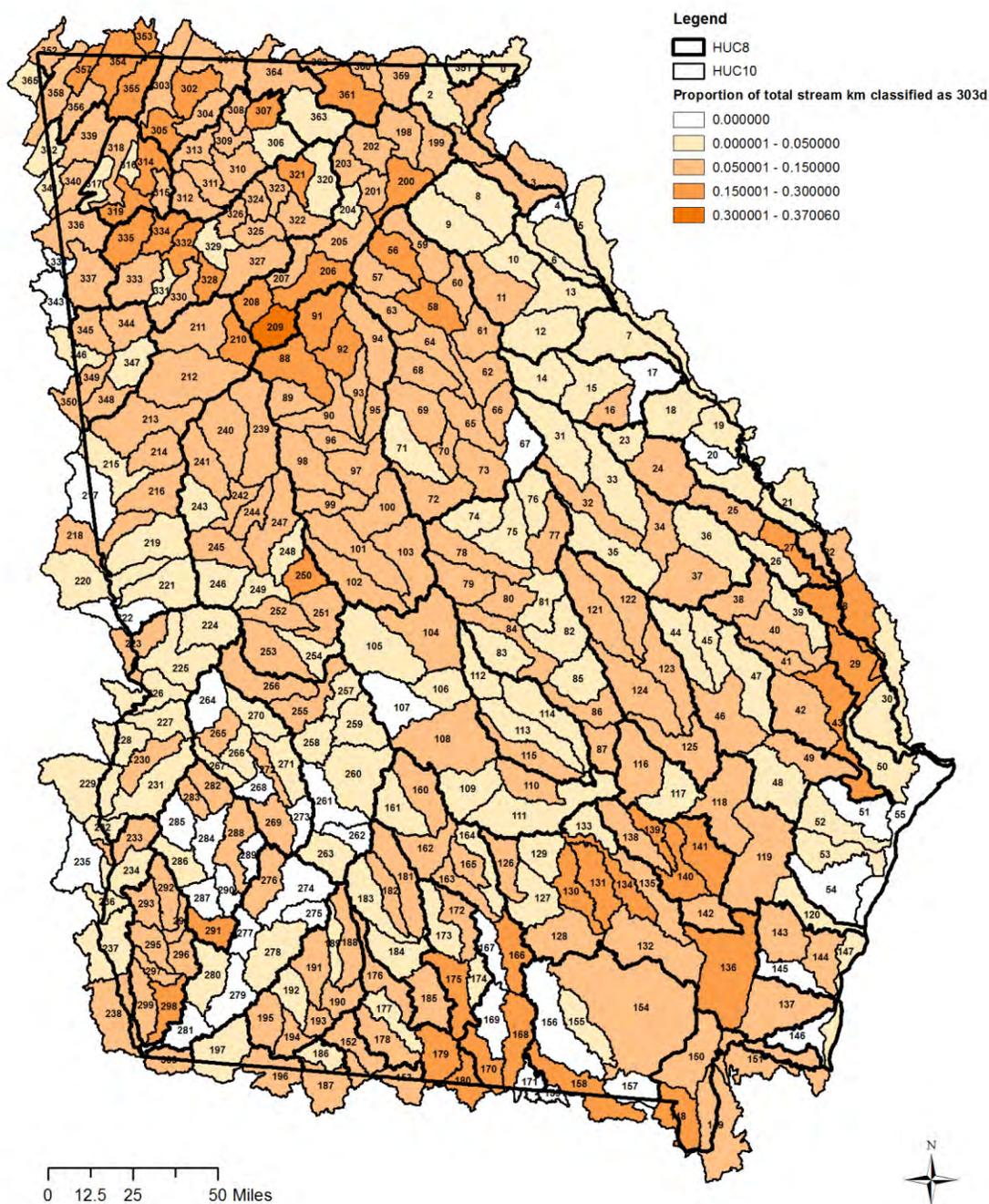
**Figure 10.** Number of dams per kilometer of stream in HUC 10 watersheds, based on the 2013 National Inventory of Dams and the National Hydrography Dataset (fine resolution hydroline). HUC 8 watershed boundaries are also shown.



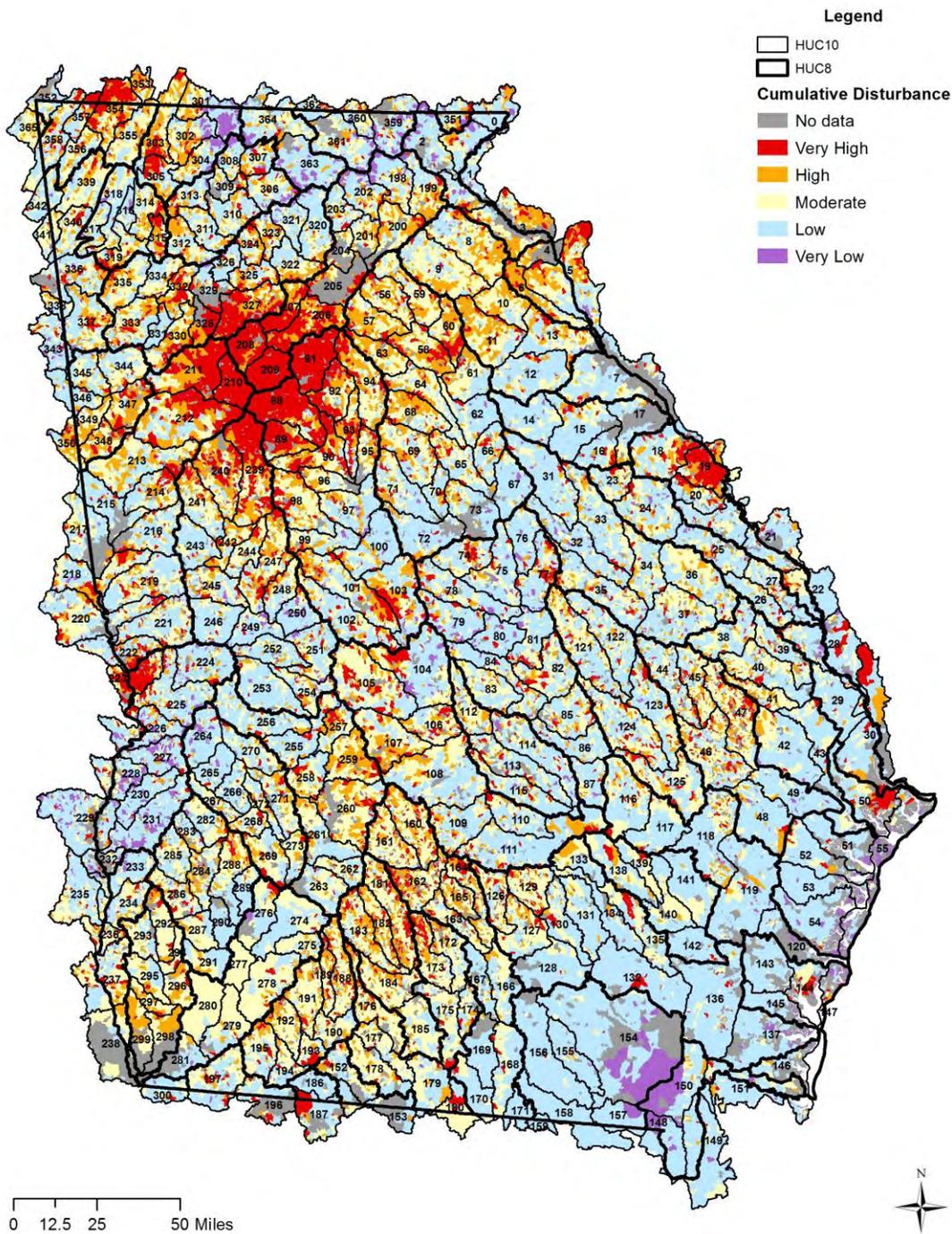
**Figure 11.** Number of road crossings per hectare of HUC 10 watershed area, based on Georgia Department of Transportation Road coverages in Georgia and the U.S and Canada Detailed Streets dataset (TomTom North America, Inc.) for portions of watersheds outside of Georgia. HUC 8 watershed boundaries are also shown.



**Figure 12.** Sites that meet their designated use under the Clean Water Act or are considered impaired (i.e., not meeting their designated use) based on Index of Biological Integrity (IBI) fish community sampling. Sites were sampled between 1998-2011 by the Georgia DNR Stream Survey Team.



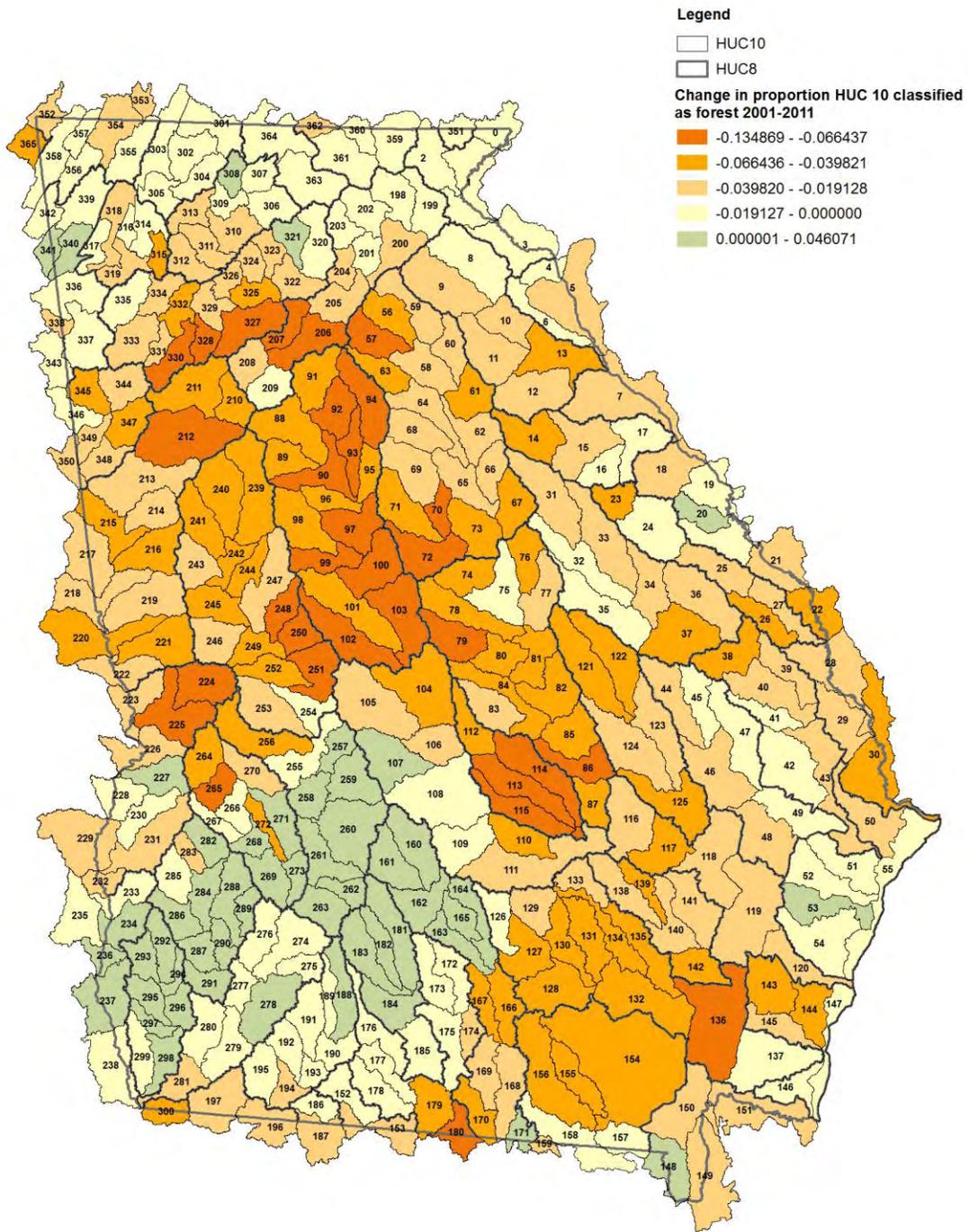
**Figure 13.** Proportion of stream length in HUC 10 watersheds on the the U.S. Environmental Protection Agency’s list of impaired waters (i.e., the 303d list), as updated through 2012. Streams are listed for violating a variety of water quality criteria, including criteria based on biological sampling, heavy metals, temperature, fecal coliform bacteria, dissolved oxygen, and other factors. HUC 8 watershed boundaries are also shown.



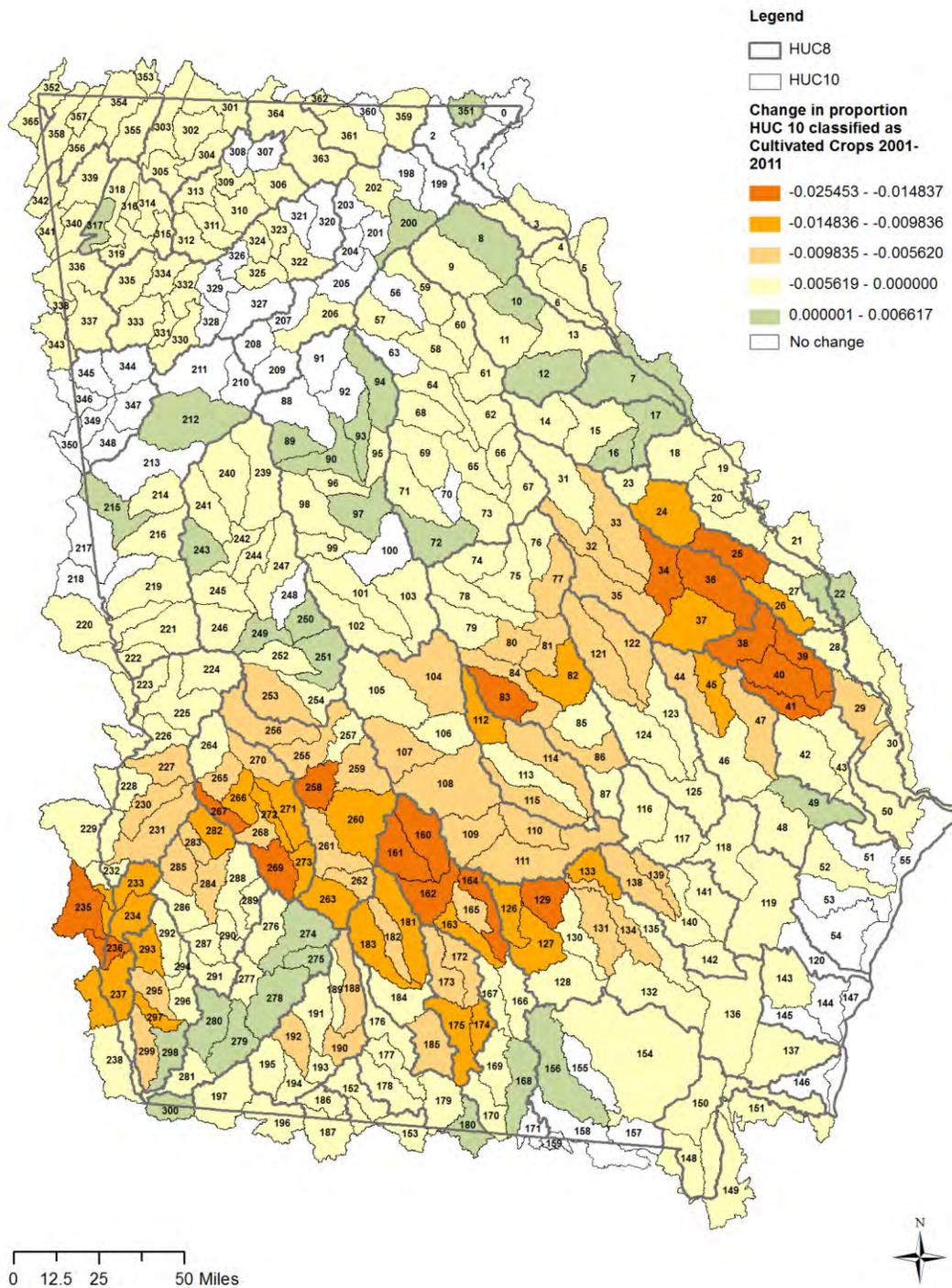
**Figure 14.** Risk of stream habitat degradation based on the cumulative influence of landscape variables such as land use, population density, roads, dams, mines, and point-source pollution. This dataset was created in support of a National Fish Habitat Action Plan and was released in 2010.

## Recent Trends and Future Threats

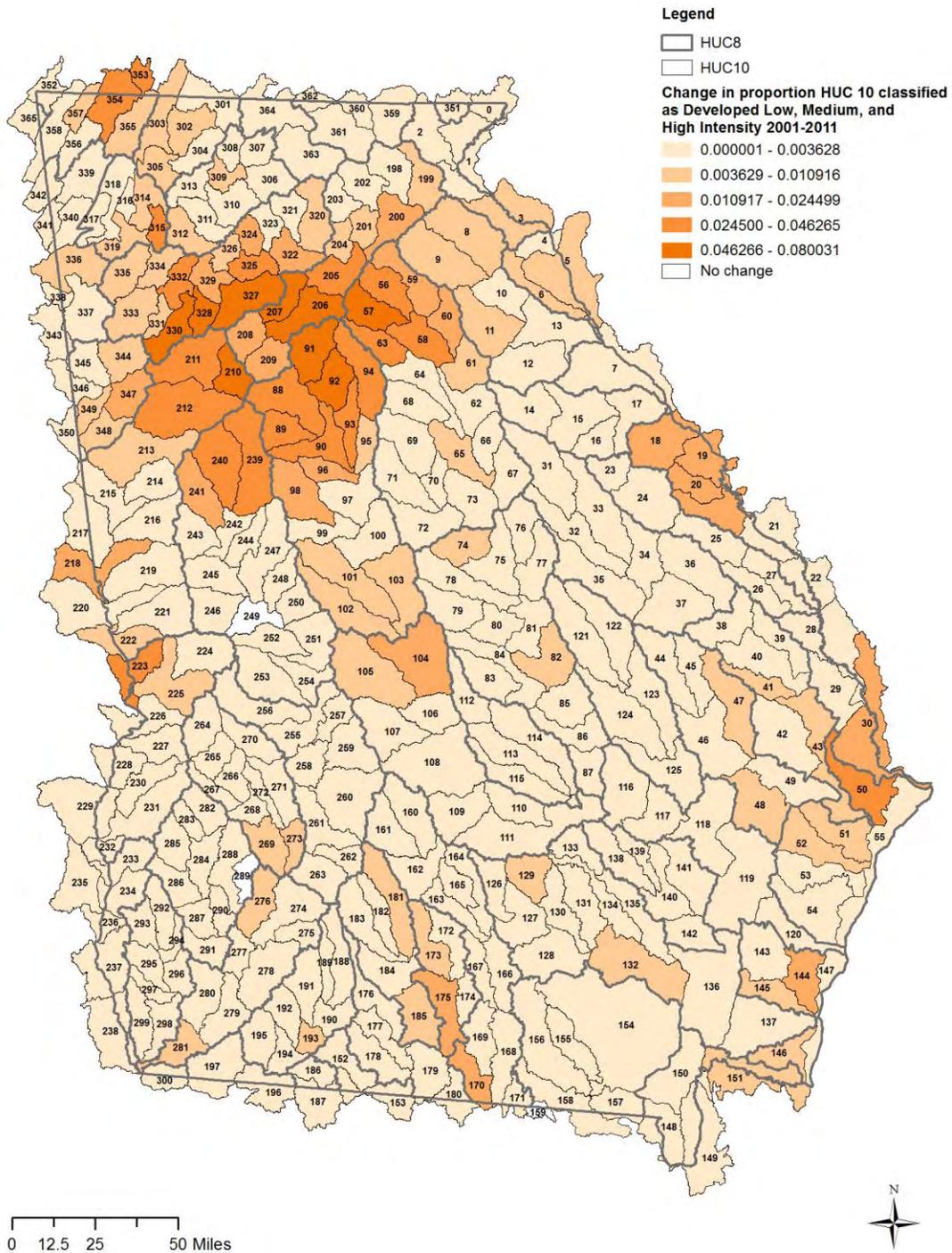
Significant loss in the proportion of forested land cover (up to 13.5%) has occurred in many watersheds between 2001-2011, particularly in Metro Atlanta, the western Piedmont, and in the central portion of the Southeastern Plains ([Figure 15](#)). Forest cover has increased in most watersheds in southwest Georgia and exhibited stability or more modest declines in other parts of the state. Overall, cultivated crop agriculture has changed little over the last decade ([Figure 16](#)). The proportion of developed land cover has increased in a large number of watersheds within the Metro Atlanta area and within a few other urbanizing areas around the state ([Figure 17](#)) and [Figure 18](#)). Similarly, there is a clustering of pixels with large increases in percent imperviousness in a wide area around Metro Atlanta ([Figure 19](#)). Projected urban growth is expected to increase modestly in these same areas in 2020 ([Figure 20](#)). By 2050, however, extensive urbanization is expected to occur throughout the Piedmont and Blue Ridge provinces and at scattered locations throughout the state ([Figure 21](#)).



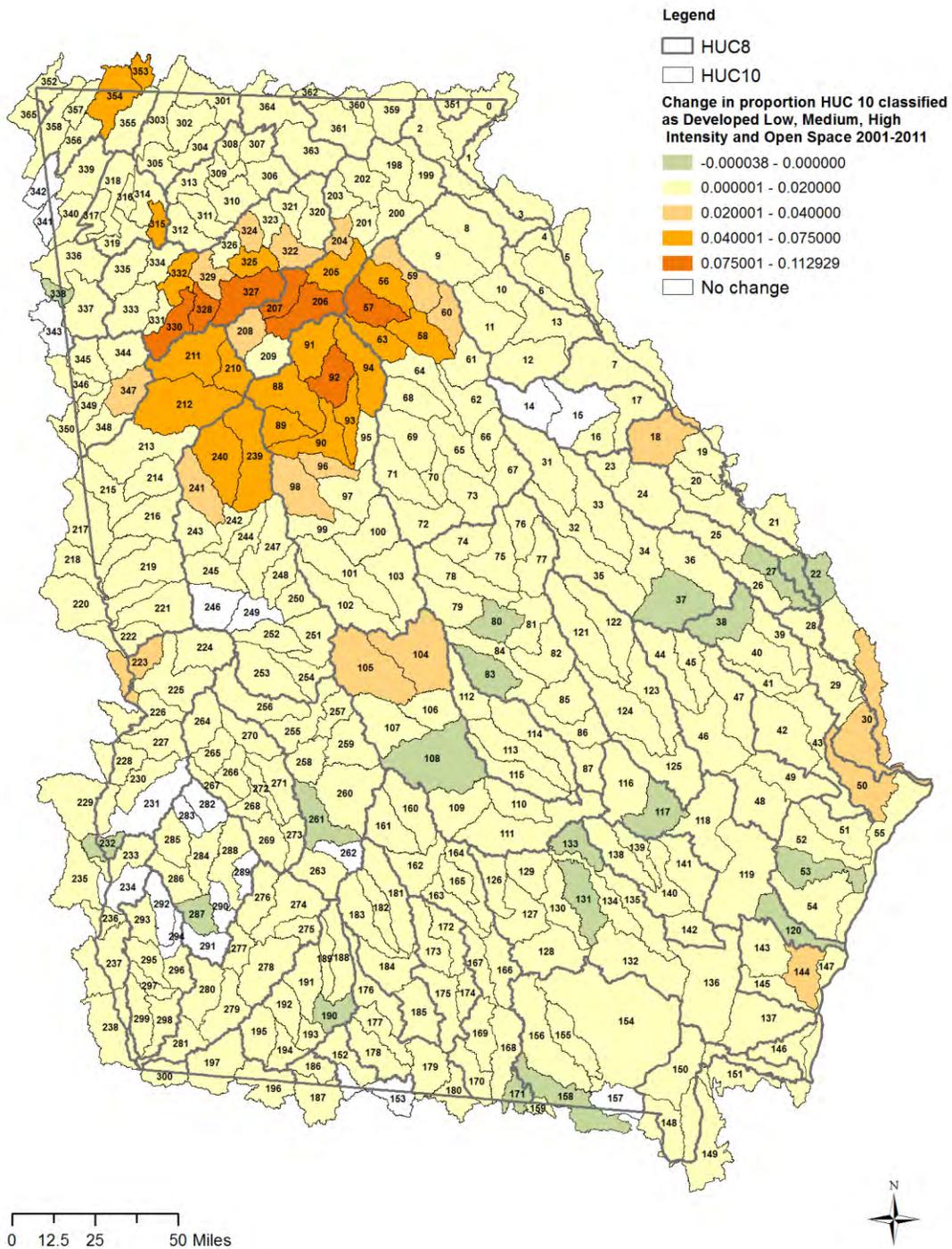
**Figure 15.** Change in the proportion of HUC 10 watersheds classified as forest between 2001-2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



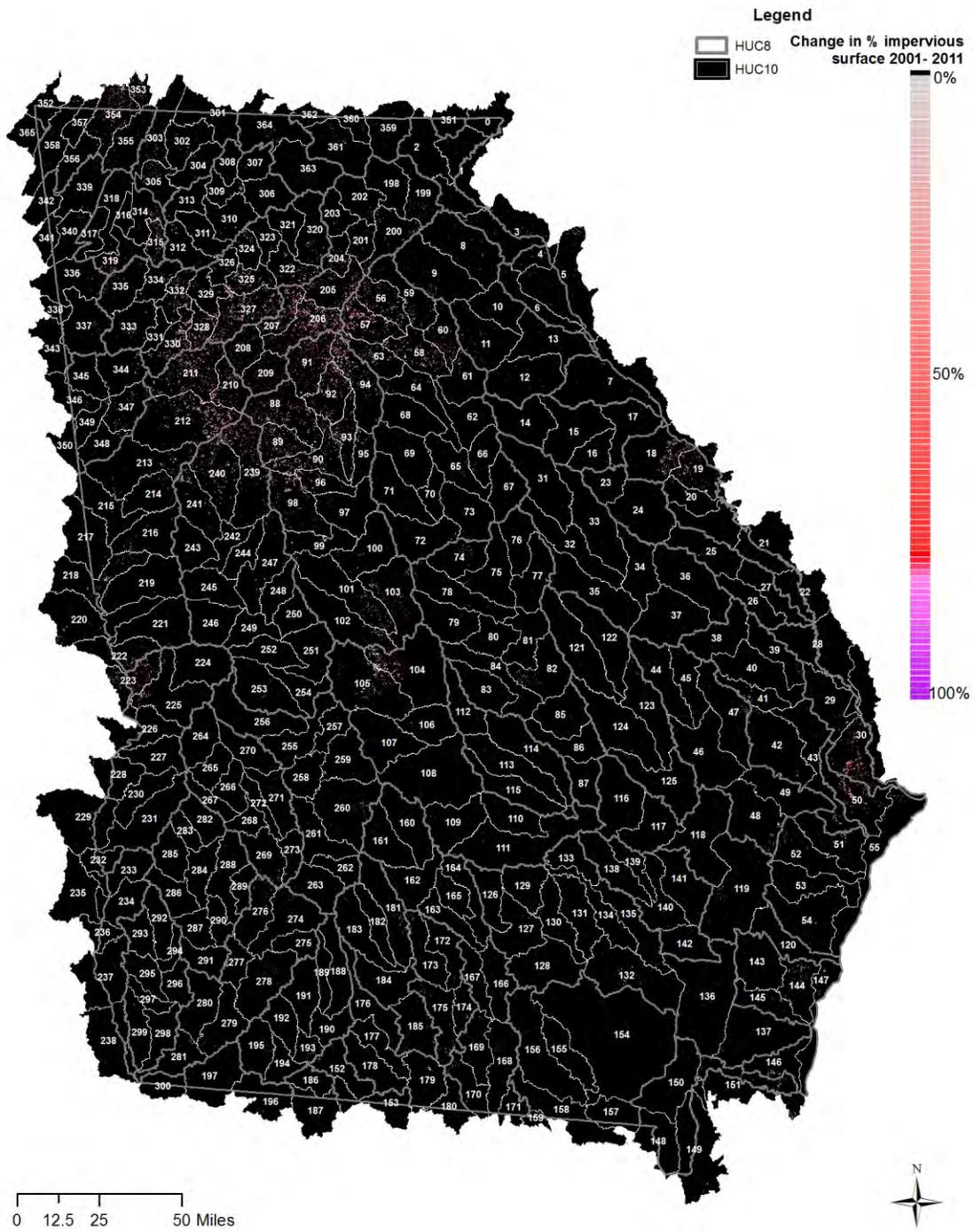
**Figure 16.** Change in the proportion of HUC 10 watersheds classified as cultivated crops between 2001-2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



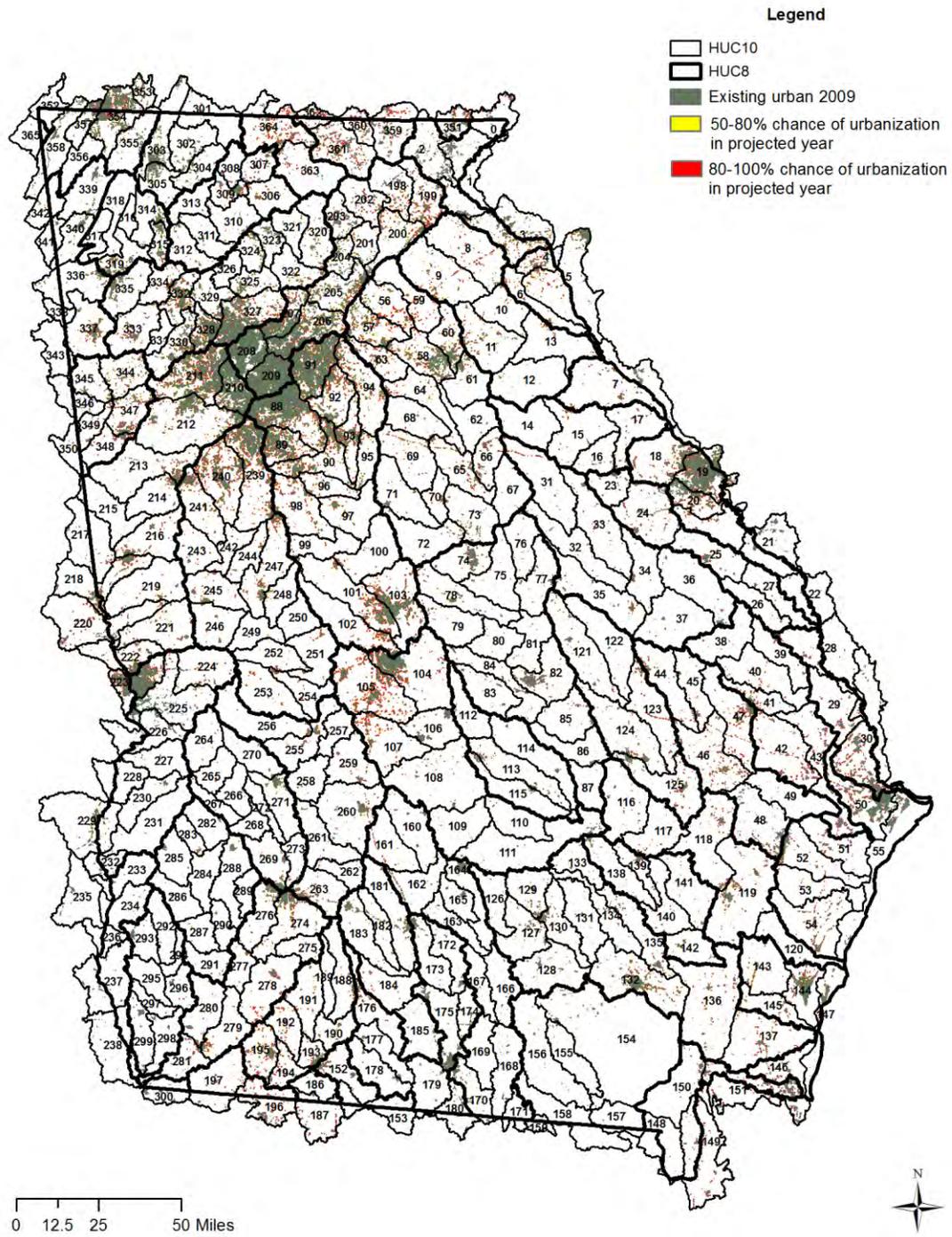
**Figure 17.** Change in the proportion of HUC 10 watersheds classified as low, medium, or high intensity development between 2001- 2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



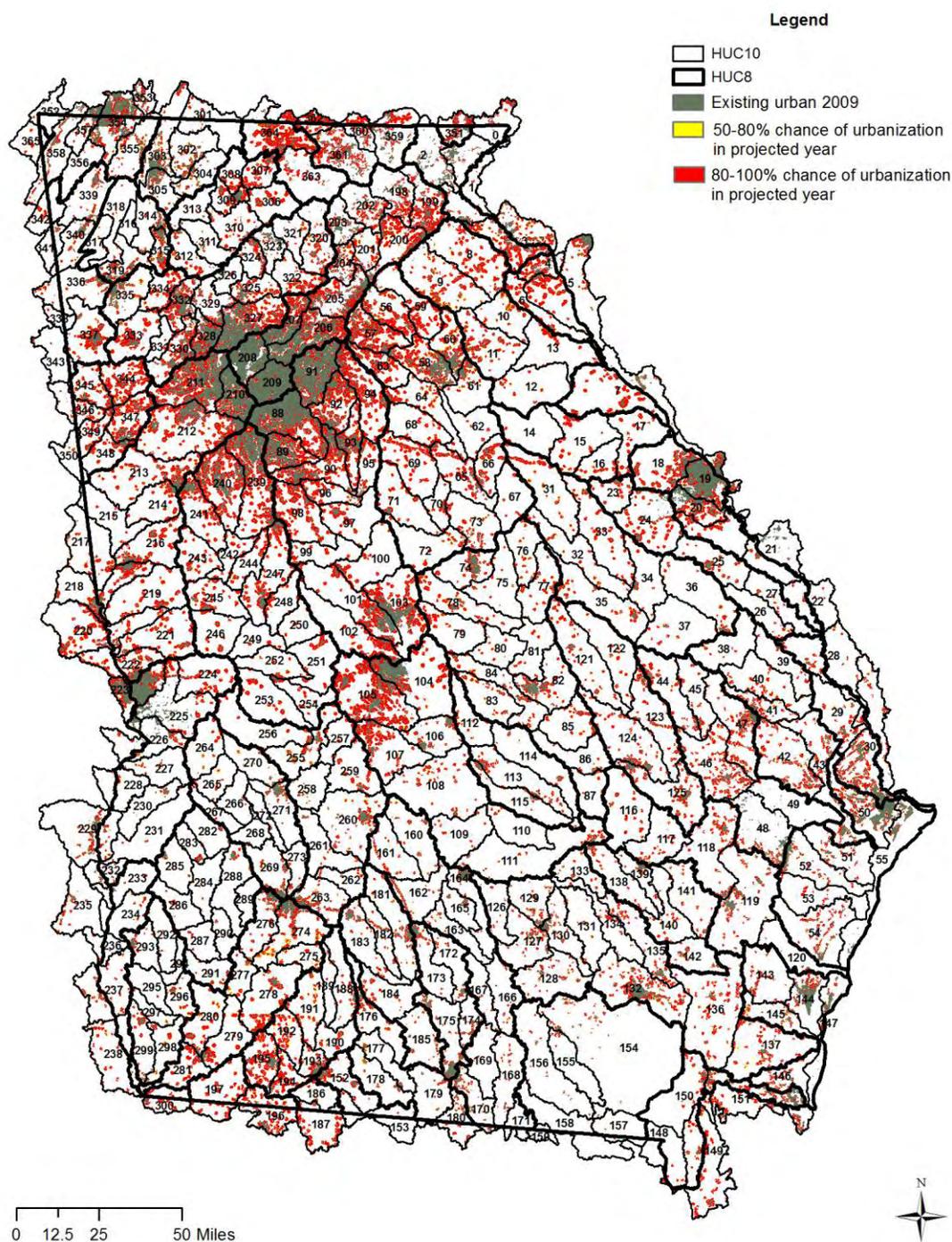
**Figure 18.** Change in the proportion of HUC 10 watersheds classified as low, medium, or high intensity development or developed open space between 2001-2011, based on the National Land Cover Classification Dataset. HUC 8 watershed boundaries are also shown.



**Figure 19.** Change in the percent imperviousness of 30 m landscape cells within HUC 10 watersheds between 2001-2011, based on the National Land Cover Classification Dataset. Additional impervious cells are visible as you zoom into the figure. HUC 8 watershed boundaries are also shown.



**Figure 20.** Predicted urbanization in HUC 10 watersheds based on SLEUTH model predictions for the year 2020. The model uses five datasets (slope, land use, excluded areas (i.e., conservation lands), existing urban, and transportation) to predict the probability of future urbanization. HUC 8 watershed boundaries are also shown.



**Figure 21.** Predicted urbanization in HUC 10 watersheds based on SLEUTH model predictions for the year 2050 (Belyea 2012). The model uses five datasets (slope, current land use, excluded areas (i.e., conservation lands), existing urban, and transportation) to predict the probability of future urbanization. HUC 8 watershed boundaries are also shown.

## Discussion

As part of the 2015 revision of Georgia's State Wildlife Action Plan, we identified 221 high priority watersheds for conservation. Collectively, these watersheds are important for conserving the best known populations of high priority aquatic species, all extant occurrences and critical habitat units of ESA listed aquatic species, migratory corridors for high priority diadromous species, important coastal habitats, and representative aquatic communities from around the state. The majority of these watersheds (165) were designated because they contained at least one important population of a high priority aquatic species. These 165 watersheds were further prioritized based upon the number and global rarity of high priority species.

We also carried out a corresponding GIS assessment of the degree of protection, existing condition, as well as trends and future threats to all Georgia watersheds. Below we provide examples of how the assessment data can be used to help identify specific conservation actions in three high priority watersheds. We chose these specific watersheds because they help illustrate a wide range of threats and conservation actions that are relevant to watersheds throughout the state. Where appropriate, we have referenced some of the specific conservation actions identified by The Fishes and Aquatic Invertebrates Assessment Team (Albanese et al. 2015). More information about these conservation actions can be found in an excel file that should always accompany this report.

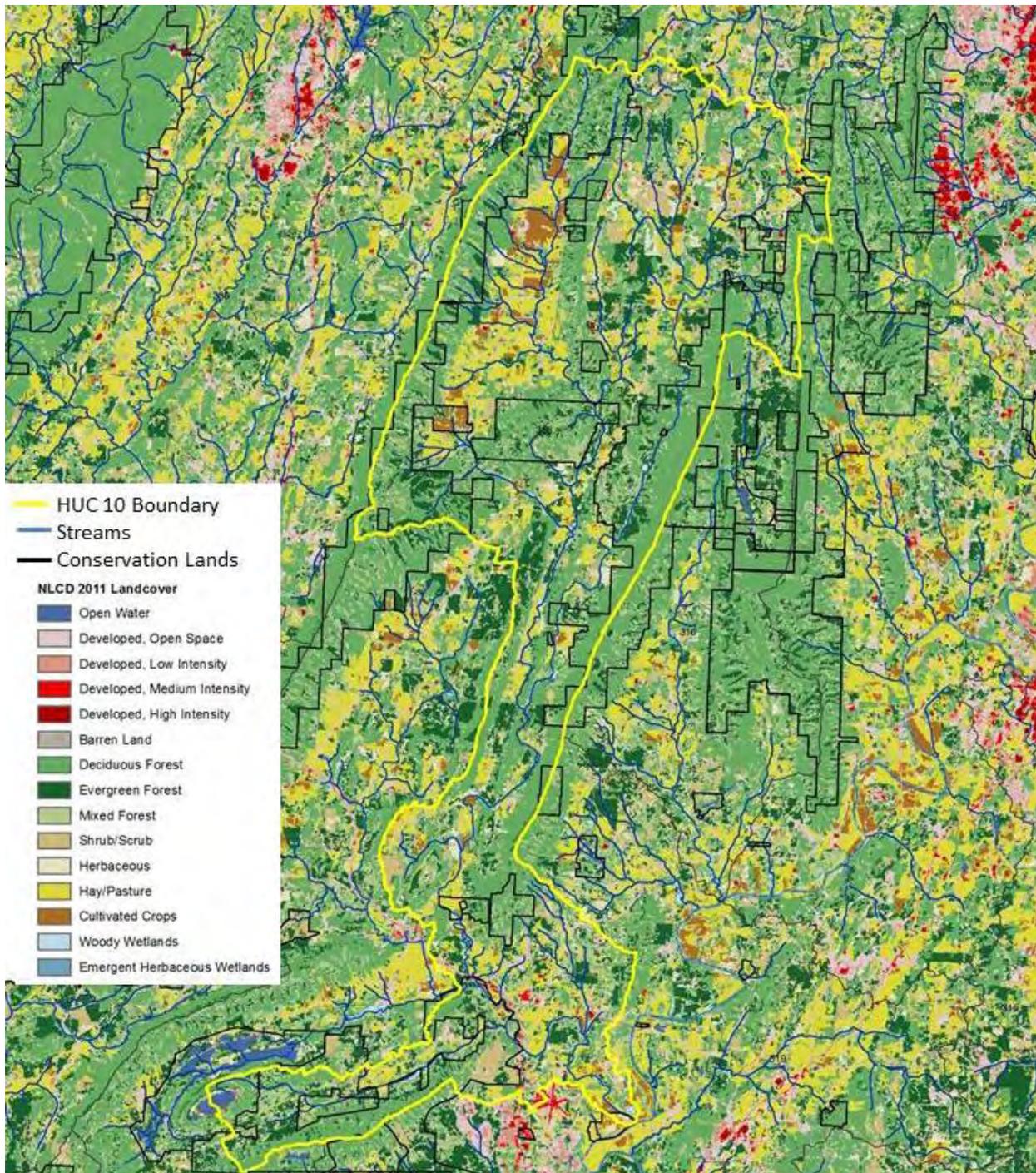
### Example 1, Armuchee Creek

Armuchee Creek (#318; [Figure 2](#)) is a high priority watershed in the Ridge and Valley portion of the Coosa River drainage in northwest Georgia. It supports important populations of 10 high priority aquatic species (3 mussels, 3 fishes, 2 snails, a crayfish and a dragonfly), placing it among watersheds with the highest global significance scores in the state. It has a high percentage of forest cover (71.1%) and a relatively high percentage of protected lands (32.9%; Table 2). Outside of forest areas, pasture (12.6%) and cultivated crops (2.6%) are the dominant land cover types, with low total urban cover (0.7%), and a moderate amount of developed open space (3.5%; [Figure 22](#)). Index of Biotic Integrity (IBI) fish community sampling has been conducted at 5 sites in the watershed, with most recent scores including poor (unnamed trib), fair (Lavender Creek), good (1 site each in East and West Armuchee Creeks), and excellent (a different site in West Armuchee Creek). Armuchee Creek still contains high quality aquatic habitat ([Figure 23](#)) and most reaches are predicted to be at low to moderate risk for habitat degradation ([Figure 14](#)). However, sampling in 2012 did document extensive mats of filamentous algae, which could indicate nutrient pollution ([Figure 24](#)). The density of dams is relatively low (1 per 166 Km of stream length; Table 2; [Figure 10](#)) and the density of stream crossings is moderate ([Figure 11](#)).

In contrast to many other north Georgia watersheds, recent landuse changes and urban growth models do not evince dramatic changes for the Armuchee Creek watershed in the future. The largest change between 2001-2011 was the loss of 3.7% forest cover, but developed land (+0.2%) and cultivated crops (-0.1%) changed little. Only a small number of pixels increased in imperviousness between 2001-2011 ([Figure 19](#)). Similarly, urban growth is not predicted to be extensive in the watershed in either 2020 or 2050 ([Figure 20](#) and [Figure 21](#)). While Armuchee Creek has exhibited little recent development and is not predicted to urbanize, the neighboring watershed to the south is (#319). In addition, the current pattern of public ownership and roads in

the watershed suggest that any additional development would be concentrated near rivers and streams.

Several SWAP conservation actions may be appropriate for the Armuchee Creek watershed. High resource quality and the low density of existing dams demonstrates the need for protection of aquatic connectivity in free-flowing systems (action #3). This action can be implemented by avoiding construction of new dams and improving aquatic organism passage through poorly designed stream culverts (see [Georgia's Stream Crossing Handbook](#)). The importance of pasture as a land cover type and the potential nutrient issue mentioned above suggest the value of technical assistance to farmers to protect streams in high priority watersheds (action #8). Targeted aquatic species outreach (action #32) would help generate local interest and support for conserving the watershed and could be completed in conjunction with additional surveys and monitoring (action #47).



**Figure 22.** National Land Cover Classification (NLCD 2011) for the Armuchee Creek HUC 10 watershed, with streams and conservation land boundaries also shown.



**Figure 23.** High quality aquatic habitat in Armuchee Creek, including a patch of native emergent vegetation, a shallow backwater habitat, a rocky riffle with moderate to swift current, and an intact and mature riparian forest.



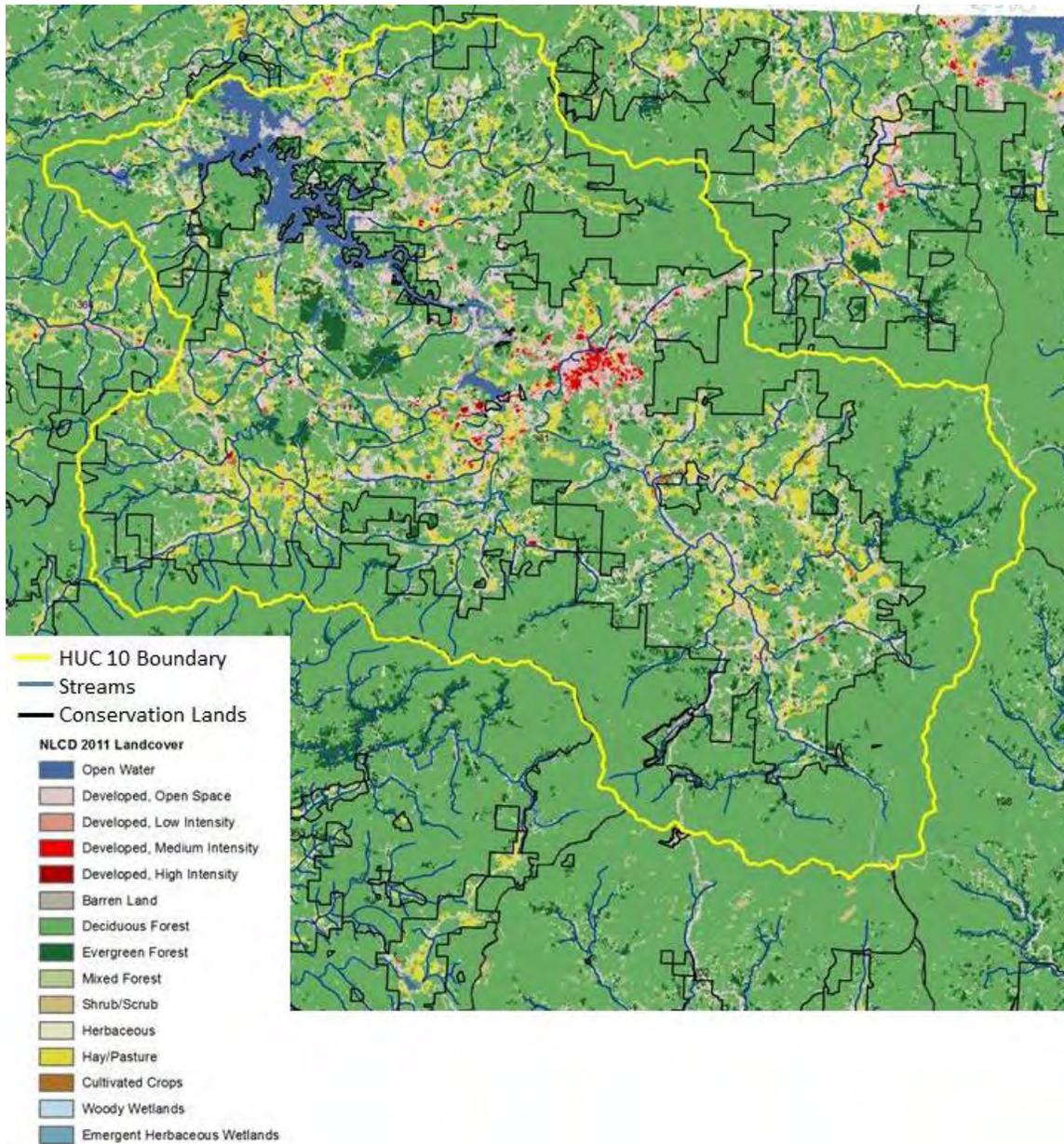
**Figure 24.** Patch of filamentous algae in Armuchee Creek. Extensive beds of filamentous algae can be an indicator of nutrient enrichment problems and may degrade habitat conditions for aquatic species.

## Example 2. Upper Nottely River

The upper Nottely River (#361; [Figure 2](#)) is in the Blue Ridge ecoregion of north Georgia near the North Carolina border. It is categorized as having moderate global significance because of important populations of [Blotched Chub \(\*Erimystax insignis\*\)](#) and [Eastern Hellbender \(\*Cryptobranchus alleganiensis\*\)](#). It is also a potential reintroduction site for the undescribed [Sicklefin Redhorse \(\*Moxostoma\* sp.\)](#), which likely occurred in the watershed before Lake Nottely was created. Like Armuchee Creek, the Upper Nottely River has a high percentage of forest cover (76.5%) and protected lands (36.4%) and low total urban cover (1.2%) (Table 2; [Figure 25](#)). Outside of forested areas, the only land cover types representing more than 2% of watershed area are developed open space (9.2%) and pasture/hay (7.4%; Table 2). There is relatively low dam density (1 per 63 km of stream length; [Figure 10](#); Table 2), but the density of road crossings is relatively high ([Figure 11](#)). Index of Biotic Integrity scores indicate widespread impairment of fish communities, with 15 of 21 sites scoring fair, poor, or very poor ([Figure 12](#)). The risk of habitat degradation is generally low and moderate, but there is a high to very high risk of degradation in the city of Blairsville and along U.S Highway 76 ([Figure 14](#)). Overall land cover has changed little between 2001-2011. However, additional urbanization is expected at scattered locations throughout the watershed by 2020 ([Figure 20](#)) and extensive urbanization is expected by 2050 ([Figure 21](#)).

While there is relatively high forest cover and a significant amount of protected land, the Nottely River watershed exhibits some signs of stress that will likely be exacerbated as urbanization continues. Because of steep mountainous terrain in the Blue Ridge ecoregion, most development and agricultural activities are limited to small floodplain areas near rivers and streams ([Figure 25](#)). Thus, the spatial pattern of land use may contribute to the widespread degradation suggested by the IBI scores. Another important factor is the impact of both small dams and Lake Nottely on aquatic connectivity, which can decrease the resilience of aquatic species populations by blocking colonization and other movements required for life-cycle completion. The large number of road crossings in the watershed also suggests that culverts may further restrict aquatic organism passage. Other sources of habitat degradation include bank erosion and nutrient enrichment associated with cattle grazing, development in riparian areas associated with vacation homes and tourism, and sedimentation from unpaved roads (personal observations). These impacts are not restricted to the Nottely River system, but are representative of impacts to streams throughout the Blue Ridge in Georgia (Owers et al. 2012).

As in Armuchee Creek, our assessment results suggest the importance of several SWAP conservation actions. Technical assistance to farmers (#8) could involve the development of alternative watering sites and fencing in reaches where cattle are currently accessing streams. There are also opportunities for riparian zone restoration (#12) in both agricultural and residential areas. The greatest challenge, though, will be protecting aquatic habitats from projected urbanization. Technical assistance to local governments (#6) could help identify and implement innovative policies to minimize the myriad of impacts associated with new development (e.g., impervious surfaces, stream crossings, water supply development, sewage treatment, etc.). The [policies developed for the Etowah Habitat Conservation Plan](#) would be a good starting point for consideration.



**Figure 25.** National Land Cover Classification (NLCD 2011) for the Upper Nottely River HUC 10 watershed, with streams and conservation land boundaries also shown.

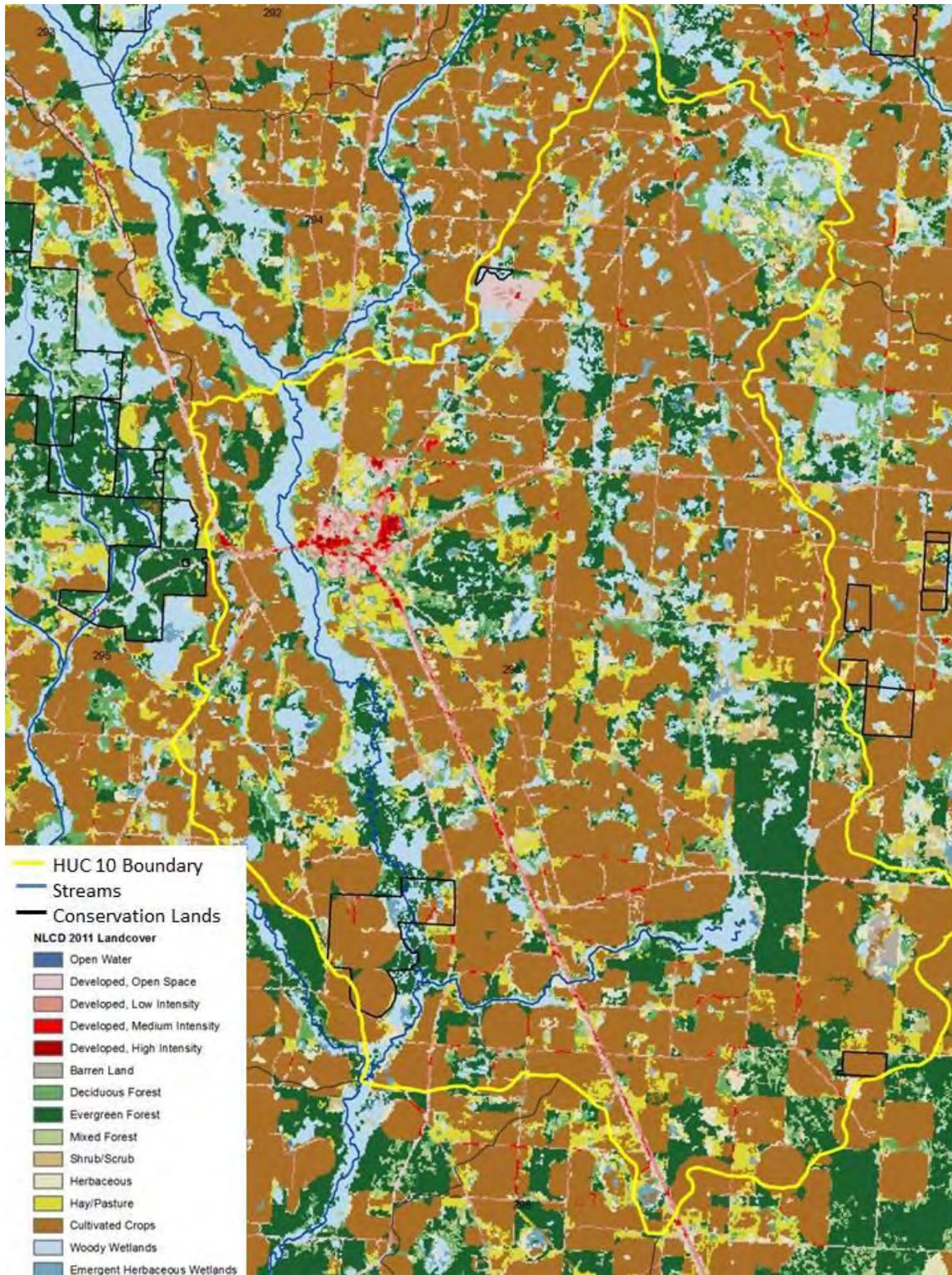
### Example 3, Spring Creek

Spring Creek (#296) is a high priority watershed in the Southeastern Plains portion of the Flint River drainage in southwest Georgia ([Figure 2](#)). It supports important populations of 7 high priority aquatic species (5 mussels, 1 fish, and 1 reptile), placing it among watersheds with the highest global significance scores in the state ([Table 1](#)). Predominant land cover types are cultivated crops (48.6%), forest (21.4%), woody wetlands (10.2%), and pasture/hay (6.0%; [Table 2](#); [Figure 26](#)). Total urban (3.1%) and developed open space (3.6%) represent a small portion of

the watershed. There are no dams (Figure 10) and the density of road crossings is moderate (Figure 11). Index of Biotic Integrity fish community sampling has not been conducted in the watershed, but 12.7% of stream length is impaired due to other water quality criteria (Table 2). The risk of habitat degradation is primarily moderate and high (Figure 14). Overall, land cover was stable between 2001-2011 and only modest increases in urbanization are predicted for 2050.

Despite the dominance of cultivated crops in the watershed, Spring Creek still provides high quality habitat for aquatic species (Figure 27). We attribute this to the occurrence of woody wetlands and forested habitat along the mainstem of Spring Creek as well as the supply of high quality water from underlying aquifers. The most significant threat to the persistence of species is the impact of severe and persistent drought coupled with agricultural water use. These two factors have resulted in record low stream flows in 9 of the past 15 years, with extensive portions of Spring Creek stagnating or going completely dry for extended time periods (Figure 28). In addition, the high density of cultivated crop agriculture appears to contribute substantial sediment loads into the creek, which degrades habitat quality and reduces the availability of deeper refuge pools during droughts. Despite these threats, this watershed contains perhaps the best remaining populations of two federally endangered mussel species. In addition, it supports 47% of all the freshwater mussel species known in the Apalachicola-Chattahoochee-Flint River Basin.

The most important conservation action for the Spring Creek watershed is the development of environmental flow recommendations (action #4), which involves identification of the timing and magnitude of stream flows needed to sustain ecosystems and provide for human use. It is an understatement to say that this issue has received considerable attention from the general public, researchers, the agricultural community, and various state and federal agencies. Nonetheless, providing adequate streamflows in Spring Creek will require continued focus, investment, and cooperation. Working with stakeholders through the statewide water planning process (action #9) and through other mechanisms is necessary to develop solutions to environmental flow issues in Spring Creek and other southwest Georgia streams. Continued monitoring of mussels (action #33) will help ensure that species are persisting and help measure their response to different management actions which protect stream flows during droughts (i.e. adaptive management). Targeted aquatic species outreach should help generate local interest and support for conservation efforts (action #32).



**Figure 26.** National Land Cover Classification (NLCD 2011) for the Spring Creek watershed, with streams and conservation land boundaries also shown.



**Figure 27.** High quality habitat in Spring Creek, which includes extensive woody debris and undercut banks, clear water with deep runs and pools, and an extensive and mature riparian forest. Photo by Jason Wisniewski.



**Figure 28.** Reach of Spring Creek impacted by low stream flows associated with drought and agricultural water use. Photo by Jason Wisniewski.

## Additional Recommendations for Conservation of High Priority Watersheds

We acknowledge that there are some limitations and caveats to consider when utilizing this report to guide conservation. First, there is underlying error in the process of classifying land cover types using satellite data ([Wickham et al. 2013](#)). Thus, while these data may identify a **potential** threat to water quality, it is important to verify actual impacts to water quality before investing resources into a project. Similarly, data sets such as the National Inventory of Dams are known to underestimate the true number of dams and are biased towards larger dams with more storage. There are many additional data sets that can help support more detailed conservation planning in high priority watersheds. For example, the Southeastern Aquatic Connectivity Assessment Project (SEACAP) has developed an online [tool](#) to help identify the most ecologically significant barriers to the movement of aquatic species. This tool could be used to identify where to improve organism passage (e.g., a dam or culvert site) to provide the greatest overall benefit to aquatic ecosystems within a high priority watershed. Another example would be the use of aerial photography and other remote sensing imagery (Klemas 2014) to identify specific areas for the protection and restoration of riparian zones.

With these considerations in mind, we still believe that the information contained in this report provides a useful starting point for watershed-level conservation in Georgia. It is our hope that this information will help support:

1. Efforts by conservation groups and government agencies to protect and restore southeastern aquatic species diversity, which is considered globally significant (Abell et al. 2000; Jelks et al. 2008). Watersheds with the highest global significance scores are a priority for implementing conservation projects carried out by groups such as [American Rivers](#), [The Nature Conservancy](#), [Southeastern Aquatic Resources Partnership](#), [The Tennessee Aquarium Conservation Institute](#), and [The U.S. Fish and Wildlife Service](#).
2. Efforts by Georgia and its conservation partners to protect and recover Georgia's high priority aquatic species. The SWAP Fishes and Aquatic Invertebrates Team identified altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction as significant threats to a large number of high priority aquatic species. Addressing these threats on a statewide basis may be unrealistic, but they can be addressed by focusing efforts in individual high priority watersheds.
3. Efforts to protect water quality and provide compatible recreational opportunities, such as angling, boating, or hiking. While the goal of a group or agency may not be to protect aquatic species *per se*, there are numerous opportunities to protect natural resources to the benefit of species, habitats, and local citizens. An example would be the establishment of a community natural area in a high priority watershed.

## **Acknowledgments**

We thank members of the SWAP Aquatic Habitat Technical Team, Fishes and Freshwater Invertebrates Team, and Advisory Committee for guidance and feedback throughout this process. Jason Wisniewski contributed to the section on Spring Creek. Sara Gottlieb and Deb Weiler provided additional editorial review. Greg Krakow developed the necessary GIS scripts to

aggregate species importance scores across watersheds. Chris Canalos helped with the interpretation of the National Land Cover Data.

## **Appendix I: Data Layers Used in Watershed Assessment**

### 1. Degree of Protection

- a. **Proportion Conservation Land (+):** Percent of watershed owned or under permanent conservation easement and managed for natural resource protection  
Source: [Conservation Lands Database](#) and [Protected Areas Database](#) for portions of HUC10 watersheds outside the state of Georgia.  
Data Type: Exploratory

### 2. Existing Condition

- a. **Proportion Forest (+):** Proportion of the HUC10 that is classified as Deciduous Forest, Evergreen Forest or Mixed Forest.  
Source: National Land Cover Dataset (NLCD 2011)  
Data Type: Potential Predictor
- b. **Proportion of Cultivated Crops (-):** Proportion of the HUC10 that is classified as Cultivated Crops.  
Source: National Land Cover Dataset (NLCD 2011)  
Data Type: Potential Predictor
- c. **Proportion Developed 1 (-):** Proportion of the HUC10 that is classified as Developed Low, Developed Medium, or Developed High Intensity.  
Source: National Land Cover Dataset (NLCD 2011)  
Data Type: Potential Predictor
- d. **Proportion Developed 2 (-):** Proportion of the HUC10 that is classified as Developed Low, Developed Medium, Developed High Intensity or Open Space. Calculated using 2011 version of 2001 and 2011 NLCD Land cover data.  
Source: National Land Cover Dataset (NLCD 2011)  
Data Type: Potential Predictor

- e. **Percent Impervious (-):** To assess the potential impact of urban development and infrastructure on aquatic environments, we used the NLCD impervious surface coverage for 2011. Percent impervious represents the fraction of impervious surface within a 30 x 30m cell.  
Source: [NLCD 2011 impervious surface coverage](#)  
Data Type: Potential Predictor
- f. **Dam Density (-):** These data are summarized in two ways: as the number of dams divided by watershed area (hectares) and the number of dams divided by stream length (km). Stream length was based upon [NHD hydroline](#) (fine resolution).  
Source: [2013 National Inventory of Dams](#)  
Data Type: Exploratory, since it does not include many small dams
- g. **Road Crossing Density (-):** number of crossings divided by watershed area, developed by placing a point at the intersection of stream and road crossing data sets. This is a general indicator of the potential for aquatic habitat fragmentation associated with poorly designed culverts and other impacts associated with roads. All underground conduit, pipelines, and artificial paths were removed from the stream data set to minimize crossings that would likely be bridges or have limited aquatic habitat  
Source: 2007 and 2012 GDOT Road geodatabase (inside GA), U.S. and Canada Detailed Streets, (TomTom North America, Inc.; outside GA)  
Data Type: Exploratory
- h. **Index of Biotic Integrity Scores (IBI) (+):** IBI fish community sampling in 1094 stream reaches sampled between 1998-2011 was used to determine if stream reaches are impaired or meet their designated uses under the Clean Water Act. Streams with no fish, a very poor, or a poor IBI category are designated as “impaired”, whereas streams rated fair, good, or excellent are designated as “meet”. Additional analyses could average IBI score by watershed.  
Source: [Georgia DNR Stream Survey Team](#)  
Data Type: Potential Predictor
- i. **Proportion Impaired (-):** Proportion of total stream length in watershed not supporting their designated uses (i.e., 303d listed streams). Calculated total m of impaired waters divided by total m of waters in the watershed. Streams can be listed for violating a variety of water quality criteria, including biotic integrity (based fish or macroinvertebrate community), temperature, dissolved oxygen, heavy metals, algae, fecal coliform and other factors. Thus, this data set is more inclusive than the

information provided by Index of Biotic Integrity scores alone. More information on Georgia's 303d list can be found [here](#).

Source: 2012 303d Stream Data.

Data Type: Exploratory

- j. **Habitat Condition Index (-):** This index was developed to reflect the cumulative influence of landscape variables on aquatic habitat and is based upon land use, population density, roads, dams, mines, and point-source pollution sites. The index is based on landscape variables and predicts the risk of habitat degradation at the scale of an individual stream reach or local catchment. Scores range from 1 (highest risk of habitat degradation) to 5 (lowest risk of habitat degradation). Risk of Current Habitat Degradation is classified as very low = 4.34-5.0, low = 3.5-4.33, moderate = 2.51-3.49, high = 1.51-2.5, very high = 1.0-1.5, and unscored reach = 0.

Esselman et al. (2011) describe the approach in more detail.

Source: [National Fish Habitat Plan 2010 Habitat Condition Scores](#)

Data Type: Potential Predictor

### 3. Recent Trends and Future Threats

- a. **Forest Change (+/-):** Forest change was expressed in two ways. First, as the change in the proportion of each watershed classified as any of the forest types between 2001 and 2011 (negative indicates loss of forest). Second, as a loss/gain map for each cell (30 x 30m block of area) in the landscape. Forest loss was attributed to cells that were classified as Deciduous forest, Evergreen forest or Mixed forest in 2001 and classified as a non-forest type in 2011. Forest gain was defined as any cells classified as a non-forest type in 2001 and classified as one of the forest types in 2011.

Source: [NLCD 2001 to 2011 Land Cover from to Change Index](#)

Type: Potential predictor

- b. **Cultivated Crop Change (+/-):** Change in the proportion of watershed classified as cultivated crops between 2001 and 2011. Also presented as a loss/gain map and calculated as described for forest change.

Source: [NLCD 2001 to 2011 Land Cover from to Change Index](#)

Type: Potential predictor

- c. **Change in Proportion Developed I:** Change in proportion of each watershed classified as Developed Low, Medium, and High Intensity between 2001-2011 (negative indicates loss of landuse type).

Source: 2011 versions of [2001](#) and [2011](#) NLCD.

Type: Potential Predictor

- d. **Change in Proportion Developed II:** Change in proportion of each watershed that is classified as Developed Low, Developed Medium, Developed High Intensity, or Open Space between 2001-2011 (negative indicates loss of landuse type).  
Source: 2011 versions of [2001](#) and [2011](#) NLCD.  
Type: Potential Predictor
- e. **Change in Percent Impervious (+/-):** Contains the difference in percent developed imperviousness of pixels that changed between NLCD 2001 percent developed imperviousness (2011 Edition), and NLCD 2011 (2011 Edition) percent developed imperviousness. “ - [http://www.mrlc.gov/nlcd06\\_data.php](http://www.mrlc.gov/nlcd06_data.php)  
Source: [2001 Percent Developed Imperviousness \(2011 Edition\)](#) and [2011 Percent Developed Imperviousness](#).  
Type: Exploratory
- f. **Predicted Urbanization (SLEUTH):** The SLEUTH-3r model was used to simulate the extent of urban growth throughout the southeastern United States as part of the Southeast Regional Assessment Project for the USGS National Climate Change and Wildlife Science Center. The model uses five datasets (slope, land use, exclusion (i.e. conservation areas), urban, and transportation) to predict the probability of future urbanization at various time intervals. We selected model outputs for 2020 and 2050 and overlaid watershed boundaries.  
Source: [SLEUTH Models for DSL-SERAP, Decadal Predictions 2000 – 2100](#)  
Type: Exploratory

## Appendix II: Other Important Data Layers Considered but Not Included in the Watershed Assessment

- a. 2001 Riparian Condition Assessment (-): Percent agricultural and urban land cover within 30 m of stream (-)  
This data set identifies the percent of agricultural and urban land cover within 100 feet of stream banks (30 m). This data set has some limitations that preclude its use as a predictor variable. For example, a few canopy trees on the stream bank would result in classification as forest even though houses, pavement, or lawns could be underneath the canopy trees. In addition, large sections of rivers were excluded from the data set due to mapping errors. Nonetheless, it may be useful for looking at coarse temporal trends in stream buffers and identifying management actions for individual HUC 10s. The model can be re-run with 2011 NLCD data, but that has not yet been completed.  
Source: [SALCC Conservation Planning Atlas](#)  
Data Type: Exploratory

- b. SARP SE Connectivity Assessment Data (SEACAP) : The goal of this project is to assess stream connectivity throughout the southeast, based on locations of dams and other barriers to aquatic organism passage. The data set was released in early 2015 and will be important for determining the ecological benefit of dam removal and culvert improvement projects.  
Source: [Southeast Aquatic Resource Partnership](#)  
Data Type: Exploratory
- c. Chemical Spill Data (-): Data documenting toxic spills and fish kills into waterways. This was identified as a data need during discussion.  
Source: Unknown
- d. Concentrated Animal Feeding Operations (-): This was identified as a data need during discussion. This data would show the locations of concentrated animal feeding operations (CAFO) and help identify areas where conservation actions could help reduce water quality impacts.  
Source: Unknown
- e. SparrowWater Quality Dataset. The U.S. Geological Survey Sparrow dataset provides models and water quality data for streams and watersheds. Models for Georgia include suspended sediment, carbon, phosphorus, and nitrogen.  
Source: [USGS SPARROW Project](#)
- f. Invasive Species Data. This provides a list of non-native aquatic species at the HUC 8 scale. Although this dataset is at a different scale than the HUC 10 used in this assessment, knowledge of invasive species could provide insight to potential threats to aquatic species identified in the SWAP.  
Source: [USGS Nonindigenous Aquatic Species Page](#)
- g. Risk of Flow Alteration (-): This dataset reflects the combined effects of water consumption, evapotranspiration, and impervious cover. Data can be viewed online in map viewer.  
Source: [Data Basin Webpage](#)
- h. Permitted Groundwater and Surface Water withdrawals (-): This data set would help estimate risk to streamflow from water withdrawals. One important caveat is that actual water use may not be well characterized from the number of permits in each watershed. Of these two withdrawal types, surface water withdrawal data would be more meaningful, as influence of groundwater withdrawals is much more variable depending on local geology. USGS conducts a national water census every 5 years, which might be a better way to assess threat of water use.  
Source: EPD or USGS

- i. Predicted Stream Temperatures: A data set that shows predicted stream temperature and precipitation changes associated with climate change at the stream reach scale. This would help understand potential impacts to species in high priority watersheds.

Source: Unknown

## **Appendix G. Terrestrial Invertebrates Technical Team Report**

**Prepared by Matt Elliott**

### **Technical Team Members**

Dr. Jerry Payne – Entomologist, University of Georgia (Retired)  
Dr. James Adams – Entomologist/Professor, Dalton State College, GA  
Pierre Howard – Independent Naturalist/Georgia Conservancy  
Dr. JoVonn Hill – Entomologist, Mississippi State University/Mississippi Entomological Museum  
Giff Beaton – Independent Naturalist/Field Guide Author  
Dirk Stevenson – Herpetologist/Naturalist, The Orianne Society  
David Hedeon – Ecology Team Leader, Georgia DOT  
Debbie Harris – Wildlife Biologist, U.S. Fish and Wildlife Service  
Anna Yellin – Wildlife Biologist, Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section  
Matt Elliott – Program Manager, Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section  
Dave Almquist, Invertebrate Zoologist, Florida Natural Areas Inventory  
Doug Booher, PhD Candidate, University of California at Los Angeles/Collections Associate, University of Georgia Museum of Natural History  
David Withers, Zoologist, Tennessee Natural Heritage Inventory Program

This list reflects persons who have participated in email, telephone, or in-person discussions related to the State Wildlife Action Terrestrial Invertebrates update. A subset of the list participated in a group discussion at the Wildlife Resources Conservation Center in Social Circle on February 27, 2014. Others participated via email, telephone conversation, or individual meeting.

### **Approach**

Terrestrial invertebrates are the most diverse taxon to be considered in Georgia's State Wildlife Action Plan (SWAP) update, but the most poorly understood. Most species of terrestrial invertebrate lack fundamental information on abundance, range, population trend, threats, or protection needs. Especially in the past there have been relatively few professionals familiar with these taxa in the Southeast from a conservation (as opposed to pest-reduction) perspective, and many species groups remain unrepresented in data that have been acquired. Since completion of the initial SWAP, the situation has improved for many taxa. Lepidoptera remain the best-studied order, and interest in this taxon has exploded in recent years especially amongst birders. In addition, groups such as ants, tiger beetles, and grasshoppers have also seen growing interest, and a growing body of information related to their abundance and conservation.

In the previous iteration of the SWAP in 2004, committee team members developed and refined a list of special concern terrestrial invertebrates for Georgia, but did not attempt to designate high-priority species. An abbreviated list of high-priority habitats was also compiled. In the

second SWAP iteration we put together for the first time a list of high-priority terrestrial invertebrates, refined the special concern list, and have expanded the list of high-priority habitats as well as developed a preliminary list of threats.

### **High Priority Species**

A number of species were recognized as high-priorities for conservation in Georgia. These are listed in the Table 1 and include species endemic to Georgia or with a similarly restricted range, narrow habitat requirements, declining populations, or significant threats (of either direct mortality or to habitat). More detailed information regarding individual species may be found in Section IV.

<b>Scientific Name</b>	<b>Common Name</b>	<b>Order</b>
<i>Cyclocosmia torreya</i>	Torreya trap-door spider	Areneae
<i>Habronattus sabulosus</i>	Jumping spider (Heggie's Rock)	Areneae
<i>Sphodros abbotii</i>	Purse-web spider	Areneae
<i>Alloblackburneus troglodytes</i>	Little gopher tortoise scarab beetle	Coleoptera
<i>Aphodius aegrotus</i>	A dung beetle	Coleoptera
<i>Aphodius alabama</i>	A dung beetle	Coleoptera
<i>Aphodius baileyi</i>	A dung beetle	Coleoptera
<i>Aphodius bakeri</i>	A dung beetle	Coleoptera
<i>Aphodius dyspistus</i>	A dung beetle	Coleoptera
<i>Aphodius gambrinus</i>	Amber pocket gopher Aphodius beetle	Coleoptera
<i>Aphodius hubbelli</i>	A dung beetle	Coleoptera
<i>Aphodius laevigatus</i>	Large pocket gopher Aphodius beetle	Coleoptera
<i>Aphodius pholetus</i>	Rare pocket gopher Aphodius beetle	Coleoptera
<i>Aphodius platypleurus</i>	Broad-sided pocket gopher Aphodius beetle	Coleoptera
<i>Aphodius tanytarsus</i>	Long-clawed pocket gopher Aphodius beetle	Coleoptera
<i>Chelyoxenus xerobatis</i>	Gopher tortoise hister beetle	Coleoptera
<i>Cicindela nigrrior</i>	Autumn tiger beetle	Coleoptera

<i>Crossidius grahami</i>		Coleoptera
<i>Euphoria aesusutosa</i>	Pocket gopher flower beetle	Coleoptera
<i>Geopsammodius ohoopee</i>		Coleoptera
<i>Hypothyce osburni</i>		Coleoptera
<i>Mycotrupes cartwrighti</i>		Coleoptera
<i>Mycotrupes lethroides</i>		Coleoptera
<i>Onthophagus polyphemi polyphemi</i>	Onthophagus tortoise commensal scarab beetle	Coleoptera
<i>Polyphylla donaldsoni</i>	Donaldson's lined june beetle	Coleoptera
<i>Bryophaenocladus chrissichuckorum</i>	Midge (Heggie's Rock)	Diptera
<i>Machimus polyphemi</i>	Gopher tortoise robber fly	Diptera
<b><i>Bombus affinis</i></b>	<b>Rusty-patched bumblebee</b>	Hymenoptera
<i>Bombus borealis</i>	Northern amber bumble	Hymenoptera
<i>Caupolicana electa</i>	Plasterer bee	Hymenoptera
<i>Dorymyrmex bossutus</i>		Hymenoptera
<i>Dorymyrmex bossutus</i>		Hymenoptera
<i>Pheidole davisii</i>		Hymenoptera
<i>Pheidolie davisii</i>		Hymenoptera
<i>Temnothorax_GA_01</i>		Hymenoptera
<i>Temnothorax_GA_01</i>		Hymenoptera
<i>Amblyomma tuberculatum</i>	Gopher tortoise tick	Ixodida
<i>Acronicta albarufa</i>	Albarufan dagger moth	Lepidoptera
<i>Amblyscirtes alternata</i>	Dusky roadside-skipper	Lepidoptera

<i>Amblyscirtes belli</i>	Bell's Roadside-skipper	Lepidoptera
<i>Amblyscirtes carolina</i>	Carolina roadside-skipper	Lepidoptera
<i>Amblyscirtes reversa</i>	Reversed roadside-skipper	Lepidoptera
<i>Atrytone arogos arogos</i>	Eastern Aragos Skipper	Lepidoptera
<i>Autochton cellus</i>	Golden-banded skipper	Lepidoptera
<i>Callophrys hesselli</i>	Hessell's hairstreak	Lepidoptera
<i>Callophrys irus</i>	Frosted elfin	Lepidoptera
<i>Catocala grisatra</i>	Grisatra underwing moth	Lepidoptera
<i>Chlosyne gorgone gorgone</i>	Gorgone checkerspot	Lepidoptera
<b><i>Danaus plexippus</i></b>	<b>Monarch butterfly</b>	Lepidoptera
<i>Erora laeta</i>	Early hairstreak	Lepidoptera
<i>Erynnis martialis</i>	Mottled duskywing	Lepidoptera
<i>Euphydryas phaeton</i>	Baltimore checkerspot	Lepidoptera
<i>Euphyes berryi</i>	Berry's Skipper	Lepidoptera
<i>Euphyes bimacula arbogastii</i>	Two-spotted Skipper	Lepidoptera
<b><i>Euphyes dukesi</i></b>	<b>Duke's Skipper</b>	Lepidoptera
<b><i>Euphyes pilatka</i></b>	<b>Palatka Skipper</b>	Lepidoptera
<i>Fernaldella georgiana</i>	Ohoopee Geometer	Lepidoptera
<i>Hesperia attalus slossonae</i>	Dotted skipper	Lepidoptera
<i>Hesperia meskei</i>	Meske's skipper	Lepidoptera
<i>Idia gopheri</i>	Gopher tortoise burrow noctuid moth	Lepidoptera
<i>Neonympha areolatus</i>	Georgia Satyr	Lepidoptera
<i>Neonympha helicta</i>	Helicta satyr	Lepidoptera
<i>Phyciodes batesii maconensis</i>	Tawny crescent	Lepidoptera
<i>Pieris virginiensis</i>	West Virginia White	Lepidoptera

<i>Poanes aaroni howardi</i>	Aaron's skipper	Lepidoptera
<i>Polites baracoa</i>	Baracoa skipper	Lepidoptera
<i>Polygona faunus</i>	Green comma	Lepidoptera
<b><i>Problema bulenta</i></b>	<b>Rare Skipper</b>	Lepidoptera
<i>Satyrium edwardsii</i>	Edwards hairstreak	Lepidoptera
<i>Satyrium kingi</i>	King's hairstreak	Lepidoptera
<i>Speyeria diana</i>	Diana fritillary	Lepidoptera
<i>Zale perculata</i>	Okefenokee zale moth	Lepidoptera
<i>Aptenopedes apalachee</i>		Orthoptera
<i>Eotettix palustris</i>		Orthoptera
<i>Floritettix borealis</i>		Orthoptera
<i>Hesperotettix floridensis</i>		Orthoptera
<i>Melanoplus acidocercus</i>		Orthoptera
<i>Melanoplus clypeatus</i>	Shield-tailed Spur-throat Grasshopper	Orthoptera
<i>Melanoplus longicornis</i>		Orthoptera
<i>Melanoplus nossi</i>		Orthoptera
<i>Melanoplus sp nov 1</i>		Orthoptera
<i>Melanoplus sp nov 2</i>		Orthoptera
<i>Melanoplus stegocercus</i>		Orthoptera
<i>Melanoplus tumidicercus</i>		Orthoptera
<i>Trimerotropis saxatalis</i>	Lichen or rock grasshopper	Orthoptera

### High priority habitats and sites

The range of terrestrial invertebrates is so diverse that they occupy nearly every conceivable niche on the planet. A number of studies have focused on rare or declining habitats (e.g. caves or pocket gopher mounds) and identified threatened or unusual terrestrial invertebrate species associated with those habitats. The SWAP list of priority terrestrial invertebrate habitats includes a number of these rare habitats but also a few more common types that contain exceptional diversity for some taxa.

***Coastal Plain (including both Southeastern Plains and Southern Coastal Plain)***

Sandhills – Longleaf pine/scrub oak woodlands and xeric Aeolian dunes were identified as high priority habitats in Georgia’s 2005 SWAP and they remain so. They are found on excessively-drained sandy soils found along the Fall Line (of Cretaceous age) or in Pleistocene aeolian deposits along rivers (such as Oohoopee Dunes), or Pleistocene marine sand deposits at the site of former barrier islands (such as Trail Ridge). Vegetation is usually dominated by longleaf pine, xeric oak species such as turkey oak, and wiregrass, little bluestem, and other herbaceous groundcover species. Because species have evolved to adapt to the relatively harsh conditions of these habitats, and because the habitats themselves are rather narrowly distributed across the landscape, a large number of high-priority animals and plants are found on sandhill habitats in Georgia and throughout the Southeast.

Lepidoptera and Orthoptera have probably been the best-studied taxonomic Orders of terrestrial invertebrates on sandhill habitats in Georgia, although they are by no means the only high priority taxa. Amongst the Lepidoptera, the following species are typically found on sandhills: *Acrionicta albarufa* (Albarufan dagger moth), *Atrytone arogos arogos* (Eastern Aragos skipper), *Callophrys irus* (frosted elfin), *Catocala grisatra* (Catocala underwing moth), *Chlosyne gorgone gorgone* (Gorgone checkerspot), *Fernaldella georgiana* (Oohoopee geometer, endemic to Oohoopee Dunes Aeolian sandhills), *Hesperia attalus slossonae* (dotted skipper), *Hesperia meskei* (Meske’s skipper), and *Polites baracoa* (Baracoa skipper). Amongst *Orthoptera*, the following are associated with sandhills: *Melanoplus acidocercus*, *Melanoplus sp nov 1*, *Melanoplus sp nov 2*, and *Melanoplus stegocercus* (a Georgia endemic restricted to Oohoopee and Canoochee Aeolian dunes with one occurrence at Yuchi WMA). In addition, a number of Coleoptera, *Cicindela nigrrior* (Autumn tiger beetle), *Polyphalla donaldsoni* (Donaldson’s lined june beetle, restricted to Oohoopee Dunes), *Crossidius grahami* (Oohoopee Dunes endemic associated with woody goldenrod as a host plant), *Geopsammodius oohoopee* (another Oohoopee Dunes endemic), *Hypothyce osburni*, and *Mycotrupes lethroides* are restricted to sandhills, as is the globally rare plasterer bee *Caupolicana electa*. A couple of other priority species are restricted to gopher tortoise burrows (often, though not exclusively, a sandhills associate) and some potential priority species are restricted to pocket gopher mounds (also often, though not exclusively, associated with sandhills). These sub-habitats are discussed below. One more Lepidoptera, *Callophrys hesselli* (Hessell’s hairstream), is restricted to Atlantic white cedar swamps, themselves found nearly exclusively (except for one occurrence at Dixon State Forest) in drainages amongst sandhills.

Ants (Order *Hymenoptera*) are of particular interest in sandhill habitats. Many species are restricted to sandy soils and species diversity may be quite high. In particular, 76 species of ants, including some unusual ones, are known from Oohoopee Dunes Natural Area. Although not enough information is available at present to identify many specific high-priority ant species in Georgia, ants undoubtedly serve as excellent site-quality indicators for sandhills. That said, two ant sandhill specialists, *Dorymyrmex bossutus* and *Pheidolie davisii*, have been recommended as high priority. They have been found only at Big Hammock Natural Area and Oohoopee Dunes Natural Area, respectively.

Although these are discussed in more detail under the “Threats” section, sandhill habitats are threatened by conversion to other land uses that may not be compatible with maintaining viable populations of native flora and fauna, including terrestrial invertebrates. Beyond conversion, permanent changes in wildfire regimes necessitating prescribed burning have complicated management for sandhills. Previously wildfires would burn in a patchy manner, leaving canebrakes along drains and some examples of fire-intolerant species such as hawthorn (critical to *Catocala grisatra*, the Grisatra underwing moth) untouched. Patchy burns are more challenging for prescribed burners.

**Longleaf pine woodlands** – This habitat type might include both dry and mesic upland longleaf pine woodlands as well as lower-lying pine flatwoods (of both slash and longleaf pine). Examples are found throughout both the Southeastern Plains and Southern Coastal Plain, but are particularly noteworthy in the Red Hills around Thomasville, GA (Thomas, Brooks, Grady, and Decatur counties), and on military bases, especially Fort Stewart and Fort Benning. Longleaf pine woodlands are well-known for requiring fire to maintain an open understory, lush herbaceous groundcover, and low-density forest canopy. They may be found on an array of soils from sand to clay, between well-drained and poorly-drained, as distinguished from the excessively-drained sands of sandhill habitats.

High-priority terrestrial invertebrate species found in longleaf pine woodlands includes: *Amblyscirtes alternata* (dusky roadside-skipper), *Atrytone arogos arogos* (Eastern Aragos skipper), *Erynnis martialis* (mottled duskywing), *Aptenopedes apalachee*, *Eotettix palustris*, *Floritettix borealis*, *Hesperotettix floridensis*, *Melanoplus clypeatus* (Shield-tailed spur-throat grasshopper, a Georgia endemic), *Melanoplus tumidicercus* (also a Georgia endemic), and *Mycotrupes cartwrighti* (a flightless scarab beetle). Longleaf woodlands with intact groundcover that have escaped tillage have also been found to be important to a number of ant species, though there is not enough information at present to identify high-priority ants.

**Freshwater marsh** – A significant number of high-priority Lepidoptera species are associated with fresh- or brackish-water marsh habitats found along coastal rivers (particularly larger examples such as the Altamaha or Savannah), other wet near-coastal environments, and in larger basin swamps, such as the Okefenokee. These marshes are dominated by emergent and submerged herbaceous vegetation of varying species.

Lepidoptera associated with freshwater marshes include: *Euphyes berryi* (Berry’s skipper), *Euphyes bimacula arbogastii* (Two-spotted Skipper), *Euphyes dukesi* (Dukes’ skipper), *Euphyes pilatka* (Palatka skipper), *Neonympha areolatus* (Georgia satyr), *Poanes aaroni howardi* (Aaron’s skipper), and *Problema bulenta* (rare skipper). Dukes’ skipper, the Palatka skipper, and the rare skipper have all been petitioned for federal listing.

Although legally protected under the Clean Water Act, freshwater marshes are still under some threats, including sea level rise due to climate change, and potentially due to saltwater intrusion from harbor deepening/dredging.

**Pocket gopher burrows** – A “micro-habitat” of sorts, these mounds are built by the Southeastern pocket gopher *Geomys pinetis*, itself a high-priority, State Threatened species in Georgia. Pocket gophers tunnel in loose, sandy or loamy soil at scattered locations across the

Coastal Plain. When they surface they push small mounds of dirt to the side. Their burrows are similar to a miniature cave system. A colonial species, Southeastern pocket gophers are often associated with longleaf pine savannas or sandhill habitats, though they are not restricted to these areas – they also often occur in pastures or are distributed along roadsides. They have demonstrably declined in Georgia in recent years, disappearing from a number of localities where they were once known.

A number of invertebrate species may be associated with pocket gopher burrows. At least 11 species of *Aphodius* (scarab, dung-eating) beetles, as well as one *Euphoria* species, are restricted to them, including some that were recently described. These species generally have G-ranks in the G2G3 range, and deserve consideration for high-priority status, especially since declines have been documented for pocket gophers across much of the Coastal Plain.

**Gopher tortoise burrows** – The gopher tortoise, *Gopherus polyphemus*, is found across the Georgia Coastal Plain in open pinewoods, sandhills, and dry flatwoods. It is a high-priority species, is listed as Threatened by the State, and is an official federal Candidate species for listing under the Endangered Species Act. Populations of tortoises, though still robust in many places, have demonstrably declined greatly from pre-European-settlement levels, and continue to be threatened primarily due to habitat loss. Individual gopher tortoises dig several burrows across their home range. The burrows usually have a wide sandy “apron” nearly devoid of vegetation, and may be up to 40 feet in length (though usually less than half that).

A wide array species are known as gopher tortoise “commensals”, being frequently found in association with tortoise burrows. Tortoise commensals include invertebrates, from the wide-ranging camel crickets to several that can be considered obligates. The latter group includes the gopher tortoise tick *Amblyomma tuberculatum*, found on the tortoise itself, as well as a dung-eating scarab *Onthophagus polyphemi polyphemi*, the little gopher tortoise scarab beetle *Alloblackburneus troglodytes*, the gopher tortoise hister beetle *Chelyoxenus xerob* *Atis*, a gopher tortoise robber fly *Machimus polyphemi*, and the gopher tortoise burrow Noctuid moth *Idia gopheri*. Although these species are at least as rare as the tortoise itself, their distributions are poorly known, and further surveys should be a priority.

### ***Southwestern Appalachians/Ridge and Valley***

**Caves and rock outcrops** – With funding from the Georgia Nongame tag a five year project exploring the caves of Georgia was begun in 1998, following up on previous work conducted by Kurt Buhlman. Some of these caves were previously known to house rare mammals such as Gray Myotis (*Myotis sodalis*) and rare amphibians such as Georgia Blind Salamander (*Haideotriton wallacei*). What was not well known was the invertebrate fauna that would be encountered. By collecting and limited trapping in 43 of the nearly 500 known caves in Georgia, eleven undescribed species of terrestrial invertebrate were encountered (Reeves et al. 2000). Six of these were new to science and one, a centipede, represents a new genus. Distributions and rarities of most invertebrate cave fauna are poorly understood, and vary widely even on very local levels.

Caves and rock outcrops can be completely destroyed by mining activities, which are becoming increasingly common in this region. Forest moisture required by terrestrial invertebrates may be compromised by significant logging or land clearing operations. Water quality of subterranean streams may be threatened by septic tanks and other sources of toxins from upslope developments.

***Mountains (including Blue Ridge, Ridge and Valley, and Southwestern Appalachians) and Piedmont***

Mesic hardwoods – Hardwood forests dominated by oaks, hickories, maples, yellow-poplar, beech, and other deciduous trees are common throughout Georgia, especially in the northern part of the state. Often they are associated with riparian areas, which affords them some legal protection (stream buffer ordinances), though not always. Some hardwood forests contain stands of river cane. Particularly in metropolitan Atlanta hardwood forests may be threatened by conversion to residential or other urban land use.

Hardwood forests are important habitat for a wide array of high-priority plant animal species in Georgia, including terrestrial invertebrates. High-priority species associated with these habitats include: *Amblyscirtes belli* (Bell's roadside-skipper), *Amblyscirtes carolina* (Carolina roadside-skipper), *Amblyscirtes reversa* (reversed roadside-skipper), *Erora laeta* (early hairstreak), *Euphydryas phaeton* (Baltimore checkerspot), *Pieris virginiensis* (West Virginia white), *Polygonia faunus* (green comma), *Speyeria diana* (Diana fritillary), and *Melanoplus longicornis*. Hardwood forests also have exceptionally high diversity of leaf litter-dwelling *Strumigenys* ants and likely litter-dwelling beetles.

***Piedmont***

Granite outcrops – The Piedmont ecoregion of Georgia contains many large exposed areas of granitic rock with sparse vegetation. These granitic exposures are typically flat, though not always. Due to the extremely harsh environments found on the surface of granite outcrops, they have a large number of endemic or nearly endemic species. Granite outcrops do not lend themselves to many land uses, but a very large number of them have and continue to be quarried for gravel, and recreational abuses (including vandalism) and illegal dumping plague many sites. The rock or lichen grasshopper *Trimerotropis saxatalis* is restricted to granite outcrops across its range. Known from only three locations in Georgia, it may occur on others but has not been adequately surveyed. Recently two very rare species were discovered on Heggie's Rock in Columbia County, GA: a jumping spider *Habronattus sabulosus*, and a midge *Bryophaenocladus chrissichuckorum* (only known from Heggie's Rock at present). It is quite likely that a number of other unusual invertebrate species will be found on other granite outcrops with increased surveys.

**Threats to Terrestrial Invertebrates**

The Terrestrial Invertebrates Taxa Team reviewed threats to high-priority species and habitats. Different species may face somewhat different sets of circumstances, but some of the most important threats overall are summarized below.

**Conversion to Agriculture or Silviculture** – This threat was mentioned for more species than any other. It is particularly acute for longleaf pine, sandhills, and other natural pine-dominated habitats. Conversion of these communities to agricultural fields or industrial silviculture is still taking place. Although planted pine stands may retain some canopy tree species, the loss of diverse herbaceous groundcover and shrub species may be extremely deleterious for invertebrate species that depend on particular plant hosts. In many agricultural fields application of broad spectrum herbicides eliminates formerly widespread host plants, and insecticides are suspected in declines of a number of bumblebees and other native pollinators.

**Altered Fire Regimes** – This threat was also mentioned for many priority species, especially those found in natural pine-dominated habitats or sandhills. Before widespread European settlement of Georgia and the Southeastern United States, large wildfires would spread across the landscape at frequent intervals, with a complex patchwork of fire effects, clearing the underbrush and woody shrubs in many areas but leaving others relatively intact. Today wildfires are nearly nonexistent (at least the uncontrolled variety) and the remaining fire-dependent habitats are maintained via prescribed burning. Although fire is absolutely essential to the maintenance of a large number of Georgia's priority habitats (and by extension, species), the complex mosaic of fire effects is equally important to many invertebrate species. This creates a challenge for prescribed burners in ensuring adequate burning to manage for species that require fire maintenance over large acreages, while also keeping that complex mosaic.

**Altered Hydrology** – This threat was noted for a number of Lepidoptera species associated with freshwater marsh habitats. Significant dredging could result in changes in salinity that could completely alter marsh ecosystems. An even more widespread threat is sea level rise due to climate change. Although marshes may migrate up river systems, the speed of sea level rise and ability of the marshes to migrate is in some doubt. Salinity changes due to sea level rise have the potential to largely eliminate the freshwater marsh ecosystem in Georgia.

**Global Warming/Climate Change** – As noted above, this threat has the potential to affect species found in freshwater marsh ecosystems (primarily butterflies). In addition, some species found in the Blue Ridge Mountains, especially those near the southern end of their range, may be impacted. Similar to the situation along the coast, communities or host plants may not be able to migrate upslope quickly enough as their current habitat/elevation range becomes unsuitable, or there may simply be no place for them to move up to.

**Residential Development** – This threat is lower at present than in 2005 due primarily to the economic downturn, but could return at any time. It is particularly acute in the northern part of the state (Piedmont and Blue Ridge especially) and in near-coastal areas. Residential development may not result in complete conversion of a habitat but often renders it unsuitable for priority species.

**Incompatible Mining/Mineral Extraction** – This threat is most pronounced for sandhills and granite outcrop-obligate species. Sand and kaolin mines along the Fall Line and elsewhere in the Coastal Plain, and gravel quarries on the Piedmont may result in complete alteration of habitats, though they usually cover smaller acreages than some of the other threats.

**Poaching or Commercial Collecting** – These activities, as well as excessive scientific collecting, have the potential to negatively impact some species, especially butterflies and tiger beetles (both very attractive to collectors). At present terrestrial invertebrates receive no protection from over-collection in Georgia.

### **High Priority Species Conservation Actions**

**State Listing of Species** – Twelve terrestrial invertebrate species have been proposed by the Taxa Team for state listing as protected species. This list includes nine butterflies, one moth, one grasshopper, and a tiger beetle. These species have been demonstrated to be under significant threat due to overcollecting, habitat loss, or restricted range. At present there are no terrestrial invertebrates protected by state law in Georgia. Protected status would confer some protection to their habitats on state lands, and require permits for their collection.

**More Inventory** - Although the pace of terrestrial invertebrate work has picked up greatly since 2005, there are still significant gaps and our knowledge of this taxonomic group is still well behind any other being considered in the SWAP. Lepidoptera and Orthoptera have received the most attention in Georgia but all taxa need work. In addition, a broader array of habitats across the state needs to be sampled in a somewhat systematic fashion.

**Updates to Biotics** - Even with recent survey efforts, there is still a lot of information that has been collected that has not made it into Biotics, our rare species tracking database. Our Biotics database allows us to make better conservation planning decisions by bringing rare species knowledge into a spatial format, and at present terrestrial invertebrates are not receiving the consideration they should.

**Terrestrial Invertebrates as Indicators of Habitat Quality** – A number of taxa, including ants, may as a group make excellent indicators of habitat quality. An Index of Biotic Integrity (IBI) incorporating characteristic, rare, and invasive species could be developed, particularly for sandhill habitats.

**Terrestrial Invertebrate Zoologist** – There is potentially a large volume of work on terrestrial invertebrate conservation in Georgia. We are a large, diverse state with relatively little previous inventory and a large backlog of data entry/management needs. Currently there are no terrestrial invertebrate experts on the staff of Georgia’s Nongame Conservation Section. Adding a Biologist to fill this role would improve our data and survey efforts, and free up other staff to work on other priorities. Funding would need to be secured.

**Monarch Butterfly** – The monarch butterfly (*Danaus plexippus*) is presented here as a special case. Still relatively common in comparison to the species listed as “high-priority” above, nonetheless the monarch is in trouble, with overwintering populations in Mexico having declined up to 90% from historic population levels (Monroe et al. 2015). It has recently been petitioned for listing under the ESA. The monarch is currently ranked as a G4 species. The importance of monarchs in Georgia to the overwintering populations in Mexico is not known, although at least some make the annual migration. In addition, efforts should be made to identify over-wintering sites for the monarch in Georgia. It is probably deserving of an S4 rarity rank in Georgia.

The monarch has received a great deal of attention in the popular press from a large number of groups across the nation. There is potentially a significant source of funding directed at the monarch to improve habitat for it and other “pollinators.” Such habitat improvements could have great benefit for other terrestrial invertebrate species, especially if efforts are directed at native plant species and habitats. Georgia’s State Parks Division is considering a number of state lands for pollinator plantings, and the Nongame Conservation Section will provide technical assistance.

**Other Native Pollinators** – In addition to the monarch, a number of other native pollinators are either known or suspected to have undergone drastic population declines in recent years. One group under particular stress appears to be native bumblebees. The rusty-patched bumblebee (*Bombus affinis*), once common throughout its range across the eastern United States, has apparently disappeared from over 90% of sites (Colla and Packer 2008), and now has a global rarity rank of G1. Its status in Georgia is unknown, although it is thought to be extirpated. Many other native bee species are also thought to have declines, but their status in Georgia is barely known, if at all. Inventory is acutely needed, and eventually a more complete review of the conservation status of the taxa. Reasons for declines are not completely clear, but are thought to include disease, loss of preferred host plants, and overuse of insecticides. Native pollinator habitat efforts for the monarch noted above would no doubt also provide help for bumblebees and other declining species.

## Appendix H. Plants Technical Team Report

Prepared by Tom Patrick and Mincy Moffett, Team Leaders

### Technical Team Members

The Plants Technical Team represents academia, professional and amateur botanical consultants, nursery staff, and personnel from nature centers and botanical gardens.

Marshall Adams, Nurseryman [woody plants]  
 Heather Alley, Plant Conservation Program, State Botanical Garden [native plant horticulture, coordinator of Botanical Guardian volunteers]  
 Joanne Baggs, Botanist, Chattahoochee/Oconee National Forest [rare plants, monitoring]  
 Wilson Baker, Naturalist [plants of the Coastal Plain; surveys]  
 Mark Ballard, Botanical Consultant [plants of the Piedmont; surveys]  
 Steve Bowling, Conservation Assistant Horticulturist, Atlanta Botanical Garden [discovery, horticulture, surveys]  
 Forbes Boyle, Botanist, Okefenokee NWR [Okefenokee Swamp flora]  
 Jim Candler, Environmental Supervisor, Georgia Power [powerline management, surveys]  
 Jaime Collazo, Ecologist, Georgia Dept. of Transportation [roadside management, mitigation]  
 Richard Carter, Professor of Biology, Valdosta State University [sedges; rare plant surveys]  
 Jenifer Ceska, Coordinator, Georgia Plant Conservation Alliance, State Botanical Garden  
 Linda Chafin, Conservation Botanist, State Botanical Garden of Georgia [general flora]  
 Alan Cressler, Hydrologist, U. S. Geologic Survey [discovery, photography]  
 Ron Determann, Superintendent, Fuqua Conservatory, Atlanta Botanical Garden [horticulture, discovery, habitat restoration]  
 Brian Davis, Ecologist, Georgia Dept. of Transportation [surveys]  
 Paul Davison, Professor of Biology, North Alabama University [bryophytes]  
 Ben Dickerson, Wildlife Biologist, Georgia Power [powerline management, surveys]  
 Jim Drake, Georgia Botanical Society [gentians, lilies, discovery]  
 Lee Echols, Botanical Consultant, North American Land Trust [conservation, blackland prairies]  
 Debbie Folkerts, Professor of Biology, Auburn University [bog ecology]  
 Chick Gaddy, Naturalist [rare plants, discovery, surveys]  
 Tom Govus, Botanical Consultant [vegetation classification, rare plants, discovery]  
 Malcolm Hodges, Director of Stewardship, The Nature Conservancy of Georgia [natural area management lichens]  
 Lisa Kruse, Botanist, Nongame Conservation Section, GADNR [general flora, monitoring, natural area management, Oxypolis canbyi]  
 Ron Lance, Land Manager, North American Land Trust [woody plants, Crataegus]  
 Eamonn Leonard, Vegetation Ecologist/Botanist, Nongame Conservation Section, GADNR [vegetation classification, invasives, native plant propagation]  
 Patrick Lynch, Botanical Assistant, Joseph E. Jones Ecological Research Station [vegetation of limestone forests of the Coastal Plain; general floristics]  
 Bob McCartney, Nurseryman [woody plants, surveys, discovery]  
 Ed McDowell, Master Gardener [rare plants, monitoring, networking within conservation multiple conservation organizations]

Max Medley, Naturalist [discovery, general flora]  
 Mincy Moffett, Botanist, Nongame Conservation Section, GADNR [general flora, natural area management, invasives, mountain bogs, Xyris, safeguarding]  
 Tom Patrick, Botanist, Nongame Conservation Section, GADNR [rare plants, Biotics database, Trillium, safeguarding, surveys]  
 Rich Reaves, Botanical and Wetlands Consultant [general flora, state land inventories, discovery]  
 Matt Richards, Conservation Coordinator, Atlanta Botanical Garden [orchids, horticulture, habitat restoration]  
 Frankie Snow, Archaeology Consultant, Science/Computer Lab Technician, South Georgia College [flora of the Altamaha Grit Region, discovery]  
 Bruce Sorrie, Botanist (retired), North Carolina Heritage Program [Agalinis, endemics of the Southeast, surveys, flora of the Fall Line Sandhills, Liliium]  
 Matthew Stoddard, Wildlife Biologist, Nongame Conservation Section, GADNR [discovery, natural area management]  
 Nate Thomas, Wildlife Biologist, Nongame Conservation Section, GADNR [discovery, natural area management, Northwest Georgia rare plant surveys]  
 Jacob Thompson, Vegetation Ecologist/Botanist, Nongame Conservation Section, GADNR [flora of the Outer Coastal Plain, monitoring, surveys; vegetation classification]  
 Richard Ware, Georgia Botanical Society [Floyd County flora, discovery, woody plants]  
 Brad Wilson, Veterinarian, Herpetologist [orchids, carnivorous plants, discovery]  
 Wendy Zomlefer, Professor of Plant Science, Director of the Herbarium, University of Georgia [herbarium access, Georgia flora atlas project, advises grad students in floristic and biosystematics projects]

## Approach

Primary information sources for this assessment were the files of the Georgia Natural Heritage Program (now within the Nongame Conservation Section), selected publications (especially volumes published to date in the Flora of North America series), and some internet sources such as the NatureServe website ([www.natureserve.org](http://www.natureserve.org)). The standard reference for taxonomy and nomenclature for Georgia vascular plants is the 2015 edition of Flora of the Southern and Mid-Atlantic States by Alan Weakley. The electronic version of this 1320-page flora is available at the University of North Carolina Herbarium website. Other information came from specialists in large and difficult groups, such as the two examples described below.

First, consider the purple foxgloves, *Agalinis* spp. In 2012 a call for information on ten-lobed purple foxglove, *Agalinis decemloba*, a name under which no specimens were located at the University of Georgia Herbarium, brought to light several taxonomic issues. Botanists from Mid-Atlantic States and published research determined that federally listed sandplain purple foxglove, *Agalinis acuta*, was synonymous with *Agalinis decemloba*. An early monograph showed *Agalinis decemloba* from the Blue Ridge of Georgia and a recent collection was identified as *Agalinis decemloba* from Catoosa Co. in the Ridge and Valley, plus a published picture in Tipularia showed the plant on Lookout Mountain near Cloudland Canyon. Field observations by Rich Reaves, Tom Govus, Max Medley and Tom Patrick confirmed *Agalinis decemloba* extant in Georgia. Meanwhile, Wilson Baker dutifully rediscovered Georgia purple

foxglove, *Agalinis georgiana*, from pristine longleaf pine-wiregrass habitat in the Southeastern Plains near Thomasville. These observations represent new findings in need of herbarium documentation and conservation actions. Bruce Sorrie assisted with determinations of collections made by various members of the Plants Technical Team.

Another conundrum is represented by the hawthorns, *Crataegus* spp. Fortunately, in 2014 Ron Lance published Haws: A Guide to Hawthorns of the Southeastern United States. This provided enough insight on *Crataegus* to allow for identification of most specimens, and, most importantly, it included detailed range maps and rarity status notes at the state level. Some 75 *Crataegus* taxa are known from Georgia, including 22 listed as rare. We include 5 species as High Priority Plants suitable for effective plant conservation activities, plus one known at present only historically. Attention to *Crataegus* has long been overlooked. With the guidance of Ron Lance we now can determine the significance of the many hawthorns found in woodland and prairie habitats that are of conservation concern. Further additions, however, to our rare plant list await more detailed field surveys.

A two-day team meeting was held at Valdosta State University on 20-21 March 2014 with selected Coastal Plain botanists. At this time team members and other volunteers were introduced to the new Biotics 5 conservation database by our botany intern, Rebecca Pudner. Richard Carter demonstrated the virtual herbarium project now underway at Georgia's two largest herbaria, Valdosta State University and the University of Georgia. Jacob Thompson discussed vegetation classification in the coastal counties. Tom Patrick reviewed other heritage methodology, including recent rare plant surveys and assignment of state rarity ranks. Some botanically significant sites were noted by the group and a preliminary list of rare plants of the Coastal Plain was presented and critiqued. Similar regional sharing of lists among team members will be undertaken.

### **Results of Initial Assessments and Discussions**

Phase I of the assessment process began with the development of a matrix, in the form of an Excel spreadsheet, that featured, as column headers, various ranking factors (abundance, habitat, last observation dates, management needs, etc.), and designated best sites. All plants in the conservation database marked as "Tracked" or "Watched" by the Nongame Conservation Section were reviewed. For SWAP (2005) this initial list contained 996 species, but grew to 1085 species for this revision, including both vascular and nonvascular plants. Nonvascular plants include lichens, mosses, liverworts and hornworts only. There are no data for the fungi of Georgia at present incorporated in the database. Currently, there are ca. 3100 vascular plants and ca. 550 nonvascular plants recorded for Georgia. Roughly 31 percent of all Georgia plants were reviewed for SWAP (2015).

The primary ranking factors identified by the team are listed below. Three in bold print at the end of the list are new criteria based on conservation actions taken through coordination with other agencies, primarily as part of decisions made through the Georgia Plant Conservation Alliance with guidance from GADNR botanists.

- Range-wide (global) abundance
- Federal and State protection status
- Narrowness of range in the state
- State rarity ranking
- Overall perceived species trends
- Degree of demonstrable threat
- Number of already protected occurrences
- Statewide abundance
- Importance of efforts in Georgia to overall status of the species
- **Whether petitioned for listing by Center for Biological Diversity**
- **Safeguarding actions already in place**
- **Urgency of overall conservation needs**

Using the criteria enumerated above, two lists of high priority rare plants were compiled.

First, State Historic (SH) plants, those plants not observed in the wild since the mid-1990s, were compiled in Table 1. The rediscovery of the so-called “Lost Plants” of Georgia is a high priority for SWAP (2015). No conservation actions besides looking for these plants can be undertaken until populations are relocated. There are 49 confirmed “Lost Plants” in addition to the famous Franklin tree (*Franklinia alataamaha*) that is now regarded as extinct in the wild. Of these 49, most were found on the Coastal Plain, especially in areas known as the Dougherty Plain and Tifton Upland primarily in Southwest Georgia on the Southeastern Plains or Inner (Upper) Coastal Plain ecoregion. Several dozen more taxa likely qualify as SH in Georgia, but data are lacking for dates of collection and latest observations of several graminoids, mosses and liverworts. In addition, even basic rarity ranks for nonvascular plants for the most part have yet to be determined.

Table 1. Distribution of "Lost" or Not Recently Seen Plants, by Ecoregion							
Scientific Name	Common Name	Year Last Seen	SA/RV	BR	PD	SP	SCP
<i>Agalinis gattingeri</i>	Gattinger's Purple Foxglove	1976	X				
<i>Agalinis harperi</i>	St. Marks Purple Foxglove	1962				X	X
<i>Agalinis laxa</i>	Spreading Purple Foxglove	1947				X	
<i>Agarista populifolia</i>	Pipe-Stem Fetterbush	Mid 1800s					X
<i>Arabis lyrata</i>	Lyre-Leaf Rockcress	1878	X				
<i>Aristida simplicifolia</i>	Chapman's Three-Awn Grass	1975				X	
<i>Asplenium heterochroum</i>	Bicolored Spleenwort	Early 1900s					X
<i>Calopogon multiflorus</i>	Many-Flowered Grass-Pink	1992				X	
<i>Calopogon oklahomensis</i>	Oklahoma Grass-Pink	1947				X	
<i>Carex brunnescens</i>	Brown Seepage Sedge	1939		X			
<i>Carex buxbaumii</i>	Brown Bog Sedge	1966	X				
<i>Carex triangularis</i>	Fox Sedge	1951	X				
<i>Carphephorus pseudoliatris</i>	Lavender Lady	1949				X	
<i>Cephaloziella obtusilobula</i>	Roundleaf Liverwort	1950		X			
<i>Corallorhiza maculata</i>	Spotted Coralroot	1946		X			
<i>Crataegus brachyacantha</i>	Blueberry Hawthorn	1941					X
<i>Delphinium alabamicum</i>	Alabama Larkspur	1900	X				
<i>Eleocharis bicolor</i>	Two-Tone Spikerush	Pre-1990				X	
<i>Eleocharis erythropoda</i>	Bald Spikerush	1963	X				
<i>Eurybia eryngifolia</i>	Snakeroot-Leaf Aster	1947				X	
<i>Ilex cuthbertii</i>	Cuthbert's Holly	1991			X	X	
<i>Iris prismatica</i>	Slender Blue Flag	1982	X				
<i>Lindernia saxicola</i>	Rock False Pimpernel	1932			X		
<i>Linum sulcatum</i>	Grooved Yellow Flax	1994	X				
<i>Linum harperi</i>	Harper's Grooved Flax	1900				X	
<i>Ludwigia brevipes</i>	Long Beach Seedbox - P	1942					X
<i>Lysimachia loomisii</i>	Carolina Loosestrife	1837				X	
<i>Minuartia godfreyi</i>	Godfrey's Stitchwort - P	1901				X	
<i>Muhlenbergia torreyana</i>	Torrey's Dropseed	1900				X	
<i>Orbexilum virgatum</i>	Slender Leather-Root	1939					X
<i>Paronychia patula</i>	Pineland Nailwort	1947				X	

Scientific Name	Common Name	Year Last Seen	SA/RV	BR	PD	SP	SCP
<i>Pieris floribunda</i>	Evergreen Fetterbush	Pre-1820		X			
<i>Plagiochila sullivantii</i>	Sullivant's Leafy Liverwort	1950s		X			
<i>Polygonum glaucum</i>	Sea-Beach Knotweed	1974					X
<i>Quercus palustris</i>	Pin Oak	1948	X				
<i>Rhexia parviflora</i>	Small-Fld. White Meadowbeauty	1940				X	
<i>Rudbeckia grandiflora</i>	Largeflower Coneflower	1948	X				
<i>Sarracenia rosea</i>	Gulf Purple Pitcherplant	1900				X	
<i>Schoenoplectus hallii</i>	Hall's Bulrush – P	1966				X	
<i>Scutellaria arenicola</i>	Sandhill Skullcap	1950					X
<i>Silphium radula</i>	Rosinweed	1948	X				
<i>Solanum pumilum</i>	Dwarf Horse-Nettle	1836			X		
<i>Solidago porteri</i>	Porter's Goldenrod	1979			X		
<i>Spiranthes brevilabris</i>	Short-Lipped Ladiestresses	Pre-1950				X	
<i>Tofieldia glutinosa</i>	Northern Bog Asphodel	1946		X			
<i>Vaccinium crassifolium</i>	Evergreen Lowbush Blueberry	1958					X
<i>Viburnum lantanoides</i>	Witch-Hobble	1947		X			
<i>Vitis palmata</i>	Riverbank Grape	1991				X	X
<i>Zamia integrifolia</i>	Florida Coontie	1971					X
Total = 49		Subtotals:	10	7	4	19	11

Second, a revised list of high priority plants, excluding “Lost Plants,” was developed. SWAP (2005) listed 435 plants with no other prioritization of urgency. SWAP (2015), Appendix A, lists 290 high priority plants. A deliberate attempt to list the rarer plants only resulted in a more reasonable number of plants that feasibly could be worked into projects over the next 10-year SWAP cycle. The Appendix A list of High Priority Plants was refined further (see Table 2 below) to emphasize the plants most in need of conservation actions. Most plants in Table 2 are known from few sites, usually under one or two, with little if any permanent protection, *in situ* enhancement or *ex situ* safeguarding. Some well-established safeguarding sites may be underway, but unless viable populations have been established, much additional monitoring and care are needed. One example is the American barberry (*Berberis canadensis*) recently outplanted near Sprewell Bluff along the Flint River, Meriwether Co., in a montane longleaf pine woodland. The outplanting site is a few miles from a known historic collection from the same ridge line and habitat. American barberry in Georgia is known from only one extant natural occurrence and is considered at risk of extinction in the wild without site protection and at least two well-managed viable populations. Another critical species is the Carolina windflower (*Anemone caroliniana*), known from a single site, perhaps extant at another not yet relocated.

The known population in the Monticello Glades, Jasper Co., consists of less than 10 small clumps, some of which are infected with a rust disease and subjected to roadside management threats.

<b>Table 2. Plants in Most Critical Need of Conservation Action</b>		
<b>Scientific Name</b>	<b>Common Name</b>	<b>Comment</b>
<i>Amorpha georgiana</i>	Georgia Indigo-Bush	One site, few plants; management agreement needed
<i>Anemone caroliniana</i>	Carolina Windflower	Few plants, rust disease threat
<i>Berberis canadensis</i>	American Barberry	One site; management agreement needed
<i>Clematis fremontii</i>	Fremont's Leatherflower	One site, few plants
<i>Crocanthemum nashii</i>	Florida Scrub Sunrose	One small site; needs formal collaborative agreement
<i>Cypripedium kentuckiense</i>	Kentucky Ladyslipper	One site, few plants; needs formal protection
<i>Eriocaulon koernickianum</i>	Dwarf Pipewort	Few sites, irregular occurrence; ecology study needed
<i>Eriophorum virginicum</i>	Tawny Cottongrass	One protected site, few plants
<i>Isoetes junciformis</i>	Rush Quillwort	One site, irregular appearance; unprotected
<i>Lilium pyrophilum</i>	Pineland Lily	Newly recognized; browsing threat; few mature plants
<i>Lindera subcoriacea</i>	Bog Spicebush	Severe dieback; few sites
<i>Liparis loeselii</i>	Fen Orchid	One small fragile site
<i>Platanthera chapmanii</i>	Chapman's Fringed Orchid	Management issues; needs rigorous monitoring
<i>Platanthera flava</i> var. <i>herbiola</i>	Pale Green Orchid	One site; very few plants
<i>Platanthera integra</i>	Yellow Fringeless Orchid	Severe decline; irregular appearance
<i>Rhynchospora solitaria</i>	Solitary Beakrush	Two sites, critical management issues
<i>Silene regia</i>	Royal Catchfly	One site; development pressure
<i>Thalictrum debile</i>	Trailing Meadowrue	One site in commercial area; land purchase needed
<i>Thaspium pinnatifidum</i>	Cutleaf Meadow-Parsonip	Small populations; global rarity
<i>Trillium pusillum</i>	Least Trillium	Threatened by development; more protection needed
<i>Trillium</i> sp. nov. (unpublished)	Southern Decumbent Trillium	Few sites; severe threats (feral hogs)
<b>Total = 21</b>		

### **Species Distribution by Ecoregion**

Appendix A lists the high priority plants with an indication of the ecoregions in which they occur. Ecoregions are indicated by the following abbreviations designated in the right-hand columns of the table:

- **SA/RV = Southwestern Appalachians/Ridge & Valley** [includes Cumberland Plateau]
- **BR = Blue Ridge**
- **PD = Piedmont**
- **SP = Southeastern Plains** [Upper or Inner Coastal Plain]
- **SCP = Southern Coastal Plain** [Lower or Outer Coastal Plain and Barrier Islands]

## Species Conservation Actions

High Priority Plants will require well-planned conservation actions. Conservation actions are divided into four categories, as defined below.

- **Category A – Broad-scale habitat restoration/management**

Criteria include current range, threats, and habitat needs that are well known. The species is considered a habitat indicator, keystone species, or good representative of a plant community of interest. Within appropriate habitat there exist discernible populations that are large enough for monitoring to be feasible. Population size and structure are assumed to be indicators of overall habitat quality. Conservation emphasis will be on broad-scale protection, restoration and management of habitat as well as monitoring of individual populations.

- **Category B – Protection/management of best populations/critical habitats**

Range, threats, and habitat needs are well known, but the species may not be a good indicator of overall habitat quality (e.g., presence and abundance may be better correlated with microhabitat factors, or may be a eurytopic species that ranges widely over many habitats but that depends on discrete areas with specific soil nutrient, light and water requirements. Plants occur in large enough numbers for monitoring to be feasible. Conservation emphasis will be on monitoring and managing existing populations at best sites within range, protecting critical habitat needs (e.g., hydrology, canopy density, etc.), protection against poaching, and dealing with other threats such as overbrowsing, invasives or disease.

- **Category C – Reintroduction/restoration of populations**

The species has suffered catastrophic declines in the state, to the point of extirpation (or near extirpation). Former range, causes of decline, and habitat needs are generally known, but may require some additional research. Existing populations are clearly imperiled and not likely to persist without intervention. Primary conservation emphasis will be on augmenting existing populations and/or establishing new populations through a variety of methods (e.g., propagation, translocation, small-scale habitat manipulation). For plants, this effort is called safeguarding and is undertaken both in botanical gardens (*ex situ* safeguarding) and in natural habitats (*in situ* safeguarding).

- **Category D – Basic research and surveys**

Evidence of rarity or endemism exists, but significant questions remain as to current range, population status, habitat needs, and/or threats. For some groups, this includes species known historically from the state and not observed in recent years. For plants, selected species known historically from the state are included in a separate table (Table 1). Species reported from only a few sites, usually less than 5 to 20 locations, but for which adequate surveys have not yet been conducted meet the criteria for this category. Generally, insufficient information exists to develop a specific conservation strategy at this time. Emphasis will be on conducting basic research to determine current status, habitat needs, and threats.

While the four categories of conservation actions are described separately, in reality, many high priority species have life history characteristics or habitat requirements that necessitate a multi-focal conservation approach. Therefore, more than one conservation action may be necessary for some plants.

In summary, a total of 21 plants are in urgent need of attention within the next one to three growing seasons. The primary reason for urgency is the threat of habitat destruction due to development, especially since each of the 21 plants is known from only one or two unprotected sites. There often is no efficient way to insure permanent protection with adequate management for small natural areas before sites are destroyed. Without safeguarding action several of these rarities will disappear from existence in the wild within Georgia.

About 103 of the 290 High Priority Plants (Appendix A) have best sites identified that need protection and enhancement and/or restoration action. In many cases, additional landowner contacts and permissions are needed, various protection efforts put into place, and safeguarding sites established. Several of the High Priority Plants are found in more than three or four sites and some work on propagation and safeguarding is already underway. Establishment and management of viable populations are imminent and should be accomplished within the next SWAP 10-year cycle. The remaining High Priority Plants require conservation actions but are found in more populations and are not as critically imperiled.

By no means do these lists contain all rare plants in need of conservation action. Listed for SWAP (2015) are 290 High Priority Plants with an additional 49 “Lost Plants” to relocate. Putting these figures in perspective, the current total number of Tracked rare plants in Georgia is 744. Tracked species are mapped and data on occurrences entered into the conservation database (Biotics). Plants on the Watch List number an additional 345. The Watch List plants lack enough distributional data to determine rarity precisely, but are considered likely to have more than 20 or 30 occurrences, have been observed regularly, and are thought to be in no immediate danger of extirpation, allowing time for a more accurate rarity status determination. Therefore, some  $290 + 49 = 340$  plants are covered by SWAP (2015) specifically out of a total of  $744 + 345 = 1,089$  plants for which records are kept and research undertaken as time permits. SWAP (2015) High Priority Plants account for about one third (31 percent) of the known plants of conservation concern. There are 6,400 rare plant occurrences represented in the conservation database (Biotics); 1,800 were added during the last SWAP cycle (2005-present).

### **Importance of Collaboration**

The Georgia Botanical Society (BotSoc), founded in 1928, continues to make invaluable contributions to plant conservation in Georgia. Some examples that help support and publicize activities supported by the Nongame Conservation Section are briefly summarized here. BotSoc annually publishes *Tipularia*, a botanical magazine with color photos and articles on field botany and current academic research. BotSoc sponsors field trips to explore sites in all physiographic provinces of the state. Several state lands have been inventoried by teams led by BotSoc members. Rare plants discovered during surveys are routinely added to Biotics.

Another botanical group focused on plant conservation is the Georgia Native Plant Society (GNPS), founded in 1994. Of special importance to the Plants Technical Team efforts are the informative newsletters, the annual Native Plant Symposium, and the plant rescue program. Plant rescues are conducted when a new development will impact native plant populations. Plant rescuers are trained in horticulture and plant taxonomy. Protected Plants, officially designated through provisions of the Georgia Wildflower Preservation Act, when encountered during rescues, are reported to the Nongame Conservation Section. Permits for transport and sale of rescued plants are then issued. GNPS rescuers were among the first to propagate Georgia aster (*Symphyotrichum georgianum*) and offer it for sale. A native plant propagation garden at Georgia's Stone Mountain Park serves to promote and make available native plants for landscaping. The plant rescue operation and technical propagation expertise are invaluable services to GADNR whenever coordination or mitigation is required by government agencies and their consultants

Botanists within GADNR are encouraged to participate in some of the activities of these grass root plant conservation organizations. The volunteer efforts undertaken by members of these groups provide a continuous flow of new botanical information, especially about Georgia's rare species of conservation concern. Our very first SWAP Priority Action Item, elaborated upon below, is to mention the importance of collaborative efforts in plant conservation in Georgia. This effort is best exemplified through the role of the Georgia Plant Conservation Alliance (discussed under Priority 1, Part 2, last section of report).

### **Additional Assessment Results**

Following completion of preliminary lists of rare species for the five ecoregions, more comprehensive lists were sent out for review. One issue became evident as lists of 100s of plants appeared too cumbersome to clearly show objectives and priorities concisely in a SWAP plan. Therefore, more attention was placed on the highest priority plants. This resulted in some additional features of the High Priority Plant List, helpful in focusing on projects that needed attention most, yet not neglecting species of importance in which some progress has already been made. The Appendix A table of High Priority Plants contains all plants known from Georgia that are petitioned for federal listing consideration by various groups, including the Center for Biodiversity. Currently, there are 43 plants (1 hornwort, 3 liverworts, 39 vascular plants) so petitioned. Since SWAP (2005), 5 vascular plants were designated as Candidates for federal listing by the U. S. Fish and Wildlife Service. These 5 high priority plants are enumerated below to show most recent developments and needs:

- *Arabis georgiana*, Georgia rockcress – Listed as Threatened in 2014; intensive safeguarding and augmentation efforts underway; needs annual monitoring
- *Dichantherium hirstii*, Hirst Brother's panic grass – more survey needed in Georgia where one large (the largest currently known) population was rediscovered in 2014; safeguarding initiated
- *Helianthus verticillatus*, whorled sunflower – Listed as Threatened in 2014; Georgia sites mostly protected and managed; needs prescribed fire management
- *Platanthera integrilabia*, monkey-face orchid or white-fringeless orchid – likely to be listed in near future due to poaching, few large populations, and continuous management

requirements (protection from browsing, maintaining open understory, herbicide avoidance); augmentation and/or safeguarding efforts being undertaken for all 9 extant Georgia populations; needs annual monitoring and additional safeguarding

- *Symphotrichum georgianum*, Georgia aster– Signed Candidate Conservation Agreement in effect as of 2014; annual survey and monitoring work conducted; needs 10-year commitment

Important discoveries of plants that appear to be state records, or at least are not well-documented with herbarium specimens or literature accounts with specific Georgia localities continue to be found. A few representative discoveries since SWAP (2005) are listed below along with respective ecoregion of occurrence and habitat.

- *Agalinis maritima*, maritime purple foxglove – Southeastern Coastal Plain; tidal marsh of barrier island
- *Calamovilfa arcuata*, Cumberland sandreed – Southwestern Appalachians; boulder gravel bar along high velocity stream
- *Clematis fremontii*, Fremont’s leatherflower –Ridge and Valley; calcareous flatwoods.
- *Coreopsis rosea*, pink tickseed – Blue Ridge; drawdown zone of Lake Chatuge
- *Crocantemum nashi*, Florida sunrose – Southern Coastal Plain; inland aeolian sand dune
- *Euphorbia purpurea*, glade spurge – Blue Ridge; open seep over serpentine
- *Galium virgatum*, limerock bedstraw – Southeastern Plains; blackland prairie
- *Gratiola graniticola*, granite hedge-hyssop – Piedmont; granite outcrop
- *Liparis loeselii*, fen orchid– Blue Ridge; open seep over serpentine
- *Rivina humilis*, rouge-plant – Southern Coastal Plain; edge of tidal marsh hammock
- *Scutellaria drummondii*, Drummond’s skullcap –Southeastern Plains; blackland prairie
- *Solidago arenicola*, Black Warrior goldenrod - Southwestern Appalachians; boulder gravel bar along high velocity stream
- *Tomostima cuneifolia*, limerock draba - Southeastern Plains; blackland prairie

## Examples of High Priority Habitats and Species

### Southwestern Appalachians & Ridge and Valley Ecoregion

- Limestone glades and barrens

These are open habitats dominated by graminoids and forbs, with scattered eastern redcedars and other trees. These habitats may contain a large number of endemic plant species. Glades occur on thin, rocky soils, and are typically dominated by forbs while barrens are in areas with deeper soils and are dominated by grasses. Although the soil characteristics of remnant prairies retard rapid establishment by trees and shrubs, woody encroachment due to fire suppression must be managed.

- Limerock arrow-wood (*Viburnum bracteatum*) [Legal Status: State Endangered]

The limerock arrow-wood is a deciduous shrub, inhabiting calcareous, rocky bluffs and found in less than six populations in the world. Quarrying operations are one of the primary threats to the species. The only known population in Alabama was destroyed by quarrying and two of the three Georgia populations, including the largest known in the state, were jeopardized by past quarrying. These sites are now protected from active quarrying, protected and safeguarded.

### **Blue Ridge Ecoregion**

- Rich mesic hardwood forests

These include a range of forest habitats, all hosting a diverse groundcover. These forests, particularly those over basic soils or cation-rich soils (e.g., serpentine, mafic, ultramafic), harbor a wide diversity of rare plant species. These habitats have been impacted by incompatible forestry practices, forest conversion, disease, invasive exotic species, and residential development. Protection from disturbance is vital to the health of these habitats and the rare species they support.

- Persistent trillium (*Trillium persistens*) [Legal Status: State Endangered, Federal Endangered]

The persistent trillium is restricted to extreme northeast Georgia and western South Carolina. In Georgia it occurs mostly in Tallulah Gorge and is associated with several rare plants including the Carolina hemlock (*Tsuga caroliniana*), monkeyface orchid (*Platanthera integrilabia*), and sweet pinesap (*Monotropsis odorata*). It was only recently discovered and described (1971). Because it is not a particularly strong competitor, populations are threatened by invasive species, especially in secondary forests, not only aggressive exotics (e.g., English ivy, Japanese honeysuckle, multiflora rose, kudzu, wild hogs), but also natives (e.g., blackberry, black locust). The species forms fruits with few seeds and seems to have a dispersal problem, resulting in its virtual restriction to a narrow gorge with two downstream disjunct occurrences for a total narrow range of 7 miles along the Tallulah-Tugaloo river system. Moreover, due to its showy nature, this species could become the focus of irresponsible collectors. Increased visitation to the gorge by recreationists requires constant monitoring so that populations are not trampled.

### **Piedmont Ecoregion**

- Granite outcrops

Georgia hosts almost 90% of the Piedmont granite outcrops of the Southeast. These habitats host unique microhabitats that are characterized by a granitic substrate with pockets of acidic, nutrient-poor mineral soil. Vernal pools, or solution pits, occurring on the outcrops host high priority species that are severely restricted in their range. Specific threats to these habitats include destruction of proximate habitat or adjacent uplands from quarrying activities, recreational use (e.g., trail bicycles, ORV traffic, littering, vandalism, fire building, unleashed dogs), eutrophication resulting from conversion of habitat to pasture (cattle waste adds

nutrients that favor the growth of competitive aquatic species), pollution (e.g., dumping of trash, airborne deposition of granite dust), invasive exotic species, and shading due to tree growth. The highest priority for management is to preserve the habitat and to avoid disturbance.

Since SWAP (2005), special attention to Lithonia gneiss outcrops, a subset of Piedmont granite outcrops, shows that additional protection efforts are needed to protect selected outcrops in DeKalb, Gwinnett, Rockdale and Walton Cos. A suite of rare taxa have their best populations on the Lithonia gneiss outcrops. Special plants more abundant here than on other granite outcrops include flatrock onion (*Allium speculae*), Louisiana bluestar (*Amsonia ludoviciana*), dwarf hatpins (*Eriocaulon koernickianum*), Wolf's Spikerush (*Eleocharis wolfii*), Alexander's rock aster (*Eurybia avita*), and granite hedge-hyssop (*Gratiola graniticola*).

- Pool sprite or snorkelwort (*Amphianthus pusillus*) [Legal Status: State Threatened, Federal Threatened]

The pool sprite is endemic to granite outcrops of the Piedmont ecoregion in Alabama, Georgia, and South Carolina. It is the only member of the *Amphianthus* genus. Recent studies show the plants to be highly specialized members of *Gratiola* and therein go by the name *Gratiola amphiantha*. One peculiar characteristic is that the small flowers can be found both among the submerged basal rosette leaves and between the paired, floating, emergent leaves. On outcrops, this species is restricted to the shallow flat-bottomed solution pits where rainwater collects. Because its microhabitat is naturally quite stable (very slow to undergo change), the pool sprite is not adapted to withstand any habitat modification. Much of its habitat has been destroyed by quarrying activities or degraded by livestock, vehicular traffic, and eutrophication through sedimentation. Newly discovered populations need protection efforts and further inventory. One such site is along Rocky Comfort Creek, Warren Co. that also harbors high quality pools of federally listed mat-forming quillwort (*Isoetes tegetiformans*).

### Southeastern Plains Ecoregion

- Fire-maintained wetlands

Some of the unique wetlands in this ecoregion include wet pine savannas and herb and shrub bogs. Wet savannas are often a matrix of an open tree canopy with high groundcover diversity, interspersed with bogs. Threats to these habitats are numerous, and include altered fire regimes, altered hydrology and water quality, invasive exotic species (e.g., particularly wild hogs), incompatible agricultural and silvicultural practices, ORV and heavy equipment traffic, and road and utility construction. These threats often compound one another. For example, conversion to pine monoculture results in a fragmented landscape, which promotes altered fire regimes, which in turn facilitate increased density of woody plants, and degrades the habitat for sun-loving bog and savanna plants.

- Purple honeycomb head (*Balduina atropurpurea*)  
[Legal Status: State Rare, Federal Candidate]

The purple honeycomb head is found primarily in South Georgia and Florida. The genus is endemic to the southern United States. This species thrives in the wetter areas of peaty pitcherplant bogs and pine savannas and is particularly vulnerable to woody encroachment and hydrologic alteration. It is important to maintain an appropriate fire regime through controlled burning and to avoid drainage of the site (i.e., take special care in the placement of firebreaks near these habitats). Controlling the impacts of feral hogs is also critical. *Balduina atropurpurea* is under scrutiny as a petitioned species for federal listing. It has been the object of several studies that demonstrate numerous populations dependent upon appropriate moisture to bloom regularly, as well as prescribed fire or mowing to maintain an appropriate habitat. Due to irregularity of prescribed fire and the sporadic blooming of small populations, the true rarity of *Balduina* is difficult to ascertain. However, where abundant (dozens of clumps or more) in a properly managed wet savanna/seepage bog habitat, the species appears to hold its own. Due to continued habitat destruction or degradation and the lack of a sufficient number of protected sites, especially in the Southeastern Plains ecoregion, much more survey work and protection efforts are needed. This species also occurs in the Southern Coastal Plain, where some of the more robust populations persist on Ft. Stewart. Since ca. 90% of the nearly 80 occurrences are historic, unprotected, unmanaged, and/or extremely small (less than 30-50 flowering stems in a good year of blooming), much remains to be done to adequately conserve this signature plant of the pitcherplant bogs of Georgia's coastal plain.

### **Southern Coastal Plain Ecoregion**

- Longleaf pine-scrub oak woodlands

These habitats occupy the drier portion of the moisture gradient. Drier habitats, such as sand ridges and scrub communities, host several rare plants. The largest threat to these habitats is altered fire regime. This includes fire exclusion, fire suppression, alteration of habitats through unnatural timing, frequency, or intensity of prescribed burns, and other incompatible fire management practices. The result of altered fire regimes includes a shift in species composition (of pines and oaks) and reduced diversity in the groundcover.

- Hairy rattleweed (*Baptisia arachnifera*)  
[Legal Status: State Endangered, Federal Endangered]

The hairy rattleweed is only found in two counties in Georgia. This rare endemic is found on sandy soils in open pine flatwoods and sometimes persists on intensively managed slash pine plantations and power line rights-of-way where invading woody plants are kept under control. Maintaining an open condition through prescribed burning is essential to the long-term viability of this species. Avoiding the drainage of the site is also imperative.

### **Conservation Actions and Research Priorities**

In the following accounts progress on priorities listed in SWAP (2005) are briefly highlighted in Part 1. Newly revised actions and research priorities for SWAP (2015) are given subsequently in Part 2. Each of these conservation actions – old and new - requires attention whether an original

SWAP (2005) topic revised and updated, or an additional conservation action with new research priorities. Each represents a broad plant conservation goal.

## **Part 1**

### **A Review of Old SWAP (2005) Priorities**

#### **Old Priority 1. Conduct statewide assessment of significantly rare natural communities.**

Assess the status, distribution, and description of significantly rare natural communities. Although there are coarse landcover analyses for Georgia, none have thoroughly assessed many of the rarer (fine-scale) natural community types. Few of these communities have been adequately described using the ecological framework developed by NatureServe. This priority includes GIS coverages, descriptions of natural communities, assessments of threats and status, and addition of community records into Biotics. Also, recommendations for the protection and stewardship of rare natural communities are needed.

Since initiation of SWAP (2005) additional staff hired as vegetation and GIS specialists conducted vegetation surveys, particularly in the coastal and adjoining tier of counties. In addition, several projects beyond the purview of rare plants were completed, such as vegetation of sandhills and monitoring of fire effects. Documentation of occurrences of rare natural communities is now a more prevalent part of Biotics, the conservation database currently used. NatureServe's ecological community classification systems are now integrated into Georgia's vegetation projects. The assessment of rare natural communities now concerns several teams involved with SWAP (2015). Some examples of the Plants Technical Team directly contributing to assessments of rare natural communities are intense mapping and surveys of mountain bogs in the Blue Ridge, investigations of sag ponds and springs in the Ridge and Valley, vegetation and floristic assessments of blackland prairies and limestone forest communities on the Fort Valley Plateau of the Southeastern Plains, oak/pine woodlands on the Piedmont, and inland aeolian sand dunes along the Oohoopee River.

Members of the Plants Technical Team have authored new plant associations approved and now included within the U. S. National Vegetation Classification hierarchy. Examples are the Southern Ridge and Valley Sub-Calcareous Shale Barrens authored by Tom Govus and Max Medley, and the South Atlantic Mixed Oak-Pine Calcareous Flatwoods Forest authored by Jacob Thompson found in the Southern Coastal Plain. Both associations have significant rare plants – Alabama larkspur (*Delphinium alabamicum*) and swamp post oak (*Quercus similis*), respectively.

#### **Old Priority 2. Develop Element Occurrence Rank specifications.**

This is particularly important for species that are either endemic to, or primarily within Georgia (plants and animals). Define specifications for ranking the quality of individual element occurrences (i.e., "observation standards" per NatureServe). Element Occurrence Ranks are much needed by the conservation community in order to prioritize conservation efforts.

Numerous metrics (e.g., population size, distribution, reproductive modes, viability, etc.) would have to be field-assessed.

It is standard procedure now to enter an Element Occurrence Rank based on data provided by the observer. There are 100s of older records that have not yet been ranked and are gradually being updated. Approximately 1,800 new plant records have been entered into the Biotics Database during the last SWAP cycle (2005-present). There have also been nearly 900 additional plant records updated (incl. all edits and deletions) during this same period.

### **Old Priority 3. Develop protocols and procedures for safeguarding rare plants.**

In 2008, a policy statement establishing protocols for an integrated plant conservation strategy combining *in situ* and *ex situ* projects and including habitat restoration and plant population safeguarding was developed and signed by 18 members of the Georgia Plant Conservation Alliance (GPCA). The DNR is both a charter member and leading institution within the GPCA. The policy/protocols document is informally known as the “GPCA Safeguarding Agreement” and is the de facto membership document for institutional participation in the GPCA. The document served to expand the scope and accelerate the process for determining and approving *ex situ* plant conservation projects in Georgia. There are currently 36 signatories to the Safeguarding Agreement.

Safeguarding, as it applies to plants, refers to all types of propagation and/or outplanting activities that constitute a conservation strategy of last resort. Specifically, safeguarding refers to various propagation and outplanting activities as they relate to *ex situ* or *in situ* efforts, including re-introductions, augmentations/enhancements, and introductions.

In Georgia, the primary vehicle for rare plant safeguarding, as well as rare plant conservation in general, is the Georgia Plant Conservation Alliance (GPCA). The GPCA, is an innovative network of public gardens, government agencies, academic institutions, utility companies and environmental organizations committed to preserving Georgia’s endangered flora. Formed in 1995 its mission is to study and preserve Georgia’s flora through multi-disciplinary research, education, and advocacy; facilitate the recovery of rare, threatened, and endangered plants of Georgia and the southeastern US through collaborative efforts within our state; and communicate the importance of preserving biodiversity worldwide.

### **Old Priority 4. Conduct surveys for nonvascular species.**

One of the groups of plants least understood are the nonvascular bryophytes (mosses, liverworts, hornworts). Little is known about bryophytes in the state including distribution, habitat requirements, and abundance data. It would be important to survey for their diversity, habitat specifics, for rare, threatened, special concern mosses and liverworts.

Since 2005, a few bryological surveys have been conducted primarily by Paul Davison, University of North Alabama, Florence and Ken McFarland, University of Tennessee, Knoxville. These surveys included searches for new populations of the headwaters hornwort (*Megaceros aenigmaticus*), and general moss collections from diverse habitats. During general collecting trips in Blue Ridge and Cumberland Plateau sites of North Georgia, significant mosses and

liverworts were documented. A checklist of Georgia liverworts was completed and a few rarities were added to the database. Other bryologists have recently reported their collections from specialized habitats, especially areas of the Altamaha Grit Formation in Coffee and Jeff Davis Cos. This geologic feature within the Southeastern Plains ecoregion resembles outcrops of sandstone often with deep crevices and cliffs and was found to harbor the rare moss *Eccremidium floridanum* in seepy depressions on the exposed bedrock.

Lichenologists are conducting final fieldwork surveying most of Georgia's 159 counties to create an atlas of the lichens of Georgia. Very few lichens have yet been added to the conservation database as special concern plants. Only one Georgia lichen is federally listed, the rock gnome lichen (*Gymnoderma lineare*), found only in the Blue Ridge. Rarity ranks need to be assigned to a preliminary list of rare Georgia lichens that has been generated from atlas data, and support given for the upkeep of a county distribution atlas.

#### **Old Priority 5. Assess conservation status of selected wetlands of Northwest Georgia.**

In 2008 and 2009, the Atlanta Botanical Garden was contracted to survey likely habitats in northwestern GA for new occurrences of Tennessee yellow-eyed grass (*Xyris tennesseensis*) and monkey-face orchid (*Platanthera integrilabia*). The botanical survey employed topographic maps, soil surveys, and known locations of *X. tennesseensis* and *P. integrilabia* to help identify areas of suitable habitat for both target species. The counties of focus for *X. tennesseensis* included Bartow, Carroll, Cherokee, Chattooga, Floyd, and Gordon Counties. Stephens County in northeastern Georgia was included in the survey as well, specifically for the monkey-face orchid. The surveys focused on spring heads, spring runs, and their nearby creek channels. Several sites with impoundments were also surveyed that might have historically been springs. In total, nearly 50 sites were surveyed. Surveys were conducted during August through October to coincide with flowering and fruiting.

As a result of the surveys, three new Tennessee yellow-eyed grass populations were discovered (two in Bartow Co. and one in Floyd Co.), including the Clear Creek Lake Springs site which contained over 20,000 flowering stems making it Georgia's largest known population of this species. Much additional suitable habitat was identified for the yellow-eyed grass. While this survey did not locate any new populations of *P. integrilabia*, areas with suitable habitat were identified, most of which were located on protected public property. These sites represent good potential for the establishment of safeguarding populations *in situ*. There is also substantial property left to survey with the hopes of finding new populations.

Some progress has also been made on sag ponds in Northwest Georgia in the Ridge and Valley ecoregion. Two recent exploratory visits revealed several coastal plain disjuncts and rediscovery of one of Georgia's Lost Plants, pale mannagrass (*Glyceria pallida*, now known as *Torreyochloa pallida*). Additional surveys and inventories of the dozen or so remaining, intact sag ponds of Bartow Co. are needed. Atop the Cumberland Plateau additional floristic work is needed on sag ponds, especially those shown to support one of our rare sedges, tussock sedge (*Carex stricta*).

### **Old Priority 6. Assess conservation status of graminoids.**

Very little is understood for this complex group of plants that makes up a large component of our state's diversity (focus on *Rhynchospora* and *Dichantherium*). Based on the SWAP (2005) evaluation, it is clear that there are numerous globally rare (G1, G2) species in need of current status surveys.

Limited work has been accomplished with graminoids, although numerous collections and observations were made. Some examples of rare graminoids are at least safeguarded in propagation and initial steps taken to safeguard *in situ*. Tawny cottongrass (*Eriophorum virginicum*) has successfully been propagated from seed collected from Georgia's single extant site. Autumn Beakrush or Solitary Beakrush (*Rhynchospora solitaria*), known from 3 extant sites, none protected, may be the rarest beaksedge known. It is a Georgia endemic described by Roland Harper in 1901. His type locality is destroyed, all but one remaining site is inaccessible due to uncooperative landowners. The accessible site is an unmanaged, frequently disturbed, roadside seepage bog with a few scattered plants, one of which was salvaged and remains in cultivation. Hirst Brother's panic grass (*Dichantherium hirstii*) was finally relocated in 2014 after not being found since 1947 – a nearly 67-year absence. The limesink depression pond/wet savanna in which it was found harbors other rarities, including Harper's beaksedge (*Rhynchospora harperi*). Meager sedge (*Carex exilis*), a state record, was discovered since the last SWAP in an Atlantic whitecedar bog on the Fall Line Sandhills. Attention has been given to a few more graminoids of conservation concern that appear to be habitat indicators, such as northern long sedge (*Carex folliculata*) in mountain bogs, and Wolf's Spikerush (*Eleocharis wolfii*) and bog oat-grass (*Danthonia epilis*) of Lithonia gneiss granitic outcrops. At least 6 new species of *Carex* found in Georgia have been described since SWAP (2005), and keys to *Dichantherium* and *Rhynchospora* much improved by Richard LeBlond in Weakley's revision of his on-line flora ([Flora of the Southern and Mid-Atlantic States](#)).

### **Old Priority 7. Promote markets for the use of native species.**

Wildlife Division Biologists have gained valuable insight and developed protocols for the use of native plant species, through the Private Lands Program (PLP), habitat restoration and management of public lands by WRD biologists, and through collaborations and partnerships with other organizations, such as the NRCS, Georgia Exotic Pest Plant Council (GAEPPC), Georgia Plant Conservation Alliance (GPCA), and the Georgia Native Plant Society (GNPS). The use of native plants is inextricably linked to the eradication/control of invasive plant species, and the identification of suitable alternatives for agriculture, horticulture, and erosion control. The GAEPPC has worked to develop a list of alternatives, as has the GNPS. The NRCS and the GPCA actively restore habitats (both large, general-vegetation acreage and small rare plant communities) using native species. These activities are, in turn, helping to increase the markets, both demand for and supply of native species.

The Protected Plants of Georgia can be propagated and sold with proper documentation and permitting. The Plants Technical Team has many horticultural and nursery representatives who promote the use of native plants. Several gardens now feature native plants, especially butterfly gardens and GADNR botanists are involved with recommending native host plants and nectar

sources. Recently many of our native plants, including some rarer ones that propagate well and exhibit favorable garden qualities, are being grown at a new facility at the State Botanical Garden in Athens called the Mimsie Lanier Center for Native Plant Studies is a research, education and plant production center that propagates native Georgia plants for habitat restoration, endangered species recovery and introduction to the gardening community. There is also the Georgia Native Plant Initiative, formed in 2010 that the State Botanical Garden coordinates to bring together commercial growers, horticultural scientists, land managers, landscape architects and restoration ecologists. By working together Georgia's plant conservationist are helping to make some of Georgia's attractive native plants available in the trade. The GADNR botanists rely on botanical gardens and native plant nurseries to propagate high priority plants for habitat restoration and other safeguarding activities.

### **Old Priority 8. Restore mountain bog habitats.**

Mountain bogs are one of the most critically endangered habitats of the Southern Appalachians. The bogs are typically small – from a half-acre to 5 acres – and usually associated with seeps, springs and small creeks. These are early successional habitats that support a variety of unique and imperiled flora and fauna, including the federally threatened bog turtle (*Glyptemys muhlenbergii*) and swamp pink (*Helonias bullata*), possibly the state's rarest reptile and plant species, respectively. Other exceptionally rare and state-protected mountain bog plants include the montane purple pitcher plant (*Sarracenia purpurea* var. *montana*), which has been petitioned for federal listing, Carolina bog laurel (*Kalmia carolina*), Canada burnet (*Sanguisorba canadensis*) and Cuthbert's turtlehead (*Chelone cuthbertii*).

For 22 years, the Nongame Conservation Section (NCS), working independently and as a member of the Georgia Plant Conservation Alliance (GPCA), has engaged in mountain bog restoration. Restoration is on-going at 8 bogs in Rabun and Union counties. The restoration focus is on manual woody competition removal, small scale "hydro-engineering", invasive species removal, introduction of prescribed fire at both landscape and bog-proper levels, and reintroductions of rare flora. Mountain Bog restoration within NCS is largely a collaboration between botanists and herpetologists. For additional SWAP accomplishments and issues, see priority actions related to bog turtles and mountain bog restoration in the Reptile and Amphibians Technical Team Report.

A cornerstone of the mountain bog restoration program is the propagation and outplanting of rare mountain bog plants. More than 5,000 individuals of five rare-plant species have been propagated during the last 20 years. During the last 10 years over 1,000 individual plants have been outplanted (*in situ*) into appropriate habitats. The remaining plants are in conservation holdings (*ex situ*) at GPCA gardens. Seedling recruitment has been documented for swamp pink and purple mountain pitcherplant at three restored bogs – this includes an F2 generation (*i.e.*, grandchildren) in, at least, one bog.

In 2007, the GPCA obtained a Wildlife Action Opportunities Fund (WAOF) Grant from the Wildlife Conservation Society and Doris Duke Foundation. DNR biologists were instrumental in securing this grant. Funds were used, in part, to: a) hire a GPCA Mountain Bog Program Coordinator; b) expand the pace of mountain bog active management/restoration; c) assist in the ground-truthing of 330 potential montane wetland sites identified from a GIS survey prepared by

the Natural Resources Spatial Analysis Laboratory (NARSAL) of UGA; and d) contract a detailed (6-inch contour interval) topographic site survey of a portion of Hale Ridge Bog, a necessary first step in the restoration of this bog, which is in need of substantial hydrologic repair.

In 2013, Georgia acquired a new partner in mountain bog restoration, the Bog Learning Network (BLN). The BLN, modeled after the highly successful Fire Learning Network (FLN), is an association of state and federal agencies, NGOs, academicians, and private consultants and land managers who have some responsibility for or interest in mountain bogs. Their mission is to help advance the stewardship and management of Southern Appalachian bogs (GA, NC, SC, TN, VA) by providing a forum for sharing information and resources. Its creation reflects a heightened regional interest in mountain bog conservation and restoration, which includes the recent proposal to create a Mountain Bogs National Wildlife Refuge. Nongame Conservation Section staff was invited to serve on the steering committee of the BLN.

### **Old Priority 9. Conduct surveys for species historically recorded in the state.**

Many globally rare species have only historically been recorded in the state; they have not been seen since prior to the mid-1990s. The standard time since the last observation is 20 years (20-25 years is also practical) for a plant to be assigned a rarity rank of “SH” (State Historic). Consequently, it is imperative that surveys and herbarium work be conducted to assist in locating populations, documenting their abundance and condition, and begin collecting landowner information to initiate conservation measures. Some progress has been made in relocating Georgia’s “Lost Plants.”

Table 1 was prepared to include plants with the state rarity rank of SH. This is a list of plants not seen within the recent past – usually within the last 20 years, or since about the mid-1990s. No conservation action can be taken on the SH plants until they have been relocated. At that time they will be considered high priority species.

Since SWAP (2005) important rediscoveries have been made. Some representative rediscoveries of SH plants made since SWAP (2005) are listed below with notes on ecoregion of occurrence and habitat.

- *Agalinis decemloba*, Ten-lobed purple foxglove – Southwestern Appalachians; grassy openings in Virginia pine/scarlet oak forest over sandstone
- *Agalinis georgiana*, Georgia purple foxglove – Southeastern Plains; well-managed, longleaf pine/wiregrass woodland
- *Carya laciniosa*, shellbark hickory – Ridge and Valley; bottomland hardwoods
- *Clintonia borealis*, bluebead lily – Blue Ridge; northern hardwood forest bordering a boulderfield
- *Crataegus aemula*, Rome Hawthorn – Ridge and Valley; opening in calcareous flatwoods
- *Crataegus dispar*, Aiken Hawthorn – Piedmont; xeric, mixed oak-hickory-shortleaf pine forest edge

- *Delphinium alabamicum*, Alabama larkspur – Ridge and Valley; shale barrens with sparse redcedar and dense *Cheilanthes lanosa*, hairy lipfern. Note: Habitat newly classified as a G1
- *Dichanthelium hirstii*, Hirst Brothers' Panic Grass – Southeastern Plains; wet savanna in seasonal depression pond
- *Lonicera canadensis* – Blue Ridge; rocky, forested, north-facing slope at head of cove hardwood forest
- *Parnassia grandifolia* – Blue Ridge; open seep over serpentine.
- *Ruellia noctiflora*, Night-Blooming Wild Petunia - Southern Coastal Plain; mowed roadside and powerline rights-of-way surrounded by remnant slash pine flatwoods.

### **Old Priority 10. Provide incentives to conserve imperiled plants and habitats.**

This priority action item was recognized as a genuine need in the mid-1990s. In 1999, WRD created the Private Lands Program (PLP) through new initiatives and consolidating existing forestry and wildlife stewardship incentive programs. The numerous programs under the PLP “umbrella” (e.g., Bobwhite Quail Initiative, Forestry Stewardship Program, and Forestry for Wildlife Stewardship Program) also provided funding to support wildlife biologists to administer these programs. A useful public document, entitled “A Landowners Guide to Conservation Incentives” was produced (currently in its 4th Edition [2010]). A central feature of the PLP was, and is, the plethora of Farm Bill programs promoting land protection, management, restoration, and stewardship. Another significant development was the passage of the Georgia Land Conservation Act (2005) establishing the Georgia Land Conservation Program (GLCP). The GLCP works to preserve a statewide network of land and water resources by promoting partnerships between cities and counties in Georgia, state and federal agencies, landowners, and other private sector partners.

The NCS biologists supported this effort by conducting plant and vegetation surveys, providing technical support to PLP biologists, and promoting the program during the performance of their duties throughout the state, especially when interacting with private landowners.

## **Part 2**

### **Updated and New SWAP (2015) Plants Technical Team Priorities**

#### **Priority 1. Continue to build the Georgia Plant Conservation Alliance; expand and enhance the rare plant safeguarding program.**

The Georgia Plant Conservation Alliance (GPCA) is an innovative network of 36 public gardens, government agencies, academic institutions, utility companies and environmental organizations committed to preserving Georgia’s endangered flora. Formed in 1995, with DNR as a charter member, GPCA initiates and coordinates efforts to protect natural habitats and endangered species through biodiversity management, public education, and rare plant safeguarding.

The GPCA has experienced tremendous growth during the last decade. Growth can be seen in the areas of institutional membership, programmatic scope, volunteer network, and resources contributed by member institutions. Institutional membership has doubled, and member

institutions are engaged in recovery projects for nearly 80 imperiled plant species. Over 60 of these are in safeguarding programs at botanical gardens, arboreta and seed banks, with close to 50 species being successfully introduced back into the wild. Monetary and in-kind contributions by GPCA member institutions have amounted to an estimated \$1.5 million in direct and indirect support for plant conservation since its inception. More than \$1.1 million of this was supplied by non-DNR members supporting high-priority species and habitats identified in the SWAP (2005). A significant portion of the contributions have come from the trained GPCA volunteer force known as Botanical Guardians, now numbering in excess of 140, and contributing more than 2,000 hours of conservation work during the last calendar year. The NCS staff has been instrumental in building both the GPCA as an organization, and in building the safeguarding program as a conservation strategy/approach. The NCS resources provided in support of the GPCA and plant conservation were leveraged substantially by GPCA partners (about 5:1).

The growth of the GPCA should continue to be supported robustly with staff resources. Additionally, the continuing development of the GPCA Safeguarding Database (maintained by the Atlanta Botanical Garden) should be supported. The database is designed to keep track of the *ex situ* collections of all GPCA propagation partners, and the *in situ* outplantings across the state. It contains inventory, location, monitoring and survivorship data, and is linked to an ArcGIS geospatial database complementing the Biotics and NatureServe databases. Lastly, some degree of funding support should be provided periodically for GPCA member institutions involved in rare plant propagation, especially for NCS-initiated plant conservation projects.

**Priority 2. Conduct statewide assessment of significantly rare natural communities; provide staff to adequately populate the conservation database with natural community data.**

The conservation database used by GADNR, Nongame Conservation Section staff contains nearly 6,400 site records for rare plants, but is lacking in detailed data for natural communities. Lacking a full-time vegetation ecologist, the GADNR is handicapped and a serious effort should be made in hiring a full-time vegetation ecologist. Since SWAP (2005), a significant step forward in describing natural communities accessible to the public was taken. The 675-page book entitled *The Natural Communities of Georgia* was published in 2013. Botanists continue to discover unique natural communities, inventory known ones, and rely on outside. Some of these have been recently described using the ecological framework developed by NatureServe. Although there are coarse land cover analyses for Georgia, none have thoroughly assessed many of the rarer (fine-scale) natural community types.

**Priority 3. Develop Element Occurrence Rank specifications and use the Conservation Rank Calculator for revamping state rarity ranks.**

The specifications used to determine the overall quality of a rare plant occurrence can be detailed using methodology developed by NatureServe. In this way, states consistently rank occurrences and the better ones can be prioritized for further conservation action. Some of Georgia's special plants need to have specifications developed. This is particularly important for species that are either endemic to, or primarily within Georgia. Element Occurrence Ranks are much needed by the conservation community in order to prioritize conservation efforts. Numerous metrics (*e.g.*,

population size, viability, habitat protectability and condition, etc.) would have to be field-assessed.

The Conservation Rank Calculator is a tool that automates the process of assigning a conservation status rank – an evaluation of the level of risk of extinction of a species, in other words, the use of state rarity ranks. Rarity ranks are used to establish priorities with the rarest species assigned a conservation status or rarity rank of S1 (at the state level) or G1 (at the global level). The most common species are ranked S5 (at the state level) or G1 (at the global level). The Conservation Rank Calculator is used extensively by NatureServe and its member programs and collaborators that collect and evaluate data for species and ecosystems of concern using a common methodology. The Rank Calculator tool facilitates the accurate application of this methodology and promotes greater accuracy and consistency of the assessments. The Rank Calculator tool has not yet been applied to Georgia's plants.

#### **Priority 4. Continue to conduct surveys for nonvascular species.**

One of the groups of plants least understood are the nonvascular plants, including bryophytes (mosses, liverworts, hornworts) and lichens. Little is known about Georgia bryophytes, especially concerning distribution, habitat requirements, and abundance. Some recent surveys were for rare liverworts and hornworts, such as headwaters hornwort, *Megaceras aenigmaticus* (*Nothoceras aenigmaticus*) and a suite of gorge liverworts. Special habitats, such as Altamaha Grit outcrops have had preliminary bryophyte and lichen surveys. All of these surveys generally result in state records and occurrences for regionally important nonvascular plants. One example is the state record Florida pygmy moss, *Eccremidium floridanum*, found on exposed, seepy, sandstone-like outcrops of Altamaha Grit. Florida pygmy moss is ephemeral and diminutive, but seems to be a quality habitat indicator of seepy outcrops in the vicinity of other plants of conservation concern. The Altamaha Grit outcrops are nearly unique to Georgia, with perhaps one outlier known from panhandle Florida. Such distinctive habitats and the diverse physiography of Georgia, strongly indicate that Georgia has important nonvascular plant diversity that needs to be documented. Rarity ranks and element occurrence data are needed for nonvascular plants of significance.

Lichens may be better known in Georgia due to volunteer efforts and county record distribution efforts of Malcolm Hodges, Sean Beaching, and Bill Buck. There needs to be an attempt to assign rarity ranks to significant lichens. Also, website resources need to be supported to promote knowledge of county distributions. The federally listed rock gnome lichen, *Gymnoderma lineare*, known from one high quality rock cliff in the Blue Ridge, is in need of further protection efforts. The face of the rock cliff supports numerous vascular plants of significance, but additional nonvascular plant inventory is justified.

Second, is the state record Florida pygmy moss, *Eccremidium floridanum*. Florida pygmy moss is ephemeral and diminutive, but seems to be an good indicator of seepy outcrops in the vicinity of other plants of conservation concern. The Altamaha Grit outcrops are mostly in Georgia, with perhaps one outlier known from panhandle Florida. Conservation actions are being put into place on newly acquired state lands and exemplified already at the Broxton Rocks Preserve, Coffee Co.

**Priority 5. Assess the conservation status of selected wetlands, especially the isolated wetlands, including the sag ponds of Northwest Georgia, and, the limesink depression ponds of Southwest Georgia.**

There are a variety of wetlands in Northwest Georgia (e.g., sag ponds, fens, seeps, spring runs, calcareous flatwoods) that support several rare plant species and communities. These wetland habitats need adequate surveys and appropriate conservation attention. An even less explored area is on the Dougherty Plain, part of the Southeastern Plains ecoregion of Southwest Georgia. Literally 100s of isolated limesink depression ponds exist in this region and dozens need to be thoroughly explored during the entire growing season. Over 25 rare vascular plants are known to inhabit seasonal ponds on the Dougherty Plain. Most lack recent information and it is likely that a few state records and range extensions will be encountered.

Extensive pre-planning using the latest aerial photography and soils data will help select suitable ponds for exploration. Preliminary field surveys confirm that appropriate surveys needs to be conducted throughout the growing season and that each pond has its own seasonal variation in water depth, may or may not have adequate drawdown zones, and variable light conditions due to fire suppression, lowering of the water table, or other disturbances. In the case of Hirst Brothers' panic grass (*Dichanthelium hirstii*), a federal Candidate recently relocated in a pond habitat in Sumter Co., the common maidencane (*Panicum hemitomon*) can overcome the rare grass, shading it out of existence. Furthermore, it appears that fire, often recommended as a management tool for curtailing woody plant invasions in ponds (e.g., establishment of pondcypress thickets in seasonal pond/wet savanna habitats), may increase maidencane to the point of seriously impacting some of the pond rarities. If significant pond vegetation is discovered, management needs will have to be addressed.

These wetland communities are currently under increased threat due to residential and commercial development, pond construction, intensive agricultural demands for water, conversion of hardwoods to planted pine plantations and anything disrupting hydrology. It is important to generate fine-scale GIS coverages (maps) and natural community and rare plant records for the conservation database (Biotics). Also, the number, size and condition of target habitats including an assessment of hydrology, plant communities, threats, conservation opportunities, and ownership are needed.

**Priority 6. Continue restoration of mountain bog habitats.**

A major accomplishment since SWAP (2005) has been the restoration of selected mountain bog communities. Efforts to reintroduce, augment, or establish rare plant populations must continue. These efforts should work in conjunction with restoration efforts for the bog turtle. Mountain bogs have been historically neglected from a stewardship perspective resulting in the decline or disappearance of many signature species. Restoration of bog habitats would include reduction of woody cover, expansion of *Sphagnum* mats, establishment and augmentation of rare species populations, and restoration of natural hydrology.

**Priority 7. Conduct surveys for species historically recorded for Georgia.**

Many globally rare species were historically recorded in the state, but have not been observed for 20 or more years and are in need of current status surveys. Consequently, it is imperative that surveys and herbarium work be conducted to assist in locating populations, documenting their abundance and condition, and begin collecting landowner information to initiate conservation measures. Eventually, those found can be evaluated further and may become high priority plants for research and additional conservation actions. Examples of State Historic (SH) plants are given in Table 1. These plants can be popularly termed Georgia's Lost Plants and information distributed to the public.

**Priority 8. Identify rare plant populations seriously threatened by invasive exotic species, develop prompt and effective responses; act to eliminate or moderate threats.**

Most of the concern, discussion, and focus regarding invasive species usually involve broad-based, landscape-level planning, research, and management schemes. While this macro-approach is appropriate for addressing the larger problem, and building coalitions, enacting legislation, changing public policy, and driving market-based solutions, it tends to ignore problems associated with small sites and/or those in need of an urgent response. In those instances where the focus is on a small sites requiring an urgent response, it is because the invader is one for which there is zero tolerance, such as cogongrass (*Imperata cylindrica*). In this situation, the Georgia Forestry Commission (GFC) will attack any size infestation within 72 hours of discovery and repeat-treat until the infestation is ruled to be eliminated. An aquatic example would be the Asian northern snakehead fish (*Channa argus*), where zero-tolerance is based on the nature of the perpetrator rather than on the imminent threat to potential victims.

Rare plant populations are particularly at risk due to the sessile nature of plants, as well as the low number of individuals and other conditions (genetics, physiology, life history, ecological niche) associated with their rarity. A rare plant population, or an entire rare plant site containing numerous rare plant species, could potentially be destroyed within a few years when under assault by a suite of invasive species. They could certainly be extirpated in less than a decade (before the next SWAP revision in 2025). One example would be the beech-magnolia hardwood forests and ravines along the Flint River at Montezuma Bluffs WMA, where some portions of lush understory that includes relict trillium (*Trillium reliquum*) and ovate catchfly (*Silene ovata*) near an abandoned trailer park are rapidly succumbing to competition and shading from English ivy (*Hedera helix*), Japanese honeysuckle (*Lonicera japonica*), Chinese privet (*Ligustrum sinense*), and Kudzu (*Pueraria montana*).

In a situation involving marauding feral pigs, extirpation could potentially happen in the time span of a few days, depending on the circumstances. The range of feral pigs in Georgia has increased by nearly 5-fold in the last 30 years. A conservative estimate of the feral hog population in the U.S. is between 5-10 million animals. Annually, these swine account for environmental and agricultural losses of \$1.5 billion across the country. In sites along Big Grocery Creek in the Oaky Woods WMA, hogs are vigorously rooting and causing great damage to the rich assemblage of spring ephemerals associated with the limestone bluffs and floodplain.

Within the last two years, more and more invasions of the unique blackland prairies of Oaky Woods have been observed and wild pig encounters are increasing.

Certain populations and sites are so special and contain such rarities as to require immediate corrective action. Sites known to be under imminent threat should be quickly evaluated and a management approach decided upon. Management action should proceed quickly. Rare plant sites impacted by invasive animal species may require the assistance of other sections within the GADNR Wildlife Resources Division (e.g., Game Management and Fisheries). Additionally, the Nongame Conservation Section will survey other special rare plant populations suspected of being at risk from invasive species. If found to be under imminent threat, they will receive the same expeditious evaluation and treatment mentioned above.

**Priority 9. Assist the U. S. Fish and Wildlife Service with data collection and implementation of the Conserving At-Risk Species Program.**

In the next 10 years the USFWS (SE Region) will evaluate a record number of species for possible listing under the Endangered Species Act (ESA). This is partially a result of successful petitioning for these evaluations by outside public interest groups (Center for Biological Diversity and Wild Earth Guardians). It is the desire of the USFWS not to list these species, but rather to engage in proactive conservation, with public and private partners, that is both voluntary and innovative, thereby precluding the need to list them under the ESA. The five action areas of the Conserving At-Risk Species Program include: (1) prioritizing “at-risk” species for pro-active conservation needs; (2) developing voluntary conservation actions that can be taken; (3) building partnerships with state and other federal agencies; (4) collecting data for listing decisions; and, (5) engaging in outreach to individuals, NGOs, and Congressional staffers.

The Nongame Conservation Section staff will help prioritize at risk species by identifying data gaps and unknowns involving species distribution, population, conservation status, and threats. They will also help determine those species that are “decision-ready” and which are appropriate for pro-active conservation. In the case of data gaps and unknowns, they will conduct status surveys of populations and update the Biotics database accordingly. They may also be asked to provide expert opinion regarding proposed USFWS actions/decisions. They will also assist with the development of practical and biologically appropriate pro-active conservation actions. One of these actions may be the development of a Candidate Conservation Agreement (CCA). See next priority action item.

**Priority 10. Assist the U. S. Fish and Wildlife Service with the development of Candidate Conservation Agreements (CCAs) for selected plants of conservation concern; maintain active monitoring and management of plants already covered by established CCAs.**

Candidate Conservation Agreements (CCAs) and Candidate Conservation Agreements with Assurance (CCAAs) are two specific instruments for pro-active conservation. CCAs are voluntary conservation agreements between the USFWS and one or more public or private parties. The Service works with its partners to identify threats to Candidate species, plan the measures needed to address the threats and conserve these species, identify willing landowners, develop agreements, and design and implement conservation measures and monitor their

effectiveness. CCAAs expand on the concept of traditional CCAs by providing non-federal landowners with additional incentives for engaging in voluntary proactive conservation through assurances that limit future conservation obligations.

A recent example of a CCA with significant involvement from GADNR staff involved the Georgia aster (*Symphyotrichum georgianum*). In 1999, the USFWS made the Georgia aster a Candidate for listing under the Endangered Species Act. The Georgia aster remained on the list for 15 years as the USFWS applied its resources to higher priority species. During this interim, state agencies and conservation organizations continued to survey for new populations and to work on the conservation of the species. In 2014, the USFWS determined listing was not necessary if precluded by a broad-based, range-wide, pro-active conservation plan (i.e., CCA). Georgia DNR was a major contributor to the development of the agreement and to consensus building among the disparate partners across four states (AL, GA, NC, and SC). In particular, Nongame Conservation Section (NCS) staff developed the management approaches and monitoring protocols.

NCS will continue to assist the USFWS with development of CCAs (and CCAAs) for species whose range includes Georgia, and for which these conservation instruments are biologically and ecologically appropriate.

#### **Priority 11. Continue to expand the knowledge base and use of native plants.**

Wildlife Resources Division biologists will continue to improve the state of restoration science using native plants through DNR's many restoration and management initiatives/activities. WRD will continue to work with important partners and collaborators, such as the Natural Resources Conservation Service (NRCS), Georgia Exotic Pest Plant Council (GAEPPC), Georgia Plant Conservation Alliance (GPCA), and the Georgia Native Plant Society (GNPS) to identify native species that could be used in lieu of invasive species for purposes of controlling erosion, landscaping, gardening, etc. There are several native plant nurseries and gardens in Georgia where collaboration is encouraged. GADNR staff presents educational programs, provides permits to sell propagated rare plants and rescued plants, collects seed, and otherwise suggests appropriate native plants for cultivation. Noteworthy efforts are undertaken by several GPCA members, including commercial nurseries, experimental gardens (e.g., Georgia Perimeter College, Decatur; Chattahoochee Nature Center, Roswell; Atlanta Botanical Garden) and the new research propagation facilities at the Mimsie Lanier Center for Native Plant Studies, State Botanical Garden, Athens.

#### **Priority 12. Assist the Private Lands Program biologists with technical support and outreach to private landowners owning significant botanical sites.**

The Nongame Conservation Section (NCS) botanists will continue to support the Private Lands Program (PLP) and PLP biologists with technical botanical assistance focusing on general vegetation and rare plant communities, as well as rare plant species information. NCS botanists will continue to promote the various aspects of the PLP, numerous Farm Bill programs (e.g., EQUIP, WHIP, CRP, and PFW), and other options (e.g., conservation easements, GA Conservation Tax Credit Program, and CUVA) to private landowners throughout the state. They

will work with the WRD/NRCS Contribution Agreement biologists located in USDA offices to provide outreach regarding the need and potential cost share for conserving rare and declining habitats and plant species. The NCS botanists will assist with botanical training for PLP biologists, NRCS biologists, and landowners, as needed. The NCS botanists will actively promote important sites that deserve permanent protection from development.

Collaboration with land trust organizations and other GADNR staff involved with real estate issues is becoming more and more essential if rare plant habitats are to be conserved. GADNR should consider full support of a biologist whose primary purpose is to work with private landowners to find conservation incentives and protection alternatives for isolated populations of high priority plants for which acquisition is not likely. Small sites, often the last stand for rare plants, need attention as well as large hunting areas and parks. The role of organizations such as The Nature Conservancy in acquisition of small sites (areas under 500 acres down to 10 acres or less) has dramatically decreased over the last decade. The need for land trusts and other holders of conservation easements for botanical sites must be promoted.

In general, imperiled plants require specific habitat management and, as a consequence, their enhancement and protection should become a part of most programs that fund habitat improvement. Habitat management incentives should at least indirectly serve to conserve known sites of botanical significance. Landowners have responded resoundingly to the availability of incentives for conservation practices. There are incentives to help conserve imperiled habitats and species, but more attention must be placed on protection alternatives for isolated populations of high priority plant species for which acquisition may be the only option for permanent protection.

## Appendix I. Habitat Restoration Technical Team Report

### Table of Contents

Achieving SWAP Objectives Over the Last Ten Years, Shan Cammack .....	3
State-Wide Initiatives.....	4
Georgia Prescribed Fire Council, Mark Melvin Invasive Species Efforts, Eamonn Leonard and Karan Rawlins Interagency Burn Team, Jimmy Rickard	
State Agencies.....	30
Department of Natural Resources 50 Year Plans in Wildlife Resources Division, Don McGowan and Matt Payne DNR Prescribed Fire Program, Shan Cammack Spotlights on Conservation, Wildlife Resources Division staff Oyster Restoration and Enhancements, Coastal Resources Division staff Working Farms and Forestlands, Reggie Thackston and James Tomberlin Private Lands Program Summary, Eric Darracq Resource Management in State Parks Division, Sim Davidson and Brian Nichols	
Georgia Forestry Commission Prescribed Burning in Georgia, Neal Edmonson Private Lands Programs, Scott Griffin	
Federal Entities .....	61
Department of Defense (DOD) Update on DOD Installations, Tim Beaty and Contributors	
National Park Service (NPS) Cumberland Island National Seashore, Doug Hoffman	
National Resources Conservation Service (NRCS) SWAP Objectives and Accomplishments, Sharon Holbrooks	
US Army Corps of Engineers (USACE) Update on USACE Projects, Ellie Covington	
US Fish & Wildlife Service (USFWS) Update on USFWS, Robin Goodloe and Carl Schmidt	
US Forest Service (USFS) Update on Chattahoochee-Oconee National Forests, Jim Wentworth	
Non-Governmental Organizations .....	87
Georgia Plant Conservation Alliance, Lisa Kruse and Contributors The Longleaf Alliance, Randy Tate The Nature Conservancy Habitat Restoration Over the Past Decade, Malcolm Hodges and Erick Brown	
Habitat Restoration and SWAP: Looking Ahead, Shan Cammack and Eamonn Leonard .....	97

## Technical Team Members

The following people served on the Habitat Restoration Technical Team. Several of these people had served on the original SWAP HRTT chaired by Shan Cammack, including Tim Beaty, Neal Edmonson, Malcolm Hodges, Nathan Klaus, and Jim Wentworth. This provided solid continuity and a longer range vision in the whole process.

### *Team Leaders*

Shan Cammack, Department of Natural Resources, Natural Resources Biologist II  
Eamonn Leonard, Department of Natural Resources, Natural Resources Biologist

### *Team Members*

Tim Beaty, Department of Defense, Chief, Fish and Wildlife Branch  
Erick Brown, The Nature Conservancy, Land Steward, Fire Manager  
Sim Davidson, Department of Natural Resources, Resource Manager  
John Doresky, Supervisory Biologist, US Fish & Wildlife Service  
Neal Edmonson, Georgia Forestry Commission, Prescribed Fire Program Manager  
Chris Goodson, Georgia Department of Transportation, Senior Ecologist  
Scott Griffin, Georgia Forestry Commission, Staff Forester  
Rob Hicks, Plum Creek, Senior Resource Forester  
Malcolm Hodges, The Nature Conservancy, Director of Stewardship  
Sharon Holbrooks, NRCS, Natural Resource Specialist  
Nathan Klaus, Department of Natural Resources, Natural Resources Biologist II  
Gail Martinez, US Fish & Wildlife Service, Wildlife Biologist  
Joe McGlincy, Consultant, Wildlife Biologist  
Matt Payne, Department of Natural Resources, Program Manager, Forestry Management Unit  
Karan Rawlins, University of Georgia, Invasive Species Coordinator  
Carl Schmidt, US Fish & Wildlife Service, Supervisory Forester  
Karen Sughrue, US Fish & Wildlife Service, Environmental Contaminants Specialist  
Randy Tate, Longleaf Alliance, Ft. Stewart/Altamaha Longleaf Partnership Coordinator  
Reggie Thackston, Department of Natural Resources, Private Lands Program Manager  
Shane Wellendorf, Tall Timbers Research Station and Land Conservancy Conservation, Coordinator  
Jim Wentworth, US Forest Service, District Wildlife Biologist

## Approach

A Habitat Restoration Technical Team (HRTT) was assembled to pull expertise from across the state representing agencies with major management responsibilities. Members reviewed materials on the original State Wildlife Action Plan (SWAP), attended a Technical Team meeting in December 2013, and prepared a chapter on habitat restoration for the SWAP revision.

The team was tasked with the following:

- review the relevant chapters and spreadsheet on threats from the original SWAP and determine if threats have changed significantly in the last ten years,
- review the Recommended Actions and Strategies and assess how well these have been addressed,
- determine which recommendations were implemented and which areas were not addressed,
- summarize the progress made on these issues and on the priority conservation strategies, and
- expand on and include more special sections (i.e. Coastal Invasive Species Management Area, Georgia Prescribed Fire Council, Longleaf Alliance Initiative, Forest Action Plan, Natural Resources Conservation Service).

The Team worked together from October 2013 to present. Much of the discussions and contributions were made electronically. The Technical Team members convened on December 10, 2013 at the Charlie Elliot Wildlife Center. Attendees presented briefly on how they have used the SWAP over the last 10 years and how they foresee its application over the next decade. Discussion was facilitated by Shan Cammack and Eamonn Leonard. Discussion points focused on HRTT tasks needed to revise the SWAP, including management needs, recommendations for future management approaches, revisiting the previously defined 25 habitat stressors, and examining the new natural environments of Georgia habitat names to determine the need to crosswalk past SWAP names to this scheme.

The following recommended actions and strategies were specifically addressed at the meeting:

- altered fire regimes,
- altered hydrology and water quality,
- habitat protection,
- reduction of development impacts,
- incompatible recreation,
- improved management practices,
- combatting invasive and alien species, and
- facilitating monitoring.

The following conservation goals and strategies were also a focus of discussion: wildlife conservation on private lands, wildlife conservation on public lands, conservation of high priority habitats and species, and reducing the impacts from development and other incompatible activities. Following the face to face meeting, communications continued through e-mail. HRTT interacted with several of the other SWAP teams on a number of high priority issues.

This chapter provides information collated from HRTT members and other contributors to highlight the management work across the state of Georgia that has occurred in the last ten years that supports SWAP objectives.

**ACHIEVING SWAP OBJECTIVES  
OVER THE LAST TEN YEARS  
Shan Cammack (GA WRD)**

The HRTT for the original SWAP defined high priority habitats by ecoregion, assessed problems affecting high priority habitats in each ecoregion, and identified habitat restoration techniques and strategies to address these problems. The current HRTT determined that these things have not changed significantly over the past ten years. Therefore the focus of this chapter is on upland management activities that have addressed SWAP objectives. Of the basic management needs that were identified in the original SWAP, the highlighted items to the right are the core of this chapter.

<b>Management Needs</b>
<b>restoring fire</b>
restoring hydrology
<b>controlling invasives</b>
<b>restoring natives</b>
protecting from disturbance
<b>vegetation management</b>

The following Recommended Actions and Strategies were identified in the original SWAP. A number of these have been addressed by different agencies state-wide and are discussed in this chapter.

<p><b><i>Address Altered Fire Regimes</i></b></p> <ul style="list-style-type: none"> <li>• Develop partnerships among agencies to increase capacity to conduct prescribed burning and to identify priority areas in need of better fire management (appropriate timing and frequency)</li> <li>• Continue support of the Interagency Burn Team</li> <li>• Work with private landowners to encourage prescribed burns in fire-adapted habitats through technical assistance and incentive programs</li> <li>• Establish NWCG (National Wildfire Coordinating Group) certification standards for all state and federal practitioners</li> </ul>
<p><b><i>Encourage Improved Management Practices</i></b></p> <ul style="list-style-type: none"> <li>• Work with USFS, NPS, USFWS, and other public land managers at multiple levels to improve habitat management on all public lands, emphasizing restoration and maintenance of natural habitats and addressing regional conservation</li> <li>• Couple habitat management and educational outreach programs on public and private conservation lands to provide the public with examples of sound stewardship for all wildlife resources</li> <li>• Work with NRCS to promote the planting of native species through Farm Bill programs.</li> <li>• Improve public familiarity with and use of BMPs for agriculture, forestry, and land development practices</li> <li>• Engage local, regional, and state stakeholders to promote better land use and water use planning</li> </ul>
<p><b><i>Combat Invasive/Alien Species</i></b></p> <ul style="list-style-type: none"> <li>• Work with gardening groups, nurseries, and major retail corporations to reduce importation of invasive exotic species</li> <li>• Promote education about exotic species, including identification, effects, and eradication measures</li> <li>• Work with land management agencies to initiate integrated control measures that focus on early detection and eradication of alien</li> </ul>

# Statewide Initiatives

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## **Georgia Prescribed Fire Council** **Mark Melvin (Ichauway)**

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The Georgia Prescribed Fire Council (GPFC) was established in 2001 to promote the use of prescribed fire and to encourage information and technology exchange between fire practitioners, policymakers, and the public. Led by a diverse group of agencies, organizations, and land owners, it grew quickly from a Southwest Georgia initiative into a statewide organization. GPFC promotes a unified message from all prescribed fire practitioners: *prescribed fire is a safe way to apply a natural process, ensure ecosystem health, and reduce wildfire risk.*

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combatted Invasive/Alien Species</i>

The GPFC works cooperatively with stakeholders to address issues ranging from education and training to policy and air quality. With support from the Georgia Forestry Commission, the council led an effort in 2007 that resulted in 157 of 159 Georgia County Commission Boards signing a proclamation supporting the use of prescribed fire. One of the key elements identified in the proclamation document was support of prescribed fire as a high priority in the SWAP. The Governor was presented with a copy of every signed proclamation in the capital during Prescribed Fire Awareness Week (PFAW) the following year. PFAW is an initiative that the council helped develop along with other partners as a platform to bring legislative recognition to the importance of prescribed fire as a natural resource management tool. The annual event also provides an opportunity to engage the media and educate the citizens of the state.

In 2007, the GPFC was presented with the “Pulaski Award” by the Fire Director from the National Association of State Foresters. This traveling award is given annually by the National Interagency Fire Center Directors to a fire organization that demonstrates excellence in fire management. The GPFC has also played a key role in improving collaboration and communication between the fire community and air quality regulators. The council was identified as the primary stakeholder to assist GA EPD and GFC in developing Georgia’s Smoke Management Plan that was formally accepted by EPA. Following the city of Atlanta being impacted from two large prescribed burns north of Macon, two members from the GPFC sat on a six person After Action Review Panel investigating the incident. As a result, GFC instituted a new policy that informs communities in the vicinity of prescribed fires over 1,000 acres the day they occur.

Today the GPFC serves as the ‘go-to’ organization for prescribed fire in the state. As a founding member of the Coalition of Prescribed Fire Councils, Inc., the GPFC has contributed significantly to the establishment of new prescribed fire councils across the United States. It is important to Georgia’s natural resources that the GPFC remain a strong, viable organization promoting the appropriate use of prescribed fire to maintain and enhance both forest and public health.

## **Invasive Species Efforts**

**Eamonn Leonard (GA WRD) and Karan Rawlins (UGA Bugwood)**

*(Adapted from the Georgia Invasive Species Strategy)*

A tremendous amount of work has been accomplished in the past ten years addressing invasive species issues and awareness of their impacts has been greatly heightened. For the purposes of this chapter, invasive species refers to nonnative species that have been introduced, either intentionally or accidentally, into areas outside their natural ranges and that cause economic or environmental harm or impacts to human health. They are not a new phenomenon. Over the course of human history, over 50,000 nonnative species have been introduced into North America. Many of these species, such as wheat, rice, cattle, and poultry were introduced as sources of food and now provide more than 98 percent of the U.S. food system, valued at approximately \$800 billion per year (Pimentel et al. 2005). Other exotic species were introduced for landscape restoration, biological pest control, sport, or pets.

	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

The introduction of nonnative species has a long history in Georgia. Many of these species were important for early colonists for establishing viable agricultural products. Some of these species were further spread and cultivated by Native Americans. Through the course of history new species continued to be introduced as Georgia became a state. While many significant benefits have resulted from these nonnative introductions, over time, natural, accidental or intentional dispersion of some nonnative species into new environments has resulted in negative effects to the ecological communities of infested areas, or to commercial, agricultural, aquacultural, or recreational activities dependent on these areas. These harmful nonnative species are considered to be invasive species. For a nonnative organism to be an invasive species in the policy context, the negative effects that the organism causes or is likely to cause must outweigh any benefits it may provide.

While nonnative species have historically played an important role in Georgia, two species that exemplify the environmental and economic damage invasive species can have are *Cryphonectria parasitica*, the causative agent of chestnut blight, and the boll weevil (*Anthonomus grandis*). Before 1900, the American chestnut tree (*Castanea dentata*) made up as much as one-quarter of the tree species in the Appalachian forest. In Georgia, chestnuts were particularly prominent in the Cohutta and Blue Ridge Mountains, but were also frequently found in the Ridge and Valley and the Piedmont ecoregions, and on the Cumberland Plateau. The American chestnut played a prominent ecological role in their environment, providing food and shelter to many wildlife species as well as having many economically important uses from ornamental trees to construction and tannin production for the US. leather industry. The chestnut blight fungus entered the U.S. through New York City on Japanese chestnut stock imported as orchard trees in the late 1800s. The infection spread south at the rate of 200 miles every ten years, reaching Georgia in the early 1930s. Nearly every mature chestnut tree within the species' natural range (estimated three to four billion trees) was killed by chestnut blight by the 1940s. Today, American chestnut trees survive by resprouting from surviving root systems in the soil. However, they rarely mature or produce nuts before falling victim to the fungus.

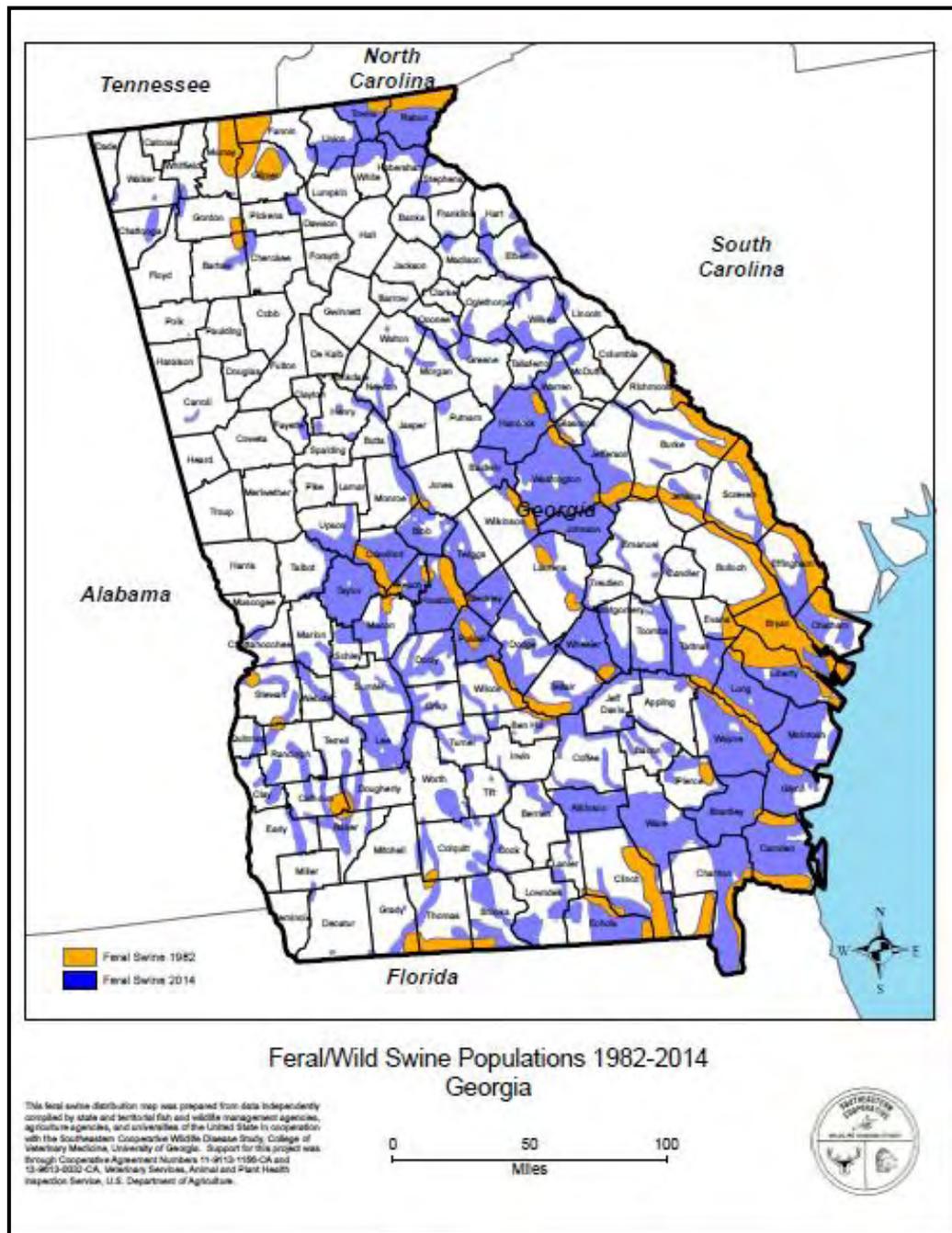
The boll weevil is another invasive species that has had enormous effects on the state. The boll weevil is an insect that feeds on cotton buds and flowers, causing extensive damage to the plant. A native of Central America, the beetle entered Texas in 1892, and reached Thomasville, Georgia in 1915. Subsequently, state cotton production plunged rapidly from a historical high of 2.8 million bales in 1914 down to 600,000 bales in 1923. Total state losses from boll weevil infestation were estimated at \$40 million by 1919. Boll weevil infestation was considered by some to be the biggest disturbance of Georgia's

economy since the end of the Civil War. In 1987, Georgia enrolled in the federal Boll Weevil Eradication Program, a cooperative effort involving USDA, state officials, and cotton growers. Consequently, the boll weevil was eradicated in the state by 1991.

Introduced nonnative species can presently be found throughout the state in each of its five major ecoregions: the Blue Ridge, Cumberland Plateau /Ridge and Valley, Piedmont, Coastal Plain, and Maritime Ecoregions. In the Cumberland Plateau /Ridge and Valley ecoregions, the red shiner (*Cyprinella lutrensis*) is suspected of having a serious effect on the native blue shiner (*C. caerulea*) through competition and hybridization. Invasive species of concern in this region include cogongrass (*Imperata cylindrical*), Japanese climbing fern (*Lygodium japonicum*), Japanese stilt grass (*Microstegium vimineum*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), oriental bittersweet (*Celastrus orbiculatus*), princess tree (*Paulownia tomentosa*), silvergrass (*Miscanthus sinensis*), and autumn olive (*Elaeagnus umbellata*). These species, along with kudzu (*Pueraria montana*), are also a concern in the Blue Ridge ecosystem. Also affecting this ecosystem is the hemlock woolly adelgid (*Adelges tsugae*), which is causing significant losses of eastern hemlock as well as loss of the few populations of Carolina hemlock in the region. Asian clams (*Corbicula fluminea*) and feral hogs (*Sus scrofa*) are examples of invasive animal species of concern in the Piedmont ecoregion. In addition, most river floodplains and valleys in the Piedmont are overrun with invasive plants such as Chinese privet and Japanese stilt grass. Hydrilla (*Hydrilla verticillata*), Japanese climbing fern, feral hogs, Chinese privet, cogongrass, and the Asian clam threaten habitats and species in the Coastal Plain. Finally, the Maritime Ecoregion is facing significant negative effects caused by flathead catfish (*Pylodictis*), feral hogs, Chinese tallowtree (*Triadica sebiferum*), Climbing Fern (*Lygodium japonicum*), water hyacinth (*Eichhornia crassipes*), common reed (*Phragmites australis*), alligatorweed (*Alternanthera philoxeroides*), parrotfeather (*Myriophyllum aquaticum*), giant reed (*Arundo donax*), and the channeled apple snail (*Pomacea insularum*). See the graph below for the significant increase in the feral hog range in the last thirty years. For an overview of the top five invasive species for the entire state in the categories of terrestrial and aquatic plants, terrestrial invertebrates, terrestrial vertebrates, freshwater fauna, and marine fauna refer to table 1 at the end of this chapter. Feral hogs have been particularly damaging and represent the top terrestrial vertebrate invasive species. See the graph below for the significant increase in the feral hog range in the last thirty years. The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) is working on an Environmental Impact Statement (DEIS) evaluating strategies to manage increasing damages and threats associated with expanding populations. The draft document can be found at <http://www.aphis.usda.gov/wildlife-damage/fseis>.

Recently the major land managing agencies that operate within the 11 county coastal regions have organized to form the Coastal Georgia Cooperative Invasive Species Management Area (CISMA). They have gone through a process to develop a priority list of invasive species in the same five categories listed in table 1 but specific to the Coastal Counties (see table 2). A regional approach such as the one the Coastal GA CISMA has undertaken would be helpful in the other ecoregions to reprioritize planning efforts that are more appropriate at the subecoregion scale.

Unfortunately, Georgia also ranks eighth in the number of imperiled species (533 species), and fourth in While most introduced species pose little threat to the environment, invasive species do constitute a significant risk. Invasive species rank second only to habitat destruction as a threat to biodiversity. Almost half of the species in the U.S. that are at risk of extinction are negatively affected by invasive species. Invasive species threaten biodiversity in several ways. They may cause or spread diseases; or act as predators or parasites of native species. Invasive species also affect native species by out-competing them for food and natural resources and/or by altering habitat in such a way that native species can no longer flourish. Finally, invasive species may hybridize with closely related local species so that within a few generations few if any genetically pure native individuals remain. Of the 26 animal species in the



U.S. that have gone extinct since being listed under the Endangered Species Act, at least three were wholly or partly lost because of hybridization with invaders.

The introduction of nonnative species poses a profound threat to the state's biodiversity. Georgia ranks sixth in the nation for overall biological diversity (4,004 species) and twelfth for number of endemic species (58 species). Nationally, Georgia ranks second in amphibian diversity (77 species), third in freshwater fish diversity (268 species), fifth in reptile diversity (83), seventh in vascular plant diversity (2,986 species), seventeenth in bird diversity (328), and eighteenth in mammal diversity (91). number of known or suspected extinctions (24 species), due in part to the introduction and spread of nonnative species. Georgia currently has 239 native species that are in danger of immediate or foreseeable extinction in all or a significant portion

of their range. Seventy-three additional native species occur rarely enough to need protection because of their scarcity.

In addition to environmental harm, invasive species can have large negative economic effects in the areas where they have become established. The costs associated with fire ants in the U.S., for example, have been estimated at \$1 billion/year. In Texas, the agricultural economic losses caused by fire ants are an estimated \$90 million annually. Texas spent at least \$580 million in 2000 to control this insect. Nationally, invasive plant species cause a 12 percent reduction in agricultural crop yields, costing the industry \$24 billion in lost crop production annually. In addition, about \$3 billion a year in herbicides are used to protect U.S. crops from invasive plants. One recent study placed the U.S. benefit of controlling invasive aquatic plant species alone, as being in the billions of dollars. Hemlock woolly adelgid infestations in the eastern U.S. have cost \$9 million for research and suppression as of 2007. Likewise, the cities of New York and Chicago have spent \$180 million to eradicate the Asian longhorned beetle. Nationwide, infestation of this beetle could kill one third of urban trees valued at \$669 billion. Costs can be incurred through the loss of economic output, such as reductions in agriculture, aquaculture, fisheries, timber, and tourism. In addition there is the direct cost of combating and mitigating the impacts of the species, such as Hydrilla which blocks irrigation and drainage canals, enhances sedimentation in flood control reservoirs, interferes with public water supplies, impedes navigation, and generally restricts public water uses. At high densities, hydrilla also reduces productivity of recreational fisheries.

While the economic costs of invasive species in Georgia have not been adequately researched, the estimated costs are very high. The state's agriculture, forestry and tourism industries produce billions of dollars of revenue for Georgia each year. The economic value of land-based agriculture exceeded \$8.8 billion in 2002, making it Georgia's single most productive industry. One out of five jobs in Georgia is related to agribusiness. Yet boll weevil eradication cost Georgia \$111.4 million between 1987 and 1999, and continues to cost the state \$2 million annually.

Likewise, the invasive plant, tropical spiderwort, costs cotton farmers \$1.2 million for extra herbicide annually. Within the agriculture industry, timber is the state's highest-valued agricultural product. Forestry is also Georgia's third-largest manufacturing sector, employing 11 percent of the manufacturing workforce at an annual payroll of \$2.1 billion while contributing billions of dollars to Georgia's economy. However, sudden oak death threatens the state's 9.8 million acres of oak forests (15.6 percent of the state's trees) valued at \$33 billion for timber, wildlife, tourism and urban forests. In addition, Georgia spends in excess of \$200,000 a year on detection surveys and suppression for gypsy moth, hemlock woolly adelgid, *Phytophthora ramorum* (causal agent related to sudden oak death), emerald ash borer, *Sirex noctilio* woodwasp, various exotic wood borers and bark beetles and cogongrass detection and suppression. Tourism is also a major industry in the state contributing \$26 billion to the economy and generating \$1.12 billion in state and local tax revenues. Tourists include hunters, anglers, campers, and wildlife observers whose activities depend on abundant, healthy natural resources.

Another challenge facing Georgia is the potential expansion of invasive species infestations due to climate change. Although scientists differ in their predictions for what temperature changes are currently occurring and what may happen in the future, some climate change models predict an increase in July heat indexes across the Southeast U.S. from 8-15° F to as high as 20° F. Higher average temperatures may enable invasive species to take advantage of weakened ecosystems and further out-compete native species. It is estimated that global warming will allow 48 percent of currently established invasive plants and animals to expand their northern distributions if temperatures continue the warming trend. This can already be seen as warming winter temperatures permit species such as kudzu and garlic mustard to survive in areas much farther north than in the past. In addition, it is expected that global warming will contribute to more severe infestations and habitat damage from invasive insect species, including the gypsy moth (id.). Studies have

also shown that increased carbon dioxide (CO<sub>2</sub>) levels appear to stimulate the growth of invasive plants, and may render herbicides less effective.

Invasive species are introduced to new environments in a number of different ways. Understanding the mechanisms, or pathways, by which invasive species enter Georgia is important in order to prevent or minimize additional introductions. These introductions can be natural, accidental or intentional. Many invasive plants were previously introduced as ornamentals or forage crops. Seeds and other propagules from invasive species can be spread by wildlife or natural processes such as water movement along riparian corridors. Nonnative fish have been intentionally introduced to enhance sport fisheries and for the pet trade. Accidental introductions arrive through pathways such as horticulture, aquaculture, commerce, tourism, or travel. Accidental introductions of aquatic invasive species can occur through the transportation and release of live bait by fishermen and anglers. Another prominent pathway for invasive species has been the trade in wood and wood products. In the U.S., 35 percent of all softwood consumed is imported, and up to 70 percent of all international cargo arrives supported by solid wood packing material (SWPM). The recent arrival in Georgia of the redbay ambrosia beetle (*Xyleborus glabratus*) in solid wood packing material has focused attention on this pathway. Other nonnative insects such as the emerald ash borer, Asian Longhorn Beetle, and *Sirex noctilio* woodwasp are all thought to have been introduced to North America via SWPM. The transportation of firewood from one place to another is another way invasive insect species are unintentionally moved to new environments. Ballast water transport and hull fouling transfers by commercial ships are two pathways for invasive species introductions in Georgia. Ballast water is pumped into a ship's hull to keep it stabilized and upright. This water is sometimes discharged at the receiving port when the cargo is being loaded or unloaded. Ballast water taken on in any port may include an abundance of live plants, animals, and pathogens not native to Georgia.

To address the challenges posed by both established and potential invasive species, federal, state, and nongovernmental agencies have individual roles in coordination, regulation, prevention, detection, education, and control actions. A summary of the roles federal agencies play is provided in table 3; state agencies in table 4; interagency alliances table 5; and nongovernmental organizations table 6. Although the programs and associated jurisdictions listed in these tables are essential for the management of invasive species in Georgia, they contain some gaps that reduce their effectiveness. Some of the known gaps and impediments include the following: coordination, education and outreach, early detection and rapid response, control and management, monitoring populations and habitats, research, regulations and enforcement, and funding.

Category	Plants - Terrestrial and Aquatic	Terrestrial Invertebrates	Terrestrial Vertebrates	Freshwater Fauna	Marine Fauna
1	Non-native Privets <i>Ligustrum spp.</i>	Hemlock wooly adelgid <i>Adelges tsugae</i>	Feral pig <i>Sus scrofa</i>	Flathead catfish <i>Pylodictus olivaris</i>	Red Lionfish <i>Pterois volitans</i>
2	Nepalese browntop <i>Microstegium vimineum</i>	Emerald ash borer <i>Agrilus planipennis</i>	Nine-banded armadillo <i>Dasypus novemcintus</i>	Grass carp <i>Ctenopharyngodon idella</i>	Asian Tiger Shrimp <i>Penaeus monodon</i>
3	Kudzu <i>Pueria montana</i>	Longhorn beetles <i>Anoplophorus spp.</i>	Coyote <i>Canis latrans</i>	Asian swamp eel <i>Monopterus albus</i>	Green mussel <i>Perna viridis</i>
4	Japanese honeysuckle <i>Lonicera japonica</i>	Gypsy moths <i>Lymantria spp.</i>	European starling <i>Sturnus vulgaris</i>	Tilapias <i>Oreochromis spp.</i>	Titan Acorn Barnacle <i>Megalbalanus coccopoma</i>
5	Cogongrass <i>Imperata cylindrica</i>	Red ambrosia beetle <i>Xyleborus glabratus</i>	Feral cat <i>Felis catus</i>	Red shiner <i>Cyprinella lutrensis</i>	Australian tubeworm <i>Ficopomatus enigmaticus</i>

Table 1. Top Five Invasive Species for the State of Georgia by Category

Category	Plants - Terrestrial and Aquatic	Terrestrial Invertebrates	Terrestrial Vertebrates	Freshwater Fauna	Marine Fauna
1	Cogongrass <i>Imperata cylindrica</i>	Redbay ambrosia beetle <i>Xyleborus glabratus</i>	Feral Hog <i>Sus scrofa</i>	Flathead catfish <i>Pylodictis olivaris</i>	Red Lionfish <i>Pterois volitans</i>
2	Chinese Tallow <i>Triadica sebifera</i>	Red imported fire ant <i>Solenopsis invicta</i>	Feral cat <i>Felis catus</i>	Blue catfish <i>Ictalurus furcatus</i>	Asian Tiger Shrimp <i>Penaeus monodon</i>
3	Japanese Climbing Fern <i>Lygodium japonicum</i>	Cactus moth <i>Cactoblastis cactorum</i>	Coyote <i>Canis latrans</i>	Asian clam <i>Corbicula fluminea</i>	Green mussel <i>Perna viridis</i>
4	Common Reed <i>Phragmites australis</i>	Kudzu bug <i>Megacopta cribraria</i>	Nine-banded armadillo <i>Dasypus novemcintus</i>	Red swamp crayfish <i>Procambarus clarkii</i>	Titan Acorn Barnacle <i>Megalbalanus coccopoma</i>
5	Water Hyacinth <i>Eichornia crassipes</i>	Brown widow spider <i>Latrodectus geometricus</i>	Feral horse <i>Equus ferus</i>	Red-eared slider <i>Trachemys scripta scripta</i>	Australian tubeworm <i>Ficopomatus enigmaticus</i>

Table 2. Top Five Invasive Species by Category for the 11 County Coastal Georgia CISMA

<b>Federal Agency</b>	<b>Role</b>	<b>Public outreach</b>	<b>Monitoring/Control</b>
<i>U.S. Army Corps of Engineers (Corps):</i>	Engineering Research and Development Center (ERDC) - Aquatic Nuisance Species Research Program & Aquatic Plant Control Research Program.	Information, marinas, reservoirs, pump out stations, displays, publications, workshops, websites.	reservoir surveys
<i>U.S. Department of Agriculture (USDA) – Animal and Plant Health Inspection Service - Plant Protection &amp; Quarantine (APHIS PPQ)</i>	National Cooperative Agriculture Pest Surveys (CAPS) identifies the top foreign insects, diseases and plants that pose a high-risk to agriculture and natural communities.	Develops outreach information for the public regarding identification of exotic pests and how to report any suspects to state or USDA personnel	Sets traps, inspects materials that would provide an entry pathway. Plant Inspection Station at the Hartsfield-Jackson International Airport, cargo container port in Savannah, and Smuggling Interdiction & Trade Compliance monitoring markeplaces.
<i>U.S. Department of Agriculture - Forest Service (FS)</i>	Nationally the Forest Service manages 191 million acres of federal lands for many purposes, including protection from invasive weeds, and is the USDA's lead agency for nuisance weed control.	The Forest Service provides training in the identification, control, and biology of invasive plants.	The Service's Invasive Species Program uses experimental forests and research field stations as well as private lands, to study the reproductive biology, dispersal rates, and distribution of invasive forest species
<i>U.S. Department of Agriculture – Forest Service (FS) – National Forest System</i>	The Chattahoochee- Oconee National Forest comprises approximately 865,000 acres in portions of 26 counties in Georgia. Non-native invasive species are being addressed on the Chattahoochee-Oconee through a program of inventory and control of invasive species.	Chattahoochee-Oconee biologists are also actively working with Georgia DNR, Georgia Plant Conservation Alliance and other volunteers to restore rare communities and cultural heritage sites on the Forest through management which includes the removal of invasive species.	Environmental Assessments (EA) specifically for mechanical and chemical treatments of non-native invasive plants.

<p><i>U.S. Department of Agriculture – Natural Resources Conservation Service (NRCS)</i></p>	<p>The NRCS considers environmental, social, cultural, and economic conditions when recommending management options for invasive species, and encourages the use of native species for a given location and conservation practice in correlation with restoration or containment goals.</p>	<p>The NRCS also uses agency programs, such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentives Program, and the Wetlands Reserve Program, whenever appropriate to help private landowners recognize, inventory, and control invasive species.</p>	<p>NRCS conservationists: provide training, guidance and assistance to field personnel regarding invasive species management; ensure that all conservation plans and contracts, where relevant, contain appropriate clauses concerning the prevention, spread, and management of invasive species; participate in state (and equivalent) rapid-response teams and efforts; and stay abreast of state and local species of concern.</p>
<p><i>U.S. Department of Commerce - National Oceanic and Atmospheric Administration (NOAA):</i></p>	<p>NOAA has regulatory authority to prevent the introduction of aquatic invasive species that may affect marine sanctuaries, such as the Gray’s Reef National Marine Sanctuary, endangered or threatened species, coastal areas, and essential fish habitats.</p>	<p>NOAA funds research, education and outreach, and control activities on aquatic invasive species issues primarily through the National Sea Grant Program, with some activities funded through the National Ocean Service and National Marine Fisheries Service.</p>	<p>Research efforts include monitoring the impacts of aquatic invasive species on coastal and other ecosystems, developing control and mitigation options, and preventing new introductions by, among other things, developing new technologies for ballast water management.</p>
<p><i>U.S. Department of Homeland Security – U.S. Coast Guard:</i></p>	<p>The Coast Guard’s core roles are to protect the public, the environment, and U.S. economic and security interests in any maritime region in which those interests may be at risk, including international waters and America’s coasts, ports, and inland waterways. One of the Coast Guard’s responsibilities is the development and implementation of a ballast water management program designed to minimize the likelihood of ANS introduction into the U.S. through the ballast water of long-distance ocean vessels.</p>	<p>NA</p>	<p>Regulations promulgated under the program require mandatory ballast water management practices for all vessels that operate in U.S. waters; establish additional practices for vessels entering U.S. waters after operating beyond the Exclusive Economic Zone (waters 200 miles from shore); and require the reporting and recordkeeping of ballasting operations by all vessels.</p>

<p><i>U.S. Department of the Interior – U. S. Fish and Wildlife Service (USFWS) and USFWS Region 4</i></p>	<p>The USFWS is responsible for preventing introductions of potentially harmful, invasive species on land and in waters under the Department of Interior’s jurisdiction</p>	<p>Partners for Fish and Wildlife Program provides funds for private landowners to manage invasive species, primarily plants, on their property. USFWS’s Regional Aquatic Nuisance Species Coordinators have developed informational websites, conducted workshops, and created outreach materials for national distribution, including traveling displays, exhibits, pamphlets, aquatic invasive species identification cards, fact sheets, and videos</p>	<p>The USFWS also created grant agreements with The Nature Conservancy regarding invasive plant control in the Altamaha basin, and funded projects to remove invasive plants and research to increase understanding of how invasive species might out-compete native fish.</p>
<p><i>U.S. Department of the Interior – National Park Service (NPS)</i></p>	<p>The NPS has a program to control and eradicate invasive species in lands and waters within agency boundaries.</p>	<p>Public education and outreach varies depending on local park units. The agency also maintains a number of websites related to invasive species, particularly terrestrial plants, and works with partners to compile, manage, and distribute data on specific occurrences of invasive species</p>	<p>One of the NPS’s largest efforts is through Exotic Plant Management Teams, which are field-based teams of NPS employees and student interns that travel to various parks and apply herbicides and mechanical treatment to rid areas of invasive terrestrial plants. The NPS cooperates with partners to respond to newly detected invasive species.</p>

Table 3. Federal Agency - Invasive Species Management Efforts in Georgia

State Agency/Organization	Role	Public outreach	Monitoring/Control
<i>Georgia Department of Agriculture (GDA)</i>	The GDA is the primary state agency given statutory authority to protect the state’s agriculture resources from invasive pests. Enabling statutes include the Entomology Act of 1937 (O.C.G.A. §2-7-1), the Georgia Boll Weevil Eradication Act of 1985 (O.C.G.A §2-7-150), the Georgia Bee Law (O.C.G.A. §2-14-40), the Bird Dealers Licensing Act (O.C.G.A §4-10-1), and the Prevention of Disease in Livestock Act (O.C.G.A. §4-4-1).	The GDA provides services and regulatory functions, protects and promotes agriculture and consumer interests, and ensures an abundance of safe food and fiber for Georgia by using state-of-the-art technology and a professional workforce.	GDA employees are authorized to inspect; survey for, and treat for pests which may be injurious to livestock, agricultural, horticultural, or other interests of the state. The GDA actively inspects establishments for the presence of livestock and plant pests and cooperates with other agencies in conducting additional surveys for exotic invasive pests.
<i>Georgia Department of Agriculture - Plant Protection Division (GDA-PPD)</i>	The GDA-PPD participates in the Cooperative Agriculture Pest Survey program for detection of harmful agriculture pests	GDA-PPD personnel work with plant nurseries to keep their production premises free from federal noxious weeds.	The GDA-PPD conducts over 8,000 inspections of plant growers and plant retail centers each year with a portion of each inspection devoted to exotic pest detection.
<i>Georgia Department of Human Resources: Division of Public Health (DPH)</i>	The DPH’s Zoonotic Disease Team works with mosquito control agencies to reduce the impact of some vector-borne diseases through proper mosquito control measures	Educational efforts are focused at reducing the breeding sites of <i>Aedes albopictus</i> , an aggressive invasive mosquito species that has been implicated in arboviral disease transmission	Mosquito surveillance is performed in July-October for arboviral disease testing purposes. Because mosquitoes are identified by species, the DPH is able to document the presence of invasive mosquito species in the state. The DPH also keeps a database of mosquito species that have been tested for arboviral diseases through its West Nile Virus surveillance program

<p><i>Georgia Department of Natural Resources: Coastal Resources Division (CRD)</i></p>	<p>The CRD manages Georgia’s coastal natural resources. The CRD partners with scientists and resource managers to determine the level of potential risks and impacts that introduced aquatic invasive species could have on coastal natural resources.</p>	<p>The CRD’s Coastal Management Program funds an education and outreach campaign for aquatic invasive species found in the port areas including boater education to prevent the transportation of aquatic invasive species as well as educational brochures targeting aquatic invasive species distribution.</p>	<p>The CRD also funds mapping and distribution of aquatic invasive species in the ports. Because the impact of known aquatic invasive species has not been determined in coastal waters, the CRD is currently funding assessments of introduced aquatic invasive species along the coast.</p>
<p><i>Georgia Department of Natural Resources: Environmental Protection Division (EPD):</i></p>	<p>The Watershed Protection Branch of the EPD works indirectly with nonnative plants and invasive species. Guidance developed or policies used by EPD incorporate information regarding the use of native plant species for re-vegetating land disturbances, stream buffers, stream restorations, and general erosion prevention/treatment.</p>	<p>The EPD promotes education and outreach regarding invasive species identification and removal, and also publishes guidance documents regarding land disturbance and mitigation. The Coastal Adopt-A-Wetland program includes outreach on aquatic invasive species and has a series of posters that are distributed throughout the Georgia coastline that ask people to report occurrences of aquatic invasive species.</p>	<p>NA</p>
<p><i>Georgia Department of Natural Resources: Parks, Recreation and Historic Sites Division (PRHSD)</i></p>	<p>The PRHSD initiated an invasive species program in 2005, originally funded by federal grants. Five state priority sites were identified and a five-year management plan was developed for each site.</p>	<p>The Georgia Botanical Society, Georgia Exotic Pest Plant Council, and other groups participate as volunteers and visitor monitors who provide the PRHSD with updated information about invasive species threats</p>	<p>Focal species could include any invasive species found in Georgia, but the plans usually focused on privet, kudzu, wisteria, English ivy and microstegium. The PRHSD is also working at a number of other sites that have ongoing invasive plant species control work but do not require the intensive professional management of the five priority sites. PRHSD staff has received invasive plant species identification training and is the PRHSD’s primary source of detection</p>

<p><i>Georgia Department of Natural Resources: Wildlife Resources Division (WRD)</i></p>	<p>The WRD is charged with acting on invasive species threats and also enforces state and federal laws regulating wildlife, boating and littering on behalf of the state's wildlife and citizens. Specifically, the WRD enforces regulations concerning aquaculture and the sale of domestic fish species with exotic definitions; wild animal licensing; general protection of wildlife and wildlife habitat; the liberation of wildlife (i.e., release and escape from captivity); transportation of trout; and wild animal auctions.</p>	<p>WRD staff developed a freestanding display, brochures, and other materials highlighting aquatic invasive species. Division staff members participate in numerous outreach efforts related to invasive species, including presentations at conferences, workshops, outdoor festivals, and trade shows with the goal to educate the public about the dangers of invasive species and to prevent their release into the environment. WRD biologists also work with the Georgia Native Plant Society, the Georgia Wildlife Federation, and other groups to promote landscaping with native plants and provide information on native plant nurseries and other sources of native plant materials.</p>	<p>Control efforts for terrestrial invasives are focused primarily on state-owned lands, while those for aquatic invasives may include both public and private waters. Once an invasive species is reported or discovered, actions are taken to eliminate or control it. The following species have had focused efforts to assess and control: flathead catfish, asian swamp eels, apple snails, tilapia, feral hogs, hemlock wooly adegid, among others.</p>
<p><i>Georgia Department of Transportation: Office of Environment and Location (GDOT)</i></p>	<p>GDOT ecologists, landscape architects, maintenance crews and construction personnel survey for invasive plant species on all transportation construction projects throughout the state.</p>	<p>The survey reports are catalogued and are reviewed by the Federal Highway Administration, USFWS and WRD. GDOT is preparing to work with the UGA Bugwood Network and the Georgia Exotic Pest Plant Council by contributing GPS data on the location of invasive plant species throughout the state. GDOT reports any cogongrass and hydrilla sightings to the WRD. GDOT is treating numerous cogongrass sites on State and Federal right-of-ways in conjunction with the GFC's eradication effort.</p>	

<p><i>Georgia Forestry Commission (GFC)</i></p>	<p>GFC is the primary state agency in charge of detection and suppression of invasive species within the state's 24.7 million forested acres.</p>	<p>Cogongrass has become a priority invasive species for GFC and efforts are underway to educate the public to recognize and report species occurrences. GFC forest health staff conducts or participates in over 150 public speaking opportunities each year to various organizations including foresters and other resource managers, fire fighters, loggers, civic groups, environmental groups, school and college groups, state and county public works departments, hunting and fishing organizations and farm organizations. In all, GFC personnel expend over 50,000 hours annually on invasive forest pest issues.</p>	<p>GFC is actively involved monitoring and control of many species including taking the lead on cogongrass control, southern pine beetle, hemlock wooly adegid, and several tree diseases including Phytophthora ramorum. GFC deploys a series of early detection insect traps at multiple locations in an effort to trap a variety of nonnative insects (i.e., sirex woodwasps, gypsy moths, and emerald ash borer). GFC surveys warehouses that receive cargo with solid wood packing material from high risk regions of the world for exotic bark beetles.</p>
<p><i>UGA – Center for Invasive Species and Ecosystem Health (Center)</i></p>	<p>The Center was established at UGA in order to address issues on invasive species and ecosystem (agricultural, forested and natural system) health. The Center's goals include: becoming a preeminent national and international public service and outreach center; developing collaboration between UGA and state, university, federal and international partners; integrating and developing information and programs; serving as a clearing house for information, applied research and training; and promoting public awareness, education and applied research.</p>	<p>The Center is currently developing and administering 20 educational web systems, seeking and archiving digital images in four topic-based web systems to support educational activities as well as developing smartphone application for quick reporting of invasive species location by the public.</p>	<p>Oversees the Georgia Cooperative Agricultural Pest Survey Program, developing policy and protocols for early detection and rapid response of invasive species, developing and administrating the Early Detection and Distribution Mapping System for the Southeast Exotic Pest Plant Council and the Everglades Cooperative Invasive Species Management Area, applying herbicide research on emerging invasive plants, and facilitating and extending program development in Europe and Central America.</p>

<p><i>UGA - College of Agricultural and Environmental Sciences - Aquaculture Unit (CAES)</i></p>	<p>The CAES provides research, teaching and extension (or public service) at the undergraduate and graduate levels in a variety of specialties, including Agriculture and Environmental Sciences.</p>	<p>Through Cooperative Extension, CAES is often the first point of contact when a member of the public observes an aquatic invasive species. CAES also provides training to county extension agents, fish farmers, fish hobbyists, county governments, and others regarding invasive species issues, and has direct contact with private individuals involved in interstate transportation of fish and invertebrates through its extension programs.</p>	<p>CAES conducts pesticide testing for effective control of aquatic plants and snails.</p>
<p><i>UGA - Department of Horticulture (Department)</i></p>	<p>Members of the Department's faculty serve on the Board of the Georgia Exotic Pest Plant Council (GA-EPPC) and the Invasive Plant Task Force of the Georgia Green Industry Association.</p>	<p>The Department works to develop educational materials, including a table-top exhibit on aquatic and terrestrial nuisance plant species, a PowerPoint presentation on invasive plant species and a list of alternative plant choices, both native and nonnative. These resources are used by organizations at trade shows and other events. They are also available on-line from the GA-EPPC web site, and are used by county extension agents across the state in local programming.</p>	<p>NA</p>

<p><i>UGA - Marine Extension Service (MAREX)</i></p>	<p>MAREX conducts research programs to monitor coastal aquatic invasive species and documents their biology and ecology.</p>	<p>MAREX also conducts outreach efforts to increase public awareness and modify behaviors in order to prevent new introductions and reduce the further spread of existing problem species. MAREX’s public education and outreach activities include: the Aquatic Invaders program; public surveys to gauge understanding of aquatic invasive species issues; “Have You Seen Me?” sheets; aquatic invasive species fact sheets; Camden County 4-H officer training, development of an aquatic invasive species volunteer monitoring manual; future incorporation of aquatic invasive species prevention best practices into the Georgia Clean Marina program; development of educational rack cards, booklets, and posters on aquatic invasive species; and work on a public service announcement to highlight aquatic invasive species and prevention tips</p>	<p>In addition, MAREX conducted a volunteer monitoring program for coastal fouling communities that will operates through the existing Adopt-A-Wetland program. MAREX conducts port surveys, participates in Mytella dock sampling, and hosts the Aquatic Invaders Zoo &amp; Aquarium program, and also compiles volunteer monitoring data and public reports from “Have You Seen Me?” flyers and publishes the data in peer-reviewed research papers. MAREX conducted a literature review for fish, mollusks, crustaceans and polychaetes in the South Atlantic Bight, and created a regional GIS database as part of port surveys. In all, the database now contains information from a total of 104 publications, representing locality information for 2,533 species.</p>
<p><i>UGA – Odum School of Ecology (Odum School)</i></p>	<p>In addition to having several faculty members who actively research invasive species, the Odum School participates in UGA’s Species Invasions Science (SIS) group and also hosts the Drake Research Group. These groups bring together individuals interested in the study of invasive species</p>	<p>While not specifically focused on public outreach, SIS is an interdisciplinary and interdepartmental group comprised of individuals from the Odum School, the Warnell School of Forestry &amp; Natural Resources, the Department of Genetics, and the Department of Crop and Soil Sciences.</p>	<p>Applied projects have focused on invasive species to answer such questions as how many individuals of a species it takes to establish a viable population, what characteristics predispose species to being good colonizers or having strong impacts on ecosystems, and where and how fast invading species will spread.</p>

<p><i>UGA - Warnell School of Forestry and Natural Resources (Warnell School)</i></p>	<p>The Warnell School developed the Early Detection &amp; Distribution Mapping system (EDD-Maps) for use by the eight Southeast Exotic Pest Plant Council state members</p>	<p>The Warnell School conducts extensive programming to train professional resource managers, extension agents, landowners, and the general public on invasive species issues, identification, management, control recommendations, and web resources.</p>	<p>The Warnell School is part of the Species Invasions Science group and the Center for Invasive Species and Ecosystem Health.</p>
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Table 4. State agency - invasive species management efforts in Georgia

<b>Organization</b>	<b>Role</b>	<b>Public outreach</b>	<b>Monitoring/Control</b>
<p><i>The Georgia Invasive Species Task Force</i></p>	<p>The Georgia Invasive Species Task Force is comprised of the Georgia Department of Agriculture, the Georgia Forestry Commission, the Georgia Department of Natural Resources, and the University of Georgia. For more than 20 years, members of this group have worked cooperatively together in invasive species detection, education, and control.</p>		<p>These agencies have been active participants in the Cooperative Agricultural Pest Survey program (CAPS). This program is a combined effort by state and federal agricultural or forestry agencies to conduct surveillance, detection, and monitoring of exotic plant pests of agricultural and natural plant resources and biological control agents. Survey targets include plant diseases, insects, weeds, nematodes, and other invertebrate organisms. Such survey activities foster early detection and rapid response to invasive pests that are not established or have limited range in the U.S.</p>

<p><i>Cogongrass Cooperative Weed Management Area (CWMA)</i></p>	<p>The CWMA is a cooperative alliance officially formed in 2008 with the sole purpose to address the short and long term negative effects of cogongrass within the state of Georgia. Key partnerships for the leadership within Georgia’s Cogongrass Program are: GFC – education, detection and field visits when reported, eradication treatments. UGA – education, detection, web support, printed materials and publications. USDA APHIS (PPQ) – detection and eradication treatments. USDA USFS – funding, education. Jones Ecological Center – education and outreach. Georgia Department of Agriculture – detection and plant industry regulation enforcement. Mark Atwater – Weed Control Unlimited, Inc.</p>	<p>Cogongrass educational efforts began in 2005. The Georgia Forestry Commission and University of Georgia Bugwood Network were the primary sponsors involved. The GFC Forest Health staff made numerous presentations across the state, delivering the cogongrass message. More than 900 presentations about the cogongrass threat have been made to 50,000+ attendees since 2000.</p>	<p>The Georgia Forestry Commission began herbicide treatments of cogongrass sites throughout Georgia in 2007. The GFC Forest Health staff sought the advice of experts from across the southeast, especially research and field trials conducted in Florida, Alabama and Mississippi, to develop an effective eradication treatment program. As with all invasive species, eradication would require multiple years of treatment followed by multiple years of follow-up inspections to insure total eradication has occurred.</p>
<p><i>Coastal Georgia Cooperative Invasive Species Management Area (CISMA)</i></p>	<p>Formed in 2011 the CISMA seeks to engage a broad cross section of state, federal, nonprofit and volunteer organizations to increase the awareness on invasive species issues, increase knowledge sharing, increase effectiveness, and achieve successful early detection rapid response to new invasive species threats to the coastal 11 counties of Georgia.</p>	<p>Conducts annual meetings where invasive species issues pertinent to the 11 county coastal region are discussed. Engages the public in training on how to identify and report an invasive species. Produced a prioritized list of invasive species specific to our region using expert input. Engages various groups to raise awareness of invasive species through lectures, training, or distribution of educational materials.</p>	<p>CISMA members and interns input invasive species location data to the EDDMapS database. Collaborative invasive species control work has been conducted for Chinese Tallow, Common Reed, Water Hyacinth, Salt Cedar, among others. Species and locations for control are selected based on the ability to achieve valuable management goals from raising public awareness to protection of ecosystem services, rare species, or in some cases the ability to truly eradicate as high priority invasive species.</p>

<p><i>Georgia Plant Conservation Alliance (GPCA)</i></p>	<p>Coordinate the active recovery of critically imperiled plant species and their habitats working with conservation organizations and specially trained Botanical Guardian volunteers throughout Georgia.</p>	<p>Participating museums and agencies offer classes, workshops, children’s activities, professional training, and volunteer opportunities on the impacts, alternatives, controls of invasive species.</p>	<p>GPCA collaborates on invasives removal from imperiled habitats, sharing techniques, equipment, and volunteers. Populations of rare plants monitored by professionals and volunteers for invasive species infestations.</p>
<p><i>Georgia Native Plant Initiative (GNPI)</i></p>	<p>Promote the use of Georgia native plants in all areas of the Green Industry, use push-pull marketing to share ethical sources of native plants, teach land restoration and garden design using native plants of Georgia, and particularly Georgia sourced natives for land restoration and biodiversity sustainability.</p>	<p>All growers marketed by the GNPI agree not to sell Category I or II invasive plant species. Partners share gardening techniques and restoration practices through classes, workshops, articles, websites, and volunteer opportunities.</p>	<p>Demonstration sites for land restoration promote invasives controls and repatriation of appropriate natives in prairies, floodplains, and roadsides. Demonstration gardens showcase Georgia natives incorporated into traditional garden designs but not allowing known invasives to displayed.</p>

Table 5. Interagency Alliances - Invasive Species Management Efforts in Georgia

Organization	Role	Public outreach	Monitoring/Control
<i>Georgia Aquarium</i>	As of 2008, the Aquarium's involvement in aquatic invasive species is limited to educational programs where the impact of aquatic invasive species on biodiversity is discussed with middle and high school students.	While the Aquarium exhibits flathead catfish, the exhibit does not include a discussion on aquatic invasive species. The Aquarium is considering setting up a discussion of lionfish and their introduction to Grays' Reef National Marine Sanctuary. The Aquarium also has a handout that it developed on aquatic invasive species for the general public.	NA
<i>Georgia Exotic Pest Plant Council (GA-EPPC)</i>	GA-EPPC is a nonprofit group that concentrates exclusively on existing and potential invasive exotic pest plants in Georgia. GA-EPPC is a chapter of the regional Southeast Exotic Pest Plant Council and a member of the National Association of Pest Plant Councils.	GA-EPPC developed the Invasive Nonnative Plants in Georgia list, which is currently the most comprehensive such list for the state. The organization provides an annual educational meeting, several workshops and other educational programs in a wide variety of venues throughout the state. GA	GA-EPPC has close working relationships with state and federal agencies that are involved in invasive plant management. GA-EPPC members participate in volunteer work parties to control and remove invasive plants, add to the EDDMaps database, and assist with education by distributing materials provided by the organization.
<i>GA Forestry Association (GFA)</i>	The GFA is the leading advocate for a healthy business and political climate for Georgia's forest environment, forest landowners and forest-based businesses.	GFA promotes invasive species awareness through communication, education and programs to its membership and other interested sectors. Target audiences include forest landowners, industry leaders and experts, foresters, elected officials, and the conservation community.	GFA attends the NRCS's State Technical Committee meeting where cost share programs can/could be developed to target invasive species.

<p><i>Georgia Green Industry Association (GGIA)</i></p>	<p>GGIA supports self-regulation and phasing out use of invasive species through public education about desirable alternatives.</p>	<p>GGIA working with the Georgia Exotic Pest Plant Council and the Georgia Native Plant Society to developed a list of alternative plants for cultivation, both native and nonnative. The goal of this effort is to have a single list of accepted and prohibited plants that will be agreeable to all and a unified message that can be conveyed to the gardening public.</p>	<p>GGIA has worked with the Center for Applied Nursery Research in Dearing, Georgia to solicit help from the research community with problems associated with invasive species and ways to combat invasiveness in ornamental plants.</p>
<p><i>Georgia Native Plant Society (GNPS)</i></p>	<p>The GNPS is involved with neighborhood restoration projects that encourage training in aquatic invasive species identification, removal, and replanting with natives.</p>	<p>The Society features at least one yearly lecture on invasive plants out of six general membership meetings a year. GNPS hosts a kiosk at the Southeastern Flower Show that includes an invasive species poster, and has the GA-EPPC invasive brochure prominently displayed and available to the public.</p>	<p>The GNPS also has a small research grant program that funds invasive research along with other topics.</p>
<p><i>Georgia Botanical Society (BotSoc)</i></p>	<p>The BotSoc is dedicated to the study and preservation of Georgia's wild, native, rare, and endangered wildflowers and plant life. This is accomplished by promoting the understanding and appreciation of plants and their environment, support habitat preservation, and promoting the practice of a conservation ethic.</p>	<p>The BotSoc members and other volunteers work to remove invasive species from multiple locations including the Chattahoochee National Forest. The BotSoc holds training workshops for members on invasive species. The Marie Mellinger Field Botany Research Grant program fund professional and students to conduct various types of research and restoration.</p>	<p>The BotSoc has been working with the USFS since 2012 to control and eradicate the exotic invasive <i>Ficaria verna</i> (fig buttercup) at Sosebe Cove, Chattahoochee National Forest. In addition several of our members are working on invasive species removal program (Exant) in the Chattahoochee River National Recreation Area in Atlanta and an invasive species "Weed Warrior" Project at Memorial Park in Athens Future control work will include Japanese Spirea. The BotSoc Marie Mellinger Grant Program is also supporting an <i>Arundinaria gigantea</i> resoration project in the Athens area. Panola Mountain has been the focus of grassland restoration for years.</p>

<p><i>Coastal WildScapes (CWS)</i></p>	<p>The mission of Coastal WildScapes is to actively preserve and restore the highly significant biodiversity of Southeastern coastal ecosystems by protecting existing native habitats, rebuilding the connectivity of impaired habitats and minimizing the future fragmentation of the coastal landscape. We have three overarching strategies to accomplish our mission</p>	<p>CWS holds several outreach and education events throughout the year including a full day annual symposium, lecture series, invasive species volunteer opportunities, native seed collection, restoration projects, interpretive signage projects, spring and fall native plant sale. Much of the education and outreach is focused on how to provide wildlife habitat in our landscapes through the promotion of regionally appropriate native species and discouraging the use invasive species.</p>	<p>The members and volunteers with CWS partner with many other agencies in the coastal Georgia region to work on invasive species control and native plant restoration projects including work on Cannon’s Point Preserve, SSI; Cay Creek Wetland Interpretive Center, Midway, GA; Altamaha River Delta; Little St. Simons Island; St. Catherines Island; Harris Neck NWR, McIntosh Co. to name a few.</p>
<p><i>Georgia Ports Authority (Ports Authority)</i></p>	<p>The Ports Authority monitors ships while they are at berth and reports any detected ballast water discharge to the Coast Guard.</p>		<p>The Ports Authority does not conduct ongoing monitoring for aquatic invasive species, but has worked with researchers in the past conducting a baseline survey of terminals in the ports of Savannah and Brunswick.</p>
<p><i>Georgia Power Company</i></p>	<p>Georgia Power manages aquatic invasive species in their 15 reservoirs across the state. In addition to the marina operator network, Georgia Power surveys Lakes Jackson, Juliette, Oconee, and Sinclair for aquatic nuisance plant species.</p>	<p>It also has a reservoir marina operator notification program and issues occasional notes to residents regarding aquatic invasive species. While Georgia Power personnel are trained to identify aquatic invasive species, the Company also relies on local residents for aquatic invasive species control requests, and has alerted resident marina operators to look out for aquatic invasive species, especially hydrilla.</p>	<p>Georgia Power manually removed and treated hydrilla found at its Lake Sinclair Little River Park marina during a routine aquatic plant management project at one of its operating plants. Personnel involved in water quality work are also looking for aquatic invasive species and the Company’s reservoirs are surveyed on a quarterly basis. Georgia Power does routine herbicide applications for a number of aquatic plants in its reservoirs including giant cutgrass, water hyacinth, spiny leaf naiad, Brazilian Elodea, and Eurasian water milfoil.</p>

<p><i>Georgia Wildlife Federation (GWF)</i></p>	<p>The GWF is Georgia’s oldest and largest member-supported conservation organization and the state affiliate of the National Wildlife Federation. GWF’s primary involvement with invasive species has been public outreach and education.</p>	<p>Its quarterly member newsletter, The Call, and the semi-annual Sportsman’s Connection contain information about invasive species such as hemlock woolly adelgid and flathead catfish. GWF partners with other nonprofit organizations such as the Satilla Riverkeeper and the Georgia River Network to educate the public about aquatic invasive species.</p>	<p>While the GWF monitors invasive species on its own property and through its involvement in Adopt-A-Stream, it also coordinates with the Teaming with Wildlife Coalition in Georgia, and looks for projects using volunteers to promote the control and management of invasive species. The GWF is also currently considering a Cooperative Agreement with the USFWS Partners for Wildlife program that will have a habitat restoration component at the Alcovy Conservation Center and possibly at the Wharton Conservation Center.</p>
<p><i>The Nature Conservancy</i></p>	<p>The Nature Conservancy is the world’s largest conservation organization. In Georgia, the Conservancy has worked for years to abate the threats that invasive species, both plants and animals, pose for Georgia’s natural resources through partnerships, planning, and management action.</p>	<p>The Conservancy also pursues communication strategies related to exotic invasive species. The Conservancy has sponsored invasive plant species workshops for land managers and other resource personnel in which participants are trained in the impact, identification, and control of exotic pest plants.</p>	<p>On-the-ground management activities include removals of invasive plants from Conservancy-owned preserves and priority lands and waterways by Conservancy personnel and volunteers. On the Georgia coast, the Conservancy is mapping and treating infestations of aquatic invasive plants including common reed, water hyacinth, and the wetland invasive Chinese tallow.</p>
<p><i>Trees Atlanta</i></p>	<p>Trees Atlanta is a non-profit citizens’ group dedicated to protecting and improving the urban environment by planting and conserving trees. It also educates the public about the value of trees and is involved with tree issues in the entire metropolitan Atlanta area.</p>	<p>Trees Atlanta educates volunteers about removing invasive plants such as Chinese Privet, English Ivy, and Kudzu.</p>	<p>Currently, Trees Atlanta is assisting with management plans and invasive plant removal in 20 City of Atlanta parks and more than 300 acres in Southwest Atlanta. Once invasive species are removed from these greenspaces, native trees and plants are replanted to ensure erosion control and streambank stabilization.</p>

<i>Savannah Tree Foundation</i>	Savannah Tree Foundation is a nonprofit organization dedicating to preserving, protecting and planting canopy shade trees in Chatham County.	The Savannah Tree Foundation promotes, through direct action and education, an awareness of trees as vital environmental resources and an important part of our cultural heritage. Volunteers are taught about invasive plant species at tree planting and maintenance events.	Currently, Savannah Tree Foundation monitors for invasive Chinese tallow at reforestation sites where STF has planted. Additionally STF works to control invasive English Ivy in Bacon Park Forest.
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Table 6. Nongovernmental Organizations - Invasive Species Management Efforts in Georgia

## **Interagency Burn Team** **Jimmy Rickard (USFWS)**

Started in 2001, the Interagency Burn Team (IBT) has been burning up Georgia in the name of rare species and priority habitats. A formal Memorandum of Understanding (MOU) was signed in 2009 formalizing the partnership. By pooling the expertise of cooperators, the IBT can draw together all of the required resources to conduct prescribed burning for the benefit of fire-dependent-ecosystems and the imperiled species associated with them. Cooperators include the U.S. Fish and Wildlife Service

(Georgia Ecological Services as well as Piedmont and Okefenokee National Wildlife Refuges), the Georgia Forestry Commission, the Georgia Department of Natural Resources, The Nature Conservancy (Georgia Chapter), The Orianne Society, The Longleaf Alliance, and the U.S. Forest Service (Chattahoochee/Oconee National Forests).

Each utilizes resources from other partners and exchange in-kind services to conduct prescribed burns.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combatted Invasive/Alien Species</i>

Effective and efficient prescribed burning is difficult because qualified burn personnel and equipment are often unavailable in sufficient numbers to conduct prescribed burns in remote habitats across Georgia when the weather is appropriate to meet site objectives. By leveraging additional manpower and equipment from all of the cooperators, larger tracts of land may be burned at one time or may be burned when an agencies workload might otherwise preclude the burn. The IBT cooperators regularly collaborate to meet individual conservation goals. Several thousand acres are burned annually on lands managed by the cooperators as well as on privately owned lands. The IBT also helps coordinate training to keep burn team members NWCG (National Wildfire Coordinating Group) qualified, which is the national standard for fire-fighting agencies.

The IBT has conducted burns for the conservation of unique habitats from the piney flatwoods and savannas in the lower Coastal Plain to the xeric (dry) sandhills and longleaf pine woodlands along the fall-line sandhills, to mountain bogs and montane longleaf woodlands within the Ridge & Valley region. Some of the exciting places where habitat restoration has occurred include Berry College in Northwest Georgia, Piedmont National Wildlife Refuge, Chattahoochee National Forest, west Georgia areas near Fort Benning, and DNR lands state-wide. These areas may not otherwise have benefited from fire were it not for the diligent efforts of the IBT.

A few species that have benefited from IBT burns include indigo snake (*Drymarchon corais couperi*), gopher tortoise (*Gopherus polyphemus*), red-cockaded woodpecker (*Picoides borealis*), Bachmans sparrow (*Aimophila aestivalis*), Canby dropwort (*Oxypolis canbyi*), hairy rattleweed (*Baptisia arachnifera*), green pitcherplant (*Sarracenia oreophila*), Georgia plume (*Elliotia racemosa*), dissected beard tongue (*Penstemon dissectus*), pineland barbara button, (*Marshallia mohrii*), Apalachicola dusky salamander (*Desmognathus apalachicola*), bluff white oak (*Quercus austrina*), agrimony (*Agrimonia incise*), Sandhills milk-vetch (*Astragalus michauxii*), green fly orchid (*Epidendrum conopseum*), Georgia beargrass (*Nolina georgiana*), and many more.

Partners signed a new five year MOU in December 2015, ensuring that this successful partnership continues into the future. The IBT has been one of the most significant factors contributing to increased burned acres state-wide.

# State Agencies

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## **50 Year Plans in Wildlife Resources Division**

**Don McGowan and Matt Payne (GA WRD)**

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The 50-Year Plan is a document that guides management of state-owned lands that are under the purview of the Georgia Department of Natural Resources (DNR). While mostly encompassing lands within DNR's Wildlife Resources Division (WRD), 50-Year Plans have also been written for lands within the jurisdiction of DNR's Parks and Historic Sites Division. Though mainly focusing on wildlife species and habitat management goals, 50-Year plans also encompass other considerations under the scope of DNR's state legislated authority such as cultural resource protection and provisioning of public outdoor recreation opportunities.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

The 50-Year Plan had its origin in the late 1980's when it was decided by WRD leadership that one of the best strategies of avoiding management conflicts and diversion of intentions was to initiate a comprehensive planning process, the end result of which would produce a written document – the 50-year Plan. A team of natural resource professionals from within DNR, along with input from relevant outside government agencies and non-governmental organizations, would contribute to the plan. Once written by the team and approved by appropriate Division level leadership, the 50-year Plan would serve as the fundamental guiding document for a particular piece of state-owned land, whether designated as a Wildlife Management Area (WMA), Natural Area (NA), or State Park. Indeed, shorter term work plans (5-year and annual plans) for a state-owned WMAs are based on the overarching goals of the 50-year Plan (for those areas that have a completed Plan). One of the key benefits of a completed 50-Year Plan is that while departmental staff may come and go, the 50-Year Plan remains as the basis upon which management decisions are made for a particular area – thus greatly favoring consistency of management approach, despite the possible whims of individual land managers and supervisory staff. These plans address many of the objectives outlined in the original State Wildlife Action Plan.

It is important to note, that a 50-Year Plan is not a static document, as natural stochastic events may, and do likely, occur (e.g. hurricanes, tornados, ice storms, etc.). These can significantly alter the habitat of an area in a short amount of time, mostly certainly changing current habitat conditions, and quite possibly changing the vision of 50-year habitat conditions. Significant revisions to a 50-Year Plan entail the same level of group participation and Division leadership sign-off as the original plan.

While there is no set template for a 50-year Plan, plans most commonly contain the following elements:

1. Introduction
  - a. Name of Area
  - b. Acquisition Process By State
  
2. Site description
  - a. Location
  - b. Soil types and Climate
  - c. Historical Ownership and Land-use
  - d. Cultural Resources
  
3. Purpose(s) of Area
  - a. Rare Species Protection, Watershed Protection, Public Recreation, etc.
  
4. Current Habitat Conditions and Proposed Conditions 50 Year Conditions
  - a. Proportion of Habitat Types
  - b. Stand-level Inventory (for forested acreage)
  - c. Maps
  
5. Management Prescriptions to Meet 50-Year Goals
  - a. Possible prescriptions: Prescribed Fire, Invasive Exotic Species Control (fauna, flora, or both), Timber Stand Improvements, Game Species Management, Hydrology Restoration, etc.
  
6. Appendices and Other Relevant Ancillary Documents

Direction and completion of a 50-Year plan for a particular area is the responsibility of the appropriate WRD Game Management Section Regional Supervisor (for WMAs) or Nongame Conservation Program Manager (for NAs). Currently, there is no set time frame for completion of 50-Year Plans, but WRD Headquarters prefers a completed 50-Year Plan within 2 years of state acquisition of a land parcel. For state owned lands in existence before the formal 50-Year Planning Process began, Game Management Regional Supervisors and Nongame Conservation Program Managers are encouraged to expedite formal 50-Year Plans as soon as possible. The current status of 50-Year Plans for lands under WRD jurisdiction is listed in Table 1.

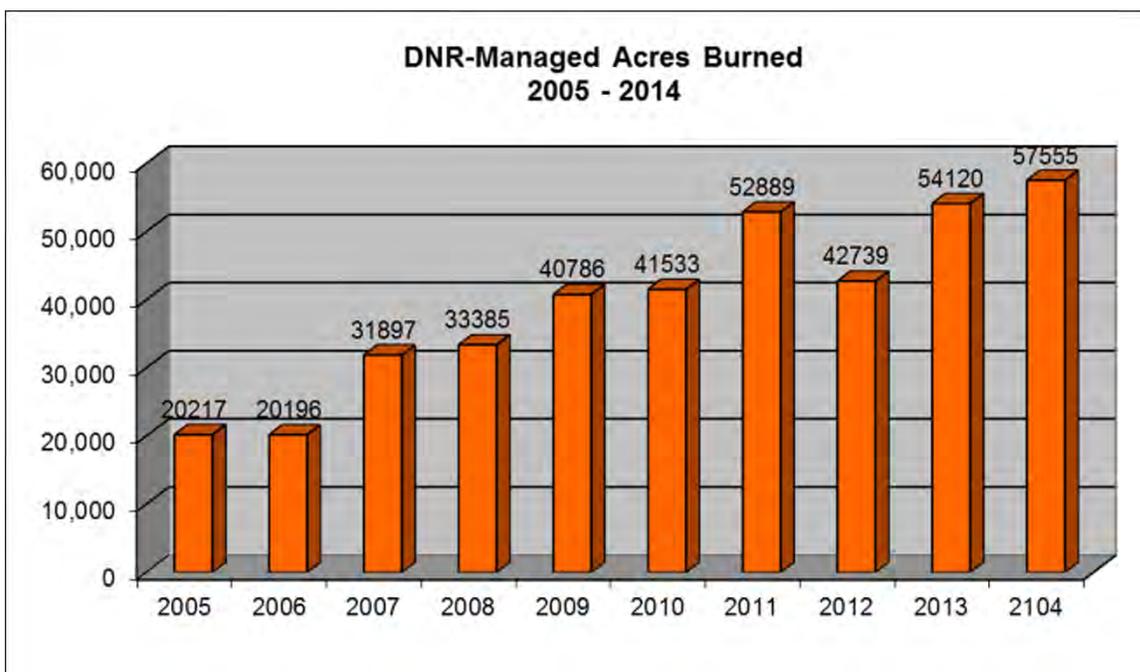


## DNR Prescribed Fire Program Shan Cammack (GA WRD)

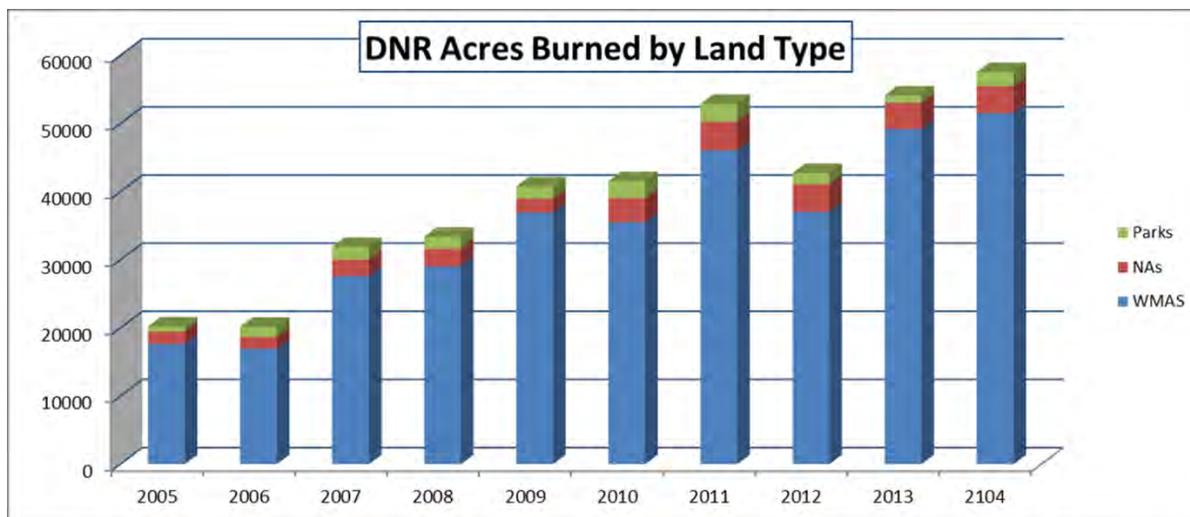
WRD has long viewed fire as one of the most important management tools available in Georgia to enhance and sustain native ecosystems. Because the need for more prescribed fire ranked so high in the State Wildlife Action Plan, a significantly greater amount of funding has been allocated to this important management tool in the last ten years. Funds were secured by WRD from several sources, including State Wildlife grants, the National Fish and Wildlife Foundation, Georgia Ornithological Society, and Wildlife Conservation Society. These supplemented the Pittman-Robertson funds that have long been earmarked for prescribed fire.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

In looking at the number of acres burned on state-managed lands in that past ten years, there is a definite upward trend. In 2005, a little over 20,000 acres were burned on DNR-managed land. This includes owned and leased acres. In 2014, 57,555 acres were burned, which is more than double.



Analyzing how that breaks down by land type, the following graph shows a general trend of more acres burned on each land type for the past ten years. This includes Wildlife Management Areas, areas managed as Natural Areas, and State Parks. The increase in acres burned on all three land types underscores the strong commitment to prescribed burning by all of DNR. Fluctuations exist from year to year based on days appropriate for burning and staff and resources available when burn units are in prescription. Staff shortages have been a problem for both WRD and the Parks Division. The drought of 2012 made the execution of prescribed fire operations difficult state-wide and helps explain the significantly lower number of acres burned that year.

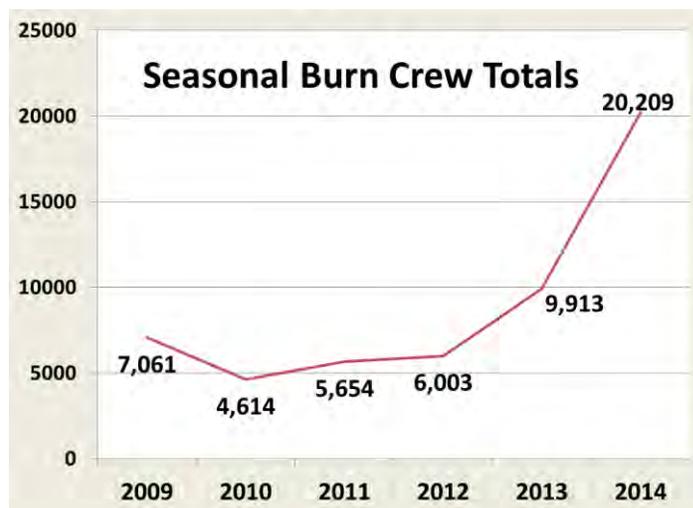


Land Types include Parks, Natural Areas (NAs), and Wildlife Management Areas (WMAs)

Several factors contribute to increased acres burned. The stronger commitment to prescribed fire since SWAP has led to increased funding, a formal prescribed fire policy, heightened training of staff and volunteers, hiring of dedicated seasonal fire crews, and an active Interagency Burn Team (IBT). The increased funding from outside sources has allowed DNR to purchase specialized wildland fire equipment and safety gear for firefighters. An important milestone for the DNR burn program was the development of a prescribed burning policy for WRD in 2007 and for Parks in 2009. This outlined standards for training, qualifications, and burn planning. The policy has produced a more consistent burn plan procedure and has brought DNR training standards up to the basic level of NWCG (National Wildfire Coordinating Group). NWCG is the recognized industry standard for fire qualifications nation-wide. Meeting these standards has allowed DNR to enter into a Memorandum of Understanding with the IBT.

Not only were more people trained, but advanced training was offered and encouraged. The IBT collaboration played a key role in increased training opportunities. The IBT also offered partners valuable experience opportunities, strengthening skills of DNR employees. Additionally, the IBT provided DNR with staff and resources on DNR burns state-wide.

Dedicated seasonal fire crews were brought on in 2009. In the first few years the crew was made up entirely of SCA (Student Conservation Association) interns. While these young passionate conservationists had to be fire trained and came with little to no fire experience, they worked tirelessly and learned quickly. Many interns have returned as seasoned wildland firefighters, providing great leadership and mentoring of incoming SCA interns. The seasonal fire crew model has been so successful--as the graph to right shows--that in 2014, the DNR expanded the program into two crews. Crews are placed regionally, based in southeast and west-central Georgia but work state-wide. The success of the fire crews is related to the 24 hour availability and flexibility to travel state-wide at a moment's notice.

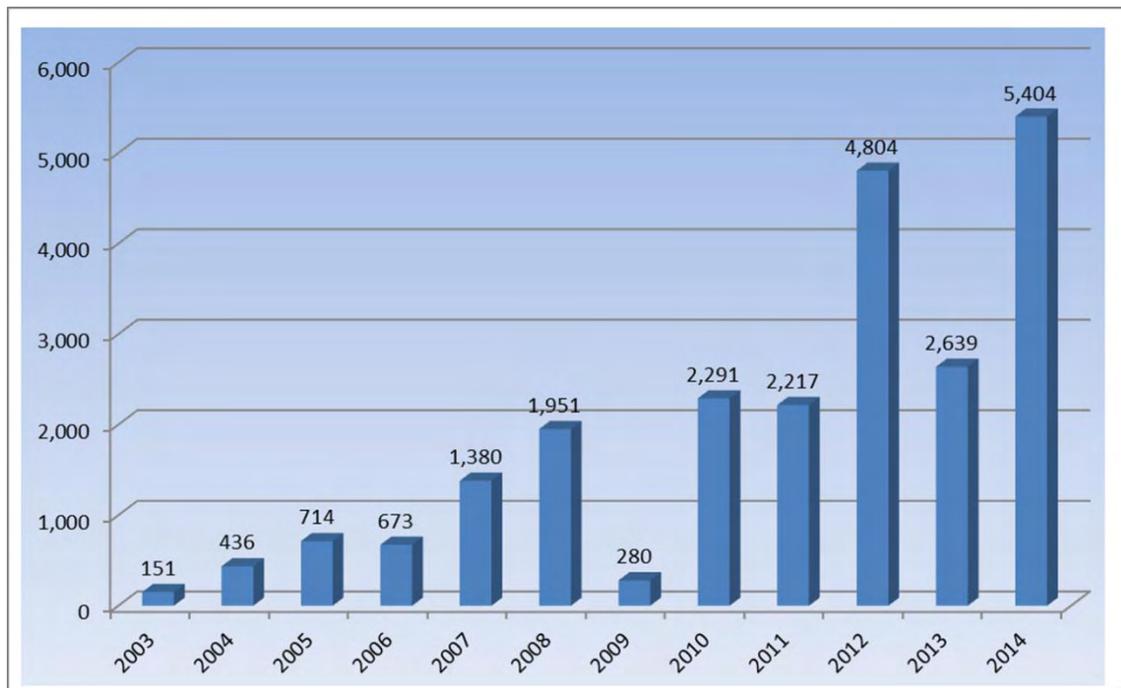


This allowed DNR fire managers to move crews to priority sites wherever weather forecasts are in prescription. The fire crews freed up DNR biologists to work on other high priority projects.

While trends are definitely moving in the right direction, managers at DNR recognize that we are not burning enough acres. If one considers that WRD manages over 363,000 acres of state-owned land, 17,760 acres of DOT mitigation lands, and the Parks, Recreation, and Historic Sites Division manages over 67,490 acres of State Parks and Historic Sites, it's a daunting task. One tool that is used is to determine how much burning is appropriate is the Fire Needs Assessment. The spreadsheet below shows a typical Fire Needs Assessment, where burnable acreage is calculated, fire frequency is determined, and acres burned are recorded. Goals for burning can be set based upon these numbers and then actual acres burned can be scrutinized each season. This can help direct resources to areas that are not hitting their target. This analysis requires a great deal of time to collate information and thought and interpretation to produce meaningful results.

Natural Area	State-owned Acreage	County	Burnable Acreage	Fire Freq	Acres Burned FY 2009	Acres Burned FY 2010	Acres Burned FY 2011	Acres Burned FY 2012	Acres Burned FY 2013	Acres Burned FY 2014	(%) FY 2014
Big Dukes Pond NA	1,692	Jenkins	1,690	Med	0	155	0	170	0	0	0%
Big Hammock NA	786	Tattnall	680	Med	0	310	0	0	340	0	0%
Black Creek NA	700	Taylor	700	High	175	295	270	450	270	450	64%
Doerun Pitcherplant Bog NA	651	Colquitt	620	High	135	281	319	350	146	105	17%
Egg Island Bar NA	226	Mcintosh	20	High	0	20	20	20	20	20	100%
Fall Line Sandhills	875	Taylor	881	High	334	0	514	335	990	380	43%
Moody Forest NA	4,425	Appling	2,850	High	984	1,495	1,050	1,155	841	1,179	41%
Ohoopsee Dunes NA	2,507	Emanuel	2,200	High	100	1,055	490	80	690	495	23%
Sprewell Bluff NA	3,150	pson/Talb	3,000	High	825	380	2136	1280	515	1745	58%
<b>Total Acres:</b>	<b>15,012</b>		<b>12,641</b>		<b>2,553</b>	<b>3,991</b>	<b>4,799</b>	<b>3,840</b>	<b>3,812</b>	<b>4,374</b>	<b>35%</b>

Another important trend in the DNR prescribed burning program is the increase in growing season fire. In 2005, a little over 700 acres of state lands were treated with growing season fire, compared to over 5,400 in 2014. Increased training and experience as well as building specialized fire equipment have all contributed to this positive trend.



Changing up the seasonality of a burn is very important ecologically. Periodic fires in the growing season can improve habitat in ways that a dormant season fire cannot. Growing season burns are incredibly effective in controlling undesirable hardwood species, promoting native species, and in restoring and maintaining the herbaceous vegetation that provides crucial habitat for brood-rearing birds as well as critical fuels for continued fire.

DNR has used the increased use of prescribed fire as an opportunity to promote the tool with landowners and the general public. Staff have developed education and outreach materials, including kiosk posters, bookmarks, and interpretive brochures. Press releases are prepared throughout the year to heighten the awareness about fire and to inform the public of current DNR activities. Staff also give presentations to schools and colleges as well as civic and conservation groups and host educational events for the public such as Fire on the Mountain. At these events, people are able to learn firsthand about prescribed burning, including seeing fire equipment, listening to speakers, and watching a prescribed burn in real time.

DNR's commitment to fire is also evident in their involvement in the Georgia Prescribed Fire Council (GPFC). Staff have been active on the steering committee since the group's inception in the early 2000's. In 2014, DNR took the helm of the group as Shan Cammack was elected Chair of the Council.

Prescribed fire is used in conjunction with other management tools, such as thinning timber, planting native tree species, restoring native groundcover, and eradicating exotic species. This is outlined in DNR's Fifty Year Plans, which are discussed earlier in this chapter. The goal of using a combination of practices is to improve altered habitats and to restore and enhance natural habitats. As outlined in the SWAP, habitats supporting rare species are made a priority for these management techniques. It is important to monitor the effects of management to ensure that the practices are achieving their objectives. DNR conducts both formal and informal monitoring to provide feedback to the adaptive management loop. One example is Fire Foto Monitoring, which is a set of protocols to take pre- and post-burn photos at specified locations. Qualitative analysis of these photos reveals if management objectives are being met. Future planning relies on the findings of the monitoring. More information can be found in the Monitoring Technical Team's chapter.



## Spotlights on Conservation

### Wildlife Resources Division Staff

Habitat restoration success stories can be found state-wide on WRD-managed lands. The following section highlights a state-owned property in each region and details the management for species of conservation concern.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

#### **Region 1: Paulding Forest /Sheffield WMA, Brent Womack**

Sheffield WMA is located within the Paulding Forest, Tallapoosa/Dugdown SWAP priority area. This area is on the northern boundary of Piedmont physiographic region and contains some of the best examples of natural mountain longleaf stands in Georgia. Over the past 10 years several efforts have been made to manage for and restore the rare mountain longleaf habitat type. Starting eight years ago 260 acres of uplands were marked for selective thinning within a 900 acre project area. The objectives of the thin were to remove overstory hardwood encroachment, to release longleaf and shortleaf pine, and open up the canopy. Upon completion of this thin a prescribed burn program was initiated. The entire project area, as well as surrounding natural stands that weren't thinned, have been placed on a 3 year burn rotation. Since the thinning was completed seven years ago the entire project area has been burned twice with one block having been burned three times. The response from the ground cover has been dramatic, with the development of lush groundcover. In addition to the project area we have also prescribed burned another 900 acres of adjacent natural pine forest on Sheffield in recent years.

At the same time we have been working on Sheffield to manage natural longleaf stands we have begun a management program on adjacent Paulding Forest that will eventually result in converting the planted loblolly pine stands to longleaf. The first steps in the process have been completed with the thinning of these loblolly stands and the introduction of a controlled burn program. A 3,000 acre area of the state owned portion of Paulding Forest has been identified as a mountain longleaf priority area and will be converted first with additional stands following suit as it becomes feasible. Within the last six years over 2,100 acres of the longleaf priority area has been burned once with much of it having been burned twice. The remainder will be rolled into the prescribed burn program over the next couple of years as we complete land acquisitions from the current owners.



One exciting result of this habitat work has been the recent documentation of fox squirrels on this part of Paulding Forest. Fox squirrels have been known to be abundant on neighboring Sheffield, but had not been known to inhabit the converted stands in recent years. With the thinning operations in these loblolly stands and the prescribed burning that has taken place the ground cover on Paulding Forest has responded well and we look forward to further improvements of the wildlife habitat in the future.

#### **Region 2: Wilson Shoals WMA, Kevin Lowrey**

Wilson Shoals WMA is located in Banks County, Georgia just south of Alto. The 2,800 acre area was former farm and timberland. The habitat is primarily oak-hickory forest with some remnant loblolly, shortleaf, and Virginia pine stands.

Management focus on Wilson Shoals WMA has been to provide quality habitat for a variety of recreation activities including hunting, hiking, camping, and wildlife watching. With the area being dominated by dense oak-hickory stands, our focus has been to create more habitat diversity and enable the use of prescribed fire. With that in mind, we have begun converting several areas to shortleaf pine with the ultimate goal being diverse shortleaf pine/bluestem grass woodlands that can be maintained with prescribed fire.

The conversion is a slow process that we are accomplishing in several ways. In 2007, we planted 70 acres of shortleaf pine seedlings in areas of pine beetle kill. In 2013, we clear-cut two 25-acre stands and replanted them with containerized shortleaf pine. Also in 2013, we were able to implement our preferred conversion strategy, which would be natural shortleaf pine regeneration. We were able to thin 55-acres of ridge tops leaving shortleaf pine seed trees and fire tolerant oaks. These areas will hopefully naturally seed with short-leaf pine. We will continue to monitor and provide hardwood control as needed. Building on that success, we have identified several areas to duplicate the same treatment. Over time, we will convert as much as 1,000 of the 2,800 acres to shortleaf woodlands that will be fire maintained.



We are excited not only to create added diversity to the Wilson Shoals WMA for wildlife benefit, but we also hope to encourage a rare plant that is found on the area, Georgia Aster (*Symphyotrichum georgianum*). In the fall of 2012, Georgia Aster was discovered growing in a gas utility right of way on Wilson Shoals. This was once a candidate species and now has a conservation plan in place. A meeting on the area in the fall of 2013 resulted in a plan to burn a woodland ridge top where we had found a single Georgia aster plant. The burn went great and we hope to see the benefit this fall. With Georgia aster on the area and as more shortleaf woodlands are created, we

expect this species to flourish along with a suite of other forbs and wildflowers.

### **Region 3: Yuchi WMA, IB Parnell**

Yuchi Wildlife Management Area (WMA) is comprised of 7,454 acres in Burke County along the Sand Hills Fall Line adjacent to the Savannah River. It is located on Georgia Highway 23 within 30 miles of Augusta, Georgia. Approximately 6,000 acres of the habitat is upland pine and pine/scrub oak mixtures. There are several creek bottoms and 3 miles of Savannah River frontage with moist to wet soils.

Yuchi WMA was purchased in 1988 from Kimberly-Clark Corporation, a forest products company. Most of the area has been cutover and replanted in loblolly and slash pines, replacing the natural longleaf-wiregrass-scrub oak community. The loblolly and slash pines are poorly suited to the dry, sandy soils found on the area and consequently are growing very poorly. The main use of the WMA is hunting for white-tailed deer, wild turkey, mourning dove, squirrel, raccoon and other game species. Fishing and boating access to the Savannah River is an additional attribute of this tract. A very popular shooting range is also present. Because of its location and soil composition, Yuchi also provides habitat for important nongame species like the gopher tortoise (*Gopherus polyphemus*).

The long-range habitat management plan for Yuchi is for the entire upland pine habitat to be converted to longleaf pine. Conversion from loblolly and slash pine to longleaf pine benefits many early successional habitat dependent species because longleaf is a fire-adapted pine species. The growth character of longleaf also allows ample amounts of sunlight to reach the forest floor, thereby stimulating many understory plant species to grow. Implementation of the long-range management plan began in 1990 and 2,279 acres have been converted to longleaf to date with an additional 1,200 acres to be planted this winter. To maintain this longleaf ecosystem, 1,000-1,500 acres are burned annually using prescribed fire. Prescribed fire prevents hardwood saplings from overtaking the longleaf understory and stimulates the growth of fire-adapted understory plant species like wiregrass, gopher apple and beargrass.

The Wildlife Resources Division's Nongame Conservation Section surveyed Yuchi for gopher tortoises in 2011 and determined that the WMA could sustain more gopher tortoises than were currently on the area. Since 2012, Yuchi WMA has become home to at least 40 translocated gopher tortoises. These tortoises appear to be acclimating well. In 2014, gopher tortoise hatchlings were released at Yuchi augmenting the growing population.

#### **Region 4: Fall Line Sandhills WMA, Nathan Klaus**

At 876 acres, Fall Line Sandhills WMA is one of the smaller WMAs in the state, however it has more rare, threatened and endangered species on it than any other WMA in Georgia. Purchased in 2007, this former timber company land seems an unlikely site to harbor such diversity. Years of agriculture followed by heavy-handed forest management have left a mark on the property. Many of the rare species found on this property had been declining for decades and many had perilously low populations at the time of state acquisition. Time was of the essence and habitat restoration was needed.



Less than ten years later most rare species are making a turn around. Gopher tortoise populations have more than doubled on the property and reproduction levels are high, almost 30 times higher than when the land was acquired. Surveys of Bachman's sparrows, a state threatened species, estimated only 8 territories in 2008. In 2014 there are an estimated 40 territories. Even game species such as northern bobwhite (another high conservation priority bird) have tripled their populations.

The following tools were used to accomplish this:

- Prescribed Fire – Since acquisition the entire property has been put on a 2-3 year fire return interval. Most fires are conducted in the growing season to better control hardwood encroachment and to encourage the recovery of native grasses
- Herbicide Application – Selective herbicides have been used over about 90% of the property to control hardwood and blackberry encroachment. Prior to their use, research was conducted on site for several years to guide decisions on which herbicides would achieve management goals while conserving groundcover

- Timber Management – Nearly all of the property (about 80%) has either been thinned or clearcut and replanted to longleaf pine. Harvest objectives put habitat restoration as a priority over timber production. Stands were thinned to low basal areas (about 50 square feet/acre) and some marginally productive loblolly pine was clearcut to make way for longleaf pine restoration
- Native Grass Restoration -- Grass seed was collected from on site and grown into grass plugs. About 110,000 native grass plugs have been planted to help develop grassy fuels for prescribed fire and to create habitat for Bachman’s sparrows, northern bobwhite and other grassland species
- Invasive Exotic Species Control – Several species of invasive exotics (Chinese privet, mimosa, and *Crotalaria spectabilis* and others) have been aggressively controlled.
- Wetland Creation – Several natural ponds, which are important breeding sites for gopher frog, striped newt and other listed species, are found on Fall Line Sandhills WMA. Climate change may be altering the hydroperiod of these ponds and limiting reproduction of rare species. Three artificial ponds were dug in 2013 with longer hydroperiods to give amphibians a wider range of breeding opportunities
- Monitoring and Research – All of these activities have been closely monitored to help us adaptively manage this site. Decisions which were made without perfect information were followed up with good monitoring, allowing corrections and adjustments as needed. Monitoring included herbicide trials, tracking longleaf pine seedling survival, photopoints to document fire effects, surveys of amphibian use in natural and artificial ponds, gopher tortoise censuses, Bachman’s sparrow surveys, monitoring of presence and reproductive success of Southeastern American kestrels and other efforts. Without strong monitoring, adaptive management would not be possible.

#### **Region 5: Silver Lake WMA, Brent Howze**

Silver Lake Wildlife Management Area (WMA) is located in the Upper Coastal Plain Physiographic Province in Decatur County, Georgia. This WMA consists of 8,430 acres of state-owned property and 1,212 acres of land leased from the U.S. Army Corps of Engineers (COE). Silver Lake WMA is located approximately 10 miles southwest of the Bainbridge city limits and was formerly part of International Paper’s Southlands Experimental Forest. The WMA consists of mixed upland vegetative cover types interspersed with numerous depressional wetlands, ponds, and 370-acre Silver Lake. Silver Lake WMA is unique among state-owned properties in Georgia in possessing extensive longleaf pine-wiregrass forest coverage (3,060 acres).

Due to its location and habitat composition, Silver Lake WMA offers a prime opportunity for restoration of fire-maintained open pine savanna and other early succession habitats and associated wildlife species. Pine savanna is one of the most diminished habitat types in the Southeast and a priority for restoration in Georgia’s State Wildlife Action Plan, America’s Longleaf Initiative, Georgia State Forestry Assessment and Strategies, and the National Bobwhite Conservation Initiative (NBCI). A major focus of Silver Lake WMA is the management and restoration activities for species inhabiting the longleaf system including



high priority species such as the endangered red-cockaded woodpecker, gopher tortoise, Bachman’s sparrow, as well as Northern bobwhite. This WMA is one of the few public land tracts in Georgia with potential for long-term sustainability of viable and harvestable bobwhite populations as well as the only state-owned land with a red-cockaded woodpecker population.

Since the acquisition of Silver Lake WMA in 2008, collaborative efforts between WRD’s Nongame Conservation Section and Game Management Section have led to habitat restoration efforts across much of the landscape. These efforts have allowed for the burning and harvesting of over 900 acres of native ground cover that is used on restoration endeavors on additional state WMAs. Prescribed burning stimulates herbaceous plants, increases the

quantity and quality of browse, controls undesirable vegetation and pests, improves access within stands, and enhances brood-rearing and nesting cover for early successional species and ground nesting birds. Growing season burns have been particularly important in this restoration.

Dormant season prescribed burning has been the predominant technique employed to manage understory vegetation on Silver Lake WMA. Prior to 2010 burn units were typically large (250-1,500 acres) contiguous blocks. Although this management was necessary for short-term fuel reduction, burning large contiguous blocks is not conducive to many wildlife species of concern as large burn units eliminate or significantly reduce the food and cover within their home ranges. In order to create a more appropriate spatial distribution of cover across the landscape, our goal is to reduce burn units to 100-acres or less burned on an alternating schedule and to move to a growing season fire regime. This would ensure a “checkerboard” pattern of burned and unburned blocks across the WMA and reduce the impact of prescribed burning on cover availability. The establishment of smaller burn blocks and varied burn seasonality allows for a greater juxtaposition of stands with different burn histories, which creates more landscape diversity and benefits multiple species.

One of the most important objectives of Silver Lake is the expansion of the current RCW population by restoring longleaf pine and associated understory vegetation. To date, there has been an increase from 18 to 25 breeding pairs of red-cockaded woodpeckers on the property. Restoring longleaf habitat will enhance biodiversity and provide additional small-game hunting opportunities, particularly for bobwhite quail as well as provide additional habitat to other grassland obligate species. The acreage of longleaf pine on Silver Lake WMA is scheduled to increase from 3,063 acres to 6,241 acres over the next 50 years. The major change will be the conversion of approximately 1,163 acres of slash and 1,944 acres of loblolly pine plantation to longleaf pine stands. The amount of acreage in open land, specifically wildlife openings, is scheduled to increase as well to approximately 600 acres of fallow openings.

#### **Region 6: Flat Tub WMA, Greg Nelms**

Flat Tub Wildlife Management Area (WMA) is located in the Coastal Plain Physiographic Region in Coffee and Jeff Davis Counties, Georgia. This WMA consists of 6,669 acres: 4,659 acres of state-owned property (DNR – 4,309 acres, GFC – 350 acres) and 1,660 acres of mitigation land owned by Plum Creek Timberlands. Flat Tub WMA is located approximately 13 miles southwest of the Hazlehurst city limits. Major vegetative cover types include pine uplands, river bottomland, and mesic hardwood drains. Flat Tub is unique among state-owned properties in Georgia in containing a significant number and distribution of “Altamaha Grit” sandstone outcrops, adjacent bogs and seeps, and associated rare plant species.

Flat Tub plays into a unique landscape scheme of high conservation value. The WMA sits immediately across the Ocmulgee River from the 8,100-acre Horse Creek WMA and the 2,500-acre Orianna Society Indigo Snake Preserve and just north of 1,500-acre Broxton Rocks Nature Conservancy Preserve and the 350-acre Georgia Forestry Commission Forest Legacy tract. On a broader scale the tract sits within the greater Fort Stewart-Altamaha Significant Geographic Area for longleaf pine. It is an extremely high priority area for the State of Georgia and collaborating conservation organizations, and has been the subject of several grant-funded projects. Future habitat developments across these properties will provide a large contiguous landscape necessary for the long-term viability of many species of concern.

Due to its location and habitat composition, Flat Tub WMA offers a prime opportunity for restoration of fire-maintained open pine savanna and other early succession habitats and associated wildlife species. Portions of the WMA’s uplands were heavily cut over by previous landowners, but possess truly outstanding groundcover of wiregrass and other herbaceous species. Pine savanna is one of the most diminished habitat types in the Southeast and a priority for restoration in Georgia’s State Wildlife Action Plan, America’s Longleaf Initiative, Georgia State Forestry Assessment and Strategies, and the National Bobwhite Conservation Initiative (NBCI). A major focus of Flat Tub WMA is the management and

restoration of high priority species inhabiting the longleaf system including the Eastern indigo snake, gopher tortoise, and northern bobwhite.

Since the acquisition of Flat Tub WMA in 2006, collaborative efforts between WRDs Nongame Conservation Section and Game Management Section have led to habitat restoration efforts and baseline wildlife and plant surveys across much of the landscape. These efforts have included burning over 1,500 acres and preparing 850 acres for replanting longleaf pine with another 318 acres identified for replanting in the near future. Conversion to longleaf will continue over several thousand acres as the current loblolly pine stands reach their rotation age. A recent large-scale gopher tortoise survey effort estimated the Flat Tub minimum population at 108 individuals (0.16/ha) and found a high-density population on the neighboring Broxton Rocks Preserve. Survey and monitoring of Eastern indigo snakes and rare plants are ongoing.



Photos from a game camera set up post growing season burn 2014 on the Rocky Hammock tract.

### **Region 7: Townsend WMA, David Mixon and Kara Nitschke**

Townsend WMA is located on the north side of the Altamaha River in Long and McIntosh Counties. Acquisition of land now associated with Townsend WMA began in 2007. Townsend WMA now totals around 32,000 acres. Included in this acreage are thousands of acres of sandhills habitat that have been targeted for restoration to a longleaf-wiregrass ecosystem. Nearly 100% of the planted sand pine or offsite slash and loblolly has been removed from the sandhills and the majority of these clearcuts have already been planted into longleaf. The habitat change is already evident, as the sandhills are now producing many different plant species in abundance where the habitat previously was subdued by the sand pine overstory. Gopher tortoises that were primarily found on road edges and powerline right-of-ways have moved out into these newly reforested areas.

The restoration of this area to a longleaf system is still underway, but the progress is very evident and habitat response has been very encouraging. In the winter of 2013-14, 785 acres of longleaf pine were planted on Townsend WMA by DNR's Forest Management Unit. Reforestation efforts on Townsend WMA are a collaboration (years in the making) between FMU, GM, and NG sections of DNR along with multiple other stakeholder agencies in an effort to return the sites to naturally occurring forest ecosystems.

Townsend WMA is one of only two known sites in Georgia that have a naturally occurring population of Radford's mint, an endangered herb found only in McIntosh County, Georgia. DNR's Nongame section has worked to provide more suitable habitat for this rare plant by selectively hand-felling surrounding offsite sand pine in an effort to promote population growth.



## **Oyster Restoration and Enhancements**

**Jan Mackinnon, Dominic Guadagnoli, and January Murray (GADNR CRD)**

The Coastal Resources Division is the state agency entrusted to manage Georgia's coastal marshes, beaches, waters, and marine fisheries resources for the benefit of present and future generations. The Division's service area extends from the inland reach of the tidal waters to three miles offshore. In 1970, the Georgia General Assembly passed the Coastal Marshlands Protection Act due, in part, to the value of the estuarine area to species of marine life and wildlife and the fact that the marshlands provide a nursery for commercially and recreationally important species of shellfish and other wildlife. Shellfish continue to be an important component to both commercial and recreational fisheries. Some species, such as the Eastern oyster (*Crassostrea virginica*) also have significant ecological value to estuarine systems by acting as a keystone species that support a host of marine fishes and other invertebrates, as well as their ability to efficiently filter water.

	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combatted Invasive/Alien Species</i>

CRD's Habitat Work Group is engaged in actively restoring, enhancing and monitoring oyster reefs along the coast. These projects are designed and constructed in harvest areas to enhance existing reefs to support a long standing fishery on the Georgia coast. In addition, projects are planned each year to restore reefs outside of harvest areas for fish habitat. These projects are partnership projects that deploy cultch material at suitable locations. Lastly, property owners have begun to use oyster clutch materials and native marsh plants to stabilize erosional shorelines. All of these initiatives require pre and post monitoring of sites for recruitment and stability.



CRD staff place bagged oyster shell in Plantation Creek, Glynn County.



Recruitment in Oyster Creek, Chatham County harvest area



Use of oyster shell material to stabilize eroding shoreline on Sapelo Island, GA.

## **Working Farms and Forestlands**

### **Reggie Thackston (GA WRD) and James Tomberlin (GA WRD)**

Georgia's landscape is 93% privately owned with the majority of its undeveloped lands being managed for agricultural and/or forestry outputs. The long-term viability for many wildlife populations depends on the successful integration of habitat practices into these working farm and forestlands. Results from more than 10 years of implementing Georgia's Bobwhite Quail Initiative, along with empirical evidence gained in the delivery of Farm Bill and other private lands programs, show that financial incentives and professional technical assistance are critical components to successfully restore and sustain priority wildlife habitats and species on private lands. Along with the Farm Bill, other state, federal and non-governmental programs have the potential to make strong contributions to wildlife management on working farm and forestlands to: 1) enhance habitat for species of conservation concern including rare, threatened, and endangered species, 2) prevent species from reaching regulatory status, and 3) keep common species common.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combated Invasive/Alien Species</i>

Conservation programs authorized and funded through the Farm Bill impact wildlife habitat at the landscape scale. For example, across Georgia during 1998-2009, the Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentives Program (WHIP) and Wetlands Reserve Program (WRP) collectively resulted in over 210,000 acres of longleaf pine planting (Figure 2), 31,000 acres of pine thinning, and 300,000 acres of prescribed burning. In fact, funding for Farm Bill conservation programs and practices potentially exceeds revenue from all other wildlife conservation funding sources.

Somewhat consistent with Georgia SWAP, in 2011 the Georgia Natural Resources Conservation Service (GA NRCS) worked with conservation partners to develop a State Natural Resources Assessment (SRA). The SRA is a prioritization process across five land use categories for nine identified resource concerns including fish and wildlife habitat. The SRA purpose is to guide and focus Farm Bill program delivery during 2012 - 2014 to optimize natural resource returns on taxpayer investments. Georgia NRCS engaged conservation partners to rank the resource concerns in order of importance and estimate the acres needing treatment. Table 1 shows the results for the NRCS Inadequate Habitat for Fish and Wildlife concern within the four applicable land uses. Forestland ranked highest in both priority and estimated treatment acres for fish and wildlife habitat. Forest habitat management needs vary with landscape context from riparian forest buffers, to forested wetlands, to fire-maintained woodland savanna. Agriculture and pasture lands were also prioritized for wildlife enhancement and offer the opportunity for integration of naturally vegetated fallow habitats to benefit wildlife species dependent on early stages of plant succession, such as grass-forb-shrub.

Table 1. Georgia NRCS 2012-2014 State Resource Assessment (SRA) for the Inadequate Habitat for Fish and Wildlife Resource Concerns.

Land Use	Potential at-risk acres	Acres Needing Treatment	Priority Rank 1 = Highest	Priority Treatment Acres
Crop	30,114	27,176	9	2,000
Pasture	110,550	90,410	8	10,000
Forest	12,937,704	12,455,643	4	500,000
Other Assoc. Ag Land	132,636	128,922	5	30,000

Woodland savanna, early succession habitats, and associated wildlife are identified as a priority for conservation in various national, regional, and state conservation plans. Examples include America's Longleaf Initiative, North American Landbird Plan, and the National Bobwhite Conservation Initiative. More specifically, Georgia WRD identifies the northern bobwhite, Georgia's state gamebird as a species of specific conservation focus. Additionally, bobwhites serve as an indicator for a much larger association of non-game and game species of conservation concern.

Widespread changes in land use, which have reduced the abundance and distribution of woodland savanna and early succession habitat, have caused bobwhite populations to decline by more than 90% since 1966. Collectively, these landscape changes have fragmented what was once a "sea" of early succession habitat into "habitat islands" that are becoming increasingly smaller in size and further apart. The overall result of this habitat loss and fragmentation is severely reduced bobwhite survival and population sustainability.

Bobwhites are not the only species suffering from this landscape scale habitat change. Georgia SWAP identifies 45 animal and 132 plant species that are associated with native grass-forb-shrub habitats and are of priority conservation concern. Additionally, quality early succession benefits wildlife species that are more abundant and adaptable than bobwhites (e.g., eastern wild turkey, white-tailed deer, and cottontail rabbit) and are important to Georgia's hunters and other citizens. In short, the bobwhite decline is indicative of a dramatic ecological change with widespread ecological, economic, and recreational impacts.

Similarly, bobwhites and other grassland obligates have experienced longterm population declines across the Southeast. In response to this decline the National Bobwhite Conservation Initiative 2.0 (NBCI 2.0) was developed by over 600 wildlife biologists and managers from 25 states and released in 2011 as a collaborative plan to restore woodland savanna and native grassland habitats ([www.bringbackbobwhites.org](http://www.bringbackbobwhites.org)).

In Georgia, as part of the NBCI 2.0 process, Tall Timbers Research Station and Land Conservancy staff, with input from biologists and managers from WRD and 11 other conservation organizations conducted a statewide habitat analysis to identify, rank and prioritize portions of counties for habitat restoration. Through this collaborative process geographic areas were prioritized as high, medium or low based on their bobwhite restoration potential and management constraints (Figure 1 and Table 2).

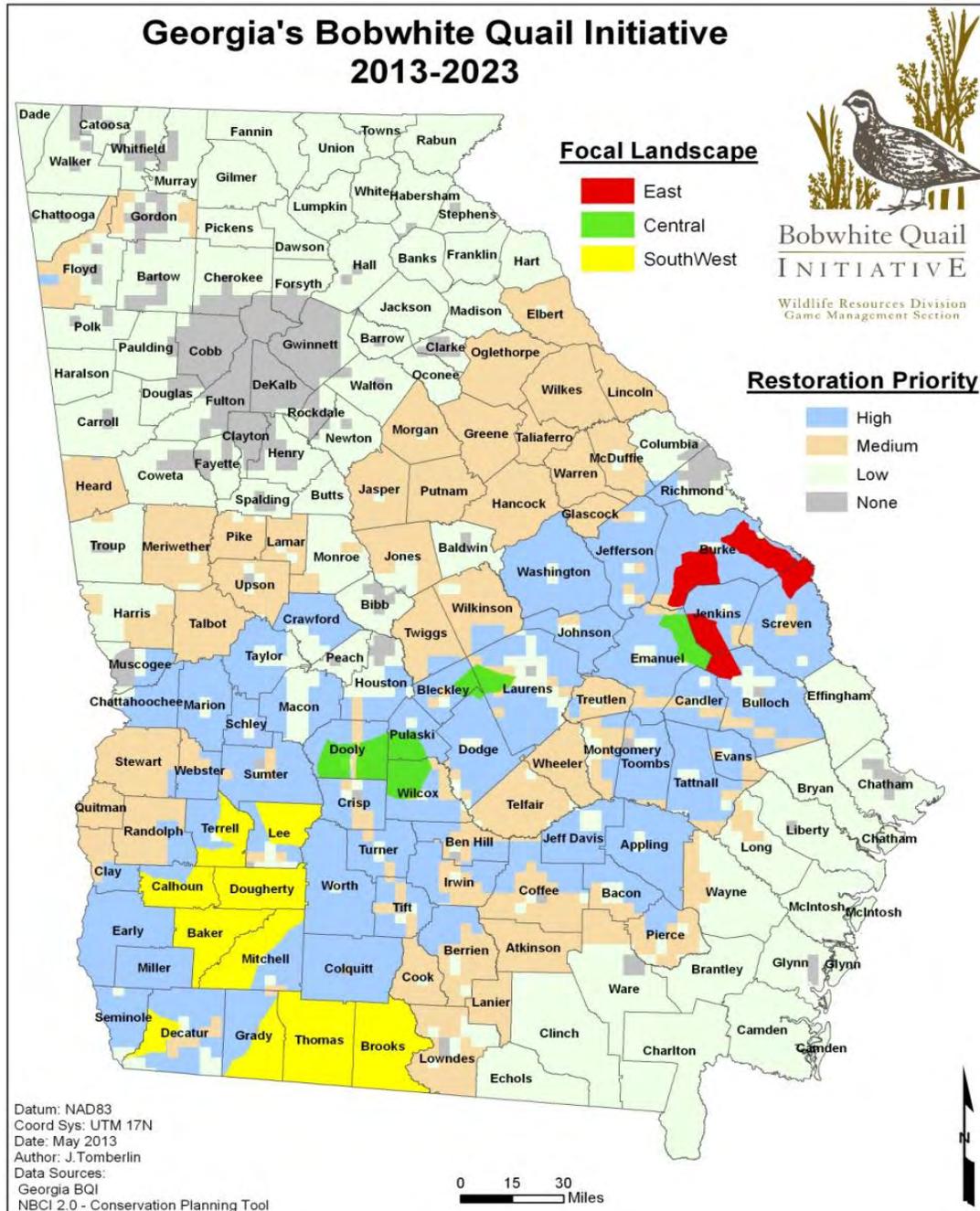


Figure 1. Habitat restoration priority delineated by Georgia’s Bobwhite Technical Team (GBTT) as part of the National Bobwhite Conservation Initiative Revision (NBCI 2.0). Areas in red, green and yellow represent 22 Focal Landscapes targeted for pine savanna and early succession habitat restoration in Georgia’s Bobwhite Quail Initiative Implementation Plan 2013-2023.

Table 2. Acres ranked as medium or high priority during the biologist ranking information workshop of the National Bobwhite Conservation Initiative 2.0.

Focal Region	Area*	Forest*	Crop*
Southwest	6,429,308	3,319,124	1,361,834
Central	4,964,576	2,842,830	655,162
East	2,454,314	1,290,371	418,073
Total	13,848,198	7,452,327	2,435,070

These high and medium priority areas were then further analyzed and filtered using the criteria of overall context, proximity to existing core bobwhite populations and WRD infrastructure. That analysis resulted in the delineation of 22 BQI Focal Landscapes into which funding and technical assistance will be prioritized for pine savanna and early succession habitat restoration (Figure 1). Habitat implementation strategies were then developed to achieve bobwhite population objectives. Analysis of habitat conditions within these Focal Landscapes revealed the potential and need for 58,360 acres of heavy pine thinning, 209,844 acres of additional prescribed burning and 63,205 acres of fallow cropland margins (Table 3).

As per the NBCI 2.0 protocol monitoring will occur for bobwhites, selected songbirds and habitat occurrence on at least one treatment and control focal area within each of the targeted landscapes. Spatially explicit delineation of landscapes and targeted acres for management are provided in the Georgia WRD Bobwhite Quail Implementation Plan 2013 – 2023 <http://www.georgiawildlife.com/conservation/quail>.

Table 3. Georgia Bobwhite Quail Initiative habitat restoration needs identified within 22 Focal Landscapes to achieve bobwhite population goals.

Focal Region	Soil & Water Conservation District	Focal Landscape (County)	Acres	Habitat Restoration Needs <sup>a</sup>		
				Pine		
				Thinning <sup>b</sup>	Rx Burning <sup>c</sup>	Cropland <sup>d</sup>
Southwest	Flint River	Baker (Baker)	118,564	3,464	0	5,041
		Calhoun (Calhoun)	103,326	1,743	0	3,743
		Dougherty (Dougherty)	31,521	1,353	0	509
		Grady (Grady)	97,623	3,533	0	2,117
		Mitchell (Mitchell)	190,000	3,100	0	6,135
		Silver Lake (Decatur)	46,542	2,694	0	2,389
	Lower Chattahoochee	Lee (Lee)	97,326	2,277	9,166	3,435
		Terrell (Terrell)	100,842	2,465	9,924	3,864
	Middle South Georgia	Brooks (Brooks)	301,088	5,315	0	5,741
		Thomas (Thomas)	213,397	7,730	0	4,094
Worth (Worth)		116,923	4,454	0	4,024	
Central	Central Georgia	Buckhorn (Bleckley, Dodge, Laurens)	67,013	2,918	29,175	1,627
	Ocmulgee	Dooly (Dooly)	71,148	1,501	14,616	4,162
		Pennahatchee (Dooly)	60,561	1,010	9,837	3,263
		Pulaski (Pulaski)	53,346	863	8,404	2,479
		Wilcox (Wilcox)	82,226	2,822	27,478	2,151
	Ohoopsee River	Emanuel (Emanuel)	72,254	2,216	22,439	1,421
East	Brier Creek	Di-Lane (Burke)	97,502	2,238	20,720	2,876
		Jenkins (Jenkins)	55,376	1,872	17,337	1,496
		Yuchi (Burke)	88,257	2,730	25,281	1,656
	Ogeechee River	Bulloch (Bulloch)	36,527	946	7,098	290
		Screven (Screven)	44,377	1,116	8,371	693
Totals		22	2,145,739	58,360	209,846	63,205

<sup>a</sup> Habitat Restoration Needs are acres established through direct habitat management.

<sup>b</sup> 10% estimated from 2009 USDA Cropland Data Layer and percentage of pine needing thinning based on analysis of stand composition using 2008 Forest Inventory Analysis data.

<sup>c</sup> Additional acres needing prescribed fire based on acres of pine burnable from 2008 Forest Inventory Analysis data, burn acres permitted by Georgia Forestry Commission and assuming a 2-yr burn interval.

<sup>d</sup> 10% of

## **Private Lands Program Summary**

### **Eric Darracq (GA WRD)**

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The following programs supported by the Georgia DNR Wildlife Resources Division have played a role in supporting SWAP objectives.

#### **Bobwhite Quail Initiative**

BQI provides technical assistance for private landowners who are interested in increasing quail and populations through habitat restoration. Georgia's quail population has declined by approximately 90% since the early 1960s primarily due to loss of quality early succession habitat. Restoring this habitat type within row crop agriculture & forest landscapes also benefits many songbirds & other wildlife, improves water quality, reduces soil erosion, and can economically enhance local communities by stimulating quail hunting and wildlife viewing. Landowners will be advised about available financial incentives. BQI is supported solely through proceeds of "Support Wildlife" vehicle license plate sales, grants, & direct donations.

In 2014, BQI biologists held 13 field days, prepared over 100 management plans, interacted with the media with newspaper articles and TV/radio interviews, and conducted research and surveys. Almost 6,000 people participated and over 285,000 acres were impacted.

Any private non-industrial landowner is eligible for a management plan. For service, visit <http://gohuntgeorgia.com/conservation/quail> & call a professional wildlife biologist within your GA BQI Focal Region: East- 706-554-3745, Central- 478-296-6176, or Southwest- 229-420-1212.

#### **Forest Stewardship Program (FSP)**

FSP helps private landowners manage their natural resources with a written management plan that integrates and focuses their objectives of sustaining quality native timber, wildlife populations, soil and water resources, aesthetics, and recreation. Plans prescribe select conservation practices for specific areas of land. A team of professional soil/water experts, foresters and wildlife biologists will provide you with a free tour of your land to monitor forest health, discuss your objectives, planning options for the next 10 years, available conservation incentive programs, & point out specific areas needing immediate attention. After they complete follow-up fieldwork you will receive a carefully tailored plan. WRD has helped the Georgia Forestry Commission with their program by reviewing/writing 546 FSP plans representing 118,016 acres & visiting 161 different properties with landowners.

Any private non-industrial forest landowner of 100-1000 acres is encouraged to apply. Applicants must have 10+ forest acres & 25+ total acres. To apply visit [www.gfc.state.ga.us](http://www.gfc.state.ga.us) and select Forest Management then Forest Stewardship. If wildlife is your focus objective, you can also inquire by calling a professional wildlife biologist at 706-557-3263.

#### **Conservation Program & Practice Guidance**

PLP biologists help private landowners find other technical and financial assistance programs that are most applicable for their objectives and land conditions. Many of these programs are offered through what is known as the "Farm Bill" and are summarized in the Landowner's Guide to Conservation Incentives at [www.georgiawildlife.com/node/807](http://www.georgiawildlife.com/node/807). Landowners can call their local conservation agency office using its directory. Services include written technical guidance, financial incentives to install conservation practices prescribed, and financial assistance to conserve land. Conservation practices are management actions that improve forest and other natural resources while helping you meet your objectives. Visit [www.gatrees.org](http://www.gatrees.org)

for Forestry Best Management Practices and [www.ga.nrcs.usda.gov/technical](http://www.ga.nrcs.usda.gov/technical) for practices in agricultural & forest lands.

**Forestry for Wildlife Partnership (FWP)**

FWP provides corporate forest landowners with technical guidance to enhance wildlife conservation through a strong proactive partnership. The program is voluntary, flexible, non-competitive and participant-driven. Participating companies are evaluated based on their involvement and forethought regarding wildlife conservation planning, education and outreach, management practices, sensitive sites/special concerns, recreation, and partnerships. Companies that achieve a certain level of wildlife stewardship on their lands are publicly recognized by the state. WRD's corporate forestry partners are CatchMark Timber Trust, Plum Creek (since 2004), and Georgia Power (since 1999). They own & manage a total of 1,054,299 acres in Georgia.

FWP had five partners from 2004-2006, when forest industry owned more land in Georgia. Any corporate forest landowner of 20,000+ acres in Georgia is eligible to receive technical guidance. To apply visit <http://www.georgiawildlife.com/node/1283> or call our FWP nongame conservation biologist (229-227-5422), game management biologist (706-557-3263), or public affairs representative (770-918-6787).

## **Resource Management in State Parks Division** **Sim Davidson and Brian Nichols (GA SPS)**

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The mission of Georgia State Parks is to “protect our state's natural beauty and historic integrity while providing opportunities for public enjoyment and education.” The first core value of state parks and historic sites is “stewardship of our state’s natural, cultural, and historical resources is fundamental to the understanding of our past and the well-being of our future.”

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combated Invasive/Alien Species</i>

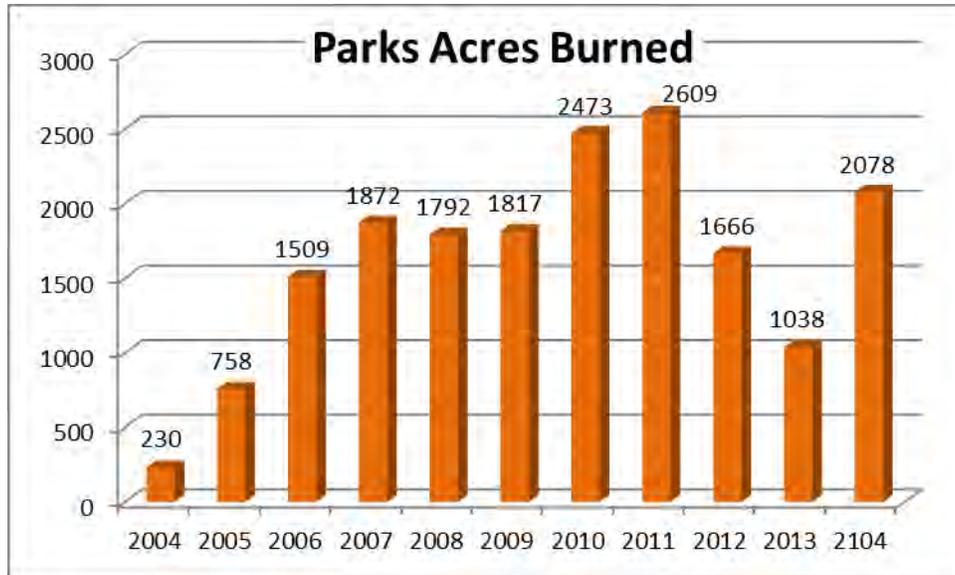
The management of the state parks natural resources falls under the responsibility of the Resource Management Unit (RMU), which was formed in 2011. A Resource Manager is assigned to each one of the two geographic regions (North and South). Primary responsibilities of the resource managers include prescribed fire, timber management, deer management, invasive/exotic species management, nuisance animal management, and natural resource management planning. Other components of the RMU include recreation, interpretation, and volunteer services.

### **Prescribed Fire**

Georgia State Parks is a part of the statewide Interagency Burn Team (IBT). Parks began training firefighters in 2005, and currently has a force of 68 members. The RMU helps manage the fire team by providing seasonal training and burning opportunities. They are slowly building their equipment cache and fire leadership.

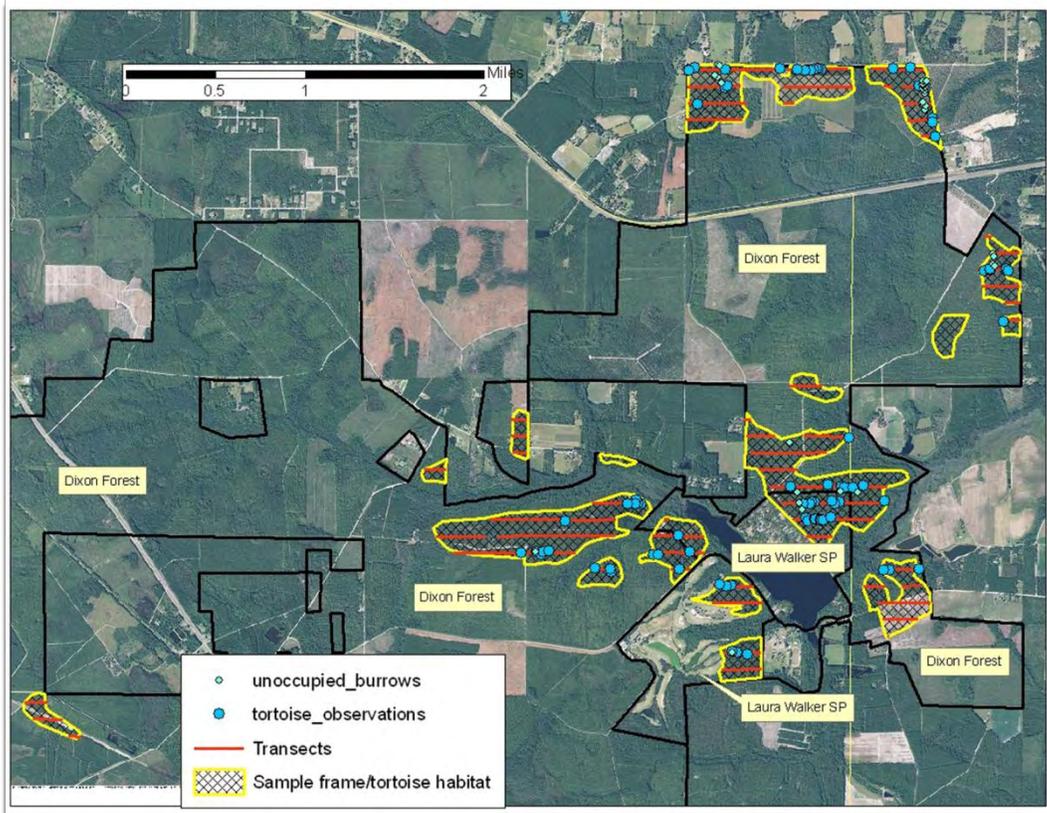
With the help of the Nongame Conservation Section, active fire management has been in place for almost a decade on high priority parks harboring rare species, including Crooked River, George L Smith, General Coffee, Laura Walker, Little Ocmulgee, Reed Bingham, and Seminole. Acres burned on state parks have increased dramatically over the past ten years, from about 200 in 2004 to over 2,000 in 2014. Parks resource managers have also been putting together plans for several new burn units at Fort Morris, Suwanee River Eco Lodge at S.C. Foster, George L. Smith, Kolomoki Mounds, Hard Labor Creek, and Sloppy Floyd.

Fire



photo

monitoring points have been established at parks across the state. Monitoring points have been set up at all parks that are actively burning for rare species. Most recently, points were established at Little Ocmulgee, George L. Smith, Georgia Veterans, General Coffee, Elijah Clark, and Mistletoe State Parks. These photo monitoring points enable practitioners to monitor the effects of fire on ecosystems and initiate adaptive management strategies for the future.



Gopher tortoise surveys have been conducted state-wide. The map above shows the high density of tortoises documented in 2014 at Laura Walker State Park is directly correlated with the prescribed burning program there.

Collaborating with Georgia Forestry Commission on fire management continues to increase. This past year, with significant assistance from GFC, Fort Mountain and Indian Springs were designated as Firewise Communities. The intention of the Firewise Communities Program is to reduce the loss of lives, properties, and resources to wildland fire by building and maintaining fire resistant communities in a way that is compatible with their natural surroundings.

### **Timber Management**

The RMU assists with managing forests and timber on 60+ parks and historic sites. The RMU coordinates with the Forest Management Unit (FMU) for assistance with timber harvests, re-forestation, etc. Recent highlights include:

- Reforestation projects have been initiated at Magnolia Springs, Hard Labor Creek, and FDR in tornado-damaged areas. Longleaf pine will be planted on appropriate sites.
- The RMU was awarded a Southern Pine Beetle Suppression grant which will be used for non-commercial thinning at Fort Yargo State Park. This twenty-two acre plot is part of a sixty-six acre tract that was clearcut a number of years ago in order to combat an intensive infestation of kudzu. Thinning this dense, naturally-regenerated pine stand will improve tree health and reduce the risk of pine beetle infestation.
- RMU continues to work with FMU to put into practice harvest plans for parks statewide. Timber thins are utilized to improve overall forest health, wildlife habitat, and recreational opportunities.

### **Nongame Species Management**

In addition to prescribed burning to restore and enhance habitat for rare species and other nongame species, Parks staff have used other management techniques. Some of these include planting of native trees and groundcover.

Chattahoochee Bend State Park will benefit from a project to enhance the population of a threatened and increasingly rare native wildflower, the monkey-face orchid. Funded through a grant received by the Atlanta Botanical Garden, and with assistance from the DNR Nongame Conservation Section, this project focuses on 3 of 11 known populations of the monkey-face orchid in Georgia. Seeds from these locations will be propagated by the Atlanta Botanical Garden and then introduced to a new location close by. Chattahoochee Bend is located very close to the Moore Creek population and offers similar wetland habitat for this orchid, making the park an ideal location to expand the population. In the coming year, the selected area at park will be prepared by removing overgrowth and opening the canopy for sunlight to reach the forest floor. The goal is to introduce the new orchids to the park during the winter of 2014-15.

This year, Panola Mountain State Park's Power of Flight area was officially recognized as an "Important Bird Area" (IBA). The goal of the IBA Program is to identify and conserve key breeding and feeding sites for birds. These areas provide essential habitats for one or more species of bird for breeding, wintering, or

migration. One of the primary reasons is the grassland restoration program that provides habitat for species such as swamp sparrows, woodcock, indigo buntings and blue grosbeak. This area represents a step toward restoring an area to quality native grassland on public land. Partners include GA DNR Nongame Conservation Section, Atlanta Audubon Society, GA Ornithological Society, GA Native Plant Society, The Nature Conservancy, etc.

### **Deer Management**

Areas where deer are overpopulated have suffered habitat degradation. The RMU takes the lead and assists designated sites with managed quota hunts. Quota hunts on the state parks began in the late 1990's and have continued ever since. In 2013, quota hunts occurred on six sites including Panola Mountain, Hard Labor Creek, Tugaloo, Richard Russell, Red Top Mountain, and Chattahoochee Bend. RMU staff attends the annual deer management meeting at WRD headquarters to determine which sites will be selected for hunts on a two year rotation. Managed hunts help improve both deer health and the habitat that supports them.

### **Invasive Exotic Species**

The RMU is tasked with the never-ending challenge of eradicating vegetative and aquatic invasive species from state park properties. Recent highlights include:

- The RMU oversaw numerous invasive species projects, both on land and water. Projects included treatment of kudzu at George L. Smith, treating the springs at Magnolia Springs, and privet resprouts at Chattahoochee Bend. Resource Managers also distributed chemical and backpack sprayers, as well as provided technical guidance to various sites for ongoing maintenance treatment of existing invasive species. Projects included treating Chinese privet at Gordonia-Alatamaha, Kolomoki Mounds, New Echota and Panola, bittersweet at Indian Springs, and Japanese Climbing Fern at Seminole and Mistletoe, as well as Autumn Olive at various locations.
- The RMU has partnered with the University of Georgia to provide training on treating aquatic invasives. RMU also hosted an invasive workshop at Panola with GA Power Land Mgt. Services for DNR staff to provide a hands-on field day to identify species and practice treatment options. Resource Managers were also able to assist with the ongoing treatment of aquatic invasives at Reed Bingham using an airboat to distribute chemical. Likewise, partners were engaged, like DNR Fisheries in their assessment and recommendations to treat duckweed at Victoria Bryant.
- The Hemlock Woolly Adelgid (HWA) continues to ravage the hemlocks of north Georgia. At current writing, all Georgia State Parks with natural stands of Eastern Hemlocks have been impacted by HWA. Initial soil injection treatments began in 2004 and followed the western progression of the adelgid. To date, staff and volunteers have protected over 3,500 individual trees on state parks, many re-treated after 5 years. Partners in this undertaking include the Georgia Forestry Commission, University of Georgia, Save GA Hemlocks- a non-profit organization, etc. The following parks have trees that have been treated: Black Rock Mountain, Unicoi, Hardman Farm, Smithgall Woods, Moccasin Creek, Fort Mountain, Amicalola Falls, Vogel, and Cloudland Canyon.
- In the early 1900's, an exotic fungus, *Chryphonectria parasitica*, was introduced and nearly eliminated the American chestnut from the landscape. Understanding the historical prevalence and

cultural significance American chestnuts played in the early 1900's, State Parks have recently partnered with The American Chestnut Foundation (TACF). Coordinated efforts include collecting pollen from established chestnut trees, installing demonstration plots and providing educational materials to visitors, with the collective goal of introducing blight-resistant chestnuts back into the environment.

- The RMU spent considerable time in the field mapping and assessing invasive species that were treated in recent years by contractors paid through the American Recovery & Reinvestment Act (ARRA). Also, professional training continued by staff attending the GA Exotic Pest Plant Council Meeting in Macon, GA.

The key to long term management of these species is proactively investing time and resources to following up on initial treatments.

### **Nuisance Animals**

The RMU also worked with USDA APHIS wildlife services (WS) on nuisance animal issues. These impact not only park visitors, but also species of conservation concern. WS provided technical assistance for predator control in the gopher tortoise management areas at Reed Bingham State Park. Raccoons, fox, cats, armadillos, and other predators present a threat to the gopher tortoise population because they prey on the tortoise eggs that are deposited near the opening of the burrows. RMU and park personnel set cage traps in an effort to catch these predators before they do any harm.

Feral hogs also caused problems at Laura Walker, Hard Labor Creek, and Hofwyl-Broadfield Plantation. Management recommendations were made by WS and will be monitored to prevent future damage to state park lands.

### **Natural Resource Management Planning**

The RMU has been tasked with putting together natural resource management plans for state parks. In the past decade, several plans have been completed, including Little Ocmulgee, General Coffee, FDR, and Kolomoki Mounds. The plans include historical data, maps, rare/threatened plants and animals, vegetative communities, and desired future conditions.

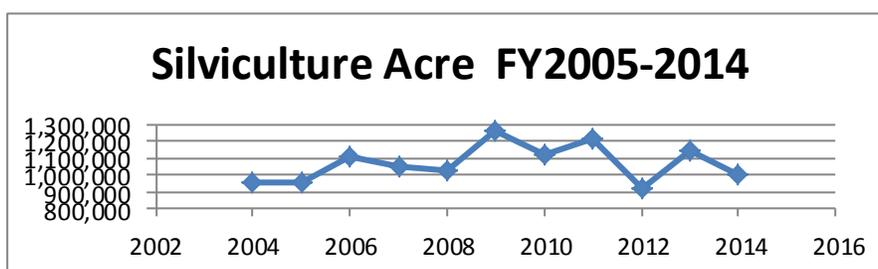
## **Georgia Forestry Commission** **Prescribed Burning in Georgia, Neal Edmonson (GFC)**

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Prescribed fire is described as a safe way to apply a natural process, ensure ecosystem health, and reduce wildfire risk.

Over the last 10 years prescribed fire (Rx fire) has been on the increase in Georgia. The attached graph shows the increase. The average number of acres burned between 2004 and 2008 was 1,287,852 acres while the average between 2009 and 2013 was 1,544,084 acres. In the years that numbers are down (such as 2012) weather was the contributing factor. Extreme drought or very wet years prevent maximum achievable acres.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>



Acres burned under the silviculture permit system in Georgia.

Prescribed fire continues to be the favored tool for most land management objectives, especially for fuel reduction, wildlife management, as well as native plant and grass restoration. Longleaf pine ecosystems would cease to exist if not for the regular use of prescribed fire.

In 2008 Georgia and Florida realized that the two states faced similar challenges for prescribed fire, both currently and in the future. The two states decided to build a team of professionals from private landowners, non-government groups, plantation owners, and government agencies to identify the challenges facing prescribed fire for the next 10 years. Out of this Summit a Strategic Plan was written for each state. The number one obstacle noted to overcome was a common message from the prescribed fire community to the public promoting the benefits of prescribed fire.

From this the “One Message Many Voices Campaign” was launched. Georgia and Florida used a professional marketing company to develop a professional campaign to get the positive word out on prescribed fire. After developing the message and a plan for the campaign the two states shared it with the other thirteen southeastern states and all agreed to use the same message.

Prescribed fire has more publicity and an understanding of its use than in any other time in history. The growth of Prescribed Fire Councils has grown from the Southeast to all across the nation as well as British Columbia, and it has become the best recognized management tool for managing our nation’s forest than any other. The Prescribed Fire Council in Georgia is one of the strongest in the nation and has an attendance of over 150 practitioners each year at its annual meeting.

## **Private Lands Programs**

### **Scott Griffin (GFC)**

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The Georgia Statewide Forest Resources Assessment and Georgia Statewide Forest Resources Strategy documents, also known as the Forest Action Plan, were produced in accordance with the 2008 Farm Bill in order to position Georgia to receive funds under the Cooperative Forestry Assistance Act. The Assessment provides a science-based foundation that analyzes forest conditions and trends in the state and delineates priority rural and urban forest landscape areas, in an approach consistent with the 2008 Farm Bill national priorities. Those priorities are to conserve working forest landscapes, protect forests from harm and enhance public benefits from trees and forests. The Strategy addresses top priority issues identified by the Assessment and will serve as the basis for formulating the GFC's five-year strategic plan.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combated Invasive/Alien Species</i>

Pressing forest issues and threats (ranked by stakeholders):

- 1) Water quality and quantity
- 2) Urbanization
- 3) Forest health
- 4) Biodiversity
- 5) Air quality
- 6) Fire management
- 7) Fragmentation and parcelization
- 8) Economics and changing markets

There is a lot of overlap in the Forest Action Plan (FAP) and the State Wildlife Action Plan (SWAP). Key common ground includes the restoration of native vegetation (longleaf pine ecosystem), the reintroduction of prescribed fire, battling the introduction and spread of invasive plants, and minimizing the impacts of development on forestland habitat. All of the priority issues above are directly tied to this common ground.

### **GFC Services - Private Lands**

GFC services are making great strides in achieving the goals set forth by the FAP and SWAP. The vast majority of the GFC management services are directed towards private lands. With 91% of Georgia's 24.4 million acres of commercial forest land in private ownership, this program is vital to sustainability of forest resources in the state. The GFC currently has around 30 field foresters and 30 forest technicians whose primary goal is to serve this private landowner base. Overall this group serves as an advocate for the sound management of forests, with a focus on multi-resource management. Every county in Georgia has a forester dedicated to it. The following is an overview of the different services and how they are helping to achieve the goals of the action plans.

### **General Advice**

This is a field visit to private property to give advice on a specific issue(s). This would include things such as prescribed burning, forest health issues, harvesting, reforestation, etc. In this case the forester or technician would visit the tract and provide written recommendations regarding the management of the issue. In FY 2014, GFC made 2,141 general advice contacts covering 250,190 acres.

### **Cost share**

GFC is heavily involved with incentive programs that have a great impact on private lands in Georgia. These programs include the Emergency Forest Restoration Program, Conservation Reserve Program, Southern Pine Beetle PRS Program, Environmental Quality Incentives Program, Wildlife Habitat Incentive

Program, Partners for Fish and Wildlife, Invasive Plant Species Control Program, and the Conservation Stewardship Program. GFC foresters and technicians serve as technical service providers developing practice plans and certifying the performance of practices. Many of these programs have practices that focus on the goals of both action plans, including longleaf ecosystem establishment, prescribed burning and invasive plant control. In FY 2014, GFC made 3,798 cost share related visits touching 255,705 acres.

### **Forest Stewardship**

A Forest Stewardship management plan is provided to landowners interested in managing their forestland for multiple use purposes such as timber, wildlife habitat, recreational opportunities, aesthetics, and soil and water conservation. The plan covers a ten year period. GFC foresters and technicians produced 189 new plans during FY14 covering 45,327 acres. This group also renewed/updated 37 plans covering 8,875 acres that were 10+ years old.

### **Cogongrass Eradication Program**

Cogongrass (*Imperata cylindrica*) is considered the seventh worst weed in the world and listed as a federal noxious weed by USDA Animal and Plant Health Inspection Service - Plant Protection and Quarantine. The GFC, using funds provided by the USFS, began treating cogongrass in 2007. An online reporting system is currently available and much effort has been expended educating the general public regarding cogongrass and the threat it poses to Georgia's forests. The eradication program has addressed 839 cogongrass spots covering 204 acres. Of these 839 spots about 80% are considered controlled or eradicated and the other 20% are being treated with herbicides. The spots are monitored and treated yearly until considered eradicated.

### **Water Quality**

In an effort to minimize erosion and stream sedimentation from forestry practices, the GFC has an agreement with the Georgia Department of Natural Resources Environmental Protection Division (EPD) to educate the forest community and promote the use of forestry Best Management Practices (BMPs). Under the same agreement with EPD and through an understanding with the U.S. Environmental Protection Agency (EPA) and the Army Corps of Engineers, the GFC also investigates and mediates forestry water quality and wetland complaints. The agreement also requires the GFC to monitor BMP implementation.

### **Prescribed Burning**

GFC personnel encourage burning on private lands wherever it is needed and feasible. The services offered include firebreak plowing, burn map development and prescribed burning assistance. GFC rangers and foresters assisted with 135,365 acres of silvicultural burning during FY 2013.

# Federal Entities

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**Department of Defense**  
**Update on DOD Installations**  
**Tim Beaty and Contributors (DOD)**

Management of the natural resources on Department of Defense (DOD) installations in Georgia is guided by each installation's Integrated Natural Resource Management Plan (INRMP). In accordance with the

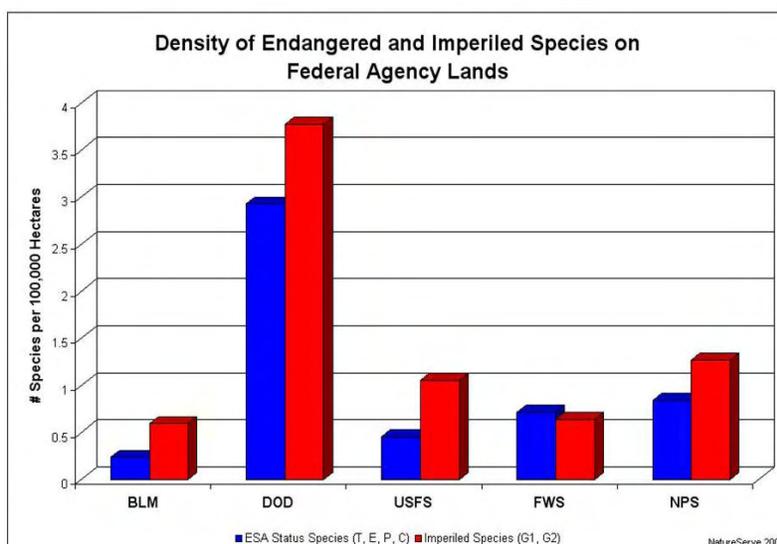
Sikes Act, each INRMP is reviewed by GADNR WRD, as well as the U.S. Fish and Wildlife Service and, at some installations, the National Marine Fisheries Service. The Goals and Objectives of the INRMPs are therefore well aligned with

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

many of the Conservation Actions in the State Wildlife Action Plan. In cooperation with our State partners in Georgia DNR, as well as other Federal and private partners, significant progress has been made in achieving many of the High Priority Conservation Actions over the last 10 years.

In general, INRMPs focus on sustaining healthy, functional ecosystems and ensuring that the land will be able to support DOD's current and future military mission requirements in harmony with traditional conservation goals. DOD lands have been increasingly recognized for their biodiversity, and they contain some of the state's largest populations of many rare species. DOD installations have been largely protected from land use pressures that have affected private lands and many public lands over the last century. As shown in the table below, DOD lands support more rare species per acre than other federal lands. This is a result of several factors, including protection from urbanization and over-utilization of forest resources. In Georgia, fire-maintained communities on DOD lands have also benefitted from frequent wildfires caused by military training activities involving the use of explosives, tracers, and pyrotechnics, as well as the use of prescribed fire as a management tool to reduce fuel loads and lessen wildfire risks. Although DOD lands are not always thought of as "conservation lands", there appears to be an inherent, enigmatic compatibility between the management needs of many natural communities and the manner in which DOD Services use those lands to meet their missions.

Most of Georgia's DOD installations were established in the early to mid-twentieth century, in sparsely



populated rural areas. Over time, however, the populations around these installations have exploded, fueled in large part by the economic stimulus from the presence of the installations and the Soldiers, Airmen, Marines, Sailors, federal employees, and contractors stationed or employed there. This change in land use patterns (i.e., increased human population density) has the potential to lead to conflict (noise complaints,

safety concerns, etc.). Consequently, in 2003 DOD initiated the Readiness and Environmental Protection Integration (REPI) program to encourage landowners around DOD installations to keep their farm and forest land in conservation use. These types of land uses generally minimize potential conflicts between adjacent DOD and civilian land owners. These REPI buffers have significant value as wildlife habitat, and GADNR WRD has been an active partner in promoting REPI programs at several installations.

The following is a summary of specific wildlife conservation accomplishments at Georgia's DOD installations over the last 10 years.

### **Kings Bay Naval Base**

Size: 16,000Acres

Date of acquisition: late 70's – early 80's

Public access allowed (yes, no, limited): Limited

REPI Buffer acres – N/A\_ protected; N/A\_\_ additional acres planned N/A

#### Species of Conservation Concern

<p><b><u>Federally Protected Species</u></b></p> <p>Wood Stork            Eastern Indigo Snake            North Atlantic Right Whale            West Indian Manatee            Green Sea Turtle            Hawksbill Sea Turtle            Kemp's Ridley Sea Turtle            Leatherback Sea Turtle            Loggerhead Sea Turtle            Atlantic Sturgeon            Shortnose Sturgeon</p>	<p><b><u>State protected species</u></b></p> <p>American Oystercatcher            Swallow-tailed Kite            Bald Eagle            Gull-billed Tern            Least Tern            Black Skimmer            Gopher Tortoise            Striped Newt</p>
<p><b><u>Other Species of conservation concern</u></b></p> <p>Fox Squirrel            American Eel            Smalltooth Sawfish            Canvasback            Redhead            American Coot            Common Ground-Dove            Loggerhead Shrike            Saltmarsh Sharp-tailed Sparrow            Painted Bunting            Black-crowned Night-Heron            Yellow-crowned Night Heron            White Ibis            Glossy Ibis            Northern Harrier            American Kestrel            Northern Bobwhite            Common Moorhen            American Oystercatcher            Lesser Yellowlegs            Solitary Sandpiper            Willet            Dunlin</p>	<p><b><u>Other Species of conservation concern</u></b></p> <p>Semipalmated Sandpiper            Western Sandpiper            Least Sandpiper            Wilson's Snipe            Yellow-billed Cuckoo            Pied-billed Grebe            Horned Grebe            White Pelican            Brown Pelican            Least Bittern            Snowy Egret            Tricolor Heron            Little Blue Heron            Least Bittern            Tricolor Heron            Grasshopper Sparrow            Eastern Diamondback Rattlesnake            Ball Moss            Bartram's Air Plant            Green-fly Orchid            Hooded Pitcher Plant            Pond Spice            Tiny-leaf Buckthorn</p>

Significant conservation actions during last 10 years:

- INRMP Implementation
- Manatee Population Monitoring (Annual Recurring)
- Rare, Threatened, and Endangered Species (RTE) Monitoring (Annual Recurring)
  - Wood Stork nesting and satellite tracking/wading bird survey - includes 5 yr. update
  - Comprehensive Avian Survey (focusing on RTE spp.)
  - Comprehensive Gopher Tortoise/Eastern Indigo Snake Survey - includes 5 yr. update
  - Sturgeon Population Monitoring (Annual Recurring; now a regional project)
- Forest thinning via timber sales
- Forest group selection cuts for conversion to longleaf, ~200 acres converted to longleaf
- Longleaf restoration/release
- Accelerated Prescribe Burn Regime
- ~3000 acres burned since Feb 2010

Significant conservation actions planned for next 10 years:

- Continue above mentioned actions
- Tailor INRMP implementation for continued support of State/Regional Initiatives, e.g.:
  - State Wildlife Action Plan
  - Longleaf Pine Initiative
  - Bobwhite Quail Initiative
  - South Atlantic Migratory Bird Initiative
- Continue Partnership with GA DNR, UGA, GFC, and USFWS
- Advance Prescribe Burn Regime towards Growing Season Burns
- Implement Loggerhead Shrike Population Monitoring (Non-annual Recurring) - to include 3 – 5 year updates; TBD

**Marine Corps Logistics Base Albany**

Size: 3,326 acres (1,400 acres forested)

Date of acquisition: 1951

Public access allowed (yes, no, limited): Limited\_\_\_

REPI Buffer acres - 0 protected; 0 additional acres planned  
(meeting in May to discuss opportunities)

Species of Conservation Concern

<p><b><u>Federally Protected Species</u></b> Wood Stork (no known nests, forages in wetlands)</p> <p><b><u>State protected species:</u></b> Gopher Tortoise – small population (&lt; 15 individuals)</p>	<p><b><u>Other Species of conservation concern</u></b> Eastern Tiger Salamander Eastern Diamond-backed Rattlesnake – no population estimate available but thought to be viable based on reproduction and adult snake sightings Yellow-Crowned Night-Heron Northern Bobwhite Quail Loggerhead Shrike Bachman’s Sparrow (&lt; 10 individuals) Bald Eagle (no known nests, forages in wetlands) Incised grove-bur Woodland poppy-mallow Crestless Plume Orchid</p>
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3 Natural Communities – Clayhill Longleaf Woodland; South Atlantic Willow Oak Flatwoods Forest, Limesink Pond

Significant conservation actions during last 10 years:

- Planted 40 acres of longleaf pine in 2009
- Developed 4-acre native groundcover restoration demonstration area (FY13)
- Mechanical treatment (brown-tree mowing/chopping) approximately 100 acres of upland pine to improve pine savannah habitat
- Herbicide treatment of 390 acres to control hardwood, kudzu (20 acres), and bicolor lespedeza (40 acres)
- Implementation of prescribed burning program with 1-3 year return interval, prescribed burned 450 acres in FY13, followed by 700 acres in FY14
- Conducted rare species survey through Alabama Natural Heritage Program

Significant conservation actions planned for next 10 years:

- Continued treatment to control invasive species, targeting hardwood, kudzu, Japanese climbing fern, bicolor lespedeza, Chinese privet, wisteria, and others in upland pine and wetland habitats
- Partnership with USDA Wildlife Services to implement gopher tortoise restoration project focusing initially on surveying population, reducing predation and mortality factors, and habitat improvements
- Incorporation of growing season burns into prescribe burning program
- Development of longleaf pine restoration plan and planting approximately 40 acres of longleaf pine (projected FY16) with additional acreage following
- Development of management program for rights-of-way and other areas to reduce maintenance costs (mowing contract) and to improve habitat for early successional species
- In-depth survey of habitat requirements of rare plant species and development of guidelines to protect and promote these species
- Forest thinning to promote early successional habitat/pine savannah on approximately 200 acres (FY15)

**Moody Air Force Base/Grand Bay Weapons Range/Grassy Pond Recreational Annex**

Size: 11,881 acres (5518 acres/5874 acres/489 acres)

Date of acquisition: 1941

Public access allowed (yes, no, limited): Limited

REPI Buffer acres -   0   protected;   0   additional acres planned

Species of Conservation Concern

<b><u>Federally Protected Species</u></b>	<b><u>State Protected Species</u></b>
Eastern Indigo Snake -- Last confirmed sighting in 1996	Gopher tortoise – In 2013 there were 319 marked burrows; Population estimated at 198 individuals
Wood stork – No rookeries, but forages in installation wetlands	Greenfly orchid – Known only from Dudley’s Hammock
Bald eagle – 1 nest at Grassy Pond Recreational Annex	on Grand Bay Range
	Round-tailed Muskrat -- Periodically observed in wetlands on Grand Bay Range

Significant conservation actions during last 10 years:

- Intensive gopher tortoise monitoring projects underway, including URTD surveillance, telemetry studies, and RFID study to determine utilization, social behaviors, disturbance factors, and competition with other species within colonies

- Management for eastern indigo snake/gopher tortoises has included longleaf pine/wiregrass restoration projects on about 500 acres, midstory hardwood removal (mechanical and chemical), timber stand improvements, prescribed burning (approximately 500 acres/yr)

Significant conservation actions planned for next 10 years:

- Continuation of above conservation actions
- Invasive species surveys, control, and monitoring (aquatic and upland species)
- Shift to growing season burns instead of dormant season burns

### **Robins Air Force Base**

Size: 6,733 acres

Date of acquisition: 1941

Public access allowed (yes, no, limited): Limited

REPI Buffer acres - 663 protected; 800 additional acres planned

Species of Conservation Concern

<b><u>Federally Protected Species</u></b> None	<b><u>State Protected Species</u></b> Ocmulgee Skullcap (threatened)
<b><u>Animal Species Listed as High Priority by the State</u></b> Bald Eagle (incidental occurrence) Swainson's Warbler Wood Stork (incidental occurrence) Southeastern Pocket Gopher	<b><u>Plant Species Listed as High Priority by the State</u></b> Spikerush Harper's Wild Ginger Boykin's Lobelia Awned Meadowbeauty Ocmulgee Skullcap

Significant conservation actions during last 10 years:

- Intensive surveys of flora and fauna to establish baselines in order to tailor specific management goals for natural resources categories (e.g., T&E Species, game and non-game species, urban forests, native ecosystems, etc.).
- Jurisdictional delineation, in-the-field demarcation, and GIS mapping of 2,230 acres of wetlands.
- Basewide survey to locate and map invasive plant species, which led to a management plan (2008) that prioritized the eradication or control of 20 species. Plan focuses on controlling species within management zones and treatment areas.
- Continued restoration of a former 23-acre longleaf pine ecosystem, including prescribed burning every 3 years, seedling establishment, and control of aggressive hardwood saplings via spot herbicide treatments.
- Development of a wildfire and prescribed burn management plan with the aid of the Georgia Forestry Commission.
- Authored a rare plant management plan with special emphasis on the propagation of the two populations of Ocmulgee skullcap. Includes the control of competing invasive species, hydroperiod management in the Grady meadow, and annual surveys.
- Established a bear scent station survey in partnership with GADNR WRD.
- Utilized a volunteer trapper program and a 9-10-month-long hunting season to remove 175-250 feral hogs per year.
- Thinned 75 acres of loblolly pine plantations to improve sunlight penetration, improving understory diversity of grasses, forbs, shrubs, and hardwoods for wildlife.
- Utilized fertilization, artificial reefs, renovation, and stocking to improve fishery health in three lakes (38 acres).

- Authored a wetland protection plan that emphasizes re-establishment of native vegetation on highly erodible sites, implementation of best management practice standards on construction sites to prevent sedimentation of storm water systems, headwall and road repairs, and establishment on “no mow” zones.
- Instituted basewide landscaping standards featuring the use of native, low-maintenance vegetation, especially species preferred by urban wildlife. Standards are incorporated into all construction projects.
- Utilized volunteers to perform a diverse array of urban wildlife projects including the planting of hundreds of native trees in urban areas, the erection of over 300 nest boxes for birds and 30 bat boxes, the construction of basking platforms for aquatic turtles and nesting houses for purple martins, the installment of Christmas trees and tires and cinder blocks as fish attractors in base lakes, modifications of trash receptacles to reduce their attractiveness to wildlife, quarterly team efforts to remove trash from lakes and fields, and the continued maintenance of two interpretive nature trails.
- Converted a former housing area into a natural habitat restoration area.
- Managed hunting program for base employees and their guests on 1,300 acres, and a fishing program on three lakes.
- Continued management practices designed to reduce Bird/Wildlife Strike Hazards, which helps to keep pilots safe, but also reduces wildlife mortality resulting from strikes. Effort includes improvements to the airfield’s wildlife exclusion fence, placing grating over culverts to prevent wildlife from using them to gain access to the airfield, diminishing plant diversity on the airfield, and using knowledge of bird movements during migration and winter to convince flight crews to alter their flying schedules in order to reduce the risk.
- Frequent public education efforts are employed, including birding and botanical walks, leading tours for students from UGA and local colleges, monthly newspaper and Facebook stories, and the use of summer interns from area colleges to do field work.

Significant conservation actions planned for next 10 years:

- Convert remaining loblolly pine stands into mixed hardwood/pine forests.
- Continue to improve the longleaf pine forest via prescribed burning and hack & squirt herbicide applications to eliminate persistent competing tree species.
- Continued emphasis on many of the above actions including invasive plant and animal control, vegetation establishment on erodible sites, fish stocking and further renovations, urban tree planting projects (and retention of snags where possible), management of hunting and fishing programs, and continued conversion of base landscaping to native plants.
- Partnership with researchers at Ft. Valley State University and with GADNR to re-establish populations of Ocmulgee skullcap.
- Further improvements in natural habitat establishment on the golf course, as well as further reductions in pesticide use. (Note: Robins AFB has maintained a continued 70-80% reduction in pesticide usage over the 1995 baseline, as measured in pounds of active ingredients used.)

**Fort Benning**

Size: 182,433 acres

Date of acquisition: 1919 and 1942

Public access allowed (yes, no, limited): limited

REPI Buffer acres - 23,444 protected; up to 12,000 additional acres planned

## Species of Conservation Concern

<p><b><u>Federally protected species</u></b>  <i>Red-cockaded woodpecker</i> – 332 potential breeding groups in 2013  <i>Wood stork</i> – No rookeries, but forages in installation wetlands  <i>Relict Trillium</i> – 5 stable population  <i>Bald eagle</i> – 2 nests</p>
<p><b><u>State protected species</u></b>  <i>Gopher frog</i> – Numerous individuals, known in two ponds on northeast portion of the installation  <i>Barbour's map turtle</i> – known to exist on the Alabama side near Chattahoochee backwaters  <i>Alligator snapping turtle</i> – stable population in the Chattahoochee river  <i>Gopher tortoise</i> – an estimated 2000 tortoises on 15,000 acres of habitat.  <i>Southern hognose snake</i> – Status not well known (1 recorded observation)  <i>Florida pine snake</i> – uncommon but present throughout installation  <i>Bluestripe shiner</i> – Known to occur in the Chattahoochee River and Upatoi Creek  <i>Bachman's sparrow</i> – Common breeder and winter resident  <i>Southeastern American kestrel</i> – Nests regularly throughout installation, have 30 nesting boxes under management  <i>Ground dove</i> – recorded in low numbers installation wide  <i>Southeastern pocket gopher</i> – found in northeastern sand hills  <i>Georgia rockcress</i> – 2 populations  <i>Croonia</i> – 2 known populations on the installation  <i>Lax water-milfoil</i> – found in several impoundments on the installation  <i>Georgia oak</i> – exists in low numbers on the southeast corner of the installation  <i>Sweet pitcher plant</i> – 4 known populations  <i>Pickering's morning-glory</i> – exists in low densities on Lakeland sands</p>

## Significant conservation actions during last 10 years:

- The RCW population grew at an average rate of over 1.8% annually, reaching 332 potential breeding groups in 2013.
- Started ACUB program in 2006.
- Started periodic population estimates for gopher tortoise populations on 4 habitat management units.
- Planted 25,000 acres of LLF to date.
- Burn 30,000-40,000 acres per year.

## Significant conservation actions planned for next 10 years:

- Recover the RCW - reach goal of 351 PBGs.
- Assist in recovery efforts for relict trillium.
- Complete revision of INRMP and RCW ESMC – implement 2007 guidelines.
- Add 12-15,000 acres of ACUB lands towards Ft. Benning baseline RCW acreage.
- Continue periodic population estimates for the eastern gopher tortoise.
- Continue Longleaf pine forest restoration with burning and LLF planting.

- Develop 11,000 acre wildlife management area from ACUB lands jointly managed by Ga DNR and The Nature Conservancy with public access.

### **Fort Gordon**

Size: 55,600 acres

Date of acquisition: 1941

Public access allowed (yes, no, limited): Yes

REPI Buffer acres – 0 acres currently protected; 1594 acres planned in FY2014 (Phase I focus) and 11,963 planned long-term (desired end state)

Species of Conservation Concern

<p><b><u>Federally Protected Species</u></b></p> <p><i>Red Cockaded Woodpecker</i> –as of 2013 -25,643 acre Habitat Management Unit, 5,083 acres in foraging partitions, 50 managed clusters, 21 active clusters, 14 potential breeding groups</p> <p><i>Wood Stork</i> –observed foraging occasionally, but no known rookery site</p> <p><i>Bald Eagle</i> –observed occasionally, but no known nest sites</p>
<p><b><u>State Endangered or Threatened Species</u></b></p> <p><i>Gopher Tortoise</i> –estimated population of 280 tortoises, 28,481 acre HMU, with 7,321 acres considered currently suitable</p> <p><i>Southern Hognose Snake</i> –common and widespread on the installation</p> <p><i>Bluebarred Pygmy Sunfish</i> -found to be abundant in several localized areas in a 1997-1998 survey, but not found in a similar survey conducted in 2010</p> <p><i>Sandhills Rosemary</i> –located on 12 different sites scattered across the installation</p> <p><i>Sweet Pitcher Plant</i> –small population of a few plants located at two sites</p> <p><i>Pickering's Morning Glory</i> - located on 9 different sites scattered across the installation</p>
<p><b><u>Species Listed on State or Federal Lists as Rare or Species of Concern</u></b></p> <p><i>Bachman's Sparrow</i> –present, detected infrequently in surveys as part of a 2010-2011avian biodiversity project</p> <p><i>Southeastern American Kestrel</i> – common near open areas (cantonment, ranges, open forests, early successional areas); band approximately 75 – 100 nestlings each year</p> <p><i>Migrant Loggerhead Shrike</i> -occasionally observed, but unknown whether resident or migrant subspecies</p> <p><i>Southeastern Bat</i> –presence unknown, not found in 2013 survey</p> <p><i>Rafinesque's Big Eared Bat</i> – present but uncommon, recorded by acoustic monitoring in 2013 survey</p> <p><i>Florida Pine Snake</i> – thought to be common although this subspecies may intergrade with the northern subspecies in this area</p> <p><i>Sandbar Shiner</i> – presence unknown, not observed in a fish survey conducted in 2010</p> <p><i>Atlantic White Cedar</i> –present and abundant at three sites along the Sandy Run Drainage</p> <p><i>Carolina Bogmint</i>– present at three sites along Brier and Headstall Creeks</p> <p><i>Indian Olive</i> –present at three sites</p> <p><i>Silky Camellia</i> – present at three sites along Brier and Headstall Creeks</p>

Significant conservation actions during last 10 years:

- Increased the population of RCWs from 8 active clusters to 21, an average growth of 14% annually
- Established a Gopher Tortoise HMU, conducted a 100% population survey, monitored activity status of 750+ burrows
- Restored 2,586 acres of longleaf pine (most of which was conversion from off-site pine species)
- Planted 207 acres of wiregrass

- Conducted prescribed burning on 182,000 acres (approximately 18,000 acres annually)
- Conducted hardwood midstory control on 6,650 acres (mechanical and chemical)

Significant conservation actions planned for next 10 years:

- Continue to grow the population of RCWs at a rate of at least 5% per year by bringing the number of active clusters up to 34
- Continue to monitor gopher tortoise population by conducting a full population survey every 2-5 years and by monitoring activity status of all burrows
- Continue to restore and maintain the longleaf-wiregrass ecosystem with the use of prescribed fire, mechanical and chemical treatment, and longleaf and wiregrass restoration plantings

### **Fort Stewart/Hunter Army Airfield**

Size: Ft. Stewart – 279,449 ac. HAAF – 5,457 ac.

Date of acquisition: 1941

Public access allowed (yes, no, limited): Yes

REPI Buffer acres – 70,795 ac. protected; 104,537 additional acres planned

### **Species of Conservation Concern**

<p><u>Federally protected species</u></p> <p>Red-cockaded woodpecker – 363 potential breeding groups in 2013</p> <p>Wood stork – No rookeries, but forages in installation wetlands</p> <p>Bald eagle – 2 nests</p> <p>Eastern indigo snake – Large, stable population (over 300 adults/sub-adults)</p> <p>Frosted flatwoods salamander – Only extant population in Georgia</p> <p>Atlantic sturgeon – Ogeechee and Canoochee Rivers</p> <p>Shortnose sturgeon - Ogeechee and Canoochee Rivers</p> <p>Smooth coneflower – 1 known population (.01 acre patch)</p>
<p><u>State protected species:</u></p> <p>2011</p> <p>Striped newt – At least 14 breeding ponds; stressed by persistent drought from 2001-2011</p> <p>Gopher frog – Numerous individuals, widely distributed</p> <p>Bachman's sparrow – Common breeder and winter resident</p> <p>Henslow's sparrow – Uncommon in winter</p> <p>Cerulean warbler – Potential migrant</p> <p>Swallow-tailed kite – Regularly sited during breeding site. Large flocks stage near Ft. Stewart prior to fall migration</p> <p>Peregrine falcon – Rare visitor</p> <p>Southeastern American kestrel – Nests regularly at Camp Oliver</p> <p>Least tern – Nests on gravel rooftops and forages in canals and ponds in cantonment area.</p> <p>Golden-winged warbler – Potential migrant.</p> <p>Rafinesque's big-eared bat – Known to occur on Fort Stewart, but status not well known.</p> <p>Spotted turtle – Status not well known (7 recorded observations)</p> <p>Gopher tortoise – Population estimated at 2,862 individuals in 2012 (LCL = 2,092; UCL = 3,917), stable or increasing</p> <p>Southern hognose snake – Status not well known (4 recorded observations)</p> <p>Diamondback terrapin – Status not well known</p>

Mimic glass lizard – Status not well known (3 recorded observations)

Say's spiketail

Black-banded sunfish – Widely distributed on Fort Stewart.

Purple honeycomb head – 17 populations

Georgia Plume – 9 populations

Greenfly orchid – Widely distributed in tupelo swamps

Dwarf witch-alder – 1 very small (.01 acre) population

Michaux's spider orchid - 1 very small (.01 acre) population

Corkwood – 1 individual known

Pond spice – Known from 9 ephemeral wetlands

Boykin's lobelia – Known from 3 ephemeral wetlands

White fringed orchid – Widely distributed

Crestless plume orchid – 1 known population, probably more

Hooded pitcherplant - Common

Swamp buckthorn – 12 known populations, widely distributed

Silky camellia – Not infrequent along the Canoochee Creek and Canoochee River bluffs.

Significant conservation actions during last 10 years:

- The RCW population grew at an average rate of over 5% annually, reaching 366 potential breeding groups in 2013.
- Planted wiregrass on 1,451 acres. Of those 1,451 acres, 1,127 acres have been planted to longleaf.
- Started annual population estimates for eastern indigo snake and gopher tortoise.
- Improved 250-500 acres annually for the gopher tortoise/eastern indigo snake.
- Conducted eDNA sampling for the frosted flatwoods salamander, striped newt, and gopher frog.

Significant conservation actions planned for next 10 years:

- Continue annual population estimates for the eastern indigo snake and gopher tortoise
- Improve 250-500 acres annually for the gopher tortoise/eastern indigo snake
- Conduct eDNA sampling for the frosted flatwoods salamander, striped newt, and gopher frog.
- Work in cooperation with the Atlanta Botanical Gardens to start a captive breeding population for the frosted flatwoods salamander and possibly release head-start salamanders onto Fort Stewart or surrounding ACUB lands.
- Plant 200 acres of longleaf/year and 200 acres of wiregrass/year.

### **Townsend Bombing Range**

Size: 5,183 acres

Date of acquisition: 1981

Public access allowed (yes, no, limited): Limited

REPI Buffer acres - 30,921 ac. protected; Unknown additional acres planned

Species of Conservation Concern

### **Federally protected species**

American Alligator (*Alligator mississippiensis*) – Likely resident; may occur on TBR but is not abundant. Threatened due to similarity of appearance.

Eastern Indigo Snake (*Drymarchon couperi*) – Unlikely resident; threatened

Frosted Flatwoods Salamander (*Ambystoma cingulatum*) – Only confirmed resident federally protected species known to occur on TBR. Listed as threatened.

Discovered on TBR during an endangered species survey in 1994. One larva was collected in a dip-net at a small cypress pond on the edge of the cleared target area. Annual surveys of TBR for presence of the species were initiated in 1998 and continue to the present. However, no larvae were observed at the breeding pond in 1998-2000. These were generally poor breeding years for the species, with inadequate rainfall in October-December of each year.

No other specimens were observed at the site until another single larva was collected in a bomb crater located at the edge of the breeding pond in April 2001. A second larval flatwoods salamander was found in April 2003 in a small borrow pit located about 200 feet east of the April 2001 site.

Fire suppression and conversion of longleaf pine flatwoods into slash and loblolly pine plantations is the major threat to the flatwoods salamander. Fire suppression has led to an increase in slash and loblolly pine species, an increase in hardwood species, and a decrease in herbaceous groundcover. The combination of these factors has reduced the availability of suitable breeding ponds for the salamander (74 FR 6700).

Bald Eagle (*Haliaeetus leucocephalus*) – Possible migrant or occasional visitor. Has not been located on TBR despite efforts to locate them during surveys in 1993-94 and 1998-2001.

Wood Stork (*Mycteria americana*) – Endangered. Confirmed migrant or occasional visitor. Has been seen flying over TBR at least once, but has not been observed nesting or feeding there (not a resident). Known rookery located approximately 9 miles northwest of proposed expansion areas (USFWS 2009c). Wetlands within proposed expansion areas may be utilized as foraging habitat for wood storks.

Red-Cockaded Woodpecker (*Picoides borealis*) – Possible resident; endangered. Has not been located on TBR despite efforts to locate them during surveys in 1993-94 and 1998-2001.

Bachman's Warbler (*Vermivora bachmanii*) – Unlikely migrant or occasional visitor; endangered

Kirtland's Warbler (*Dendroica kirtlandii*) – Unlikely migrant or occasional visitor; endangered

Striped Newt (*Notophthalmus perstriatus*) – Listed as candidate species in 2011; possible resident. Primary threat is habitat loss due to fire suppression and hardwood invasion (76 FR 32911-32923).

### **State protected species**

American Alligator (*Alligator mississippiensis*) – Likely resident; may occur on TBR but is not abundant. Threatened due to similarity of appearance

Eastern Indigo Snake (*Drymarchon couperi*) – Unlikely resident; threatened. Has not been located on TBR despite efforts to locate them during surveys in 1993-94 and 1998-2001.

Southern Hognose Snake (*Heterodon simus*) – Unlikely resident; threatened

Mimic Glass Lizard (*Ophisaurus mimicus*) – Likely resident; rare

Gopher Tortoise (*Gopherus Polyphemus*) – Unlikely resident; threatened

Spotted Turtle (*Clemmys guttata*) – Possible resident; unusual

Frosted Flatwoods Salamander (*Ambystoma cingulatum*) – Confirmed resident; threatened. (See “Federally protected species” above for further information)

Striped Newt (*Notophthalmus perstriatus*) – Possible resident; primary threat to newts is habitat loss due to fire suppression and hardwood invasion (76 FR 32911-32923).

Gopher Frog (*Rana capito*) – Possible resident

Swallow-tailed Kite (*Elanoides forficatus*) – Possible migrant or occasional visitor

Peregrine Falcon (*Falco peregrinus*) – Possible migrant or occasional visitor

Bald Eagle (*Haliaeetus leucocephalus*) – Possible migrant or occasional visitor; threatened. Has not been located on TBR despite efforts to locate them during surveys in 1993-94 and 1998-2001.

Wood Stork (*Mycteria americana*) – Confirmed migrant or occasional visitor; endangered

Red-Cockaded Woodpecker (*Picoides borealis*) – Possible resident; endangered

Southeastern Kestrel (*Falco sparverius paulus*) – Possible resident; rare

Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii*) – Possible resident/Possible migrant or occasional visitor; rare

Blackbanded Sunfish (*Enneacanthus chaetodon*) – Possible resident; endangered

Bluefin Killifish (*Lucania goodie*) – Possible resident; rare

Pondspice (*Litsea aestivalis*) – Possible resident; rare

Greenfly Orchid (*Epidendrium conopseum*) – Confirmed resident; unusual

Dwarf Witch-alder (*Fothergilla gardenia*) – Possible resident; threatened

Hooded Pitcherplant (*Sarracenia minor*) – Confirmed resident; unusual

#### Significant conservation actions during last 10 years:

- Management of the flatwoods salamander.  
Managed the flatwoods salamander in cooperation with U.S. Fish and Wildlife Service (USFWS) to maintain the existing population and periodically search for new or undiscovered populations on TBR. Management consists of (1) monitoring the population at yearly to evaluate reproduction and habitat use; (2) searches for new populations; (3) assessing hydrological systems to determine the area where drainage or other development would impact the species, and (4) continuing prescribed burning both at the breeding pond and in the adjacent areas.

Wildlife management activities on TBR property in the vicinity of the flatwoods salamander breeding site and upland buffer zones would include prescribed fire, hunting, and various wildlife surveys.

Land management activities in the vicinity of the flatwoods salamander breeding site and upland buffer zones would include surveys for and control of various exotic plants and erosion control.

- Range-wide surveys for rare, threatened, and endangered species and suitable habitat
- Range-wide monitoring for rare, threatened, and endangered species and suitable habitat
- Prescribed burning as appropriate for best compromise of mission sustainability and management of T&E species' suitable habitat

#### Significant conservation actions planned for next 10 years:

- Continue management actions for the flatwoods salamander
- Continue range-wide surveys for rare, threatened, and endangered species and suitable habitat
- Continue range-wide monitoring for rare, threatened, and endangered species and suitable habitat
- Continue prescribed burning as appropriate for best compromise of mission sustainability and management of T&E species' habitat

**National Park Service**  
**Cumberland Island National Seashore**  
**Doug Hoffman (NPS)**

Cumberland Island National Seashore is the largest and southernmost barrier island in Georgia. It encompasses 36,000 acres, with roughly half of this acreage in upland habitat and the other half in salt marsh and freshwater wetland habitats. The island's 18 miles of undeveloped beach is arguably one of the most important areas in the state for sea turtle nesting, consistently producing 25% of the statewide total of nests each year. It is also an important winter stopover location for shorebirds, wading birds, and neotropical migrants. Habitat diversity is considerable on Cumberland, with 22 plant communities, 34 vegetative classifications, and 500 species of plants identified. The island was designated a National Seashore in 1972 and is owned and managed by the National Park Service.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combated Invasive/Alien Species</i>

While the park is not guided directly by the Statewide Wildlife Action Plan, it does work closely with the Georgia Department of Natural Resources Coastal Resources Division, Nongame Division, and Wildlife Resources Division in numerous capacities. Interagency coordination includes habitat enhancement or restoration projects, surveys, consultations and decision making, and direct management actions for species of both state and Federal importance. With increased human use of coastal areas and specific proposed development for the Camden and Glynn county areas, it will be important to continue the relationship with GADNR and other state, Federal, and local agencies to ensure wise management and conservation of coastal resources.

**Fire Management**

Cumberland hired a fire management officer in 2011 and is currently in the final phases of approval for a newly-developed fire management plan with the goal of restoring fire to a more natural regime throughout the island. The plan will incorporate prescribed fire and management of natural ignitions to reduce fuel loads and benefit the numerous vegetative communities found on Cumberland Island. In addition to resource management, the plan addresses protection of the numerous historic structures and residential buildings scattered throughout. The fire management program is currently working with island residents to implement the Firewise program to reduce fuel near structures. Cumberland's fire management and response team is an interagency effort including the National Park Service, U. S. Fish & Wildlife Service, U. S. Forest Service, Georgia Forestry Commission, and Camden County.

**Feral Hog Management**

The park began intensive feral hog management activities in 2001 to reduce losses of sea turtle nests and minimize general destruction of resources from rooting. This effort has been successful in reducing the population to minimal numbers. During the last 10 years, hog-related losses to turtle nests have been almost non-existent with only 6 nests being impacted out of a total of 3,760 nests recorded during this time period on Cumberland. Damage to other natural resources is localized and minimal. Competition with native wildlife species is also significantly reduced. Hog management activities are conducted year-round by the park's biologist and include hunting during daylight hours, use of night vision equipment to remove specific animals at night, and trapping when conditions warrant. While the park conducts 6 managed public

hunts each fall/winter, hunter harvest is normally minimal. Public hunts alone are not capable of reducing or maintaining the hog population at a level that would achieve the desired results.

### **Invasive Plant Management**

The park has documented approximately 70 species of non-native plants on Cumberland, most of which can be attributed to earlier inhabitants introducing plants for ornamentals and/or production of seeds, oils, wood, etc. While most species are not considered invasive, there are several species of concern including tung oil, tamarisk, Chinese tallow, and tree of heaven. Cumberland has a certified pesticide applicator on site who conducts annual control with chemical and mechanical means. NPS also has a regional team that assists annually with specific treatments. Recently NPS partnered with GADNR and Georgia Forestry Commission to monitor and treat a small, newly-established stand of cogongrass discovered in innerdune meadow habitat.

### **Oyster Reef Restoration**

Two oyster reef habitat restoration projects have been initiated around Cumberland Island. One reef was established in the spring of 2014 covering 530 feet of shoreline. A second reef site is planned for the near future. Objectives of the project include buffering shoreline erosion and establishing a viable living reef to benefit estuarine species. Oyster reef habitats were overharvested during the mid-1800's during a boom in the oyster canning industry. Restoration of this reef habitat has been shown to attract many estuarine species including commercially important fish species, bait species, and many crustaceans. These species can utilize the reef for part or all of their life cycle as shelter or foraging habitat. Some of the species documented to increase in these restoration areas include commercial species (spotted sea trout, red drum, black and rock bass, gag grouper, summer and southern flounder, bluefish, ladyfish, inshore shark species, and all local blenny and goby species) and bait species (pinfish, pig fish, mummichogs, blue crab, all whelk species, stone crabs, and penaeid shrimp to name a few). NPS has worked closely with GADNR for guidance and permitting during the habitat restoration process. NPS personnel and members of the Camden County Future Farmers of America Chapter bagged over 3,000 oyster shell bags in 2014 for the two reef projects.

**Natural Resources Conservation Service (NRCS)**  
**Georgia Accomplishments from 2005-2013**  
**Sharon Holbrooks (NRCS)**

NRCS-Georgia uses the State Wildlife Action Plan (SWAP) in several ways. For Financial Assistance programs, the SWAP has been/is used in ranking higher priority properties, helping to set priority landscapes, and as a keystone document to guide program implementation. For Conservation Planning, the SWAP GIS layer indicating locations/occurrences of threatened and endangered (T&E) species has been used in our Environmental Evaluation process, and as a keystone document to guide conservation planning.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combatted Invasive/Alien Species</i>

For program specifics and potential impacts that NRCS may have had on T&E/rare species habitat, the following financial assistance program numbers are provided:

**Environmental Quality Incentives Program (EQIP) – General:**

The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program from the USDA Natural Resources Conservation Service for farmers, ranchers and owners of private, non-industrial forest land. Through EQIP, farmers may receive financial and technical assistance with structural and management conservation practices on agricultural land to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner.

- 2009-2012: \$71,758,000 total
- 20% (\$13,652,061) in forestry/wildlife related practices

**EQIP/WHIP – Longleaf Pine Initiative:**

Georgia NRCS under the Longleaf Pine Initiative (LLPI) helped private landowners improve the sustainability and profitability of longleaf pine forest ecosystems. The longleaf pine ecosystem provides critical habitat for 29 threatened and endangered species. Environmental outcomes included improving herbaceous understory conditions in longleaf pine forests, improving habitat conditions in existing longleaf pine forests, as well as establishing new longleaf pine forests.

<b>State</b>	<b>Contracts Obligated</b>	<b>Contracted Acres</b>	<b>Obligation Amount</b>
<b>Georgia</b>	<b>715</b>	<b>40,509.34</b>	<b>\$10,951,646.79</b>
<b>EQIP 2008</b>	<b>315</b>	<b>16,797.10</b>	<b>\$4,845,048.77</b>
<b>2012</b>	<b>95</b>	<b>5,163.20</b>	<b>\$1,383,541.85</b>
<b>2013</b>	<b>220</b>	<b>11,633.90</b>	<b>\$3,461,506.92</b>
<b>WHIP 2008</b>	<b>400</b>	<b>23,712.24</b>	<b>\$6,106,598.02</b>
<b>2010</b>	<b>36</b>	<b>1,739.90</b>	<b>\$653,378.67</b>
<b>2011</b>	<b>364</b>	<b>21,972.34</b>	<b>\$5,453,219.35</b>
<b>Total:</b>	<b>715</b>	<b>40,509.34</b>	<b>\$10,951,646.79</b>

### Wildlife Habitat Incentive Program, Working Lands for Wildlife:

The Wildlife Habitat Incentive Program (WHIP) is a voluntary program for conservation-minded landowners who want to develop and improve wildlife habitat on agricultural land, nonindustrial private forest land, and Indian land. In 2013, NRCS is only offering financial assistance in the Working Lands for Wildlife partnership.

Working Lands for Wildlife is a partnership between NRCS and the U.S. Fish and Wildlife Service (FWS) to combat the decline of seven specific wildlife species whose decline can be reversed and will benefit other species with similar habitat needs. In Georgia, the focus was on the gopher tortoise, in order to prevent listing of this species under the Endangered Species Act.

In 2011-2013, NRCS Georgia awarded 422 contracts on 75,000 acres for \$3.7 million to enhance gopher tortoise habitat.

In both EQIP, and WHIP, Fish and Wildlife Habitat has been listed as a conservation concern in all of the 2008 Farm Bill financial assistance programs. As a summary, below shows the amount and acres that were selected to address Fish and Wildlife Habitat as a conservation concern.

State	Contracts Obligated	Obligation Amount	Contracted Acres
Georgia	5,773	\$86,065,164.80	493,190.11
EQIP 2008	4,223	\$63,073,595.05	301,392.30
2009	1,010	\$16,195,995.64	77,167.39
2010	1,919	\$31,055,092.60	141,565.67
2011	490	\$7,232,442.59	34,813.69
2012	475	\$3,898,536.07	26,914.65
2013	329	\$4,691,528.15	20,930.90
WHIP 2008	1,550	\$22,991,569.75	191,797.81
2009	462	\$3,878,763.27	31,163.20
2010	532	\$6,235,857.26	52,182.90
2011	62	\$517,391.71	17,587.70
2012	287	\$7,645,145.46	66,745.21
2013	207	\$4,714,412.05	24,118.80
<b>Total:</b>	<b>5,773</b>	<b>\$86,065,164.80</b>	<b>493,190.11</b>

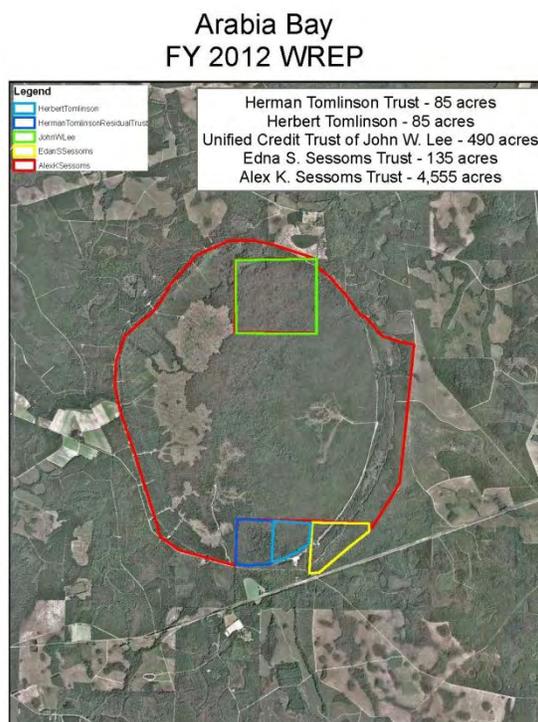
Out of those contracts, below is a summary of which T&E habitat was selected as the expressed conservation concern:

State	Applications Received	Application Acres	Contracts Obligated	Obligation Amount	Contracted Acres
Georgia	857	86,806.54	601	\$9,766,384.63	73,834.70
EQIP 2008	444	29,442.54	303	\$4,259,263.80	24,781.00
2010	341	20,412.60	234	\$3,317,116.77	18,062.40
2011	37	5,462.74	25	\$289,689.94	4,036.40
2012	10	1,040.00	9	\$60,191.63	1,040.00
2013	56	2,527.20	35	\$592,265.46	1,642.20
WHIP 2008	413	57,364.00	298	\$5,507,120.83	49,053.70
2010	119	13,649.00	86	\$813,489.14	11,958.00
2011	22	4,668.00	13	\$100,586.29	4,126.00
2012	191	29,582.30	126	\$2,965,080.03	25,168.40
2013	81	9,464.70	73	\$1,627,965.37	7,801.30
<b>Total:</b>	<b>857</b>	<b>86,806.54</b>	<b>601</b>	<b>\$9,766,384.63</b>	<b>73,834.70</b>

## Wetlands Reserve Program (WRP)

Another area where NRCS Georgia made great strides toward Fish and Wildlife Habitat is in the Wetlands Reserve Program (WRP.) WRP is a voluntary conservation easement program that assists landowners in restoring, protecting, and enhancing wetlands on eligible private or tribal lands while maximizing wildlife habitat benefits. The emphasis of WRP is to protect, restore, and enhance functions and values of wetland ecosystems on privately owned lands to attain habitat for migratory birds and other wetland-dependent wildlife and protection and improvement of water quality. Agricultural production ceases from lands enrolled in WRP, but WRP lands are usually marginal agricultural lands poorly suited for efficient agricultural productions. NRCS Georgia has 106 easements for 37,580 acres protected from a period of 30-years to perpetuity (87% permanent easements.) See state map below. Most of this acreage is known habitat for rare and declining, including T&E species. The wood stork, bald eagle, gopher tortoise, indigo snake, and game animals directly benefit from protection and restoration accomplished through WRP. Another major area where WRP affects wildlife habitat is through the upland acres included in most easements. NRCS Georgia strives for a ratio of 50% upland to 5-% wetland. In these upland acres, NRCS Georgia restores habitat through longleaf planting, native warm season grass planting, thinning, burning, and maintenance of early successional habitat in wildlife openings.

Here is a highlighted WRP project where SWAP was used to get funding through the Wetland Reserve Enhancement Program (WREP) in 2012. Through this funding, NRCS Georgia was able to permanently protect 5,458 acres in Clinch County. Known locally as Arabia Bay, this cypress/hardwood wetland depression is the largest intact Carolina Bay formation in the state of Georgia. Arabia Bay contains a Pond Cypress/Pine Savanna that is a major rookery for the federally endangered wood stork and other wading birds, and provides significant habitat for the federally threatened flatwoods salamander. As well as protecting the habitat, wildfire prevention and protection was also a major goal of this project. Restoring hydrology, as well as getting prescribed fire back into the upland habitat surrounding the bay, is a critical component of the restoration of Arabia Bay.

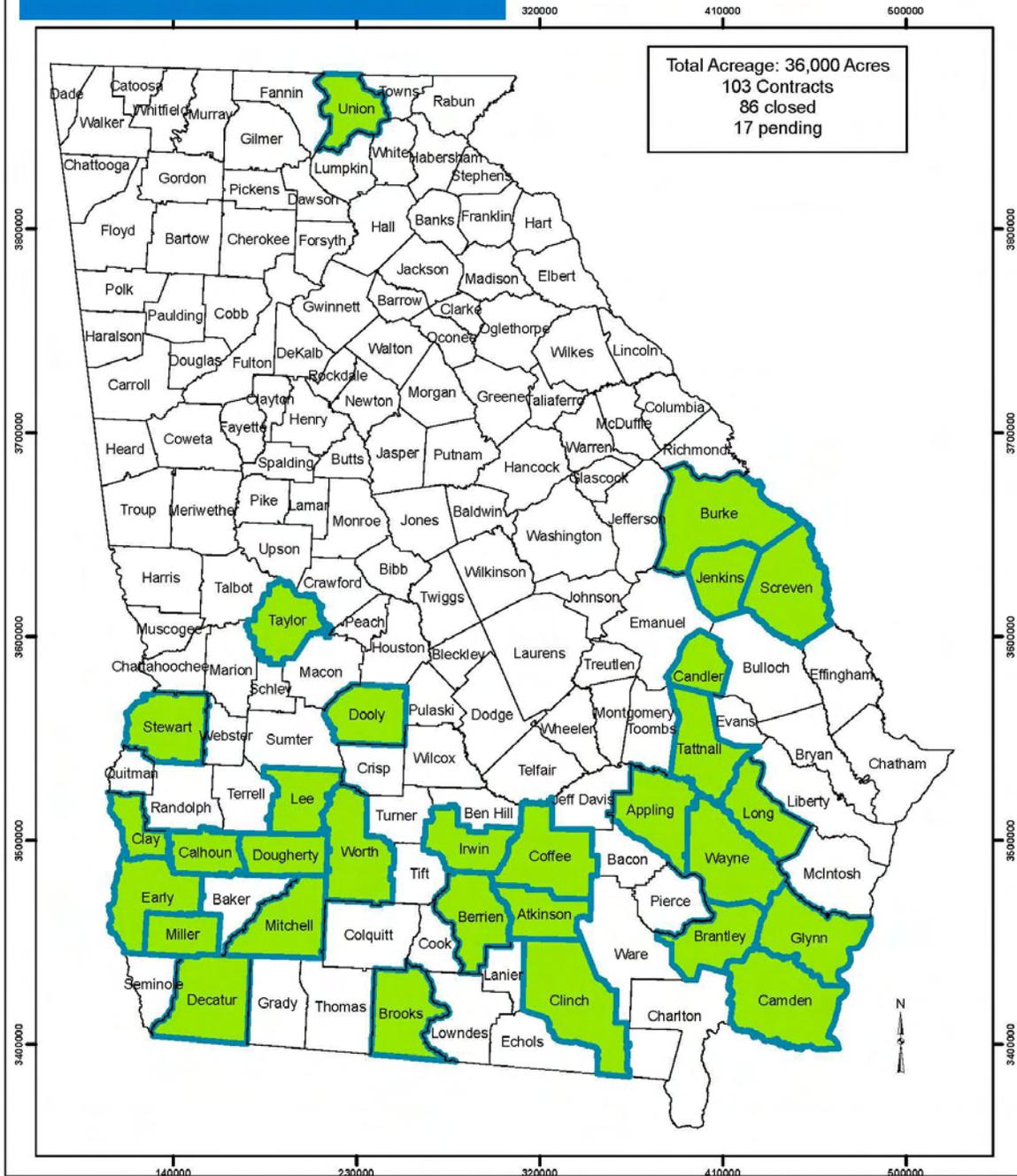




United States Department of Agriculture  
Natural Resources Conservation Service

# Counties with WRP Easements

Includes FY 2013



The following is information on the funding and number of forested acres impacted by Farm Bill programs along with the types of habitat management that were funded.

## NRCS GEORGIA

### 2008 Farm Bill Forestry Impacts

2011 - 2013

Year	Program	Contracts	Acres	Funding Total	LLP Initiative	General EQIP
2013	EQIP	370	22,360	\$4,424,724	\$3,874,176	\$550,549
2012	EQIP	354	19,265	\$3,790,126	\$1,385,976	\$2,404,150
2011	WHIP	331	20,698	\$5,437,211		
<b>Three year total</b>		<b>1,055</b>	<b>62,323</b>	<b>\$13,652,061</b>		

### Three year practice total

Practice	Acres Contracted	Practice Frequency
Early Successional Habitat	6,025	44
Forest Stand Improvement	6,872	45
Forest Trails and Landings	6,545	50
Firebreak	8,524	98
Prescribed Burning	39,938	415
Silvopasture Establishment	1,401	18
Tree and Shrub Establishment	55,067	956
Tree and Shrub Site Preparation	50,714	919
Upland Wildlife Habitat Management	165	5

**US Army Corps Engineers (USACE)**  
**Update on USACE Projects in the Savannah District**  
**Ellie Covington**

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The U.S. Army Corps of Engineers Savannah District oversees a multi-million dollar military construction program at 11 Army and Air Force installations in Georgia and North Carolina and manages water resources across the Coastal Georgia region, including maintenance dredging of the Savannah and Brunswick harbors; operation of three hydroelectric dams and reservoirs along the upper Savannah River; and administration of the Regulatory stream and wetland permitting program within the state of Georgia. The District's operations produce ecological impacts to fish and wildlife resources, including temporary impacts during construction and permanent habitat loss if not mitigated.

	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

**Brunswick Harbor Deepening (includes Andrews Island and Beneficial Use Island)**

Brunswick Harbor is a deep-water port located in Brunswick, Glynn County, Georgia through St. Simon's Sound, Brunswick River and East River. The Corps completed deepening the navigation channel by 6 feet in August of 2007. Other major components of the project included enlarging the turning basin in the upper South Brunswick River; widening the inner harbor channel to 400 feet; and creating a 1,300 foot bend widener for safe ship handling. Other improvements completed in FY08 included enlarging the East River Turning Basin and the associated mitigation for that feature.

This project included the creation of a beneficial use dredged material island in St. Simon's Sound. This island is dedicated to providing nesting habitat for shorebirds, with human visitation restricted to only maintenance activities. In addition to providing rare bare ground bird nesting acreage, the island also provides essential fish habitat (EFH) through the oysters and mudflats that occur along its perimeter. Other essential fish habitats provided by the island include two acres of salt marsh and both rock and sandy bottom intertidal habitat. In order to ensure the mitigation features are providing the habitats intended, annual monitoring is conducted and corrective actions are taken if needed.

Post-construction began after the mitigation features were constructed. Wetland mitigation sites were altered in 2011 and a 5-year monitoring period began on the performance of those features in October 2011. Invasive species have presented an issue in several of the wetland mitigation sites. The District worked with the Coastal Georgia Cooperative Invasive Species Management Area to obtain an Americorps NCCC (National Civilian Community Corps) team to treat salt cedar in 2013 in marsh mitigation sites on Andrews Island.

The creation of the Island in the St. Simons Sound has benefited threatened, endangered, and candidate bird species. Specifically, nesting and activity of the following species was documented during 2014: 6,573 royal tern pairs nested (only nesting site in Georgia for this species) and thousands fledged, 50 sandwich tern pairs nested (only nesting site in Georgia for this species) and many fledged, 250 Least Terns nests (many fledged), 4 gull-billed tern nests (all failed), 90 black skimmer nests (many fledged), 5 brown pelicans, and 152 laughing gulls. Because laughing gulls are considered a pest species and can reduce the nesting success of the desired threatened, endangered, and candidate bird species, control of this species was initiated.

**Savannah Harbor Navigation Project**

The Savannah Harbor Navigation Project is a deep water port located in Savannah, GA. In the 1990's, the project impacted 311 acres of salt marsh in South Carolina when it created a new diked dredged material containment area. To mitigate for those impacts, the Corps developed and implemented a Long Term Management Strategy for the harbor. The plan commits the Navigation Project to provide 1,769 habitat units of bird habitat each year, generally as follows: 74 habitat units of bare ground nesting, 450 habitat units of wetland nesting, 505 habitat units of waterfowl feeding, and 740 habitat units of shorebird feeding. The plan included constructing bare ground nesting islands within the diked sediment disposal areas and managing water levels appropriately on a rotating program. Providing bare ground nesting habitat involves clearing invasive vegetation, herbicide treatment, and control of predators such as fire ants, coyotes, and feral hogs. As part of these efforts, the Corps established a rookery within one of the dredged material containment areas. The 350-acre site provides wetland nesting habitat for a number of waterbirds, with egrets, herons, and anhingas successfully fledging young. Other species have benefited from roosting/feeding in the rookery, including woodstorks, roseate spoonbills, and white ibis.

In 2011, the Corps rehabilitated a previously abandoned dredged material containment area (Area 1N on Onslow Island). This rehabilitation allowed the Corps to reuse the site for sediment placement and production of wildlife habitats.

The EIS requires the District to monitor and report on the mitigation status. Most of the construction work for this mitigation occurred between 2009 and 2014. The Corps monitors these sites on a regular basis to ensure the features continue to provide the intended amount of bird habitats. When new issues arise, such as erosion of a site, the District investigates ways to stabilize the site and ensure continued mitigation compliance.

Savannah District staff partner with many other federal and state agencies, including the US Fish and Wildlife Service and the GA DNR Nongame Conservation Section to protect the nation's environment and provide valuable and productive wildlife habitats.

**United States Fish & Wildlife Service**  
**Update on USFWS**  
**Robin Goodloe and Carl Schmidt (USFWS)**

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FWS-Georgia Ecological Services uses the SWAP to assist in ranking proposed Partners for Fish and Wildlife projects in the state. We worked with the Savannah District to incorporate consideration of the goals of the State Wildlife Action Plan into District requirements for selection of mitigation properties; each mitigation bank prospectus must clearly identify how the bank furthers the goals of the SWAP. The SWAP, in addition, serves as a source document for GAES biologists for information on non-listed priority species in different areas of the State.

The State Wildlife Action Plan affects National Wildlife Refuges in several ways. For example, the Georgia Land Conservation Partnership Plan, Identification of Conservation Opportunity Areas in Georgia, and High Priority Conservation Actions appendices may affect proposed projects, proposed land acquisitions, etc. A primary way SWAP affects a refuge's management activities is through the plan's influence on determining what the USFWS calls Resources of Concern. These are "plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), system mission, or international, national, regional, state, or ecosystem conservation plans or acts." For instance, Piedmont National Wildlife Refuge's resources of concern and priority habitats were determined, in part, by the High Priority Species and High Priority Habitats appendices of the state plan. Determining these species and habitats sets the management direction and potential management strategies for the next fifteen years.

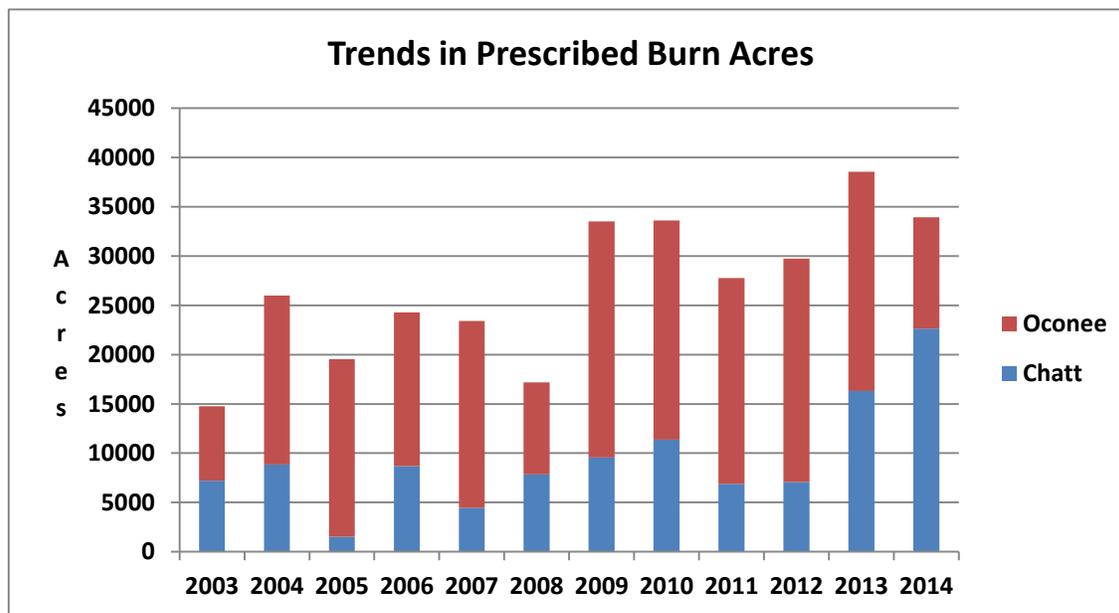
**US Forest Service**  
**Update on Chattahoochee-Oconee National Forests**  
**Jim Wentworth (USFS)**

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Management of the Chattahoochee-Oconee National Forests is guided by the 2004 Land and Resource Management Plan (Forest Plan). The Goals and Objectives of the Forest Plan are well aligned with many of the Conservation Actions in the State Wildlife Action Plan. In cooperation with our State partners in Georgia DNR, as well as other Federal and private partners, significant progress has been made in achieving many of the High Priority Conservation Actions over the last 10 years.

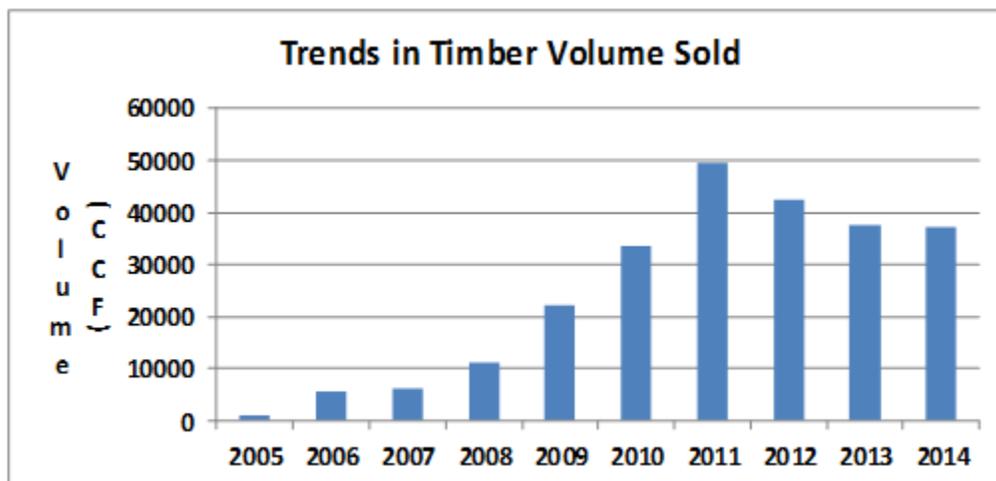
X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combated Invasive/Alien Species</i>

The Forest Plan places emphasis on the restoration of native forest communities as well as a number of rare communities. An expanded program of prescribed fire and timber harvest is being utilized to restore native communities including open southern yellow pine forests (shortleaf, pitch, table mountain, and longleaf pine), as well as oak and oak-pine woodland. These measures are also being used to create suitable



conditions for species that require early successional habitats including high elevation early

successional habitat. An example is the Brawley Mountain project in Fannin County that involves the restoration of woodland habitat for the golden-winged warbler (*Vermivora chryoptera*). A combination of canopy thinning, prescribed burning, selective herbicide use, and the establishment of native warm season grasses are being used to enhance habitat conditions for the last remaining golden-winged warbler population in Georgia. On the Oconee National Forest, prescribed burning, timber harvest, midstory control and the installation of cavity inserts are being used to improve conditions for the endangered red-cockaded woodpecker (*Picoides borealis*).

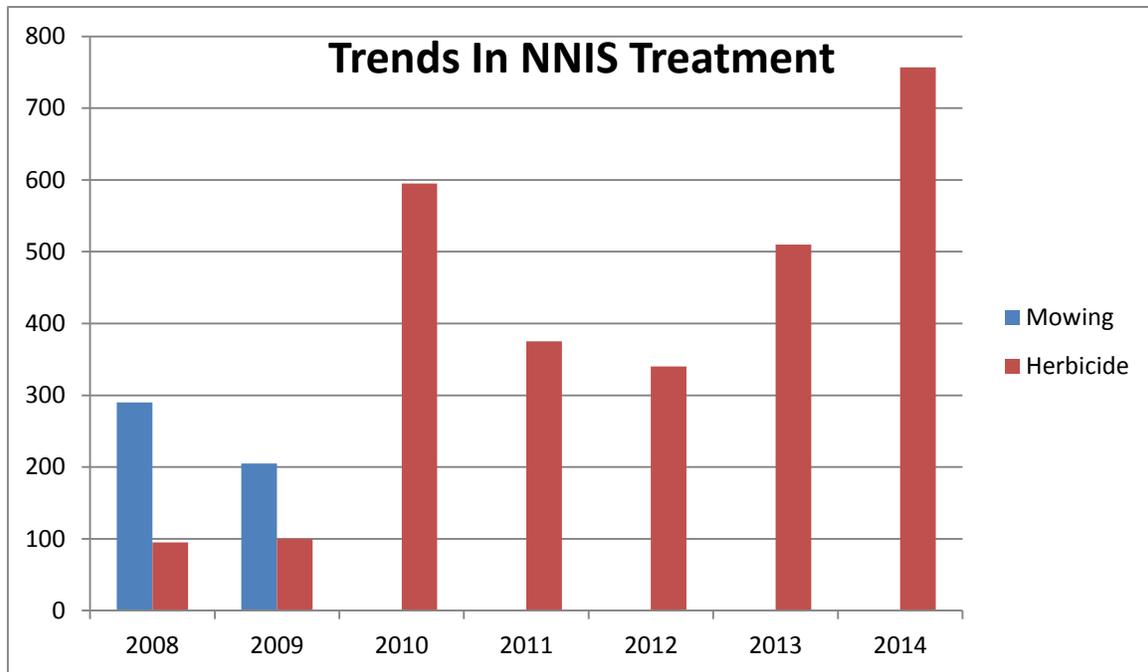


In

cooperation with the Georgia Plant Conservation Alliance (GPCA), the Forest is involved in the establishment and management of safeguarding sites for rare bog flora including mountain purple pitcher plant (*Sarracenia purpurea* ssp. *purpurea* var. *montana*), swamp pink (*Helonias bullata*), and Carolina laurel (*Kalmia caroliniana*). Hand tools and prescribed fire are being used to restore mountain bog habitat in 7 bog complexes, several of which also contain the federally listed bog turtle (*Glyptemys muhlenbergii*). Habitat for woodland plants such as smooth purple coneflower (*Echinacea laevigata*), Georgia aster (*Symphotrichum georgianum*), and eastern turkeybeard (*Xerophyllum asphodeloides*) also is being managed with prescribed fire and vegetation management. Additionally, safeguarding sites for federally listed smooth purple coneflower and large-flowered skullcap (*Scutellaria montana*) have also been established. The Forest is also working with the Atlanta Botanical Gardens and the University of Georgia to complete a habitat assessment, assess the monitoring program, develop a spatial model, and conduct germination trials for the federally threatened small whorled pogonia (*Isotria medeoloides*). In addition to establishing safeguarding sites, the Forest is working with other GPCA partners such as Georgia DNR and Atlanta Botanical Garden, to improve data sharing through development of the safeguarding database. The database tracks the safeguarding program from source material, to outplanting, to monitoring. Increased efforts for survey and monitoring continue to focus on rare bog plants, small whorled pogonia, smooth purple coneflower, and Georgia aster.

As a result of the increased concern due to the effects of white-nosed syndrome as well as recent discovery of an Indiana Bat (*Myotis sodalis*) maternity colony in north Georgia, the Forest has placed additional emphasis on forest bats. In conjunction with Georgia DNR and US Fish and Wildlife Service personnel, the Forest has undertaken acoustical and mist net surveys to establish baseline bat populations. The Forest is also implementing measures to control human access to caves and mines and is developing a Forest Plan Amendment to incorporate additional measures to protect and enhance habitat conditions for forest bats.

The Forest also has a growing program of inventory and treatment of non-native invasive species (NNIS). The early detection and rapid response program continues to identify new invasive plant risks including fig buttercup (*Ficaria verna*) on the Chattahoochee National Forest and Japanese climbing fern (*Lygodium japonicum*) on the Oconee National Forest. The Forest also has an extensive program to reduce the threat of the exotic insect hemlock woolly adelgid (*Adelges tsugae*) on our native hemlocks. This includes the chemical treatment of individual groups of hemlocks and the release of several species of predator beetles produced at labs at Young Harris College, the University of Georgia, the University of North Georgia in Dahlonega, and Clemson University. The invasive species program also includes an effort on the Chattooga River Ranger District to control feral hogs in high priority bog habitats. The Forest has also increased use of native herbaceous species for erosion control and restoration.



For aquatic species, the Forest has installed bottomless arch culverts on several streams to enhance passage for brook trout (*Salvelinus fontinalis*), Eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*), and other species. To increase the availability of spawning for the blue shiner (*Cyprinella caerulea*), log spawning structures were installed in portion of the Conasauga River where large woody debris was limited. On the Oconee National Forest, we are working with Federal, State, and private partners in the Robust Redhorse (*Moxostoma robustum*) Conservation Committee to help in the recovery of this species. The Forest has an ongoing effort with Conservation Fisheries Inc. to monitor rare aquatic species. Finally, in the last decade, the Forest's land acquisition program has focused on high priority watersheds including the acquisition of nearly 800 and 400 acres in the Conasauga and Etowah River watersheds, respectively.

# **Non-Governmental Organizations**

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## **Georgia Plant Conservation Alliance**

**Lisa Kruse (GA WRD) and Contributors**

### **Georgia Plant Conservation Alliance**

**Jennifer Ceska, Jim Affolter, Heather Alley (State Botanical Garden of Georgia)**

The Georgia Plant Conservation Alliance (GPCA) is a professional network of botanical gardens, state and federal agencies, non-profit organizations, universities, and large land-owning companies working together on statewide plant conservation projects. GPCA began its work in 1995 with the goal of preventing plant extinctions in Georgia. There has been real success over the last two decades, expanding to include 36 active organizations, with 80 endangered species in active recovery, and 31 species in safeguarding in wild protected sites. Habitat restoration on these sites is essential for the longterm success of these high priority species.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

GPCA was launched by the State Botanical Garden, Callaway Gardens, the Atlanta Botanical Garden, the Georgia Department of Natural Resources Nongame Conservation Section, the U.S. Forest Service, and The Nature Conservancy of Georgia, expanding slowly to create a network for statewide conservation projects. The mission of GPCA is to facilitate partnerships among private and government agencies that have the knowledge, the critical habitat, and the resources to implement high-priority, science-based plant conservation and education projects statewide.

The GPCA goal is to protect all populations of imperiled plant species in Georgia. Horticulture experts store plant material collected from the wild at botanical gardens. While collecting, growing, and storing rare species is an important conservation strategy, safeguarding plant species *ex situ* (outside of their natural populations) is only part of a recovery strategy for the GPCA. Our priority for endangered plant species conservation is to restore original populations or introduce new populations *in situ* (at appropriate wild sites) on protected land. The critical work of locating those plants on the land, finding secure sites appropriate to the species' range and habitat, makes our land-holding and land-managing partners essential to the formula of conserving rare plant species' populations in Georgia. Our partners in The Nature Conservancy of Georgia, the US Forest Service Chattahoochee and Oconee National Forest, and the Georgia Department of Natural Resources, particularly the Nongame Conservation Section, help locate and provide sites for safeguarding rare plant populations on protected lands.

### **Safeguarding Sites State-Wide**

Of the 80 species that GPCA has prioritized for conservation safeguarding work, 65 species have material in safeguarding *ex situ* either as plants, seeds, or tissue. Of those 65 species in safeguarding, 49 species have made the horticulture conservation loop and have been returned to the wild to safeguarding sites. A majority of these species have been returned to wild sites that are on lands owned or managed by GA DNR. These 38 species are planted state-wide and include 21 Wildlife Management Areas (WMAs), 7 areas managed as Natural Areas (NAs), and 10 State Parks/Historical Sites.

Several of GPCA's most successful safeguarding projects occur on these state lands. The sites are protected and are under active restoration and management. GPCA has returned a number of critically imperiled plant species to the wild on areas such as Broad River WMA, Ochopee Dunes WMA, Rock and Shoals Outcrop WMA, and Cooper's Creek WMA. The projects require long term commitments for protection as well as dedicated resources for the land restoration, management, and monitoring until a species begins to take hold in its new safeguarding home.

Because the WMAs are under active restoration and management, they provide GPCA not only with a protected site, but also a team of professionals working to remove invasive species, apply prescribed fire to the land, and to restore hydrological systems to their natural flows. Working with lands already in active management saves the GPCA years of time, enabling us to return plants to wild sites faster than we would if we were working with other lands that are at the beginning of their restoration phase.

Reciprocal work between the Interagency Burn Team and GPCA partners has enabled us to return imperiled plant species and protect Georgia rare plant populations on land held by different parent agencies, including private, state, and federal. This collaboration has allowed working together as a team, leveraging the work, volunteers, and equipment to get land restored and plants back on the ground. GPCA has been proud to support networking on all of these lands and with significant successes.

### **Safeguarding Highlight on State Land Dwarf Sumac at Lower Broad River WMA, Mincy Moffett (GA WRD)**

Aggressive habitat-level management, coupled with careful “surgically” applied micro-site management has saved one of Georgia’s only two natural populations of the federally endangered dwarf sumac (*Rhus michauxii*) from extirpation. Dwarf Sumac is a small deciduous shrub preferring open woodland habitat.

The male population of dwarf sumac in Elbert County occupies a 1-acre knoll within the larger Lower Broad River WMA (LBRWMA). It began a precipitous decline in the late 1990’s, and by 2005, the number of visible male stems at the Elbert County site had dwindled to just two. The site had become incredibly overgrown with a nearly closed canopy and rapidly encroaching mid-story. It was at that time that the Georgia Plant Conservation Alliance (GPCA) added the dwarf sumac to its safeguarding work list and began designing the concept of a 40-acre LBRWMA safeguarding area. The GPCA safeguarding model combines landscape-level management/restoration with more intensive micro-site management to achieve amazing results. Landscape-level management includes such things as prescribed fire, as well as chemical and mechanical removal of woody competition with a focus on large acreage. Micro-site management occurs on a scale of square feet and is essentially *in situ* conservation horticulture.

During the last 8 years, the LBRWMA safeguarding area has received three prescribed burns and one mechanical thinning. In addition, the knoll area received a more thorough manual thinning using chainsaws, and benefits from an annual hand-pruning of woody growth where needed. The plants have responded vigorously to this management scheme, producing 750 stems in 2014. A genetics study by a GPCA member institution indicated the presence of at least 10 different genotypes in the male population, meaning that most of the genotypes were just lying dormant beneath the burden of woody competition and shade during those “lean” years. They were rescued from their slowly-senescent dormancy by the intervention of habitat management.

The GPCA undertook another dwarf sumac initiative designed to encourage sexual reproduction. Fifty stems from the female population in Newton County were transplanted into the male population at LBRWMA. The micro-sites for outplanting were carefully selected and prepped, and young plants received stewardship visits on a regular basis during their first year. In 2013, the mixed population produced viable seed that later germinated in conservation greenhouses. This was the first successful sexual reproduction event ever witnessed for this species in Georgia.

The GPCA also maintains numerous *in situ* and *ex situ* safeguarding collections of both populations of this species as a hedge against extinction.

### **Safeguarding Highlight on Private Land Coastal Plain Pitcher Plant Bog, Lisa Kruse (GA WRD)**

Another GPCA success story lies in southeast Georgia. The GPCA and its partners have restored endangered herbaceous seepage bog habitat in Georgia's Atlantic Coastal Plain in a long-term public-private partnership for monitoring and management. Intact seepage bogs are extremely rare in Georgia, with less than a dozen high quality bog habitats identified in the entire state. This habitat was identified as a high priority habitat in the original SWAP. One of these bogs near Claxton was chosen by the nascent GPCA around 1999 as one of its five top priority initial conservation projects. It is a complex of seepage bogs in 8 discrete swales along a rolling 5-mile stretch of powerline right of way, within a matrix of intact longleaf /turkey oak sandhill and pine plantation. It is important as the only known Georgia location for the Coastal plain purple pitcher plant (*Sarracenia purpurea* var. *venosa*), for having eight other Georgia protected plant species, and for overall high floristic species diversity that includes at least five orchid and seven carnivorous plant species.

Conservation of these bogs is challenging because they are in multiple private ownership, each with differing land management objectives. Further complications arise from management activities by two utility companies in their right-of-ways across the bogs. Significant threats include fire suppression, herbicide and fertilizer use, off-road vehicle intrusion, invasive plant species, and industrial forestry practices.

GPCA's involvement was initiated when a miscommunication within a utility company resulted in herbicide application that destroyed the herbaceous component of one of the bogs. From that low point GPCA took on the role of 1) centralizing communication among land managers, land owners, and conservationist biologists, 2) formalizing a shared management agreement with utility companies, and 3) monitoring the rare habitats through the Botanical Guardians program.

When regular monitoring from 2002-2006 indicated that the bogs were in rapid decline due to off-road vehicle trespass and fire suppression, GPCA coordinated a multi-pronged management effort to counter these threats. Utilizing the Interagency Burn Team (IBT), prescribed fire was conducted at one property in 2006. In 2007, new fences and educational signs were installed at five of the bogs to deter off-road vehicle use. As GPCA had been in contact with landowners and utility companies for years, permission was not difficult to obtain. The management was mutually beneficial to all parties. Subsequently, Coastal Plain purple pitcher plant and one orchid species have been planted at one bog, grown from seed collected at the site. Four additional prescribed burns, including a second landowner, have been conducted by the IBT. The latest, in 2014, was a growing season burn where nearly 35 acres of wiregrass groundcover flowered and set seed. Fences and signs have remained intact and no further damage has been done by off-road vehicles. Pitcher plants, orchids, and incredible herbaceous diversity are flourishing, particularly where prescribed fire has been implemented. The benefits extend to animal species as well, as evidenced by the numerous gopher tortoise burrows on the site. These great successes have provided inspiration to continue maintaining good landowner relations, expand to additional properties in the restoration management activities, and possibly create long-term legal agreements for conservation of this special habitat.

## **The Longleaf Alliance**

**Randy Tate (LLA)**

The Longleaf Alliance (LLA) was established in 1995 at Auburn University when it became apparent that the interest in the longleaf ecosystem and the tree itself was growing rapidly, but there wasn't an outlet available for ecologists, foresters, wildlife biologists, land owners and land managers seeking information nor was there a means to distribute information they did know.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
	<i>Combatted Invasive/Alien Species</i>

A growing body of anecdotal information, personal experience, and scientific data was being passed on fitfully, and many groups were not being reached. The LLA was therefore created with the express purpose of coordinating partnerships between private landowners, forest industries, state and federal agencies, conservation groups, researchers, and other enthusiasts interested in managing and restoring longleaf pine forests for their ecological and economic benefits.

The structure of the LLA is simple, with a direct goal, the establishment of a functional longleaf forest ecosystem to the extent feasible in today's Southern forest environment. We understand that the restoration of a fully functioning longleaf ecosystem appeals to landowners in varying degrees. Recognizing that an intact longleaf forest ecosystem is not likely ever again to dominate the southern landscape, we have adopted the philosophy that "better is better." We believe that longleaf in any form is better than a cotton field; that longleaf and native ground cover (like wiregrass) is better than longleaf alone; that longleaf, wiregrass, and gopher tortoises are better than longleaf and wiregrass alone, etc.

The LLA serves as a clearinghouse for information on regenerating, restoring and managing longleaf pine; provide networking opportunities for supporters to connect with other landowners, managers and researchers with similar interests and problems; and coordinate technical meetings and education seminars.

The vast majority of forest acreage in the Southeast is privately owned. For example, of the approximate 24 million acres of forest land in GA, 92% of that is privately owned (*Sustainable Forest Management in Georgia, GFC, 2008*). Consequently, the LLA feels that the greatest opportunity to significantly re-establish longleaf pine forests is on private lands. A primary focus is to provide economically viable and voluntary options for recovery of longleaf on private lands where most of the losses are occurring.

In 2009, the LLA joined several other agencies, organizations and private individuals in creating a range wide plan for the restoration of longleaf pine. That plan became *America's Longleaf Restoration Initiative*. (<http://www.americaslongleaf.org/>) America's Longleaf Restoration Initiative (ALRI) is a collaborative effort of multiple public and private sector partners that actively supports range-wide efforts to restore and conserve longleaf pine ecosystems. The vision of the partners involved in ALRI is to have functional, viable longleaf pine ecosystems with the full

spectrum of ecological, economic and social values inspired through the voluntary involvement of motivated organizations and individuals.

ALRI has recognized 17 Significant Geographic Areas (SGA) for longleaf throughout its range. Five of these are wholly or partly in Georgia. No other state within the range has as many as Georgia. Each of these SGAs has established a Local Implementation Team (LIT) to coordinate and guide restoration and conservation activities within the boundary they have drawn. These are the *Talladega-Mountain Longleaf Pine Conservation Partnership*, the *Chattahoochee Fall Line Conservation Partnership*, the *Fort Stewart/Altamaha Longleaf Restoration Partnership* the *Okefenokee and Osceola Local Implementation Team* and the *Apalachicola Regional Stewardship Alliance*.

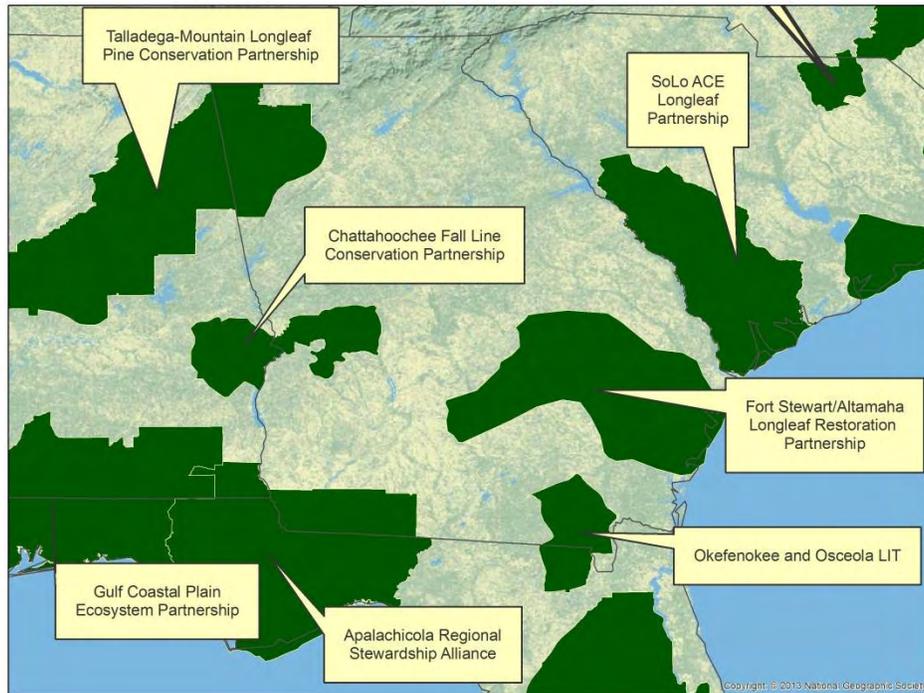
The National Fish and Wildlife Foundation established the Longleaf Stewardship Fund (LSF) in 2012. It is a landmark public-private partnership supported with federal funding from the Department of Defense, the U.S. Forest Service, the Natural Resources Conservation Service, the U.S. Fish and Wildlife Service, and private funding from Southern Company and International Paper's Forestland Stewards Initiative. It is the LSF that has largely funded the establishment and operations of the LITs.

In order to disseminate the best information possible on longleaf establishment and management, the Longleaf Alliance initiated Longleaf Academies in 2008. Longleaf 101 provides the basics of longleaf ecology, establishment and management. They have proved enormously successful and now include Longleaf 201 courses on understory establishment and management and prescribed fire. Several Academies have been held in GA and more are planned in the future.

There has been much work on groundcover restoration in GA. In 2012 the LLA initiated the *Longleaf Understory Common Garden Project*. The project evaluates differences in germination, establishment, phenological characteristics and growth rates among proposed seed transfer zones for six common understory plant species that provide functionality in the longleaf ecosystem. One of the four sites is located in GA at the Joseph Jones Ecological Research Center in Newton, GA. Also, a groundcover seed production plot has been established at K&L Forest Nursery in Buena Vista, GA. Six different common longleaf understory species are being grown for the purpose of seed production. And, in conjunction with the Chattahoochee Fall Line Ecosystem Partnership, 21 acres of native grasses were established on The Nature Conservancy owned Ingram Tract that borders the Ft. Benning Military Installation. Over the next two years (2015-2016), a five acre groundcover restoration demonstration site will be established at Moody Forest Natural Area in Appling County.

Additionally, in collaboration with Trees Atlanta, the LLA established a demonstration planting of longleaf and understory species along the Eastside Trail on the BeltLine in Atlanta, GA, in 2012.

Each LIT within Georgia currently has funding for two more years and anticipates continued work given future funding. These LITs form an infrastructure for longleaf pine restoration and management into the future. Dozens of species of conservation concern will benefit.



America's Longleaf Restoration Initiative recognized 17 Significant Geographic Areas

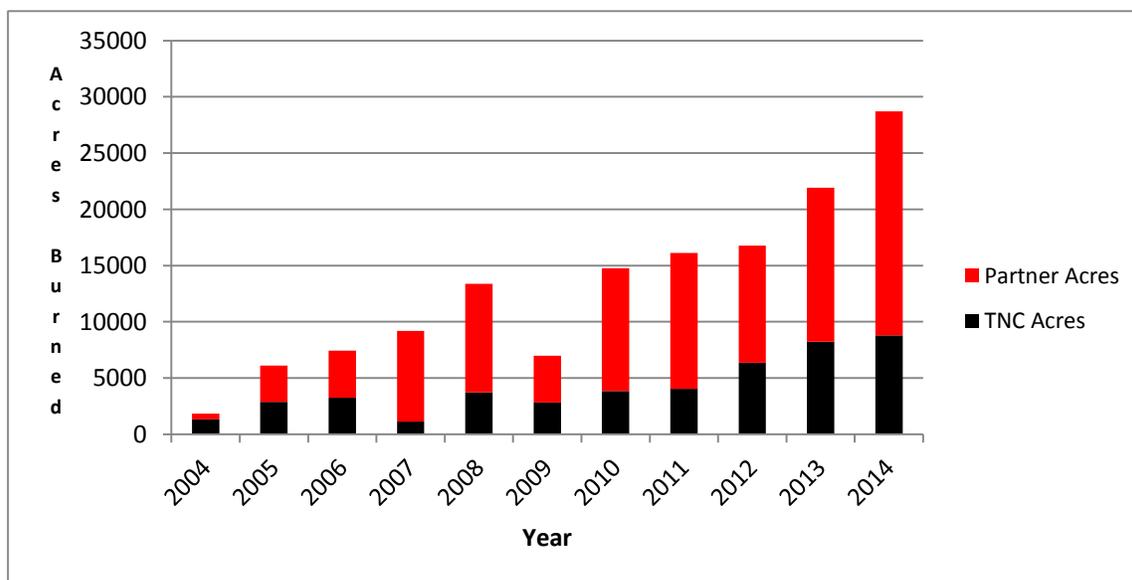
## **The Nature Conservancy (TNC)**

### **Habitat Restoration Over the Past Decade, Malcolm Hodges and Erick Brown (TNC)**

Over the past decade (2004-2014), The Nature Conservancy has increased both its need for habitat restoration and its capacity in Georgia. In general, our conservation staff has declined, but we have gone from three to four full-time land stewards, two site-based and two statewide. Most of the latter half-decade we went without a state-dedicated fire manager, but that was rectified in 2013. TNC-owned lands in Georgia have more than doubled in the past decade, and the conservation easement acres managed by our land stewards have also increased significantly (see Figure 1). To fill the capacity gap, we rely heavily on volunteers, interns, and short-term fire crews, as well as assistance from partners such as GA DNR.

X	<i>Addressed Altered Fire Regimes</i>
X	<i>Improved Management Practices</i>
X	<i>Combatted Invasive/Alien Species</i>

Our habitat restoration strategy places high priority on prescribed fire. In addition, we remove pine plantations and native invasive hardwoods (e.g., water oak, sweetgum) and replant uplands with site-appropriate pine species. We also harvest native plant seed and replant in areas where necessary. Finally, we remove non-native plants and animals negatively impacting natural systems. Over the last decade, we have continued with all these practices, with varying degrees of success. Emphasis on fire, which we believe is the most important single action we can take, has increased outside TNC lands, with our participation in fire on partner lands growing tenfold over the last decade. We began the decade relying on staffing prescribed burns with full time employees and short term Americorps NCCC teams, then moved to a seasonal crew based out of Baxley, and now routinely hire two crews each spring. We believe that we achieve the greatest success at efficiently conserving biodiversity by ensuring our fire program, and the fire programs of our partners, continues to grow and achieve programmatic objectives.



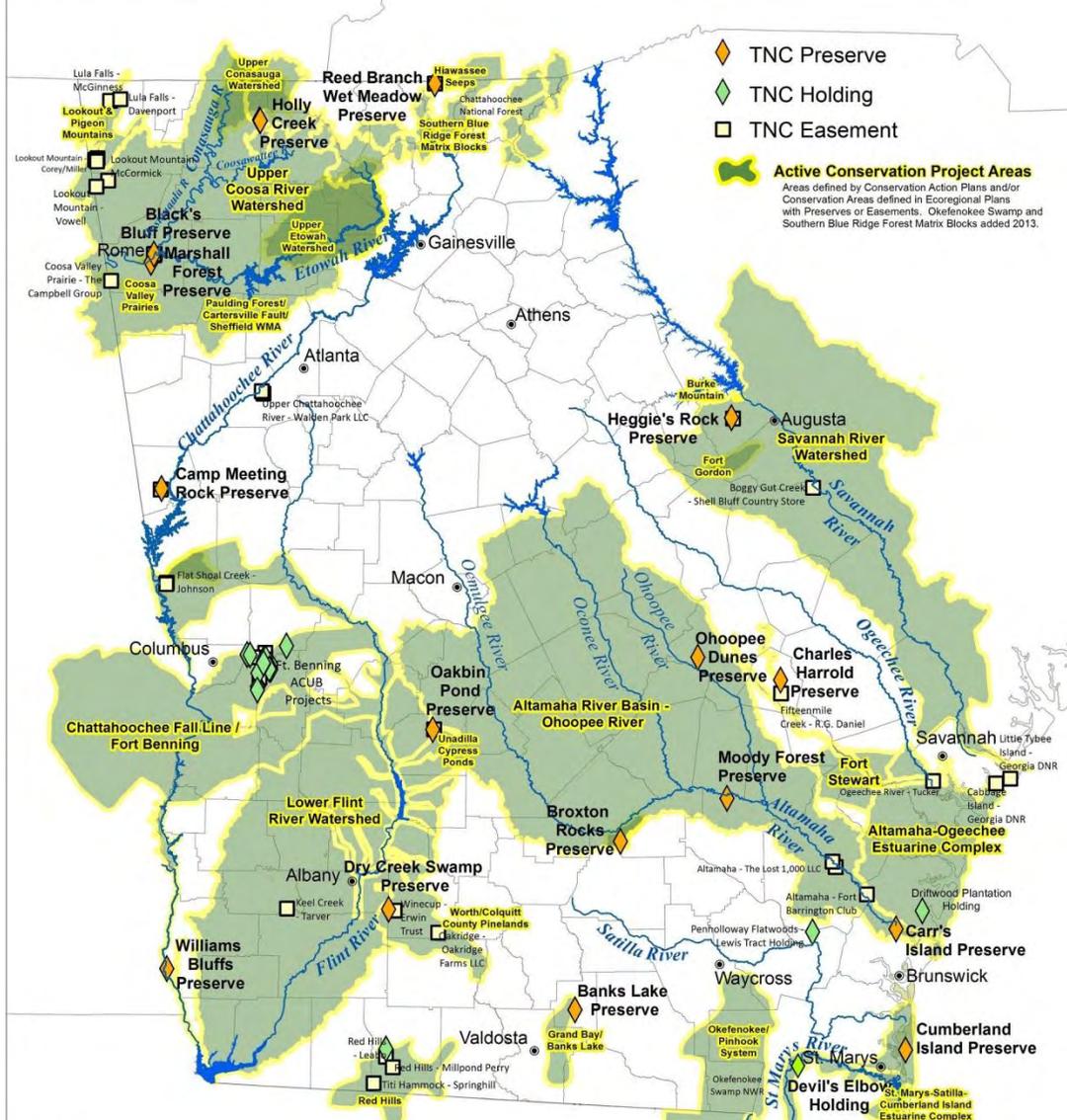
TNC attempts to use its preserves as a testing ground for best habitat restoration practices, and then use that knowledge to assist in restoration efforts and land management undertaken by partner agencies and organizations statewide. Over the past decade, we have experimented with tree and herb planting methodology, fire frequency in xeric habitats, restoration of fire-suppressed mature pinelands with organic soils, and methods for restoring exotic grasslands. Many of these attempts at “adaptive management” are ongoing, and engaging partners has often involved a slow, osmotic transfer of information.

Conservation of biodiversity in conjunction with habitat restoration can sometimes result in surprises, some good and some bad. For instance, over the past decade fire management in remnant prairies in the Coosa Basin has resulted in significant increases in populations of two federally protected plants, Mohr's Barbutton (*Marshallia mohrii*) and whorled sunflower (*Helianthus verticillatus*). However, two key habitat-indicator plants, prairie dock (*Silphium terebinthinaceum*) and prairie purple coneflower (*Echinacea purpurea*), have declined. Increased fire at sites with populations of Georgia plume has invigorated some populations, while others have suffered setbacks from excessive deer browse on root sprouts. Habitats are complex systems and pushing on one part can cause unanticipated effects in other areas.

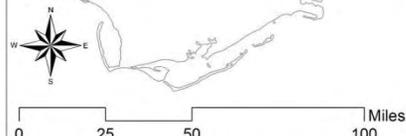
Habitat restoration of increasingly isolated tracts begins to look like zoo-keeping in a state with less than 10% of its land area in protected lands. Our manipulation of populations of rare plants and animals has grown, with reintroductions, ex-situ propagation and safeguarding of rare organisms all increasing greatly over the last decade. Examples include the introduction of gopher frog to Williams Bluffs Preserve (Early County), augmentation of green pitcherplants (*Sarracenia oreophylla*) at Reed Branch Wet Meadow Preserve (Townsend County), reintroduction of Georgia rockcress (*Arabis georgiana*) from ex-situ cultivation at Black's Bluff Preserve (Floyd County), and safeguarding of Cooley meadowrue (*Thalictrum cooleyi*) from Dry Creek Swamp Preserve (Worth County) at a nearby conservation easement. Such creative methodology will only increase as we make full use of a weak conservation portfolio to conserve the state's existing biodiversity.

As large-scale land protection wanes in the face of an increasing human population, careful restoration and management of existing conservation lands becomes more important. Collaboration among conservation-lands managers has increased and will no doubt continue to do so, as we seek best practices for habitat restoration and develop multi-site cooperative projects.

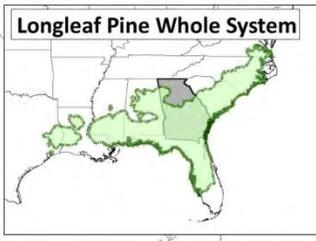
Rapid changes in land tenure, intensification of anthropogenic extraction processes, climate change, declines in government funding, and the shifting structure and mission of non-profit environmental groups create a mercurial environment for long-term land-management practitioners. In particular, the uncertain future of fire management in the face of increasing concern over smoke management and atmospheric carbon inputs places our most important restoration strategy at risk. Prioritization of management practices on those lands most resilient to change is one way to minimize risk. Belief in the ecologically redemptive power of fire can reach an almost evangelical zeal amongst land stewards, but careful evaluation of and experimentation with alternatives to fire would be wise in the coming decades. Examples include close-mowing and rotational grazing schemes.



**Legend Notes:**  
Easements directly adjacent to Preserves are indicated, but not labeled  
TNC Holding = Conservation Buyer Transaction planned for property (TNC currently owns, but will not hold as a preserve)



Map by Sara Gottlieb  
The Nature Conservancy in Georgia  
TNC\_in\_GA\_Arc10.mxd



## **Habitat Restoration and SWAP**

### **Looking Ahead**

**Shan Cammack and Eamonn Leonard (GA WRD)**

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The State Wildlife Action Plan was developed by a comprehensive planning team as a conservation strategy to protect and maintain the full complement of species native to a Georgia, especially species of greatest conservation need. The strategy assessed the extent and condition of habitats required by these species, as well as existing and potential problems and conservation opportunities for these habitats. The plan remains as strong and relevant to habitat restoration today as it was when it was published ten years ago.

Recommended Actions and Strategies that were outlined in the original SWAP were addressed in the past ten years.

<p><b><i>Address Altered Fire Regimes</i></b></p> <ul style="list-style-type: none"> <li>• Partnerships continue to grow and increase capacity to conduct prescribed burning and to identify priority areas in need of better fire management. More emphasis is being placed on appropriate timing and frequency.</li> <li>• The Interagency Burn Team (IBT) continues to be successful and will continue with the recent re-signing of the Memorandum of Understanding.</li> <li>• Several programs focused on working with private landowners owning high priority habitat. Technical assistance and incentive programs encouraged prescribed burns in fire-adapted habitats.</li> <li>• NWCG (National Wildfire Coordinating Group) certification standards were adopted by all state and federal practitioners in the IBT.</li> </ul>
<p><b><i>Encourage Improved Management Practices</i></b></p> <ul style="list-style-type: none"> <li>• As outlined in this chapter, USFS, NPS, USFWS, and other public land managers worked together at multiple levels to improve habitat management on public lands. Restoration and maintenance of natural habitats was emphasized as well as addressing regional conservation.</li> <li>• IBT partners work to couple habitat management and educational outreach programs to help provide the public with information to inspire sound stewardship for wildlife resources on private lands.</li> <li>• NRCS used SWAP widely to promote the planting of native species through Farm Bill programs.</li> <li>• State agencies worked to improve public familiarity with and use of BMPs for agriculture, forestry, and land development practices.</li> </ul>
<p><b><i>Combat Invasive/Alien Species</i></b></p> <ul style="list-style-type: none"> <li>• A strong interagency push was made to work collaboratively on invasive species issues. This included promoting education about exotic species that covered identification, effects, and eradication measures. Efforts were also made to reduce the importation of invasive exotic species.</li> <li>• State, federal and NGOs worked tirelessly to eradicate invasive species on their properties.</li> <li>• Land management agencies worked to initiate integrated control measures that focus on early detection and eradication of alien species.</li> </ul>

Thanks to the Georgia State Wildlife Action Plan, land management agencies across the state have been working hard to improve habitats for species of special concern. Perhaps the most useful benefit of the SWAP is heightened importance of habitat restoration and the increased availability of funds. Federal funding entities as well as non-profit organizations relied on the SWAP to set priorities and rank projects. This has funded a lot of on-the-ground management activities that have benefitted a myriad of species.

These priorities remain in place. This, coupled with the momentum that has been generated in the last ten years, suggests that the vision of habitat restoration will continue into the future. Part of this success has been due to the high level of collaboration and cooperation between the various state, federal, and non-profit agencies and groups. The unique landscape of Georgia and the high level of private landownership has forged these alliances and led to creative ways to implement effective land management. Species of special concern in Georgia will experience new challenges in the future in the form of economic, demographic, environmental, and political change that will force land managers to be adaptive. The SWAP will continue to be used as a blueprint to guide the prioritizing of habitat restoration activities for years to come.

## Appendix J. Monitoring Technical Team Report

Prepared by Lisa Kruse and Jacob Thompson

### Technical Team Members

#### *Team Leaders*

Lisa Kruse, WRD, Nongame Conservation Section – Botanist; Ecologist

Jacob Thompson, WRD, Nongame Conservation Section – Botanist; Ecologist

#### *Team Members participating at Monitoring Technical Committee Meeting*

Jon Ambrose, WRD – Nongame Section Chief

Mike Byrne, U.S. Park Service – Terrestrial Ecologist

Sim Davidson, GADNR Parks – Wildlife Biologist

Brian Davis, GA Department of Transportation – Ecologist

Matt Elliott, WRD – Nongame Program Manager

Robin Goodloe, U.S. Fish and Wildlife Service - Biologist

Jim Hanula, U.S. Forest Service – Research Entomologist

Steve Holzman, U.S. Fish and Wildlife Service – Data Manager

Dorset Hurley, Sapelo Island National Estuarine Research Reserve – Senior Marine Biologist

Brian Irwin, USGS, Georgia Cooperative Fish & Wildlife Research Unit – Assistant Unit Leader (Fisheries)

Michael Juhan, Fort Gordon Army Base – Wildlife Biologist

Tim Keyes, WRD – Wildlife Biologist; Ornithologist

Kay Kirkman, Joseph Jones Ecological Research Center – Scientist; Plant Ecologist

Joyce Klaus, Gordon College – Assistant Professor; Herpetologist

Patti Lanford, WRD – Stream Survey Team - Biologist

George Matusick, The Nature Conservancy – Forest Ecologist

Clint Moore, USGS, Georgia Cooperative Fish & Wildlife Research Unit – Assistant Unit Leader (Wildlife)

Katrina Morris, WRD – Wildlife Biologist

Rebecca Pudner, Auburn University – Graduate Student

James Tomberlin, WRD – Private Lands Biologist

Susan Walls, U.S. Geological Survey (Amphibian Research & Monitoring Initiative) - Regional Coordinator

#### *Team Members participating through email and correspondence*

Analie Barnett, The Nature Conservancy – Landscape Ecologist

Laurel Barnhill, U.S. Fish and Wildlife Service – I&M Chief & Atlantic Zone Coordinator

Richard Chandler, University of Georgia – Assistant Professor

Nathan Klaus, WRD – Wildlife Biologist

Alison McGee, The Nature Conservancy – Coastal Plain Program Director

Joe O'Brien, USDA Forest Service Southern Research Station – Research Ecologist

Rob Sutter, Enduring Conservation Outcomes – Conservation Ecologist

Dirk Stevenson, Orianne Society – Assistant Conservation Scientist; Herpetologist

Jennifer Welte, GADNR Environmental Protection Division – Wetlands Biologist

Jim Wentworth, U.S. Forest Service – Wildlife Biologist

*Invited but unable to participate*

Bob Cooper, University of Georgia – Professor

Joe DeVivo, U.S. Park Service – Southeast Coast Network I&M Program Coordinator

Chelsy Miniatt, USDA Forest Service Southern Research Station – Coweeta Hydrologic Lab  
Project Leader

Lissa Leege, Georgia Southern University – Professor; Plant Ecologist

Betsie Rothermel, Archbold Biological Station – Assistant Research Biologist

Becky Sharitz, University of Georgia, Savannah River Ecology Lab – Professor Emeritus

## **Executive Summary**

As part of the 2015 Georgia State Wildlife Action Plan (SWAP) Revision, a monitoring technical team was assembled to determine ways to improve monitoring efforts in Georgia. Based on meetings and discussions with monitoring team members, a list of actions to improve monitoring was created and then ranked to create a priority subset of monitoring improvement actions. Other SWAP technical teams gave input on their top ranked monitoring actions, which along with discussions with team leaders, were assessed to determine overlapping monitoring needs and priorities.

Throughout this process, we found that the most consistent theme encompassing actions to improve monitoring was improving coordination state-wide, and regionally, among professionals conducting monitoring and management. Improving coordination involves a variety of actions that were emphasized by the monitoring team and other SWAP technical team leaders. These actions include tying monitoring to adaptive management, hiring a GA DNR monitoring coordinator, improving internal GA DNR communication related to monitoring, using standardized monitoring protocols and data forms when possible, improving sharing of protocols and data, and using technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects. We believe that all of these goals are achievable within the 5-10 year period covered by this SWAP Revision.

Because the monitoring improvement actions promoted by the monitoring team are often related, implementation of one action will often result in the success of another. For example, development of online tools will enable a greater capacity for protocol and data sharing. However, coordinating and improving monitoring statewide would be a significant time and resource commitment. Therefore, meeting the challenge of improving rare species and habitat monitoring likely hinges on hiring a monitoring coordinator. In particular, we find that the concept of tying monitoring to adaptive management requires careful consideration for the optimal level of implementation within GA DNR, mainly because of the necessity for status and trends monitoring in determining rare species status. However, working in an adaptive management framework is important because it is conducive to an institutional culture of constant assessment of monitoring results and communication of management implications.

Monitoring and an adaptive approach to species and habitat management are more important than ever considering uncertain future conditions with potential anthropogenic impacts and climate change. We propose that an adaptive management approach should be integrated throughout state monitoring programs, with results of monitoring informing conservation actions. Advances in technology will be integral to developing more rigorous monitoring/adaptive management programs. Overall, communication and coordination about monitoring and management should be emphasized within GA DNR and should incorporate partners to allow for conservation success.

## Introduction

Monitoring is critical to the work of researchers, biologists, and practitioners in the conservation field. From the collection of basic qualitative data by conservation managers to the analysis of complex long-term datasets by statisticians, monitoring can shape conservation and management actions in a significant and positive way. Well-designed monitoring can show status and trends over time in species, natural communities, and ecosystems; document the implementation and efficacy of conservation and management actions; guide decisions regarding conservation and management actions; and provide knowledge about the biology of the species and systems monitored (The Nature Conservancy 2009, Larsen 2013).

Because of its importance in conducting sound conservation and management, monitoring is essential to the implementation of statewide conservation strategies such as the Georgia State Wildlife Action Plan (SWAP). The 2005 SWAP discussed the significance of monitoring and highlighted monitoring in the adaptive management framework (Georgia SWAP 2005), whereby monitoring is designed to indicate whether conservation objectives are being met, and informs whether particular conservation actions should be continued or changed (Elzinga et al. 1998). The 2005 SWAP gave guidance on how to prioritize species for monitoring, and gave a list of actions that would improve efficiency and efficacy of monitoring in Georgia. These actions included recommendations such as improving volunteer networks for monitoring, utilizing available databases of partner agencies, requiring monitoring to be a component of conservation projects, integrating new technologies and GIS resources into monitoring, and working internally and with partners to create efficient, easy-to-use monitoring protocols (Georgia SWAP 2005).

Progress has been made in many of those actions since 2005. An incomplete list of examples follows: To engage citizen scientists, the volunteer network of the breeding bird survey has been expanded, and also used as a model for annual frog and bat monitoring. The Georgia Plant Conservation Alliance has developed a network of trained volunteers who help with rare plant monitoring state-wide, and with research on specific high priority projects such mountain pitcher plant bog restoration. Certain grants, such as the Multi-State Sandhills Restoration Grant, require monitoring for completion, and through this grant management effects on breeding birds, gopher tortoise, and vegetation community of the sandhills ecosystem have been tracked since 2009 on thousands of acres. GA DNR freshwater aquatic biologists have used GIS analysis of survey metadata improve prioritization of watersheds for monitoring. Extensive baseline habitat mapping and classification projects have been completed, focusing especially on sandhills communities, state parks, and the eleven-county coastal region. Monitoring of longleaf pine ecosystem restoration has improved understanding of the effects of GA DNR's land management, including site preparation methods, timber management, and prescribed fire in extremely fire-suppressed sites, which has subsequently been applied to improving GA DNR strategies for restoration of this critical ecosystem. And, to address the need for a simple, broadly-applied protocol, a fire effects photo monitoring program has been implemented in 25 state parks and natural areas state-wide. For this program, local staff collect data and submit it to a centralized repository of photos, and the data manager organizes chronological documentation of fire effects for each conservation property.

It is clear that across Georgia, monitoring of species, natural communities, and landscapes is conducted at many scales by multiple agencies and organizations. However, knowledge of monitoring programs in Georgia is not yet well-cataloged, nor is there an established mechanism for communicating about monitoring programs and results within the GA DNR nor among its partners. Certain partner agencies have developed rich monitoring programs and networks, such as the Inventory and Monitoring Network of the U.S. Fish and Wildlife Service (<http://www.fws.gov/Refuges/NaturalResourcePC/landM/>), the Southeast Coast Network of the National Park Service (<http://science.nature.nps.gov/im/units/SECN/>), the Forest Inventory and Analysis Program of the National Forest Service (<http://www.fia.fs.fed.us/>), and the Fire Research and Management Exchange System, or FRAMES (<https://www.frames.gov/>). These programs provide important examples for monitoring strategies, protocol design, data management, and results reporting. Also over the past decade, rapid development in computer technologies has occurred, making available convenient, reasonably priced and ergonomic tools for digital data collection and management. The need to effectively use and coordinate these resources to improve monitoring is great, as development and other pressures on Georgia's natural resources continue to increase, while simultaneously conservation and restoration programs continue to expand in scope and acreage.

Considering these factors, it was imperative to update and create new monitoring strategies to include in the revision of the Georgia SWAP for 2015. Therefore a monitoring technical team was convened to focus on monitoring issues for Georgia's rare species and habitats. The purpose of the monitoring technical team was to create a synthesis of how species, habitats, and conservation actions are currently being monitored in the state and to develop strategies to monitor more effectively in the future. The goals of the monitoring team were to assess the most significant gaps in monitoring in Georgia, what steps are critical and practical to improve monitoring in the next 5-10 years in Georgia, and how the Georgia Department of Natural Resources (GA DNR) can collaborate with partners to achieve these steps.

This monitoring chapter of the 2015 SWAP revision serves two functions. Primarily we make recommendations on how to improve monitoring in Georgia based on the work of the SWAP monitoring technical team. In addition, we begin the process of summarizing the priority monitoring projects and programs of the Nongame Conservation Section and key partners within the state. Both sections describe the current status of rare species and habitat monitoring in Georgia and provide an initiation point for collaborations and information gathering. We hope that this chapter will encourage new coordination for improved monitoring among DNR and its partners.

## **Methods**

The SWAP Revision monitoring technical team members were selected across different organizations based on their prior experience with monitoring. Professionals who conduct monitoring or have some expertise in monitoring including design, data collection, data storage, data analysis, and results reporting, were contacted to participate. The final team included a range of monitoring experience and was comprised of taxa experts, ecologists, researchers, conservation managers, and statisticians. Each team member submitted information about their monitoring work or monitoring work carried out by their organization.

The monitoring technical team assembled for a single-day meeting at Little Ocmulgee State Park in McRae, Georgia in order to: 1) Learn about existing projects and their objectives; 2) Discover overlapping priorities for monitoring in the next 5-10 years; and 3) To make plans on how to coordinate resources for improvement of monitoring of rare species and communities in Georgia. At the meeting, GA DNR Nongame Conservation biologists gave an overview of past and current Nongame monitoring projects in Georgia. Also, representatives from the National Park Service and U.S. Fish and Wildlife Service Inventory and Monitoring Networks gave presentations on their monitoring projects. In the afternoon, the team split out into five breakout groups to address the following questions:

What steps do you see as most practical and critical to improve monitoring of rare species and communities in Georgia? How can we coordinate resources to implement these steps over the next 5 to 10 years?

- How can we improve protocol design, data collection, and analysis of monitoring projects?
- What suggestions do you have to improve sharing of monitoring results with scientists, land managers, and others who can apply them?
- How can we improve our engagement of citizen scientists in monitoring projects?
- How can we use qualitative monitoring information?

After the breakout group discussions, the team reconvened to review each group's responses to the questions. Ideas were recorded and placed in a spreadsheet.

After the meeting, ideas were reviewed and overlapping concepts were combined. They were categorized and organized into a monitoring actions table (Table 1). The monitoring actions table was then sent out to the team for review. Team members were asked to rank the importance of each numbered action based on these seven ranking criteria: 1) providing multiple benefits for high priority species/habitats, 2) addressing un(der)funded needs, 3) overall importance of Georgia efforts, 4) timeliness or urgency, 5) connections with other conservation actions, 6) building public support for wildlife conservation, and 7) probability of success. Responses were then used to edit the monitoring action table and determine the most important monitoring actions in the table.

Once we had feedback from the team members, we held individual discussions with various technical team members to refine the highest priority actions and develop insights on how these actions can be applied to rare species and ecosystem conservation. In particular, insight was especially needed on pragmatic application of adaptive management and monitoring in the rare species monitoring context, and on the development of a monitoring coordinator position within GA DNR.

Also, the monitoring team leaders sought feedback from other SWAP technical teams on their highest monitoring priorities and their methods for determining these priorities. We found that this feedback was critical for assessing how the monitoring actions fit within the current context of monitoring conducted by GA DNR biologists, and to refine the prioritization of the monitoring actions. The results of this process are listed in Table 2.

## Results

### *Selection of actions to improve monitoring*

The breakout sessions provided monitoring actions that were grouped into five categories. These categories are: ways to improve coordination and communication of monitoring activities, prioritization of monitoring to optimize resource allocation, monitoring design and data collection, data reporting, and citizen and volunteer involvement in monitoring projects (Table 1).

**Table 1.** Actions to improve monitoring in Georgia

<i>Improve coordination and communication of monitoring activities</i>
<ol style="list-style-type: none"> <li>1. Improve awareness among scientists about monitoring work that supports conservation in Georgia               <ol style="list-style-type: none"> <li>a. Conduct regular meetings of monitoring biologists in key agencies</li> <li>b. Conduct an inventory of ongoing rare species and habitat monitoring programs in the state. This includes research, surveys, and databases maintained by academic institutions and agencies. Create a database that is easily accessible and updatable</li> </ol> </li> <li>2. Improve internal GA DNR communication related to monitoring               <ol style="list-style-type: none"> <li>a. Conduct regular meetings of DNR Biologists working on similar issues (e.g. land management, species monitoring, freshwater streams) to share monitoring programs and address problems in monitoring. Meetings should include field tours. Include the Environmental Protection Division, Parks Division, and Private Lands Program where appropriate</li> <li>b. Maintain a database of qualitative information regarding land management and land management decisions for high priority properties</li> <li>c. Maintain a database of rare species and habitat monitoring conducted within GA DNR</li> </ol> </li> <li>3. Communicate SWAP priorities to universities and other research institutions for potential collaboration               <ol style="list-style-type: none"> <li>a. Create a concise list of SWAP monitoring priorities to disseminate to universities and other research institutions.</li> <li>b. Relate priorities to potential funding opportunities.</li> </ol> </li> <li>4. Improve sharing of protocols and data               <ol style="list-style-type: none"> <li>a. Develop an easily accessible mechanism to share protocols and data</li> <li>b. Identify current monitoring protocols that work for state objectives. Where no standard protocol exists, work with other agencies and universities to create standardized protocols for species and ecosystems. Move toward greater consistency across state boundaries (e.g., Index of Biological Integrity, National Bobwhite Conservation Initiative)</li> <li>c. Coordinate with agencies that regularly collect rare species data (Department of Transportation, National Park Service, U.S. Forest Service, U.S. Geological Survey) to improve rare species monitoring</li> </ol> </li> <li>5. Hire a GA DNR monitoring coordinator to compile data, increase collaboration, improve and standardize agency protocols, and coordinate funding opportunities</li> </ol>

***Improve prioritization of monitoring to optimize resource allocation***

6. Determine realistic monitoring frequencies for high priority species and habitats
7. Determine data gaps for priority habitats and species to help set monitoring priorities
8. Establish and share clear monitoring priorities to enable greater collaboration with other institutions

***Improve monitoring design and data collection***

9. Use technology to increase information that can be obtained from photos and to improve access to the data.
  - a. Use photo monitoring with simple quantitative data collection for rapid assessment of management effects. Use local personnel or volunteers to expand data collection capacity.
  - b. Where applicable, use remote sensing of spatial data to monitor habitats
10. Tie monitoring to adaptive management
  - a. Include trigger points in protocols, i.e. design monitoring to include agreed upon actions that are engaged when certain conditions are detected
  - b. Identify specific courses of action that would be implemented when monitoring questions are answered
  - c. Consider thresholds and variability, rather than only the mean as important measures. Increased variability could indicate a catastrophic event
11. Census important reference sites and relate to management and monitoring
12. Monitor common species along with rare species to prevent rarity
  - a. Use strategies such as Index of Biological Integrity (IBI) and Floristic Quality Indices (FQI) that includes both rare and common species
13. Use standardized monitoring protocols and data forms when possible
  - a. Collect data on at least one main variable across different monitoring projects.
  - b. Include the statistical approach in monitoring designs
  - c. Require a standard format for maintaining all metadata relating to monitoring project rationale, objectives, techniques used, data format, and summary of findings throughout the project
  - d. Archive protocols and all associated data in a central location
  - e. Use protocols for storing qualitative data established by institutions such as the Joseph W. Jones Ecological Research Center, National Park Service, and U.S. Fish and Wildlife Service
14. Capture qualitative data on management results. Compile information from managers; conducting periodic and exit interviews may be a useful way to collect this data

***Improve monitoring data reporting; make results accessible to the appropriate end-user***

15. Use the outreach capacity of organizations that emphasize public education such as the Joseph W. Jones Ecological Research Center, the Longleaf Alliance, and Rivers Alive to improve monitoring data reporting
16. Provide short-term feedback from monitoring projects to participating landowners and managers. This will allow for greater future collaboration and adaptive management
17. Develop a website to make reports accessible to land managers and biologists

***Involve citizens and volunteers in monitoring projects***

18. Use technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects
  - a. YouTube videos to share protocols
  - b. Smart-device apps to engage large numbers of citizens (e.g. EDDMaps for invasive species)
  - c. Recognize contributions of individuals or communities with social media
  - d. Create a mechanism for quick data entry to reduce work load of the coordinating biologist
19. Incorporate monitoring into Master Naturalist programs
20. Use the Environmental Education Alliance to reach teachers with programs for monitoring in school classrooms.
21. Reciprocate monitoring participants' efforts with rewards, both tangible (certificates, badges, books, gift certificates) and intangible (knowledge, accolades)

After the monitoring action table (Table 1) was sent out to technical team members for review, nine team members ranked and/or gave feedback on the monitoring actions. Of the nine, only six members provided ranking for each monitoring action. In addition, we had in-depth discussions with ten scientists, some additional to the original team, regarding their use of monitoring and priorities for improving monitoring. After this process, some of the actions in Table 1 were refined. So although we did not have explicit feedback on the monitoring conservation actions from a majority of the monitoring technical team, we feel that between the detailed information gathered at the meeting and the conversations we held, we have developed a consensus on the most critical actions to improve monitoring. It should be noted, however, that many technical team members felt uncomfortable ranking each of the 21 actions, finding many of the actions to be equally important and also finding it difficult to rank specific actions ahead of others.

There were six actions from the table above which were most frequently ranked as the most important. They are listed here in order of rank: 1) Tie monitoring to adaptive management; 2) Hire a GA DNR monitoring coordinator; 3) Improve internal GA DNR communication related to monitoring; 4) Use standardized monitoring protocols and data forms when possible; 5) Improve sharing of protocols and data; and 6) Use technology to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects.

*Monitoring priorities of other SWAP technical teams*

Many of the technical teams included monitoring priorities in their section of the SWAP Revision (Table 2). After discussing how these priorities were selected with technical team leaders and reviewing the priorities, we found that each group included monitoring actions based on different needs, though there were similarities in many of the goals and some teams had overlapping priorities.

Status and trends monitoring is a significant component of the Georgia DNR's species conservation programs. This type of monitoring is necessary to track populations of high priority species over time, and allows biologists to detect potential threats and assess the need for conservation measures. When determining how these types of monitoring projects were

prioritized, we found that some were initiated prior to the start of the SWAP Revision process, such as Indigo Snake monitoring on the Altamaha, while others were determined as priority monitoring actions by SWAP Revision technical teams. Some priority species groups, such as sea turtles, have had a long history monitoring and will continue to be monitored while a greater focus can be placed on management strategies to help increase populations. For other programs such as bat monitoring, only recently has there been a higher level monitoring intensity, due to the devastating threat of the disease, White Nose Syndrome. In this case, biologists are still learning about species biology, so the greatest monitoring need is to determine population status and trends, while developing more standardized protocols and increasing information sharing capacity across state boundaries.

Some species are given high priority for monitoring as a result of legal agreements, such as Candidate Conservation Agreements. A Candidate Conservation Agreement (CCA) is a voluntary conservation agreement between the U.S. Fish and Wildlife Service and one or more public or private parties as a way to reduce threats and conserve candidate species. Under these agreements, species populations are monitored to determine the effectiveness of conservation measures. In Georgia, the Gopher Tortoise and Georgia Aster have been prioritized for monitoring to fulfill the requirements of CCAs.

Monitoring response to management, especially prescribed fire, was a significant priority for some teams, including the habitat restoration and bird teams. The Georgia DNR fire management program is central to the conservation of many fire-adapted species and habitats in the state, thus monitoring the effects of fire management is critical to understanding the success of this program. Another shared goal was the need for baseline landcover/habitat data. Both the Ecosystems/Habitat Mapping and Climate Change Adaptation teams expressed the need for this type of information in order to monitor landscape level changes over time and to help model the effects of land use and climate change on species and habitats in the state.

Monitoring priorities for many teams reflect several of the ideas mentioned by the Monitoring Technical Team as actions to improve monitoring (see Table 1). A significant overlapping need is the improvement of standardized protocols and a greater capacity for the sharing of these protocols and monitoring data. This is mentioned as a high priority monitoring action for many taxa, including birds, plants, mussels, and bats. Related to these goals is the improvement of online tools, including methods to collect data and share monitoring information. For example, the habitat restoration team prioritized the use of EDDMaps, an online tool used to detect and monitor infestations of invasive species. Also, the habitat restoration team would like to take advantage of advances in online technologies to improve monitoring protocol and data sharing for photo monitoring in fire-adapted habitats.

**Table 2.** List of monitoring priorities for each of the SWAP Revision technical teams

<b>Technical Team</b>	<b>Monitoring Priorities</b>
Reptiles and Amphibians	<ol style="list-style-type: none"> <li>1. Gopher tortoise population monitoring using Line Transect Distance Sampling on all inventoried state lands and select private lands at intervals no less than every five years but no greater than every 10 years. This is required by the tortoise Candidate Conservation Agreement to which WRD is a party.</li> <li>2. Occupancy monitoring of eastern indigo snakes at select sites in the lower Altamaha River sandhills region. This effort, contracted out to Oriante Society, has taken place annually for the past three years, but will likely be extended to a greater interval.</li> <li>3. Continue 3 year occupancy monitoring cycle of eastern hellbender populations at known sites, including disease screening</li> <li>4. A statewide index of abundance for diamondback terrapins will be developed to determine trends in abundance over time</li> <li>5. Trends in adult female sea turtle abundance will be assessed through nest monitoring programs and genetic mark-recapture sampling. Sea turtle strandings will be monitored (and necropsies performed to determine cause of death) as an index of threats in coastal marine waters.</li> </ol>
Birds	<ol style="list-style-type: none"> <li>1. Pursue coordinated monitoring and data storage for seabirds across the Southeast states to better understand status and trends. Prioritize using a shared database such as the Avian Knowledge Network to serve as a central clearinghouse for data storage and dissemination for many of our bird conservation efforts.</li> <li>2. Continue participating in national/international coordinated efforts such as the Breeding Bird Survey, U.S. Nightjar Survey, and International Shorebird Survey.</li> <li>3. Develop a regional survey/monitoring protocol for wading birds.</li> <li>4. Develop and implement monitoring protocols for secretive marsh birds. Make these protocols compatible with similar efforts in other parts of the Southeast or the species' range.</li> <li>5. Monitor the effectiveness of management, particularly prescribed fire, on bird populations.</li> </ol>
Mammals	<ol style="list-style-type: none"> <li>1. Annual monitoring of caves with populations of bats currently affected or likely to be affected by White Nose Syndrome</li> <li>2. Annual summertime monitoring of gray bats and southeastern bats in caves</li> <li>3. North Atlantic Right Whale: satellite tagging to study movement and habitat use; seasonal aerial and boat photo-ID surveys and genetics sampling for population monitoring</li> <li>4. Bottlenose Dolphin: Boat photo ID surveys to assess abundance, vital rates, residency patterns and stock structure; capture-release studies and remote biopsy sampling to assess health of dolphins</li> </ol>

	<p>in Brunswick area</p> <ol style="list-style-type: none"> <li>5. Monitoring spotted skunks with camera “traps”</li> <li>6. Monitoring pocket gophers with mound counts</li> </ol>
Fishes and Freshwater Invertebrates	<ol style="list-style-type: none"> <li>1. Evaluate status and distribution of high priority snails</li> <li>2. Surveys for petitioned aquatic species</li> <li>3. Update GA Dept. of Transportation Mussel Sampling Protocol</li> <li>4. Continued aquatics species monitoring in high priority watersheds, where numerous high priority species can be targeted in one project.</li> </ol>
Terrestrial Invertebrates	<ol style="list-style-type: none"> <li>1. Inventory to obtain baseline information for priority species and for species habitat associations</li> <li>2. Develop invertebrate-based Indices of Biotic Integrity [IBI] for specific high priority habitats</li> </ol>
Plants	<ol style="list-style-type: none"> <li>1. Monitor high priority plant species and habitats when scientific uncertainty and/or stakeholder disagreement exists about suitability of management actions (e.g. <i>Lindera melissifolia</i> and <i>Ceratiola ericoides</i> population response to prescribed fire, and timber harvest for restoration of prairies at Oaky Woods WMA).</li> <li>2. Monitor select populations for which regulatory conservation agreements exist to document success or failure of the agreements (e.g. <i>Symphyotrichum georgianum</i>)</li> <li>3. Monitor high-priority <i>in-situ</i> population augmentation or introductions (e.g. <i>Arabis georgiana</i>, <i>Echinacea laevigata</i>, <i>Rhus michauxii</i>, <i>Sarracenia</i> species).</li> <li>4. Develop a standard DNR-wide protocol for monitoring suites of rare species that occur in specific high priority rare habitats, in particular in coastal plain seepage bogs of the sandhill habitat.</li> </ol>
Habitat Restoration	<ol style="list-style-type: none"> <li>1. Expand and improve DNR’s fire photo monitoring program. <ol style="list-style-type: none"> <li>a. Incorporate simple quantitative data collection methods associated with the photo points for high priority sites, especially where land managers desire more information.</li> <li>b. Include Game Management biologists and Wildlife Management Areas.</li> <li>c. Use technology to improve photos and increase information that can be obtained from them (e.g. vegetation cover, canopy cover).</li> <li>d. Create a geodatabase of the fire monitoring points</li> <li>e. Develop an online mechanism for uploading photos and data points to a centralized system</li> <li>f. Include reference sites of high priority habitats</li> </ol> </li> <li>2. Where there are significant questions related to the management of high priority habitats and/or species, initiate adaptive management vegetation monitoring projects</li> <li>3. Organize and complete a unified “lessons learned” report that includes the multi-faceted monitoring and research that has been conducted in the longleaf pine ecosystem by DNR Nongame</li> </ol>

	<p>Conservation Section biologists. This compilation could be published by the DNR and made available to landowners and research institutions.</p> <ol style="list-style-type: none"> <li>4. Continue incorporating and promoting online tools such as EDDMaps that can be used for early detection of invasive species, to track the spread of invasives, and to monitor occurrences over time.</li> <li>5. Foster invasive species working groups such as the Coastal CISMA to help track invasive species at a regional level.</li> </ol>
<p>Ecosystems/Habitat Mapping</p>	<ol style="list-style-type: none"> <li>1. Conduct landcover mapping for the state, particularly the Coastal Plain. This baseline data along with future mapping can be used to track changes in the landscape over time, including land use, climate change, and restoration activities.</li> <li>2. Incorporate new remote sensing technologies where appropriate to monitor habitats at the local scale.</li> <li>3. Use field surveys and monitoring to inform habitat mapping and vice versa. Data collected during field surveys can serve as valuable reference points for landcover mapping efforts. Also, habitat maps can be used to inform monitoring by directing surveys and detecting landscape level changes undetectable by fine-scale monitoring programs.</li> </ol>
<p>Climate Change Adaptation</p>	<ol style="list-style-type: none"> <li>1. Similar to the Ecosystems/Habitat Mapping team, the highest priority is to map natural communities throughout the state. Mapping products can be used as a baseline to monitor vegetation response to climate change and to strengthen climate change adaptation models of resiliency, sea level rise, and impacts on species.</li> <li>2. Establish data loggers in rivers and streams. These loggers can be used to create more accurate models for fish and other aquatic species susceptible to climate change. Engage the Georgia River Network to help establish data loggers throughout the state.</li> <li>3. Conduct basic plant phenology monitoring to evaluate long-term change related to climate change. Integrate monitoring efforts with those of national phenology monitoring networks.</li> <li>4. Monitor depressional wetlands, maritime communities, and other habitats sensitive to climate change. Continue monitoring salt marsh transects to determine the effects of sea-level rise on coastal habitats.</li> </ol>

## Discussion

The Georgia DNR and its partner organizations conduct a wide range of monitoring activities on a regular basis. These actions, including ecological research, species and habitat status and trends monitoring, and management effectiveness monitoring, are critical to our mission to conserve priority wildlife and their habitats. However, during the process of evaluating current monitoring strategies, it became clear that better organization and a more strategic approach would improve the overall value and effectiveness of monitoring in the state. Here we discuss some approaches to improve monitoring of species and habitats in Georgia, and outline the highest ranked priority actions for monitoring improvement based on the work of the Georgia SWAP Revision monitoring technical team. We give emphasis to mechanisms that are feasible on the time frame of 5 to 10 years.

In many ways, each of the monitoring conservation actions listed in Table 1 cannot exist as a single action. All are intertwined, and development of one will facilitate development of another. For example, tying monitoring to adaptive management relies on improving communication about monitoring, as those who are conducting monitoring must successfully coordinate with those who set management objectives, and with those who can change management actions. New technologies subsequently are essential to improving coordination and standardizing protocols, especially for species and habitats whose status is determined across a region that is larger than one agency's purview. This is one reason the monitoring actions were difficult to rank. It is also a strong argument for centralizing the efforts to improve monitoring in one agency with state-wide perspective and networking capacity such as GA DNR, because the actions must occur across many specializations and roles in the conservation arena. Without centralization of efforts, the coordination required to carry out these actions would not likely occur.

### *Develop a monitoring coordinator position*

Therefore, to improve efficiency and efficacy of monitoring in Georgia, our highest priority action is to hire a state-wide monitoring coordinator. Because of the complexity of the biological monitoring network in Georgia and because so many of the priority monitoring actions depend on good communication, having a person dedicated to coordinating monitoring improvement actions is critical to their successful implementation. Biologists who are responsible for conducting monitoring in their specialized fields would not have it in their current job priorities to coordinate among the diverse array of monitoring professionals in Georgia.

Key responsibilities of a monitoring coordinator would include review and compilation of monitoring plans and protocols within Georgia DNR; inventory of monitoring programs outside of GA DNR; facilitate communication between resource management, administrative, and monitoring staff to develop adaptive management protocols that are consistent with GA DNR priorities and policy; development of mechanisms for sharing monitoring programs and data in Georgia; consult on and set standards for protocol development, protocol documentation, data management, and reporting within GA DNR; outreach to academic institutions to develop opportunities for collaborative adaptive management projects; and provide venues for sharing of results, technologies, and ideas across GA DNR, such as in a periodic symposium advertised internally and externally.

*Tie monitoring to adaptive management*

Tying monitoring to management actions was the highest ranked monitoring action from the monitoring technical team. In contrast, status and trends monitoring without specified management actions is the most commonly listed type of project for GA DNR (Table 2). However, these projects are often tied to management in an informal manner. For example, populations of a shorebird species are monitored annually and have shown a steady decline in the past ten years since monitoring was initiated. A decision is made to burn habitats associated with the species to decrease shrub encroachment and expand the preferred open, grassy habitat. After the prescribed fire, bird populations are monitored to examine response to management.

In a rigorous adaptive management framework, also called “active adaptive management,” monitoring is designed not only to determine trends but also to learn about the species or habitat of concern (e.g. Larson 2013, Westgate et al. 2013). Hypotheses are tested about how the monitored system functions, or about which management approaches are optimal (Westgate et al. 2013). It is considered an important strategy because management actions, which are usually time-critical, can be conducted at the same time as research to understand key biological concepts for conservation (Nichols and Williams 2006, Westgate et al. 2013).

There are a number of challenges to implementing adaptive management (see especially Westgate et al. 2013). A primary challenge for GA DNR is the lack of simple institutional control over management options—especially at the landscape or watershed level. At this level, GA DNR staff frequently cannot execute management actions for rare species and habitats even when monitoring indicates management is critically needed for conservation of the resource (B. Albanese, P. Lanford, and T. Morris, pers. com.). Other challenges include difficulties in managing and measuring effects on extremely rare and/or hard to detect species (T. Morris pers. com.), lack of expertise and resources for experimental design and statistical analysis (T. Keyes pers. com. and Kruse and Thompson pers. obs.), and lack of space and resources for replicating management treatments (Kruse and Thompson pers. obs.).

Because they require additional staff resources and expertise, careful prioritization of adaptive management projects is necessary. Active adaptive management is highest priority when there is scientific uncertainty, high risk, and conflict about management actions (Larson 2013), and these projects must be carefully designed to measure only the most pertinent environmental variables to answer the specific high priority questions the monitoring is being implemented to answer (Larson 2013). For GA DNR, opening avenues of collaborations with academic researchers for adaptive management projects could provide an important tool for learning about our high priority biological systems at the same time as we are managing them.

A less rigorous framework, an “adaptive approach” (*sensu* Westgate et al. 2013), is more congruous with rare species and habitat monitoring in Georgia. In an adaptive approach, monitoring is tied to management by incorporating management objectives into specific population indicators that will be measured (Elzinga et al. 1998, The Nature Conservancy 2009). For example, if reduction of shorebird nest failures by 30% is a management objective, measuring nest failures should be the highest priority of a monitoring protocol, rather than measuring any other feature of that shorebird population. The sampling protocol subsequently

must be designed so that it is possible to detect the desired amount of change in nest failure rate with a statistical test. The data will then be capable of demonstrating whether the management objective has been met, and therefore whether management actions need to be modified. In this way, specific monitoring results feedback directly into decisions about the status of priority species and habitats, and the management actions that will be taken for their conservation.

An adaptive approach takes place qualitatively in management actions all the time, as managers make skilled observations and implement actions based on their observations. The advantage of tying monitoring of specific variables to specific management objectives is that a focus on the most critical indicators of rare species and habitat status is ensured (Kirkman, pers. com). This approach gives a way to communicate rare element status and the effects of management to a broader audience. Focusing on key management-oriented variables is more efficient than an approach where multiple variables are measured for their general interest, with no clear *a priori* idea of how the data are to be used. Thus monitoring is designed for decision making, producing data that are used for assessing the effectiveness of management actions, ultimately reducing management and conservation uncertainty (Sutter 2014).

Although all monitoring projects conducted by GA DNR will not directly feedback to an immediate management decision, underpinning the monitoring program with an adaptive management philosophy will promote a holistic approach to monitoring projects that utilizes sound science. A monitoring program that emphasizes adaptive management will continually be vigilant for opportunities to improve conservation actions for rare species and habitats. Such a program will prioritize effective monitoring design, constant assessment of monitoring results, and insist that biologists and managers communicate implications for conservation, whether action can be taken now or ideas are being advocated for the future (R. Sutter, pers. com).

Therefore we advocate that a monitoring coordinator work in an adaptive management framework, and develop departmental guidelines as to when, and at what level, adaptive management monitoring should be conducted by GA DNR or through contracts with academic research institutions.

#### *Improve sharing and standardization of protocols and data forms*

This action was ranked third highest priority by the monitoring technical team, but was the singular most important action for improving monitoring when discussing monitoring with leaders of the taxonomic technical teams. For some priority species groups, such as bats, monitoring technologies are not developed to the extent that statistically strong data can be collected and there is a lack in available experts to conduct the monitoring (T. Morris, pers. com.). For these types of species, the most important actions to improve monitoring are development of strong regionally standardized protocols and strong data management and sharing. Organized records that are kept systematically, with strong metadata that clearly describe the work flow, protocols, and functioning of the database, can be employed across organizations for generations. This is critical for understanding long-term trends and for eventual development of adaptive management protocols when technology improves.

Other priority species and habitats have relatively well-developed technologies and protocols for monitoring, but have wide ranges such that monitoring is often performed by multiple

organizations. Protocols tend to vary within and across state boundaries. Examples include certain high priority shorebirds, the gopher tortoise, and longleaf pine ecosystem restoration that occurs on private lands. Standardization and sharing is equally important for monitoring these entities so that efforts are not duplicated and that data can be compared across their geographic ranges.

One mechanism for sharing protocols suggested by the monitoring technical team is a searchable internet database that partners could use to post and access information related to their specific monitoring projects. As an example, the National Biological Information Infrastructure (NBII) was an online database that provided access to monitoring information as one of its components (Wikipedia 2014). Funding for NBII was discontinued in 2012, but information about its development and structure could be accessed as a model for a simpler project focusing only on sharing protocols.

Another mechanism is for biologists to reach out directly to partners who already collect rare species data to work together to modify and standardize protocols to meet joint objectives. This mechanism is already recognized as critical for improving monitoring. For example, working with GA Dept. of Transportation to standardize their mussel sampling protocol is a high priority conservation action for the updated Georgia SWAP. In particular, the monitoring team noted the need for standardizing monitoring of the vast longleaf pine ecosystem restoration projects occurring on private lands throughout the state.

*Improve internal GA DNR communication related to monitoring*

Internally, GA DNR exemplifies similar challenges to coordination of monitoring that exist state-wide. Among the divisions of the agency, there is lack of awareness of monitoring projects and associated challenges, even among biologists studying the same ecological systems. For example, the Private Lands Program, Game Management Section, and Nongame Conservation Section conduct longleaf pine restoration but there is little opportunity for communication regarding results of their restoration projects and how they are monitored. As GA DNR is a large agency, good communication can be difficult to achieve. In particular, those coordinating monitoring often work separately from site managers, or may have different philosophical approaches to management. In an adaptive management framework communication is especially critical to facilitate standardization of management objectives, prioritize management activities, and enable managers to adapt management actions based on monitoring results.

Improving coordination of monitoring within GA DNR will serve as a model for coordination of monitoring among partners state-wide. Therefore we rank this as the fourth highest priority monitoring improvement action. Two mechanisms for communication will be used in combination, by developing a department-wide online database of monitoring projects, and special-interest topics presented at department-wide meetings.

The objective of the online database is not only to share monitoring reports, but to provide a standardized system to store protocols, data, qualitative information regarding land management results, and metadata about projects. Metadata provide the documentation necessary for a project to be carried on regardless of staff and resource availability, and should be required for all monitoring projects. Important metadata include project rationale, objectives, techniques used,

data format, sampling dates, and summary of findings throughout the project. Implementation would likely occur in a two-phase process, with the first phase to develop the system for posting project reports and qualitative management results, and the second to develop the system for storing and accessing protocols, data, and metadata.

The objective of GA DNR monitoring meetings is to share ideas on how to meet monitoring goals in an environment where peer-review of projects is cultivated. Peer-review provides an internal mechanism for improving monitoring and conservation projects. The meetings can be informal or structured, but should include all disciplines that use monitoring and staff of Wildlife Resources, Environmental Protection and State Parks Divisions. The meetings will provide a venue to discuss monitoring issues, share protocols and results, demonstrate new monitoring technologies, and to coordinate monitoring with management staff. Staff who monitor overlapping ecological systems should meet separately, either concurrently or at another time in the field. Due to the effort required to establish these meetings, we envision that a monitoring coordinator is essential to their success.

*Incorporate technology and citizen-scientist networks to improve monitoring*

With the ubiquity of smart phones, tablets, and other electronic handheld devices, there is increasing opportunity to collect valuable field data electronically for survey and monitoring projects. Many of these devices can use cellular phone service or GPS to give accurate location information. Also, the ability to take and store field notes electronically and take pictures with a camera on the same device greatly simplifies field data collection. It is critical to incorporate this technology into monitoring work in ways that will be useful and efficient. Furthermore, because so many citizen scientists and volunteers already own these types of devices, there are great possibilities to create networks of people collecting valuable data for conservation. An excellent example of such a network is the invasive species detection application EDDMaps. EDDMaps is an easy to use web-based mapping system for documenting distributions of invasive species. This application allows smart phone users to collect field data on an invasive species occurrence and track infestations through time. These remote data collection technologies should be considered for other monitoring programs, particularly where volunteers can be engaged.

Another improvement in technology is a greater ability to share information online. Online tools can now be used for easy data entry and for the rapid transfer of data to others. Improving online tools to allow for easier access to protocols, simple data entry, and sharing of data and reports with others should be a high priority for the DNR and other agencies. Social media and video-sharing websites can be used to make monitoring more transparent, by alerting people or groups about monitoring or for sharing protocols. They can also be used to improve training, coordinating, and data sharing for citizen scientist and volunteer networks involved in monitoring habitats and species.

Some other technologies have advanced in recent years and can now be considered when collecting field data. For example, a University of Georgia graduate project is currently using unmanned aerial vehicles, also known as drones, to assess vegetation recovery after prescribed fire in dune grasslands on Little Saint Simons Island. Only recently have these vehicles become more affordable and readily available for monitoring applications, although new regulations and potential privacy issues should be taken into account. GIS technologies and online mapping tools

such as Google Earth are making community and landscape level changes easier to track. The availability of high resolution aerial imagery and detailed elevation data such as LiDAR allows for more detailed habitat mapping. It is necessary to continue promoting aerial imagery and LiDAR flights in Georgia to help improve mapping and monitoring efforts over the next 10 years.

In recent years, the DNR's photo-monitoring program has been greatly expanded to help monitor the effects of prescribed fire in fire-adapted habitats on State Parks and other state lands. Camera technology should be researched to determine if simple quantitative data can be derived from photos taken at these established photo-points. The photo points could also be used for additional quantitative data collection for assessing whether broad management goals have been met.

## **Conclusions**

Improvement of monitoring statewide is a challenging topic, particularly for the breadth of disciplines that must be involved. Across Georgia's diversity of species and habitats, there are varied obstacles to successful monitoring. Aside from resource limitations for monitoring, these obstacles include species detection difficulties, populations that range far outside state boundaries, and the inability to enact adaptive management. Monitoring professionals have approached solutions in multiple ways, often without a collaborative process. Despite these difficulties, monitoring has become more important in natural resource management institutions for documentation of conservation actions and whether these are successful—for accountability, learning, and public education objectives.

The monitoring technical team provided an abundance of ideas for improving monitoring. All members of the monitoring technical team were adamant that, first and foremost, coordination of efforts is critical to improving monitoring in Georgia. Most of the monitoring actions that were ranked highest include steps toward meeting that broad goal, including hiring a monitoring coordinator, developing an online database to share protocols region-wide, holding regular GA DNR monitoring symposia, and creating an internal database for standardized metadata relating to all GA DNR monitoring projects.

For the monitoring technical team, working in an adaptive management framework was also high priority. There are clear reasons why strict adaptive management is not appropriate for all rare species and habitat conservation actions. However, we advocate that working in an adaptive management framework will encourage sound science and protocol design in monitoring and timely incorporation of monitoring results into conservation actions.

Finally, it is clear that new technologies are abundant and provide many exciting opportunities to facilitate all of the priority monitoring actions developed here, by increasing accessibility to protocols, data, and results that can be used by volunteers, scientists, managers, and administrators alike.

From the ideas documented in this chapter, and from the enthusiasm for sharing monitoring projects and ideas we witnessed during this project, it is clear that conservation professionals are

passionate about the quality of rare species and habitat monitoring in the state. We are eager to work together to increase effectiveness of this important aspect of conservation biology.

### **Acknowledgments**

We are grateful to the monitoring technical team members for volunteering their time and expertise for the development of the monitoring improvement actions, as well as their helpful comments as we worked to refine the results of this project. Several colleagues within GA DNR spent considerable time helping us understand monitoring from the perspective of their specializations. We thank Dr. Jon Ambrose for his excellent guidance in determining key topics for the SWAP within this broad topic. We appreciate the staff of Little Ocmulgee State Park for providing excellent conference facilities.

**Table 3.** Conservation partner organization monitoring priority table (to be developed)

<b>Partner Organization</b>	<b>Monitoring nexus</b>	<b>Types of projects and available resources</b>
<i>U.S. Fish and Wildlife Service – Ecological Services (USFWS ES):</i>	Track results of management and special programs on rare species and habitats; provide data for rare species conservation and regulation as required by federal legislation	1. Changes in populations and habitat after management implementation, esp. for aquatic habitat restoration, plant or mussel population augmentation; 2. Trends in rare or special concern plant and wildlife populations, and in their habitats, especially freshwater aquatics, birds, bats, and rare plants; 3. Success of stream restoration for mitigation; 4. Development of protocols and supervision of their implementation
<i>U.S. Forest Service (USFS) – Chattahoochee and Oconee National Forest</i>	In Georgia the USFS manages approximately 865,000 acres of federal lands for many purposes, and is required by law to protect and monitor rare species and habitats on these lands	1. Monitors or assists GA DNR in monitoring of rare plants, rare freshwater aquatic species, migratory and rare birds, and bats on National Forest lands; 2. Database of rare species occurrences on the National Forest
<i>U.S. Forest Service (USFS) – Southern Research Station</i>	Forest ecology research	Conducts research relevant to forest threats, disturbance regimes, and fire ecology; research questions are developed both in response to management and basic science needs
<i>U.S. Forest Service (USFS) – Forest Inventory and Assessment (FIA)</i>	Assesses condition of forests in the U.S. and projects future conditions for the next 5-10 years	Monitors status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership
<i>Enduring Conservation Outcomes, LLC</i>	Consulting on and development of monitoring and adaptive management protocols	Consults on establishing monitoring objectives, identifying indicators, developing study and sampling designs, analyzing, interpreting and communicating results, including qualitative data, and integrating monitoring results into adaptive management
<i>GA Dept. of Transportation</i>	Tracks rare species occurrences related to transportation projects. Minimizes impacts to rare species and habitats within proposed road construction corridors	Conducts surveys for rare species located with proposed road projects. Monitors potential transportation impacts to rare species located within transportation corridors or DOT lands. Works with GA DNR, USFWS, and other conservation organizations to minimize impacts to rare species in proposed or current transportation corridors.
<i>U.S. Geologic Survey – Cooperative Research Unit, University of Georgia, Athens</i>	Facilitates research between natural resource agencies and universities, provides technical assistance and consultation on natural resources issues	Current staff have expertise in: 1. Consultation on how to connect monitoring to decision making and reducing critical uncertainties 2. Connecting management questions to monitoring objectives, for example, as in evaluation of harvest policies; 2. Quantitative models of population responses to natural and anthropogenic influences; 3. Design of adaptive management frameworks for agencies

<i>Dept. of Defense – Fort Benning, Gordon, and Stewart Army Bases</i>	Protects and conserves rare species and their habitats on military bases in accordance with Dept.of Defense’s military missions	Monitors rare species located on military bases. The primary focus of monitoring are federally listed and candidate species such as the Red-cockaded Woodpecker and Eastern Indigo Snake. However, state-listed or special concern species are also tracked. Restoration activities such as prescribed fire are emphasized to improve and maintain habitats for rare species.
<i>Natl. Park Service – Southeastern Inventory and Monitoring Network</i>	Facilitate collaboration and information sharing for monitoring and management among National Parks; establish a region-wide integrated program for natural resource monitoring	1. A long-term biological monitoring program, called “Vital Signs Monitoring” is in place to track key indicators of ecosystem integrity at National Parks. Biological components are land bird, vocal anuran, and vegetation community monitoring, with standardized protocols for each. 2. Grants are available for studies that apply to the parks and adjacent lands.
<i>Georgia Dept. of Natural Resources – Coastal Resources Division</i>	Manages and monitors coastal marshes, beaches, waters, and marine fisheries in Georgia	Monitoring of various marine fisheries, oyster reefs, salt marsh plant and animal communities, and marsh dieback. Some specific marine fisheries monitoring projects include trawl surveys of finfish and invertebrates in estuaries, eel surveys, and important recreational finfish monitoring. CRD also monitors oyster reef restoration and living shoreline projects. Regular “drop ring” sampling is used to monitoring plant and animal communities associated with tidal river levees.
<i>Georgia Dept. of Natural Resources – State Parks Division</i>	Helps restore and maintain natural communities on state parks, including conducting prescribed burns in fire-adapted habitats	With assistance from WRD Nongame Conservation Section, photo monitoring of fire-adapted habitats have been established on the majority of Georgia’s state parks. Local parks staff conduct the monitoring annually or biennially.
<i>Georgia Dept. of Natural Resources – Environmental Protection Division (GA EPD)</i>	Monitoring of environmental quality to inform condition of natural resources and their regulation	An example project with close ties to Wildlife Resources is EPD’s wetland monitoring program. The goal is to assess wetland quality and function throughout the state. As part of this work, various indicators of wetland condition are being investigated for development of a rapid wetland assessment method.
<i>Sapelo Island National Estuarine Research Reserve</i>	Research, stewardship, and sound management of coastal resources	1. High resolution mapping of marsh vegetation; 2. Detection and monitoring of invasive animal and plant species and their ecosystem effects; 3. Reproductive success of wading shorebirds; 4. Oyster reef ecology
<i>Project Orianne</i>	Conservation of the Indigo Snake and its habitat; conservation of high priority reptile species	1. Monitors Indigo Snake populations throughout S. GA; 2. Monitors Gopher Tortoise on select properties; 3. Monitors high priority snake species throughout GA; Surveys for spotted turtles throughout GA.

<i>The Nature Conservancy – Georgia Field Offices</i>	Biodiversity conservation and land stewardship	Monitor rare species and community responses to management on Nature Conservancy lands. Conducts inventories and monitoring on military bases and Army Compatible Use Buffer (ACUB) lands. Coastal priorities include monitoring critical maritime forests, living shorelines, wetlands, and oyster reefs.
<i>The Nature Conservancy – Eastern Science Division</i>	Develops spatially explicit data on natural habitats and communities at the regional level, beyond state boundaries, for conservation planning	1. Resilience of terrestrial communities to climate change; 2. River and stream habitat classification; 3. Protected lands database; 4. Floodplain assessments
<i>Joseph J. Jones Ecological Research Center</i>	Understand and demonstrate excellent natural resource management and conservation in the southeastern U.S. coastal plain	Ecology of longleaf pine woodlands and their wildlife, including wetlands and aquatic resources; research on the problem of natural resource management and environmental quality
<i>U.S. Fish and Wildlife Service – Refuges Inventory and Monitoring Network</i>	Monitor the status and trends of fish, wildlife, and plants in each refuge; integrate the monitoring system with the broader scientific community; provide data to inform adaptive management and conservation planning	1. Developing standard protocols across all refuges (e.g. amphibian community monitoring); 2. Developing an integrated data management system for storage of protocols, reports, management plans, and historical data; 3. Baseline data to evaluate impacts due to climate change and other long term environmental stressors in coastal and marine habitats; 4. Monitoring of federally listed species in the refuge system; 5. Fire risk, fire ecology, and prescribed fire monitoring; 6. Invasive species monitoring; 7. Bird surveys

## **Appendix K. Education Technical Team Report**

### **Technical Team Members**

Kim Bailey, DNR Environmental Protection Division - EEinGeorgia.org  
 Melanie Biersmith, Georgia 4-H  
 Berkeley Boone, DNR Wildlife Resources Division - Charlie Elliott Wildlife Center  
 Amanda Buice, Georgia Department of Education  
 Casey Corbett, Georgia Southern University - Center for Wildlife  
 Rusty Garrison, DNR Wildlife Resources Division - Charlie Elliott Wildlife Center and Project WILD  
 Caleb Griner, DNR Wildlife Resources Division - Shooting Sports Program  
 Deborah Harris, US Fish & Wildlife Service  
 Kris Irwin, UGA Warnell School of Forestry & Natural Resources and Environmental Education Alliance of GA  
 Jeff Jackson, Georgia Department of Transportation  
 Tamara Johnson, US Fish & Wildlife Service  
 Melissa Martin, Flint Riverquarium  
 Linda May, DNR Wildlife Resources Division - Nongame Conservation Section  
 Paul Medders, DNR Coastal Resources Division  
 Joseph Mendelson, Zoo Atlanta  
 Kim Morris-Zarneke, Georgia Aquarium  
 Robert Phillips, Georgia Wildlife Federation  
 Carla Rapp, Georgia Forestry Association - Project Learning Tree  
 Cindy Reittinger, DNR State Parks and Historic Sites  
 Anne Shenk, State Botanical Garden of Georgia  
 Vicky B. Smith, A-Z Animals and Cochran Mill Nature Center  
 Lisa Weinstein, Turner Foundation  
 Karan Wood, Captain Planet Foundation

### **Purpose of this Report**

In 2005, the Wildlife Resources Division of Georgia Department of Natural Resources (DNR) with various partner agencies and organizations completed a comprehensive statewide plan for conserving Georgia's wildlife. The best available data on the distribution and abundance of wildlife in the state was used to create this conservation strategy, now referred to as the State Wildlife Action Plan (SWAP). It examined the extent and condition of habitats required by these species and threats to these habitats, as well as addressed research and survey needs, habitat restoration needs and monitoring needs. The original SWAP also included an assessment of current regulations, policies, and programs for wildlife conservation in Georgia. Several technical teams were formed to address specific elements of this plan, including a group to strategize how environmental education could be used as an effective tool for conservation.

The GA DNR made a commitment to review and revise the SWAP every ten years. Therefore, the technical teams reconvened to produce an updated wildlife conservation plan for Georgia. In Fall 2013, thirty environmental educators from various agencies and organizations were invited to

serve on the SWAP Education Revision Team. Twenty-three of them agreed to help with updating the statewide strategy for wildlife conservation education, offering their time and expertise in-kind. At their first meeting in January 2014, since many of the team members were new to this effort, DNR staff familiarized the group with the SWAP and the original education report. The team then determined which of the 2005 recommendations were still relevant and in need of implementation, which could be revised and consolidated, and which would best be addressed by the SWAP Communications Team. The Education Team also added a few conservation actions to complete their revised list of recommendations below:

1. Assess the current level of wildlife conservation literacy among Georgia citizens;
2. Create educational core concepts with key messages that support the main SWAP themes;
3. Identify and develop targeted educational materials to facilitate the delivery of SWAP conservation messages to the public;
4. Improve communication of SWAP messages to regional education networks and community groups; and
5. Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in Georgia.

Based on areas of expertise, the SWAP Education Team divided into five subcommittees (one per conservation action) to further develop these recommendations. They were charged with writing a more detailed description with justifications as well as determining funding sources, lead organizations, partners, and other variables required for successful implementation. The group reconvened in March 2014 to review each subcommittee's work. For the entire group to access and further develop the five conservation actions, sharable files were created via Google Docs. In May 2014, the Education Team's revision was complete and ready for review by the SWAP Advisory Board. Public comments were incorporated in July 2015, prior to submission to the U. S. Fish and Wildlife Service for approval.

### **Environmental Education in Georgia**

The health and well-being of Georgia's plants, wildlife, and people depends on the quality and integrity of the environment. Loss, degradation, and fragmentation of habitat are the greatest problems facing fish and wildlife. To effectively protect Georgia's natural heritage, the public must be aware of and engaged in conservation.

More than 400 organizations including private non-profit and for-profit entities, universities and governmental agencies provide environmental education programs for the citizens of Georgia. A statewide network of about 250 environmental educators, the Environmental Education Alliance (EEA) of Georgia, supports these organizations through their annual conference, an outdoor learning symposium, an accredited environmental education certification program, and networking opportunities. EEinGeorgia.org, the online guide to environmental education in Georgia, makes information about environmental education resources readily available. This comprehensive website is a collaborative effort of the Environmental Protection Division (EPD) of the Department of Natural Resources (DNR), the Department of Community Affairs, the Department of Education (DOE) and EEA. It includes EE lesson plans for all grades and subjects based on the state education standards, a searchable directory of EE organizations and their

resources, facts about Georgia's environment, and a calendar of EE events.

### **SWAP Environmental Education Team Recommendations**

1. Assess the current level of wildlife conservation literacy among Georgia citizens.

A statewide survey to measure environmental literacy of Georgia residents has never been conducted. We recommend that a survey be developed and conducted to establish a baseline of wildlife conservation knowledge and to measure the effectiveness of environmental education initiatives in Georgia. While many examples of environmental literacy surveys exist, a subcommittee of the Environmental Education Technical Team reviewed the following surveys and recommends them as suitable models for Georgia:

- National Environmental Education and Training Foundations report – Understanding Environmental Literacy in America: And Making it a Reality ([https://archive.org/details/ERIC\\_ED522832](https://archive.org/details/ERIC_ED522832))
- The First Pennsylvania Environmental Readiness for the 21st Century Survey Report by the Pennsylvania Center for Environmental Education ([http://www.pcee.org/Research/research\\_1main.asp](http://www.pcee.org/Research/research_1main.asp))
- Report Card on Minnesotan's Environmental Literacy (2003-04) by the Wilder Research Center ([http://www.seek.state.mn.us/eemn\\_b.cfm](http://www.seek.state.mn.us/eemn_b.cfm))

The major steps required to implement a statewide survey include:

- Determine the key conservation and environmental issues affecting Georgia's wildlife resources today by consulting with SWAP technical teams and other experts. Potential concerns may include habitat loss and alteration, controlling invasive exotic species, education about misunderstood or feared species, and the lack of consistent funding for nongame conservation and environmental education. Partner with a local university or independent research firm to develop survey questions that will assess the knowledge, attitudes, and behaviors of Georgians regarding these key issues.
- Determine how to best collect data from various ages and audience types.
- Conduct a statistically valid phone survey of Georgia citizens, legislators and community leaders to determine their knowledge of key conservation issues.
- Work with the SWAP Communications team to post these questions on the GA DNR website and/or via software like Survey Monkey, and encourage citizens to take this quiz (with the understanding that the web instrument lacks statistical independence between survey respondents, so this survey would only be an index of understanding of these issues).
- Create some an incentive for participating in the survey (i.e., random drawing for a gift certificate).

Funding required for this project may be minimal. Graduate students may be utilized for analysis and reporting, and DNR Wildlife Resources already has a Survey Monkey account. Partners to help promote survey participation include various environmental education groups, Georgia Public Broadcasting, Parent-Teacher Associations (PTAs), colleges, nature-oriented groups. Ideally, we would like to receive at least 250,000 responses to effectively analyze and summarize the results of this wildlife literacy survey.

2. Create educational core concepts with messages that support the main SWAP themes.

Under the leadership of the Georgia DNR Wildlife Resources Division, a team of partners including content experts (such as SWAP taxa team members), educators, and public affairs experts will create a SWAP logo with ‘slogan’ as well as a set of educational core concepts with key messages. The content experts will provide expertise in science and natural resources, and the educators and public affairs experts will provide guidance related to the readability and effectiveness of message construction. The focus will be on conserving all of Georgia’s natural resources including plants, wildlife and their habitats, while calling every Georgia citizen to responsible action.

The core concepts will be fairly broad and simple, while the key messages supporting each core concept will address the SWAP themes more specifically. The implementation committee should strive to convey that every species matters, that everyone’s actions impact our natural resources, and that we can all have a share in protecting the quality of our environment and maintaining biodiversity. The importance of consistent funding for wildlife conservation and education should also be emphasized. The results of the environmental literacy survey (if completed) will provide a valuable resource for developing core concepts and message content.

We recommend limiting the list to five core concepts with associated key messages that tie back to the main SWAP themes, as most people are capable of processing only five to nine different pieces of information at a time (George Miller, 1956 “Magical number seven plus or minus two,” <http://www.musanim.com/miller1956/>). Key messages can be adapted to fit the conservation concerns in specific ecoregions and for particular audiences. We not only need to focus on what we want people to know, but also what we want them to do and how they can help with specific calls to action.

The Conservation Education Core Concepts developed by the Association of Fish & Wildlife Agencies (AFWA) provides a national example of core concepts with supporting messages, which may serve as a good reference for this Georgia SWAP Education initiative: [http://jjcdev.com/~fishwild/?section=conservation\\_education\\_core\\_concepts](http://jjcdev.com/~fishwild/?section=conservation_education_core_concepts)

Another helpful reference is a toolkit for creating engaging messages, developed by the Audubon Society in partnership with the U.S. Fish and Wildlife Service and the Environmental Education and Training Partnership: <http://web4.audubon.org/educate/toolkit/pdf/section-c.pdf>

Funding for this work could be minimal with in-kind donations of staff time. Indicators of success include agreement on the core concepts and supporting messages by partner agencies and organization, as well as their cooperation by incorporating these themes into their communications,

materials, and conservation work. A future wildlife literacy survey, when compared to a baseline survey, could reveal if these messages have impacted the behavior of Georgia citizens.

3. Identify and develop targeted educational materials to facilitate the delivery of SWAP conservation messages to the public.

To help Georgia's environmental educators promote the SWAP's core concepts and key messages, easy-to-use resources should be identified and produced. The goal is to make available exemplary and innovative resources, tools, materials, and models consistent with the goals, priorities, and technical expertise in the SWAP. Materials should be tailored to the general public as well as formal and informal educators, property owners, land managers, recreationists, businesses, faith communities, and students (K-12 and college level) who will become the next generation of caretakers of Georgia's natural environments. SWAP materials and models should:

- Encourage Georgians to get outdoors and connect with nature, learn about the environment, reduce unfounded fears about wildlife (such as snakes), and/or participate in environmental stewardship and conservation projects such as scientifically sound citizen science and service learning.
- Include effective curricula in science and other STEM fields, technical references, hands-on materials and website information.
- Be disseminated via DNR websites, EEinGeorgia website, and other partner websites, as well as at festivals, college awareness days, and other venues.
- Be accessible through an organized, online database that links education programs and resources with SWAP priorities. So that users can easily identify conservation materials that pertain to them, such a database should offer search and filter functions that allow users to sort information by:
  - geographic area/ecoregion within the state
  - particular habitats or plant/animal communities
  - conservation threats
  - key conservation actions identified in the SWAP
  - audience
  - gaps in resources, where new materials and models need to be created

EEinGeorgia.org is the most comprehensive source of environmental educational materials for K-12 students and teachers. The effectiveness of this tremendous resource could be enhanced by adding search filters specific to SWAP and stewardship. In addition, an EEinGeorgia link or button should be prominently displayed on GA DNR Division websites (such as <http://www.georgiawildlife.com/>), GA DOE websites, and other websites used by Georgia educators. GA DNR and partners' web pages should be updated with resources and opportunities for stewardship, citizen science and environmental education. SWAP brochures, in the style of EEinGeorgia's one-page summary of Farm to School resources (<http://growing-minds.org/lesson-plans>), are needed for various target audiences.

Funding possibilities should be investigated, including through The Environmental Resource Network (TERN), to enhance the search and filtering functions of the EEinGeorgia website so that it's easier to find SWAP-consistent educational resources related to priority species and/or habitats

for any part of the state. Other funding sources or grants may need to be pursued to enhance the DNR/SWAP website so that it can offer more educational content for landowners and other stakeholders, market educational messages, and analyze website usage.

Many of Georgia's natural resources are managed by public agencies, but since most wildlife lives on private land, landowners play an important role in sustaining habitat and protecting biodiversity. Sustainable natural resources depend on the support of an informed and responsible citizenry. The public must be aware and supportive of conservation actions necessary to protect Georgia's natural heritage.

#### 4. Improve communication of SWAP messages to regional education networks and community groups

SWAP educational messages and materials will best be disseminated through existing ecoregional networks. Working with EEA, EEinGeorgia, Georgia Science Teachers Association (GSTA), DNR Nongame Conservation, DNR Hunter Education, Natural Resources Conservation Service (NRCS), land trusts, advocacy groups (i.e., Riverkeepers), and other agencies/organizations, leaders/moderators within each ecoregion and in priority land acquisition areas first need to be identified. Virtually or via in-person workshops, representatives could network with each other, learn about the unique features and issues of their ecoregion, discover easy-to-use materials for teaching about high priority conservation issues, and incorporate the SWAP messages into their programming. Education partners also could deliver messages to people as they engage in outdoor recreation -- at boat access points, campgrounds, and through guides and outfitters.

To further infuse SWAP themes and messages into current practices, educators could work with various SWAP technical team members (namely Communications) to identify good stories that can be used to hook learners on issues in that ecoregion. In addition to the general public, target audiences will include school children, teachers (including pre-service), outdoor enthusiasts, and community groups that affect land use (private property owners, business leaders, government officials, etc.). To encourage buy-in by these groups, community gatherings could integrate SWAP strategies with local issues, thereby creating a common educational strategy.

We also suggest developing a GovDelivery bulletin to better disseminate SWAP messages. For two-way communication, a Facebook page should be developed. Also consider creating a SWAP clearinghouse website, separate from or part of the GA DNR Wildlife Resources Division website ([www.georgiawildlife.com](http://www.georgiawildlife.com)).

The effectiveness SWAP communications may be evidenced by the following performance indicators:

- # of downloads of educational materials and other website analytics
- # of additional open online environmental education resources and technical information available through [eeingeorgia.org](http://eeingeorgia.org) or Georgia DNR web pages
- # of requests for information resulting from personal interaction at festivals, meetings, training
- Tracking the distribution of printed materials

- Results of click rates and other web analytics, as well as short, instant surveys at targeted websites and outdoor places where people visit, to measure awareness of SWAP-related educational materials such as GA DNR's e-newsletter, Dragonfly Gazette (Project WET), Junior Rangers (DNR State Parks), and EEinGeorgia.org
  - Development of new materials to fill gaps, as needed
5. Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in Georgia.

Many citizens enjoy our state's rich cultural and natural heritage, and they cherish outdoor memories from childhood. Therefore, Georgia's parents tend to be passionate about their children's education and the environment in which they are raised. They also are concerned about their health and the future of the economy. These concerns are justified, because our quality of life is threatened. Our energy practices are not sustainable, our schools are struggling to meet national standards, and many of the fields and forests we once explored have disappeared. Today's youth spend their time in front of electronic screens. All of these issues are inextricably linked to environmental literacy. To reverse this trend, citizens must understand the conservation issues we face in order to make informed decisions about our state's environmental health. We must increase our state's environmental literacy in order to sustain and improve our way of life.

According to the North American Association for Environmental Education (NAAEE), creating an environmental literacy plan (ELP) provides the framework for school systems to expand and improve their environmental education programs. A state environmental literacy plan ensures that environmental education is integrated into formal education systems, that a consistency and accuracy in environmental content knowledge is established, and that underserved communities are engaged.

The SWAP Advisory board should support the Georgia Department of Education in creating an ELP. In partnership, the Department of Natural Resources' Wildlife Resources Division can advise the Georgia Department of Education on how to best address wildlife conservation concepts in the ELP. Currently, no federal funds are available in regards to the No Child Left Inside Act. Private and local sources must be sought. However, in the meantime, the SWAP Advisory Board could become involved in the development of the Next Generation Science Standards as a near-term goal. <http://www.nextgenscience.org/Georgia>

The actual development of the ELP could be accomplished with no additional funds other than gifts in-kind, by allowing employees to serve on a writing committee. Success would include a resolution signed by the Governor, a functioning Georgia Partnership for Children in Nature (GPCN), a completed ELP, and annual assessment of progress towards becoming an environmentally literate adult. To measure effectiveness, we need a method of measuring baseline knowledge and health data, increased time spent in nature by children, and how exposure to the outdoors affects test scores and health (perhaps via a survey to assess literacy upon graduation).

## **Conclusion**

The State Wildlife Action Plan presents us with an opportunity to: 1) educate the citizens of

Georgia about natural communities and the conservation priorities within their ecoregions; and 2) measure the effectiveness of the campaign. These goals can be accomplished by establishing a baseline of knowledge through a wildlife literacy survey, incorporating those findings into SWAP core concepts and messages, identifying and creating teaching resources that target specific audiences, and taking advantage of Georgia's strong and diverse network of environmental educators and other conservation organizations to effectively communicate how we can all play a role in protecting biodiversity. Future surveys and studies can aim to measure the long-term effectiveness of these efforts.

### Georgia Wildlife Education Providers

This list was compiled with contributions from the Environmental Education of Georgia website ([www.eeingeorgia.org](http://www.eeingeorgia.org)) and other sources. Audiences served are arranged by Level III Ecoregions in Georgia ([www.hort.purdue.edu/newcrop/cropmap/georgia/maps/GAeco3.html](http://www.hort.purdue.edu/newcrop/cropmap/georgia/maps/GAeco3.html)), as well as organizations that offer wildlife education statewide.

#### Blue Ridge (Ecoregion 66)

Amicalola Falls State Lodge Park, Dawsonville, Dawson County  
 Anna Ruby Falls/U.S. Forest Service, Helen, White County  
 Birding Adventures Inc., Atlanta, DeKalb County  
 Blue Ridge Outdoor Education Center, Toccoa, Stephens County  
 Camp Toccoa/Camp Fire USA Georgia Council, Toccoa, Stephens County  
 Dalton-Whitfield Solid Waste Authority, Whitfield County  
 Fort Mountain State Park, Chatsworth, Murray County  
 Medicine Bow, Ltd., Dahlonega, Lumpkin County  
 Northeast Georgia Youth Science & Technology Center (GYSTC), Clarkesville, Habersham County  
 Rolling Thunder Enterprises, Jasper, Pickens County  
 Smithgall Woods-Dukes Creek Conservation Area/DNR, Helen, White County  
 Soque River Watershed Association, Clarkesville, Habersham County  
 Tallulah Gorge State Park, Tallulah Falls, Rabun County  
 Tellus Science Museum, Cartersville, Bartow County  
 Unicoi State Lodge Park, Helen, White County  
 Upper Etowah River Alliance, Canton, Cherokee County  
 Wahsega 4-H Center, Dahlonega, Lumpkin County  
 Wildlife Rehab Sanctuary & Outdoor Educational Program, Ellijay, Gilmer County  
 Wildlife Wonders - ZOO TO YOU, Cleveland, White County

#### Southwestern Appalachians/Ridge & Valley (Ecoregions 67 and 68)

Arrowhead Environmental Education Center (GA DNR Wildlife Resources), Armuchee, Floyd County  
 Birding Adventures Inc., Atlanta, DeKalb County  
 Cloudland Canyon State Park, Rising Fawn, Dade County  
 Dalton-Whitfield Solid Waste Authority, Whitfield County  
 Georgia Girl Guides, Rising Fawn, Dade County  
 Georgia WildTalk, Armuchee, Floyd County

Red Top Mountain State Park, Acworth, Bartow County

Piedmont (Ecoregion 45)

Altizer Lab, Athens, Clarke County  
 Anna Ruby Falls/U.S. Forest Service, Helen, White County  
 Arabia Mountain Nature Preserve, Lithonia, DeKalb County  
 Athens-Clarke County Recycling Division, Athens, Clarke County  
 Atlanta Audubon Society, Atlanta, Fulton/Dekalb County  
 Atlanta Reptile Connection, Atlanta, Fulton County  
 Autrey Mill Nature Preserve, John's Creek, Fulton County  
 Bear Hollow Wildlife Trail, Athens, Clarke County  
 Birding Adventures, Inc., Atlanta, DeKalb County  
 Blue Ridge Outdoor Education Center, Toccoa, Stephens County  
 Callaway Gardens Education Department, Pine Mountain, Harris County  
 Camp Toccoa/Camp Fire USA Georgia Council, Toccoa, Stephens County  
 Cane Creek Farm, Cumming, Forsyth County  
 Charlie Elliott Wildlife Center (GA DNR Wildlife Resources), Mansfield, Jasper County  
 Chattahoochee Nature Center, Roswell, Fulton County  
 Chattahoochee-Oconee National Forests, Gainesville, Hall County  
 Chattahoochee River Environmental Education Center (National Park Service), Alpharetta, Fulton County  
 City of Alpharetta Department of Engineering/Public Works, Alpharetta, Fulton County  
 City of Roswell Environmental Protection Unit, Roswell, Fulton County  
 Cobb County Adopt-A-Stream, Cobb County  
 Cochran Mill Nature Center, Palmetto, Fulton County  
 Dauset Trails Nature Center, Jackson, Butts County  
 Dunwoody Nature Center, Inc., Dunwoody, DeKalb County  
 EcoAddendum, Decatur, DeKalb County  
 EcoReach (UGA Odum School of Ecology), Athens, Clarke County  
 Elachee Nature Science Center, Gainesville, Hall County  
 F. D. Roosevelt State Park, Pine Mountain, Harris County  
 Fernbank Museum of Natural History, Atlanta, DeKalb County  
 Fernbank Science Center, Atlanta, DeKalb County  
 Forty Oaks Nature Preserve, Clarkston, DeKalb County  
 Georgia Aquarium, Atlanta, Fulton County  
 Georgia Museum of Natural History, Athens, Clarke County  
 Georgia Wildlife Federation - Alcovy Conservation Center, Covington, Newton County  
 Georgia Wildlife Federation - Mill Creek Nature Center, Buford, Gwinnett County  
 Gordon Georgia Youth Science & Technology Center (GYSTC at Gordon College), Barnesville, Lamar County  
 Greening Youth Foundation, Atlanta, Fulton County  
 Gwinnett Adopt-A-Stream, Buford, Gwinnett County  
 Gwinnett Environmental & Heritage Center, Buford, Gwinnett County  
 Hard Labor Creek State Park, Rutledge, Morgan County  
 Hightower Educational Forest, Dawsonville, Dawson County  
 Homestead Atlanta, Atlanta, Fulton County

John Tanner State Park, Carrollton, Carroll County  
 Keep Forsyth County Beautiful, Cumming, Forsyth County  
 Lazy B Farm, Statham, Barrow County  
 Mistletoe State Park, Appling, Columbia County  
 National Wildlife Federation--Southeastern Natural Resource Center, Atlanta, Fulton County  
 Nature Corners, Peachtree City, Fayette County  
 Newman Wetlands Center, Hampton, Clayton County  
 Oconee River Georgia Youth Science and Technology Center (GYSTC), Winterville, Clarke County  
 Outdoor Activity Center (West Atlanta Watershed Alliance), Atlanta, Fulton County  
 Oxford Institute for Environmental Education, Oxford, Newton County  
 Panola Mountain State Conservation Park, Stockbridge, Henry County  
 Piedmont National Wildlife Refuge, Round Oak, Jones County  
 Reynolds Nature Preserve, Morrow, Clayton County  
 Rock Eagle 4-H Center, Eatonton, Putnam County  
 Sandy Creek Nature Center, Athens, Clarke County  
 Science Excitement Inc., Marietta, Cobb County  
 Serenbe Farms, Chattahoochee Hills, Fulton County  
 Southeast Institute for Place-Based Education, Palmetto, Fulton County  
 Spring Valley EcoFarms, Athens, Clarke County  
 State Botanical Garden of Georgia, Athens, Clarke County  
 Stone Mountain Park, Stone Mountain, DeKalb County  
 Sweetwater Creek State Conservation Park, Lithia Springs, Douglas County  
 Trees Atlanta, Atlanta, Fulton County  
 Victoria Bryant State Park, Royston, Franklin County  
 Warm Springs National Fish Hatchery (US Fish & Wildlife Service), Warm Springs, Meriwether County  
 Warnell School of Forestry and Natural Resources, Athens, Clarke County  
 Watson-Brown Foundation, Thomson, McDuffie County  
 Wild Intelligence, Athens, Clarke County  
 Wylde Center, Decatur, DeKalb County  
 Zoo Atlanta, Atlanta, Fulton County

#### Southeastern Plains (Ecoregion 65)

Albany Audubon Society, Albany, Dougherty County  
 Bartram Forest, Milledgeville, Baldwin County  
 Birdsong Nature Center, Thomasville, Thomas County  
 Bond Swamp National Wildlife Refuge, Round Oak, Jones County  
 Coastal Rivers Water Planning and Policy Center, Statesboro, Bulloch County  
 Flint RiverQuarium, Albany, Dougherty County  
 Florence Marina State Park, Omaha, Stewart County  
 General Coffee State Park, Nicholls, Coffee County  
 George T. Bagby State Park, Fort Gaines, Clay County  
 Georgia College & State University Outdoor Education Programs, Milledgeville, Baldwin County  
 Go Fish Education Center (GA DNR Wildlife Resources), Perry, Houston County

Grand Bay Wetland Education Center (GA DNR Wildlife Resources), Valdosta, Lowndes County  
 Keep Tift Beautiful, Tifton, Tift County  
 Leaders in Environmental Action for the Future (LEAF - The Nature Conservancy), Atlanta, Fulton County  
 Little Ocmulgee State Park, McRae, Wheeler County  
 Magnolia Springs State Park, Millen, Jenkins County  
 McDuffie Environmental Education Center (GA DNR Wildlife Resources), Thomson, McDuffie County  
 Middle Georgia Youth Science & Technology Center (GYSTC), Warner Robbins, Houston County  
 Museum of Arts and Sciences, Macon, Bibb County  
 Oxbow Meadows Environmental Learning Center, Columbus, Muscogee County  
 Parks at Chehaw, Albany, Dougherty County  
 Phinizy Swamp Nature Park (Southeastern Natural Sciences Academy), Augusta, Richmond County  
 Providence Canyon State Park, Lumpkin, Stewart County  
 Reed Bingham State Park, Adel, Colquitt County  
 Spirit Creek Educational Forest (Georgia Forestry Commission), Hephzibah, Richmond County

Southern Coastal Plain (Ecoregion 75)

Bull River Cruises, Savannah, Chatham County  
 Burton 4-H Center on Tybee Island, Tybee Island, Chatham County  
 Coastal Ark (GA DNR Coastal Resources), Brunswick, Glynn County  
 Coastal Georgia Audubon Society, Brunswick, Glynn County  
 Coastal Audubon Society, Brunswick, Glynn County  
 Coastal Resources Division (GA DNR), Brunswick, Glynn County  
 Coastal Rivers Water Planning and Policy Center, Statesboro, Bulloch County  
 Crooked River State Park, St. Mary's, Camden County  
 Driftwood Education Center, St. Simons, Glynn County  
 Georgia Sea Turtle Center, Jekyll Island, Glynn County  
 Jekyll Island 4-H Center, Jekyll Island, Glynn County  
 Leaders in Environmental Action for the Future (LEAF - The Nature Conservancy), Atlanta, Fulton County  
 Mary Kahrs Warnell Forest Education Center, Guyton, Effingham County  
 Oatland Island Education Center, Savannah, Chatham County  
 Ogeechee Audubon Society, Savannah, Chatham County  
 Okefenokee Education and Research Center, Folkston, Charlton County  
 Okefenokee National Wildlife Refuge, Charlton County  
 Okefenokee Swamp Park, Waycross, Ware County  
 Sapelo Island National Estuarine Research Reserve, Darien, McIntosh County  
 Skidaway Island State Park, Savannah, Chatham County  
 St. Catherines Island Sea Turtle Conservation Program, St. Catherines Island, Liberty County  
 Stephen C. Foster State Park, Fargo, Charlton County  
 Taylor Schoettle, Author and Naturalist, Darien, McIntosh County  
 Tidelands Nature Center, Jekyll Island, Glynn County

Tybee Island Marine Science Center, Tybee Island, Chatham County  
 University of Georgia Marine Education Center and Aquarium, Savannah, Chatham County

Serve a Statewide Audience

A-Z Animals, Fayetteville, Fayette County  
 Discover Life, Athens, Clarke County  
 Environmental Education Alliance of Georgia  
 EEinGEORGIA.org (GA DNR Environmental Protection)  
 Garden Club of Georgia, Athens, Clarke County  
 Georgia 4-H Environmental Education Program  
 Georgia Adopt-A-Stream (GA DNR-EPD), Atlanta, Fulton County  
 Georgia Botanical Society, Marietta, Cobb County  
 Georgia Department of Natural Resources - Environmental Protection Division  
 Georgia Department of Natural Resources - State Parks and Historic Sites (65 sites)  
 Georgia Department of Natural Resources - Wildlife Resources Division  
 Georgia Native Plant Society, Atlanta, Fulton County  
 Georgia Organics, Atlanta, Fulton County  
 Georgia Parent Teacher Association (PTA), Atlanta, Fulton County  
 Georgia Power, Atlanta, Fulton County  
 Georgia Project Learning Tree (Georgia Forestry Foundation), Forsyth, Monroe County  
 Georgia Project WET (GA DNR Environmental Protection), Atlanta, Fulton County  
 Georgia Project WILD (GA DNR Wildlife Resources), Mansfield, Newton County  
 Georgia Reptile Society, Dry Branch, Twiggs County  
 Georgia River Network, Athens, Clarke County  
 Georgia Wildlife Federation - Alcovy Conservation Center HQ, Covington, Newton County  
 Georgia Youth Science & Technology Centers (GYSTC)  
 Monarchs Across Georgia (Environmental Education Alliance), Atlanta, Fulton County  
 Nature Conservancy (Georgia Chapter), Atlanta, Fulton County  
 Southeastern Reptile Rescue, Orchard Hill, Spalding County  
 US Department of Agriculture - Forest Service

## **Appendix L. Communications and Outreach Technical Team Report**

**Prepared by Rick Lavender, team leader**

### **Technical Team Members**

David Allen, Georgia DNR Wildlife Resources Division Public Affairs  
 Carey Adams, Georgia Power  
 Wendy Burnett, Georgia Forestry Commission  
 Sherry Crawley, The Nature Conservancy  
 Eric Darracq, Georgia DNR Wildlife Resources Division Private Lands Program  
 Brian Foster, Georgia Conservancy  
 Susan Gibson, U.S. Department of Defense  
 Chris Groskreutz, USDA Natural Resources Conservation Service  
 Kim Hatcher, Georgia DNR Parks & Historic Sites  
 Matt Hestad, Georgia Forestry Association  
 Sharilyn Meyers, Georgia Department of Transportation  
 Ron Morton, USDA Natural Resources Conservation Service  
 Pete Pattavina, U.S. Fish and Wildlife Service  
 Rob Pavey, Augusta Chronicle (retired)  
 Stacy Shelton, U.S. Fish and Wildlife Service  
 Sandra Spivey, U.S. Fish and Wildlife Service  
 Judy Toppins, USDA Forest Service  
 Marshall Williams, U.S. Department of Defense

*Regrettably, during the revision Stacy Shelton of the Fish and Wildlife Service and Marshall Williams of the Defense Department moved on to other responsibilities and could not continue with the committee. Susan Gibson volunteered to serve in Williams' stead.*

### **Approach**

Georgia's Comprehensive Wildlife Conservation Strategy, finalized in 2005 and now referred to as the more digestible State Wildlife Action Plan, was built on reports from teams of experts who researched conservation of specific aspects of Georgia wildlife and natural habitats, such as birds and plants. As part of that initial effort, one team tackled environmental education, an already vast realm made larger by including communications. When revising the plan in 2013 and 2014, as required every 10 years, DNR decided to form a team centered solely on SWAP communications. This group would also work with the Environmental Education Technical Team on common ground and goals.

Made up of representatives from 12 state and federal agencies, private organizations and companies that participate in conservation around the state, the Communications Team met in December 2013, and then and through follow-up in 2014 explored ideas and issues about SWAP communications. Work included a survey of members' opinions concerning communication objectives, target audiences and outreach tools; a survey of other technical team leaders regarding their top communication objectives and audiences; a brief strengths-weaknesses-opportunities-

threats analysis of SWAP communications; the beginnings of contact lists for priority audiences; and drafts of generic, high-level messaging.

The missions of members' organizations and agencies were also compared to identify areas where those missions intersect with SWAP values. The four core touchstones revealed mark where partners would be more motivated to promote the SWAP, a critical point in communicating by network. The four areas:

- Conserve and enhance native Georgia wildlife, plants and habitats on public and private lands.
- Promote land uses via farmers, forest owners and others that ensure healthy woods and waters.
- Identify natural habitats and wildlife species that need conservation attention in Georgia.
- Pursue effective wildlife conservation that allows for public recreation and military training.

Such legwork led to the discussion and recommendations that follow.

### **Conservation Communications**

The original SWAP included at least five priority actions tied specifically to communications. The one with the longest reach called for developing a statewide campaign to increase public support for wildlife conservation. That general effort has included many facets of outreach, including SWAP-specific elements such as a 2010 DNR article series and lineup of events celebrating the 10<sup>th</sup> anniversary of the State Wildlife and Tribal Grants Program ([www.georgiawildlife.com/node/2321](http://www.georgiawildlife.com/node/2321)), and a 2009 photo contest led by the Georgia Conservancy and called the Great Georgia Photo SWAP ([www.flickr.com/groups/greatgeorgiaphotoswap](http://www.flickr.com/groups/greatgeorgiaphotoswap)).

Other recommendations called for developing educational materials to promote conservation to the public (items have included brochures such as “Is It a Water Moccasin?” produced by DNR and the University of Georgia’s Savannah River Ecology Laboratory), targeted messaging about natural resources conservation, and technical educational materials – examples of the latter include “The Breeding Bird Atlas of Georgia” (UGA Press, 2010) and “Amphibians and Reptiles of Georgia” (UGA Press, 2008).

Of course, the world of communications is far different than when the SWAP was completed a decade ago. Social media is now the go-to source for engagement (for comparison, in 2005 YouTube launched and Myspace ruled led social networking in the U.S.). More than two-thirds of Americans use online devices most frequently for news, second only to television (American Press Institute). In response, agencies, nonprofits and companies have plunged into social media, overhauled websites and revamped communications.

But, arguably, the goals for wildlife conservation communications remain the same: raise awareness, rally support, engage supporters, advance conservation. Communicating the revised SWAP will build on the foundation laid by the original, if with new tools and a renewed focus.

### **Recommendations**

The messaging, products and other outreach efforts that result from the following three recommendations will be shaped by a) the SWAP revision themes determined by the Advisory Committee and b) outreach needs identified by other technical teams. Also, in all a robust communications network of SWAP partners will be vital.

1. Increase stakeholders' support for wildlife conservation; awareness of the SWAP, its importance, themes and successes; and, awareness of the partnership effort involved in SWAP.

As used here, "stakeholders" refers to five audiences that team members deemed most critical to reach with SWAP messaging. Those audiences: conservation and outdoor sporting organizations; state and federal lawmakers; private and corporate forestland owners; agencies that regulate or are otherwise significantly involved with wildlife and land uses that affect wildlife in Georgia; and, wildlife watchers.

The recommended action is written in stair-step fashion: Greater support for wildlife conservation leads the pack. But this action is obviously a tall order. As noted, messaging, including calls to action, will flow from the SWAP revision themes and technical team needs. The communication options used and items produced will be suited to the targeted group, be it providing a social media post with video to conservation/outdoors organizations, informing wildlife watchers through DNR's Georgia Wild e-newsletter (circulation, 43,000) and the partners network, or connecting with private landowners through a Georgia Forestry Today article and by supporting landowner days with brochures explaining forest management practices that benefit gopher tortoises and native groundcover.

Audience contact lists will be further developed. Online surveys will help measure before-and-after opinions on support and awareness. Analytics can be used to gauge traffic to related websites.

2. Increase awareness of the SWAP among partner organizations.

In-reach is important, considering that partners are the face of the SWAP. Raising awareness and understanding of the plan among our staffs will better prepare them to address the topic with constituents and fellow workers, and can widen the base of support for the SWAP.

Work with partners will identify best ways to reach their staffs on specific messaging. Online surveys of willing partner organizations can set benchmarks to monitor changes in knowledge of the SWAP. Partners' use of messaging can also be reported.

3. Work with the Education Team where needed to achieve its recommendations.

Specifically, this could involve creating an online survey supporting the assessment of Georgians' wildlife conservation literacy; helping shape the content of core educational concepts, related messaging and educational materials; and, helping identify SWAP stories per eco-region for use in regional education networks and community groups.

## **Conclusion**

The analysis of SWAP communications strengths, weaknesses, opportunities and threats (SWOT for short) noted that a significant opportunity – a sustained, active network of communicators can benefit SWAP and other conservation priorities in Georgia – is faced by an equally significant threat: Workloads and changing priorities and staff can undermine any communications network focused on the plan.

Maintaining a strong communications network will be the key in following the course suggested in this report. While not expansive, that course is achievable and – because of the SWAP's focus – will help conserve Georgia wildlife and raise awareness of the plan and the conservation actions it emphasizes.

## **Appendix M. Database Enhancements Technical Team Report**

**Prepared by Greg Krakow and Anna Yellin, Team Leaders**

### **Technical Team Members**

#### *Team Leaders*

Greg Krakow, WRD

Anna Yellin, WRD

#### *Team Members participating in Database Enhancement Meeting*

Jon Ambrose, WRD, Nongame Conservation Section

Joanne Baggs, U.S. Forest Service

Chuck Bargeron, UGA, Bugwood Network

Larry Carlile, DOD

Jamie Collazo, GDOT, Ecology Section

Sonny Emmert, GA DNR, Coastal Resources Division

Sara Gottlieb, The Nature Conservancy

Tom Govus, Independent Contractor

Alex Jaume, U.S. Forest Service

Greg Krakow, WRD, Wildlife Biologist

Thom Litts, WRD, Fisheries Management Section

KC Love, Edwards-Pitman, Consultant

Katy McCurdy, U. S. Fish and Wildlife Service

Eric McRae, UGA

Ani Popp, WRD, Nongame Conservation Section

Becky Pudner, WRD, Nongame Conservation Section

Melanie Riley, WRD, Fisheries Management Section

Carrie Straight, U. S. Fish and Wildlife Service

Jacob Thompson, WRD, Nongame Conservation Section

Deb Weiler, WRD, Nongame Conservation Section

David Whitehouse, International Paper

Anna Yellin, WRD, Nongame Conservation Section

#### *Team Members available to participate through e-mail and correspondence*

Nikki Castleberry, UGA, Natural History Museum

Brad Dethero, Geo-Source

Matt Elliott, WRD, Nongame Conservation Section

Trina Morris, WRD, Nongame Conservation Section

Cristin Walters, UGA, Herbarium

#### *Invited but unable to participate:*

Shawna Babin, Rocky Branch Elementary School

Pete Pattivina, U. S. Fish and Wildlife Service,

Dirk Stevenson, The Orianne Society

Wendy Zomlefer, UGA Herbarium

## **Objectives**

The primary objectives of the Database Enhancement Team are to address the strengths and weaknesses of the Georgia DNR biodiversity database, how the data are used, how the data can be improved, and what additions or changes are needed to make the database a more valuable conservation tool. Participants were invited from a diverse group of organizations (above) that use biodiversity data in a variety of ways.

Technical team members were asked what their needs are and where the database has proven to be difficult to use or does not meet expectations. A meeting was held at the Charlie Elliott Conference Center on March 4, 2014. Twenty-two members of the team were in attendance.

## **Data for Input**

### *Increase Data Sources*

Data are obtained from contributors in many forms. This is sometimes done by submission of reports of individual sightings through the U.S. mail or e-mail. More common sources of data are e-mailed or digitally submitted data (through the website) from surveys conducted by contractors (who submit environmental reports due to NEPA requirements), DNR biologists, federal agency biologists, or staff of cooperating organizations, such as The Orianne Society and The Nature Conservancy.

There are certainly more surveyors that continue to collect valuable information regarding Georgia rare species than WRD staff are aware of. Identification of new data sources (and obtaining data from) these individuals and organizations is essential. Underutilized data sources identified by the group included the Tennessee Valley Authority, utility companies, timber companies, the National Park Service, and biological staff on military bases. These organizations and more should be contacted to help fill data gaps that have been identified.

### *Standardize How Large Amounts of Biodiversity Data Are Provided To Georgia DNR*

Given the number of records that are submitted, maintaining the timeliness of EO entry is a challenge. One of the identified problems is that data are submitted in many different formats. These include, but are not limited to, the following: anecdotal e-mails, historic records, museum records, rare species submission datasheets, literature, shapefiles (with varied projections), Google Earth images, points / polygons on satellite imagery, points/ polygons on topographic maps, tax records, and survey reports. Although all forms of records will continue to be accepted, standardizing the format to will lead to greater efficiency by decreasing the amount of time spent interpreting the data.

One solution is to insist that DNR employees and contractors hired by DNR to perform surveys submit records using a standard format or template. The WRD staff has developed an EXCEL spreadsheet that should be completed and submitted with each report. Shapefiles that link to the locations to the entries in the spreadsheet should also be submitted.

This EXCEL sheet is available on the WRD website at the following location: ([http://www.georgiawildlife.com/conservation\\_data\\_electronic\\_submission](http://www.georgiawildlife.com/conservation_data_electronic_submission)). Publicizing the preference that data is turned in on this sheet will be necessary. Requesting frequent cooperators to use these standard data forms in their submissions (such as GDOT contractors) should be encouraged.

#### *Add Methods As Technology Improves*

Many wildlife organizations are encouraging the use of ‘apps’ on smart phones to aid in data submission. It is recommended that WRD staff and cooperators utilize this technology. Different methods of internal data collection are also being developed through the use of tablets, which may be used by contractors in certain cases. This could be made available on the WRD website for others to utilize for rare species reporting.

In order to gather data with the use of ‘apps’ we need forms. Currently under development is the use of ODK (Open Data Kit) XForms for gathering data. ODK XForms (formally known as OpenRosa XForms) is an open standard for making entry forms that is currently used by many related technologies. What distinguishes these forms is that they can be used from remote areas without internet connection, they are easy to develop and they have little or no cost for usage. Apps and Web pages have been developed to utilize this technology on iPhones, Android phones and tablets as well as other devices like laptops and desktops.

Because ODK XForms is a standard, forms can be created using one technology and then implemented by any other related technology. The aggregated data can then be viewed and used by those who administer the server site.

#### *Schedule Information Requests*

One identified cause of data not reaching the WRD databases is the lack of an established schedule for obtaining data. Without deadlines, it is easy for a task to be overlooked. Although WRD staff inputs data that are submitted, they don’t recognize the lack of data when we are not sent reports. A simple method that can be used to remedy this is to create a Google Calendar with ‘go-to’ people that should be contacted to request data. Staff will need to obtain assurances that these people that they will send us data and they will follow up with their organization when it does not come. This will need to be done for requests of information within Georgia DNR as well.

#### *Coordinate With Special Permits Unit Of Georgia DNR*

In the past, scientific collecting permits for special concern animals and plants were reviewed only by the Special Permits office of the Georgia DNR Law Enforcement Division. In many cases, insufficient information was submitted by scientific collection permit holders to determine or confirm rare species occurrences. In addition, these survey reports were rarely seen by staff of the Nongame Conservation Section. This situation has been remedied by updating the permit reporting form to include all of the necessary data fields for developing an element occurrence record, and by coordinating with staff of the Special Permits office to extract useful data from

collection reports. Nongame Conservation Section staff now review the collection reports and identify useful location information on special concern species. The relevant data are then extracted for development of element occurrence information in the Biotics database.

#### *Obtain Data From Smartphone Applications Utilized By Other Wildlife Organizations*

Citizen science applications such as *e*bird and *i*naturalist can be used for obtaining data. Biologists within NCS and cooperating organizations will need to review the records to verify that the species is correctly identified and the location information is from a reliable source. Staff will work with cooperators to identify priority sources for data acquisition.

#### *Expand Collection And Use Of Negative Data*

Typically only positive occurrence data are entered into Biotics, not updates from surveys in which the species surveyed for was not observed. It is planned that this will change. The Nongame Conservation Section is awaiting the development of the Georgia Natural, Archaeological, and Historical GIS (GNAHRGIS) <https://www.gnahrgis.org/gnahrgis/index> to provide the technology for this improvement. This reporting tool is being developed at the University of Georgia and meetings are ongoing.

WRD aquatic zoologists that conduct periodic field surveys for fishes and mollusks maintain databases that are used to track the results of these efforts. Negative data can be inferred by results of these periodic surveys when species don't show up in the surveys. Such negative data can be very valuable for conservation assessments. Similar survey databases for plants and other groups should be developed.

### **Data Provided to Others**

#### *Improve Accessibility of Species Profiles on the Web*

The Database Enhancements Team made the following recommendations to improve the accessibility of species profiles on the WRD website:

- 1) Convert the rare species profiles from pdf format into a web based application that stores treatments locally on mobile phones, tablets, and computers for viewing offline.
- 2) Make the species profiles accessible from links embedded in lists of special concern species. (Note: the ability to click on species in lists on the web was implemented in early 2015 and the same is being done to quickly link to range maps.)

#### *Ensure That All Species in Georgia Are Acknowledged As Present in the Biotics Database*

This is particularly necessary in the case of invertebrates. According to the National Wildlife Federation website (<http://www.nwf.org/wildlife/wildlife-library/invertebrates.aspx>), there are over 140,000 species of invertebrates in the United States. Because of a lack of baseline species data, a very small percentage of terrestrial invertebrates are tracked. If a particular species isn't tracked (or even if it is), relatively few have been entered into Biotics as 'present.' However, we do not need to know the status of these species to put them on the map as being present in

Georgia. Of all species entered into the database as present in Georgia, just 1000 of them are terrestrial invertebrates. Getting these species into Biotics as present is a necessary action item.

### *Create A Profile For Every Tracked Species*

The Nongame Conservation Section maintains a set of rare species profiles that can be referenced for information on habitat, distribution, rarity, seasonality, and photographic identification. This page ([http://www.georgiawildlife.org/rare\\_species\\_profiles](http://www.georgiawildlife.org/rare_species_profiles)) is utilized by students, educators, biologists, ecologists, etc. The profiles are of state protected species and some other rare species that are tracked in the Biotics database. A recommendation of the Database Enhancements Team is to increase the number of profiles to eventually include all species tracked in the Biotics database. Identification information is essential if we expect contractors to be able to identify tracked species in the field.

### *Add Range Maps to Species Profiles*

Predicted range maps should be included with our species profiles. The team expressed significant interest in having these maps downloadable from the WRD website to a shapefile. There have been a number of attempts at creating species range maps. For aquatic species it is often enough to list species by HUC10 (USGS ten digit hydrologic unit code) watersheds. Terrestrial species are sometimes a problem, especially with some plant species that have disjunct ranges or that can persist under variable environmental conditions. For these species, range extensions and new disjunct populations are frequently showing up.

Downloadable information and instructions to make range maps of known locations of species are available on the WRD website. Information is provided by HUC8, HUC10, Georgia county and quarter quads (1/4 of USGS 7.5 minute quadrangle maps). Fishes, crayfishes and mollusks already have links to range maps from their species profiles.

Aquatic biologists in the Nongame Conservation Section have developed a methodology for developing Conservation Status Maps that display occurrences of a given species within a HUC10 watershed. Date ranges of the last documented occurrences of a species are color-coded, and indicate areas in which additional surveys may be needed to confirm the continued existence of the species in a watershed. This method and similar methods can be used to show areas of the data that could be improved by further field work or data scrutiny.

### **QC (Quality Control) of Data**

Currently WRD staff uses an established methodology to QC rare species and natural community occurrence (EO, element occurrence) data. This usually works well for newly entered or revised data, but occasionally errors get through this process. There are many older records that have not gone through the current QC process. These records as well as errors in newer records could be addressed by using adjunctive QC methodologies. One such method would be to run special QC queries against Biotics data to find fields that aren't filled in or contain lower quality data. The team recommends including a link on the website to report data errors or website problems.

## **Appendix N. Ecosystems and Habitat Mapping Technical Team Report**

**Prepared by Jason Lee, Team Leader**

Wildlife conservation measures such as land acquisition on a statewide level are challenging due primarily to the scale and complexity of issues regarding prioritization, especially for a state as biologically diverse as Georgia. With a limited budget, how does a state assess wildlife value on one property versus another? A good decision process is one that accounts for the complexity of the issues while producing an easy to understand result, typically a map. The SWAP Habitat Mapping process attempts to compile current biological knowledge, current land conditions, predicted future impacts, and biological opinions in a transparent and objective way to better define areas of biological importance.

This report details the cumulative efforts of DNR to initiate and plan for this process, and is intended to be both an internal blueprint for SWAP Habitat Modeling and also a public resource. It our hope that federal, state, local government and private partners can utilize this prioritization process to promote and conserve wildlife in Georgia.

### **Technical Team Members**

*Team Members participating in the meeting:*

Kevin Samples, NARSAL, UGA  
 Sonny Emmert, CRD  
 Dr. Nate Nibbelink, UGA  
 Dr. Jeff Hepinstall-Cymerman, UGA  
 Matt Elliott, DNR  
 Dr. Jon Ambrose, DNR  
 Eamonn Leonard, DNR  
 Jacob Thompson, DNR  
 Amy Keister, SALCC  
 Will Duncan, FWS  
 Alison McGee, TNC  
 Linda Chafin, UGA  
 Megan Pulver, GADOT  
 Jason Lee, DNR

*Team Members corresponding and/or reviewing*

Wade Harrison, TNC  
 Dr. Clark Alexander, SKIO  
 Christi Lambert, TNC  
 Chris Canalos, DNR  
 Tom Govus, Ecologist  
 Sara Gottlieb, TNC  
 Steve Holzman, FWS  
 Dr. Liz Kramer, UGA

Dee Pederson, NRCS  
Dr. Ken Myer, ARC  
David Gregory, DNR  
Brent Womack, DNR  
Thom Litts, DNR  
Andrew Szwak, GEFA  
Fuller Callaway, GEFA

## **Approach**

On December 12, 2013, Team members assembled at Ocmulgee State Park in McRae, Georgia to discuss goals and plans for SWAP habitat mapping and modeling. Nongame DNR presented a general outline of preferred approaches based on SWAP needs, singular and overall goals, and processes to achieve them. This overall goal can best be described as a comprehensive modeling and mapping approach, and was approved by the team. The team then discussed the status of individual components such as land cover products or species models in terms of availability, potential importance, and accuracy. After review of available datasets and budgetary limitations it was obvious to the group that only portions of that overall objective could be achieved by the 2015 SWAP deadline.

In spite of this and after subsequent internal Nongame DNR deliberation and research and approval by the Habitat Team, it has been determined that steps toward the overall goal of an exhaustive modeling approach will be appropriate. Although not all individual datasets will be incorporated due to lack of availability, those will be developed and included in the near future. We consider this a dynamic modeling process that will be useful by 2016, but continue to build on current available data and eventually produce the desired comprehensive model.

In the following draft report, the process proposed and deliberated for SWAP Habitat modeling is presented, as well as future goals and opportunities, and merits of individual components that will contribute to the overall goal.

## **Identified Overall Needs**

- To update the original SWAP Conservation Opportunity Areas map with a thorough prioritization process that is based primarily on the habitat needs of rare species and land cover maps, answering the question of ‘What areas do we need in conservation to sustain Georgia’s biodiversity’?
- To create a dynamic process that allows for improving the map over time as new information becomes available.
- A public website to display the prioritization and engage public and partners.

## **Identified Products**

Final products that will need to be developed for the SWAP to achieve identified needs are the specific goals. The final opportunity map will be a single integrated composite index based on ranked component input data (the individual components will also be made public). Some of

these data are not available currently, so an essential part of this process is to identify data needs (which will then be listed as goals). Occasionally a placeholder may be used until an improved dataset can be developed. Products identified as goals are (Goals 2-5 will form the composite Conservation Opportunity Map):

1. Land cover maps & status and trends over past decade
2. Land cover derivatives (urban projections, Landscape Suitability, Habitat Richness, etc.)
3. Wildlife Corridor Opportunities (Greenways)
4. Priority Watersheds
5. Conservation Lands, status and trends
6. Species Habitat Models

With each of these products, a list of goals and data needs for improving the Opportunity map components will also be produced if necessary.

The following Sections discuss these individual products in more detail.

## **1. Land Cover Mapping**

The basis of all habitat prioritization modeling is land cover. Most importantly it is used as the building block for all species models, and for land cover status/trends. For some types of analysis, general land cover is adequate. Analysis related to urban projections, agriculture land changes, or acres of silviculture for example are best done at a coarse scale.

### Status and Trends for General Land cover:

Below are spatial and tabular representations of general land cover trends per Ecoregion from 2006 to 2011 (the most recent NLCD land cover map). Although this only covers half of the time period since the 2005 SWAP, it covers the time period from 2006-2008, a very intense period for development in the State. The trends are presented in percentage increase per land cover class (so, for instance Agriculture in the Southeastern Plains decreased by 2.7%, from 6,603 total square miles to 6,423 total square miles).

Overall, the 2006-2011 period appears to be relatively stable from a general land cover perspective. The most notable overall trends for these 6 years are a substantial increase in 'Early Successional', a significant increase in 'Developed', mostly stable 'Wetland' trends and significant 'Forest' and 'Agriculture' loss.

The forested loss, spread evenly across Deciduous, Evergreen and Mixed Forests types (see table below), is primarily into Herbaceous and Scrub/Shrub (shown in figures below as Early Successional) and Development. Herbaceous and Scrub/Shrub can represent conversion to another land use or can represent the early reforestation phase. Some of this loss from forest could also be explained from timber revenues declining after 2007, and silviculture becoming substantially less lucrative relative to other land uses, but most likely represents substantial clearcuts from 2006-2008 when timber prices were significantly higher, and cut areas are in the early, more open phase of silviculture reforestation. Presumably neither of these are an overall forest loss as those areas will return to forest. Hay/Pasture and Cultivated Crops appeared to be

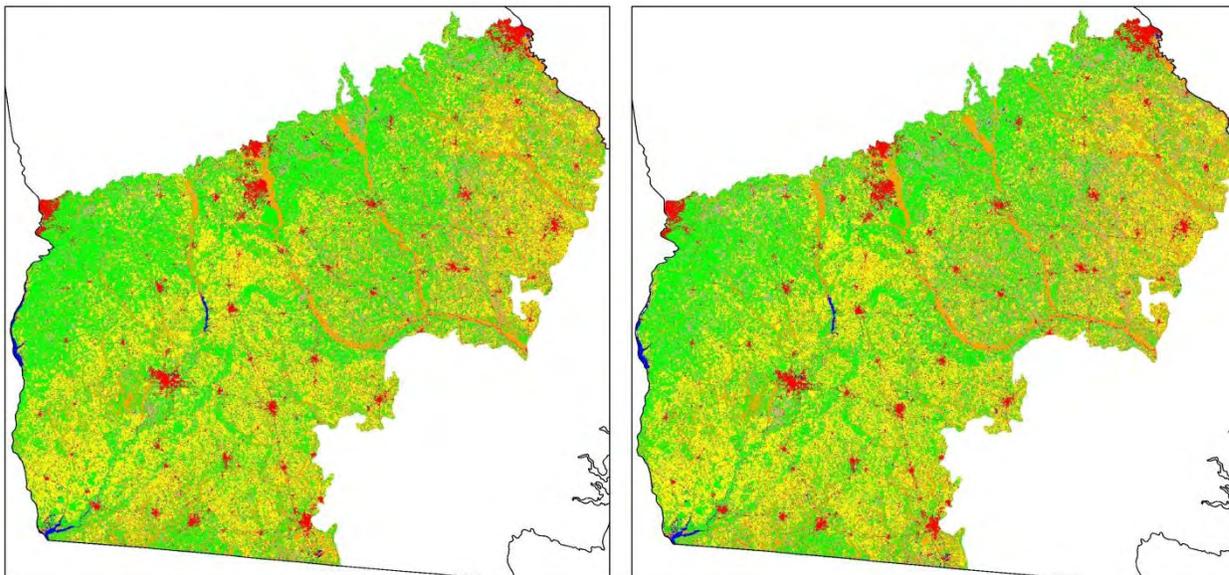
stable overall in the State. The increase in Development is likely to have been due to larger forested and agriculture properties being subdivided, sold and converted to suburban type developments during the growth period (2006-2008). This loss of forest and agriculture to development is significant and concerning.

Importantly, virtually no wetland loss may signal good news statewide as the trend of wetland loss seems to have abated for now. Coastal and Southeastern Plain wetlands, which have been drained and heavily converted to pine plantation over the past few decades appear to be stable from 2006-2011. Perhaps this is due to more marginal, easily converted, wetlands being exhausted and decreased timber revenues not justifying further hydrologic modifications.

<b>NLCD Classes</b>	<b>Square Miles 2006</b>		<b>Square Miles 2011</b>	
Open Water	856		872	
Developed, Open Space	3524		3588	
Developed, Low Intensity	1580		1564	
Developed, Medium Intensity	453		522	
Developed, High Intensity	211		230	
<b>Total Developed</b>	<b>5767</b>		<b>5904</b>	
Deciduous Forest	10788		10350	
Evergreen Forest	12933		12326	
Mixed Forest	2079		1914	
<b>Total Forest</b>	<b>25801</b>		<b>24590</b>	
Hay/Pasture	4740		4634	
Cultivated Crops	5766		5631	
<b>Total Ag</b>	<b>10506</b>		<b>10265</b>	
Woody Wetlands	8162		8018	
Emergent Herbaceous Wetlands	1111		1270	
<b>Total Wetland</b>	<b>9273</b>		<b>9288</b>	
Barren Land	180		199	
Shrub/Scrub	2705		3835	
Herbaceous	3562		3711	
<b>Early Successional</b>	<b>6446</b>		<b>7746</b>	

*Table of overall land cover status and trends for Georgia per the National Land Cover Dataset. Figures below are generalized further and described in maps (figures generated by Chris Canalos)*

**Changes in Land Cover**  
Ecoregion: Southeastern Plains



2006\*

2011\*

Land Cover Type	Percent change (%)	Change
 Open Water	2.4	increase
 Developed	1.2	increase
 Forest	5.0	decrease
 Agricultural	2.7	decrease
 Wetlands	<0.1	increase
 Early Successional	21.2	increase

**National Land Cover Database (NLCD) Class Collapse Scheme:**

Developed: Open Space, Low Intensity, Medium Intensity and High Intensity

Forest: Deciduous, Evergreen and Mixed Forest

Agricultural: Hay/Pasture and Cultivated Crops

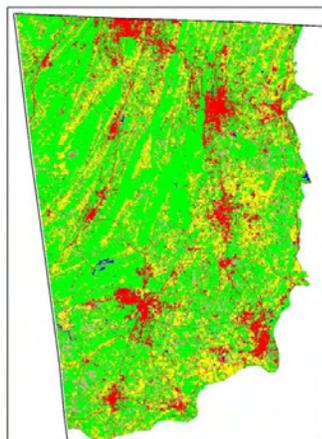
Wetlands: Woody and Emergent Herbaceous Wetlands

Early Successional: Barren, Herbaceous and Scrub/Shrub

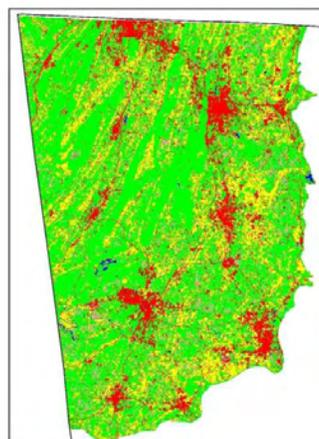
\*US Geological Survey National Land Cover Database (NLCD)

**Changes in Land Cover**

Ecoregions: Southwestern Appalachians and Ridge and Valley



2006\*



2011\*

Land Cover Type	Percent change (%)	Change
 Open Water	0	no change
 Developed	2.4	increase
 Forest	1.5	decrease
 Agricultural	1.1	decrease
 Wetlands	0	no change
 Early Successional	11.2	increase

**National Land Cover Database (NLCD) Class Collapse Scheme:**

Developed: Open Space (Low, Medium, and High Intensity)

Forest: Deciduous, Evergreen and Mixed Forest

Agricultural: Hay/Pasture and Cultivated Crops

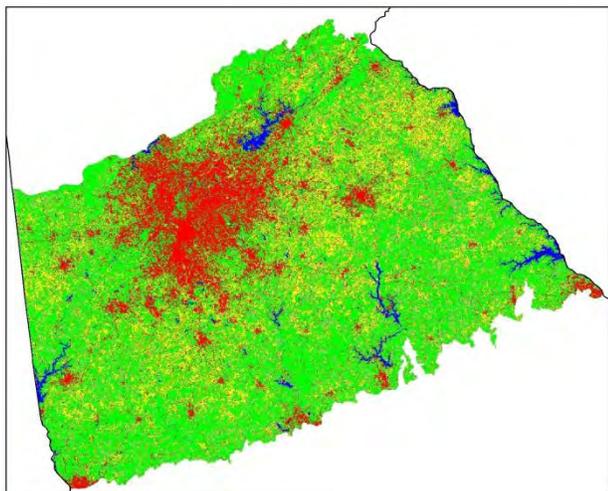
Wetlands: Woody and Emergent Herbaceous Wetlands

Early Successional: Barren, Herbaceous, Scrub/Shrub

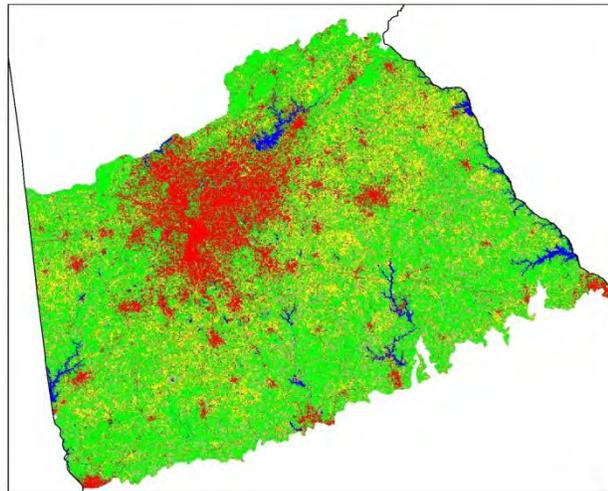
\*US Geological Survey National Land Cover Database (NLCD)

### Changes in Land Cover

Ecoregion: Piedmont



2006\*



2011\*

Land Cover Type	Percent change (%)	Change
Open Water	0	no change
Developed	3.2	increase
Forest	5.4	decrease
Agricultural	1.1	decrease
Wetlands	2.0	increase
Early Successional	27.1	increase

**National Land Cover Database (NLCD) Class Collapse Scheme:**

Developed: Open Space, Low Intensity, Medium Intensity and High Intensity

Forest: Deciduous, Evergreen and Mixed Forest

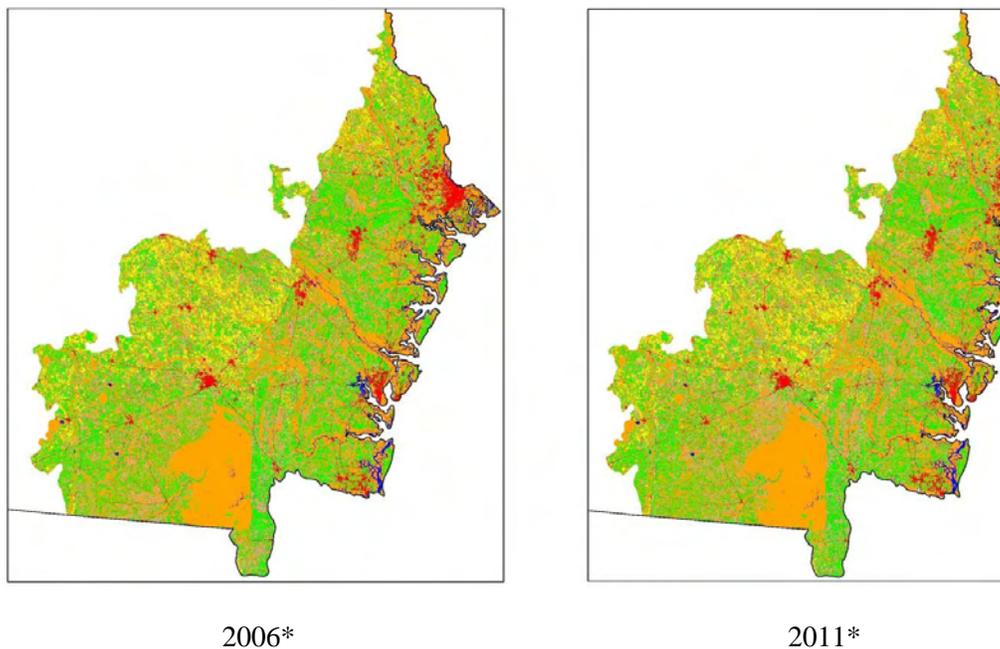
Agricultural: Hay/Pasture and Cultivated Crops

Wetlands: Woody and Emergent Herbaceous Wetlands

Early Successional: Barren, Herbaceous and Scrub/Shrub

\*US Geological Survey National Land Cover Database (NLCD)

**Changes in Land Cover**  
 Ecoregion: Southern Coastal Plain



Land Cover Type	Percent change (%)	Change
 Open Water	6.1	increase
 Developed	2.1	increase
 Forest	6.0	decrease
 Agricultural	3.0	decrease
 Wetlands	<0.1	increase
 Early Successional	12.1	increase

**National Land Cover Database (NLCD) Class Collapse Scheme:**

Developed: Open Space, Low Intensity, Medium Intensity and High Intensity

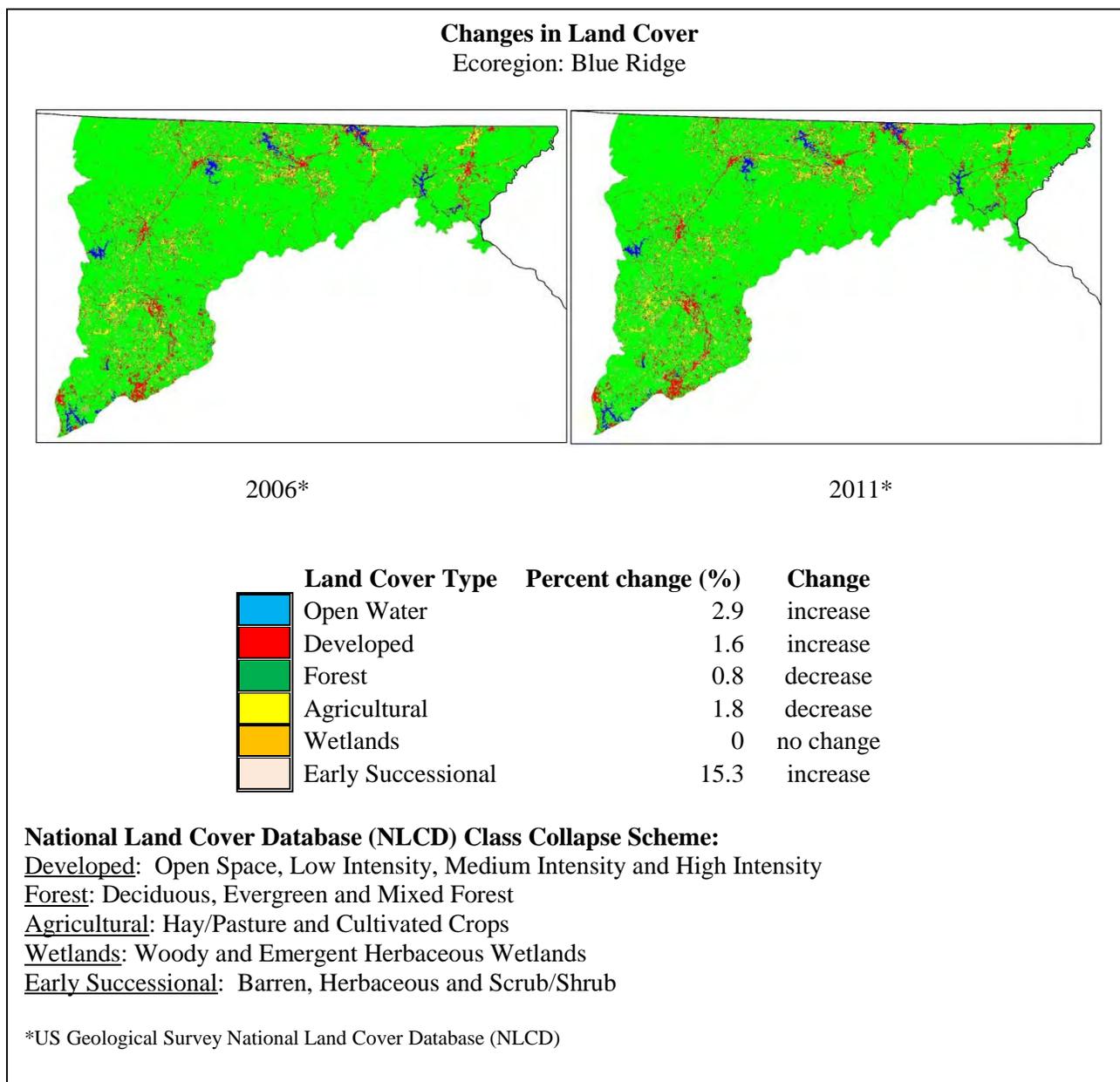
Forest: Deciduous, Evergreen and Mixed Forest

Agricultural: Hay/Pasture and Cultivated Crops

Wetlands: Woody and Emergent Herbaceous Wetlands

Early Successional: Barren, Herbaceous and Scrub/Shrub

\*US Geological Survey National Land Cover Database (NLCD)



*Maps are generated from NLCD; for percentages, Developed classes are merged, Forest classes are merged, Hay/Pasture and Cultivated Crops are merged into Ag, Wetland Classes are merged, Barren Land, Shrub/Scrub and Herbaceous are merged into Early Successional and Open Water stays Open Water.*

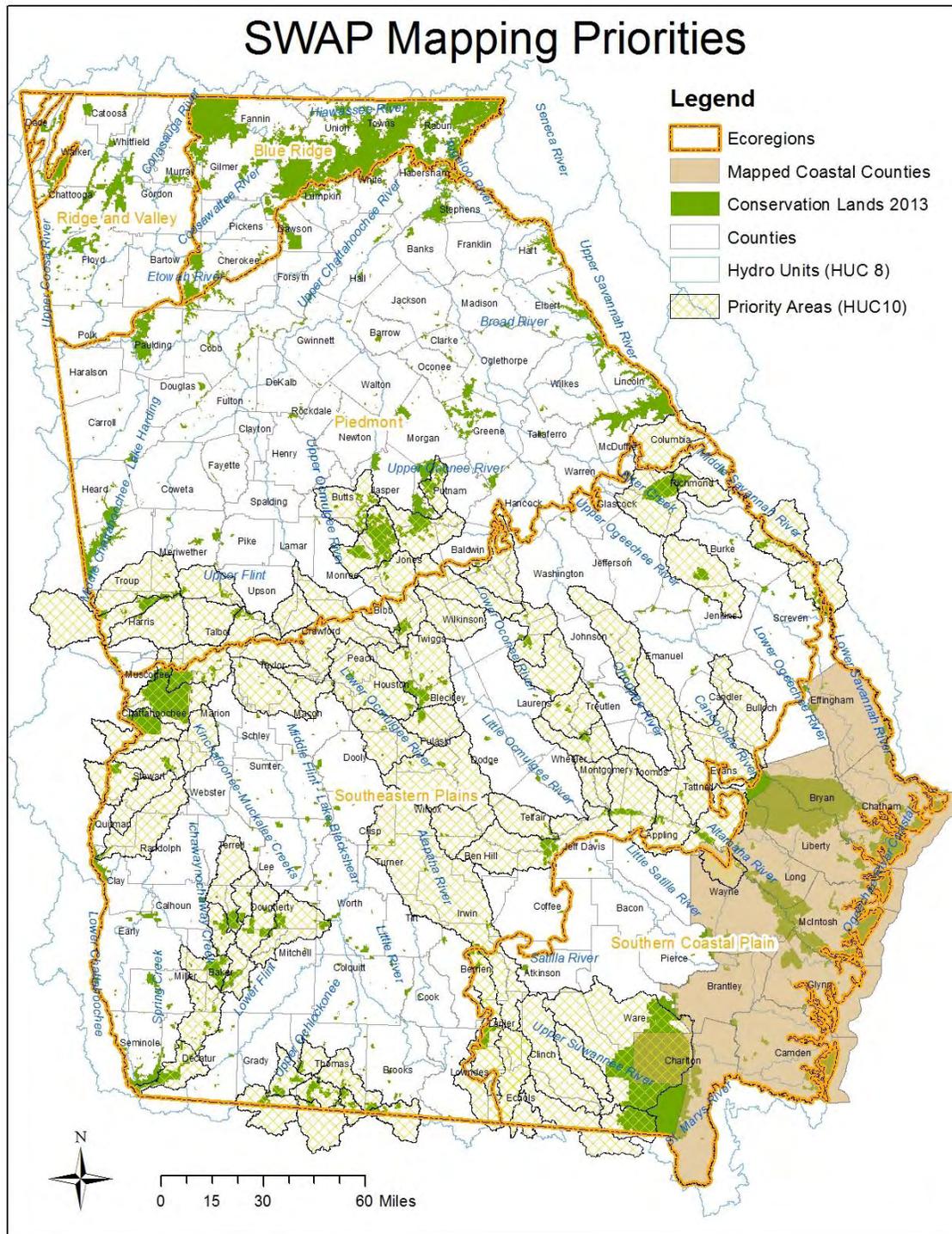
However, there is much diversity of habitats within the more natural land cover types that are important for individual species use. For example, upland longleaf pine and pine flatwoods may both be called natural pine in a general land cover, but usually consist of very different flora species (and attract different fauna).

Due to this, it is crucial that land cover maps be as accurate and details as possible. From 2007 to 2010, Nongame staff mapped vegetation for much of the Southern Coastal Plain of Georgia to

a precise level based on the National Vegetation Classification System developed by NatureServe. This field-based inventory and fine-scale mapping approach has yielded great benefits for coastal conservation, specifically in the ability to analyze habitat priorities. With the coastal habitat map, we are able to clearly ascertain the relative abundance plant communities and refine our priorities accordingly. This ability has led DNR to the conclusion that precise inventory mapping is worth the investment statewide, as it allows us to remove considerable uncertainty and refine our priorities.

To that effect, and considering budgetary limitations, we have drafted a prioritization for the State for future fine-scale mapping efforts (see map below). Natural systems, (not overly affected anthropogenic ones such as agricultural and urban classes) will be the primary targets for mapping, decreasing the mapping extent considerably. The target classification system will be determined later, but the Natural Communities of Georgia is our current goal, with NatureServe Ecological Systems/Associations also possibilities depending on budget factors and needs for specific areas.

The Habitat Team agreed that the Southeastern Plains stands out as the biggest land cover gap. The Team also agreed that for many needs, the Piedmont, Appalachians, Ridge and Valley and Cumberland Plateau Ecoregions can be currently served by 2002 Southeast GAP Land cover data. Although 10 years old, some change detection from current GLUT/NLCD maps can accurately incorporate major changes and so can still be useful until further fine scale mapping is completed.

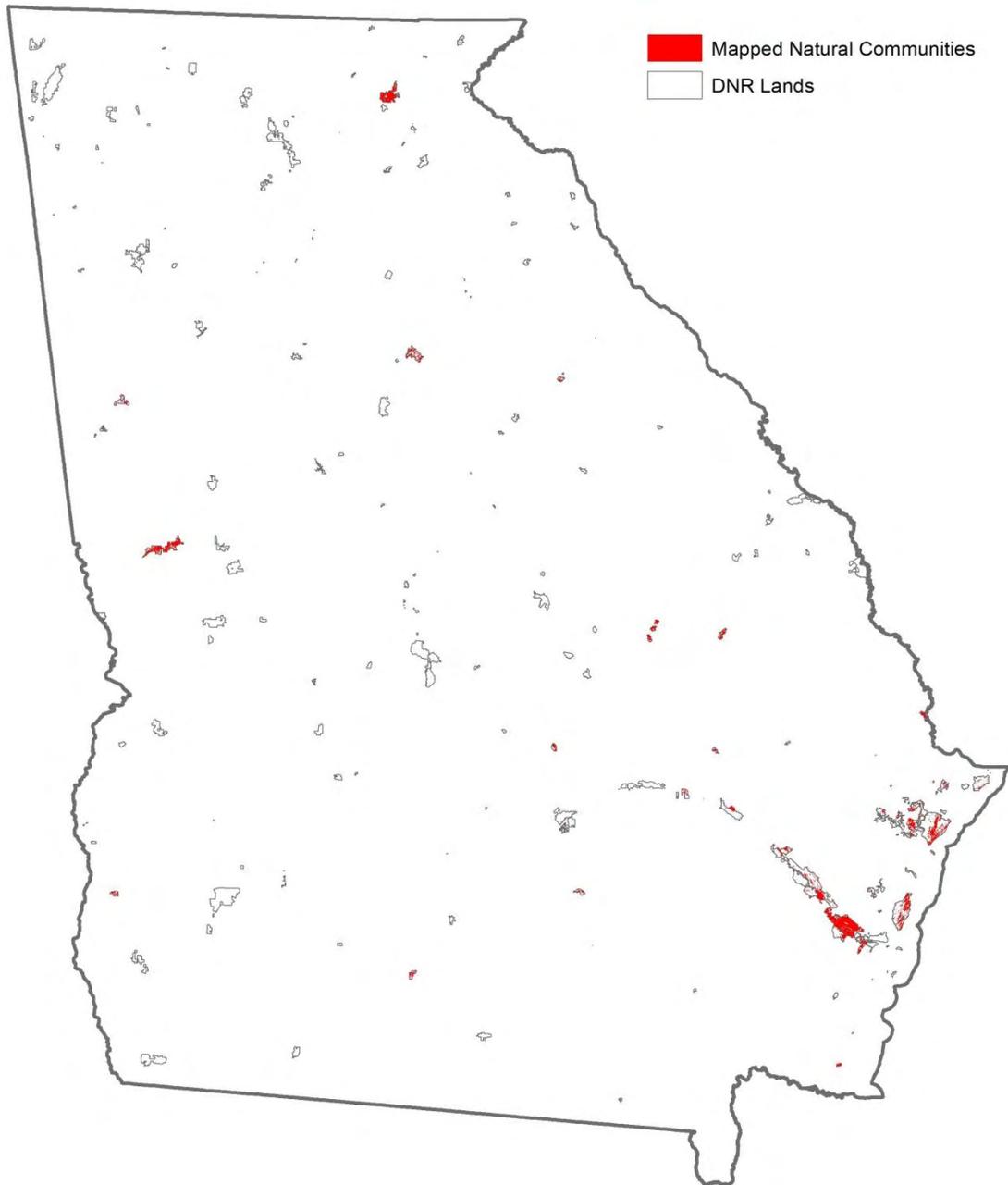


*The Southern Plains is our largest land cover gap as it does not have a reliable land cover map (of finer scale than general land cover) since 1998. The draft Priority Areas above show areas of conservation interest and without recent land cover, and the coastal areas (in brown) previously mapped.*

In addition to the above spatial prioritization, DNR has identified some Southeastern Plain priority habitats that need to be inventoried and mapped. These include high quality longleaf pine- savannas and woodlands, wet pine flatwoods, pitcherplant bogs, cypress savannas (limesinks), mesic slopes, calcareous bluffs, Altamaha grit outcrops and associated wetlands, remnant black belt prairies, canebrakes, calcareous flatwoods, river shoals, granite outcrops, ultramafic glades, and Florida scrub. Two more important habitats to map at finer resolutions are saltmarsh and brackish marsh and associated components such as high marsh, low marsh, levees and oyster beds. Although we have the extent of each well mapped, there is much biodiversity within each that should be better studied, classified and mapped accordingly.

DNR has completed fine scale mapping for Sandhills, Carolina Bays, sagponds, Dougherty Plain isolated wetlands, and wet oak flats. Having these and the above areas mapped to the Natural Communities level will help answer the question: ‘What natural habitats are present in Georgia, and what is their extent and abundance?’

DNR has also completed fine scale land cover maps for most State Parks, Natural Areas and a few Wildlife Management Areas. These are currently being compiled and crosswalked (status below) to a standardized, single map, to begin to answer the question: ‘What natural habitats, and how many and how much of, do we have protected?’ To completely answer that question, fine scale mapping for ALL conservation lands including federal and private conservation lands, so this is a SWAP high priority.



*Lands in red denote fine scale mapping, all others are DNR lands that are priority mapping areas. Most DNR and other protected lands are not mapped to a fine scale. Map and data below generated by Jacob Thompson and Jason Lee, NCS.*

From the initial crosswalk, acreages of Natural communities currently protected are:

<b>Natural Communities</b>	<b>Acres</b>
Acidic glades, barrens, and rocky woodlands	13
Bottomland hardwoods	4635
Coastal wet oak flats	51
Cove forests	109
Cypress-gum ponds	1911
Cypress-tupelo river swamps	3037
Depression marshes and cypress savannas	2
Dry deciduous hardwood forests	1192
Dry evergreen oak woodlands	3236
Dry upland longleaf pine woodlands	469
Floodplains, bottomlands, and riparian zones	1389
Freshwater and oligohaline tidal marshes	2789
Granite outcrops	19
Interdunal wetlands	1225
Intertidal beaches, sand bars, and mud flats	669
Low- to mid-elevation oak forests	2135
Maritime dunes	456
Maritime forests	12729
Mesic forests	1265
Mesic slope forests	830
Montane longleaf woodlands and forests	1326
Mountain bogs	1
Oak-pine-hickory forests	7568
Pine flatwoods	5552
Pine-oak woodlands and forests	3563
Riverbanks and levees	240
Sandhills and river dunes	2973
Seepage slope swamps and shrub bogs	1544
Seepage wetlands	16
Small stream floodplain forests	60
Tidal swamps	13906
<b>Total</b>	<b>74910</b>

The total acreage mapped to the classification level we need is 74,910 acres. Georgia DNR owns over 475,000 acres, so more mapping needs to be accomplished to complete all state lands to a fine-scale level (although many of these lands are mapped accurately to a coarser level such as Ecological Systems) that is often necessary for decision making. Again, a comprehensive, fine scale inventory of all habitats in protection will be very useful in analyzing conservation needs.

Although we have not developed a schedule for fine scale mapping these and other priority habitats, we will seek funding for this work and set timelines and goals in 2015. The SWAP Monitoring team will have overlapping and complimentary efforts, and will be consulted with.

### Land Cover Updates

A crucial component of land cover mapping is regular updates that reflect changes in extent, type or quality of habitat. This is an approach that may not be cost effective if the original method is re-employed for fine-scale mapping (which is considerably expensive). Therefore, change-detection methods are the preferred solution for updates. This consists of an automated process that identifies areas of substantial change, and the remapping process is then a more manageable and less costly process.

In addition to change detection methods, advances in automated land cover classification are showing promise for fine-resolution vegetation mapping. Of particular note are methods successfully pioneered by the Missouri Resource Assessment Partnership (MoRAP) for Missouri and Texas land cover mapping utilizing high quality point data to inform customized classification models. This option needs to be properly vetted for usefulness and application to the Georgia landscape, and may have applications in areas where fine-scale mapping is not possible. The option of mapping the entire Southeastern Plains with a MoRAP-type methodology will also be considered. Urban, silviculture and agricultural areas can be updated with coarser scale land cover datasets such as GLUT or NLCD.

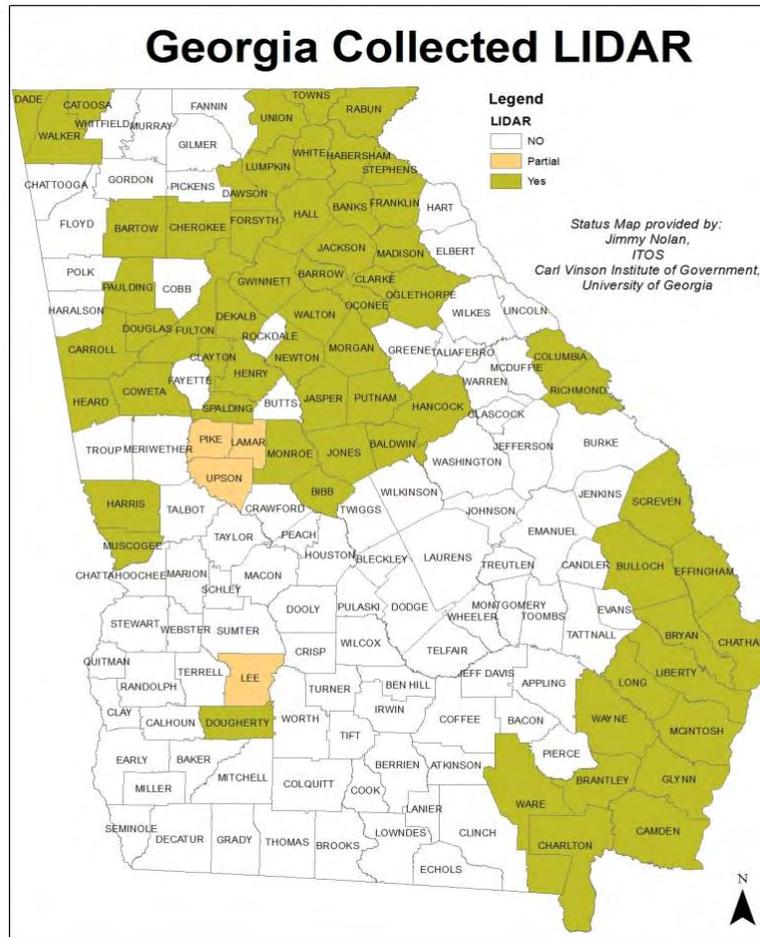
Restoration of ecosystems, especially of longleaf pine systems, needs to be accounted for in future mapping efforts. The reintroduction of prescribed fire is improving habitat across the state, and monitoring fire frequency is an important goal. The Landfire program is actively pursuing monitoring and mapping fire history in Georgia, and collaboration in this effort would be beneficial. Hydrologic restoration will be important to account for as well. The SWAP monitoring Team will be engaged for collaboration to achieve this goal.

### Soils Maps

NRCS SSURGO (soils) digital maps have been completed for the entire State. This is an extremely beneficial dataset that will offer us a chance to increase land cover mapping accuracy and detail significantly. Vegetation responds closely to soil types, and some fauna such as the keystone species gopher tortoise inhabit only certain soil types.

### Identified data needed to facilitate land cover mapping

One of the most significant needs to support land cover mapping is higher resolution digital elevation data produced by Lidar. Accurate elevation models derived from Lidar data are capable of refining the vegetation mapping process greatly, producing more accurate and more detailed land cover datasets. The Lidar status map below shows current availability of Lidar for Georgia. (Note that not all data are publicly available; some are the property of individual counties.)



*Counties that have acquired Lidar in Georgia as of December 2014.*

Also important to land cover mapping is timely, high resolution imagery. There are multiple ways to acquire high resolution imagery, and cost is usually the determining factor in how that acquisition takes place. Working with federal partners and local governments is commonly the most productive way forward. Another alternative that has the added benefit of repeatability is DNR aerial mapping capabilities such as onboard helicopter sensors.

When prioritizing land for conservation, it is often advantageous to include ecosystem services (or function of habitat) for land cover types. Future mapping efforts should consider modifiers to help with this task. Attention should be paid to species present or other important components.

## **2. Land Cover Derivatives and Landscape Condition Models**

Data layers that qualify and quantify lands for habitat purposes can help prioritize land for conservation. These layers are mostly derived from general land covers using metrics that describe land cover attributes such as patch size (how large a homogenous land cover area such as a forest is) or contiguity. Other complementary layers (such as number of inventoried species per area) are often added to increase functionality. *The overall goal for our landscape*

conservation initiatives is to target biologically and topographically diverse, well connected, large areas. Given that, our identified layers needed are:

- Species Richness for Vertebrates Landscape Suitability (Patch/parcel size & Natural land cover)
- Wetlands, Floodplains & Recharge areas
- SLEUTH model of projected urban development
- Landscape Resilience concept: landform/connectivity/fragmentation. For the Coast and the Southeastern Plain, these datasets need reworking with higher quality elevation data.

Of these, the SLEUTH and Floodplains/Recharge Areas datasets are currently available.

### 3. Wildlife Corridors

Habitat connectivity provides benefits for most species, including plants, insects and mobile vertebrates. To foster connectivity between existing and future conservation lands, and to further provide corridors for species movement, a Greenway/corridors layer has been drafted for input into our prioritization process. Please note that this is only one input of the final Conservation Opportunity Map. Due to the complex issues that determine the feasibility of establishing and maintaining wildlife corridors, the actual drafting is mostly a manual process that utilizes multiple datasets. Many of the corridors shown below exist and function currently as wildlife corridors, and so the primary goal is to retain that current land use, and to promote a matrix of restored and working lands, (not necessarily publicly owned).

The following are important themes and priorities we considered when developing the draft map of potential wildlife corridors:

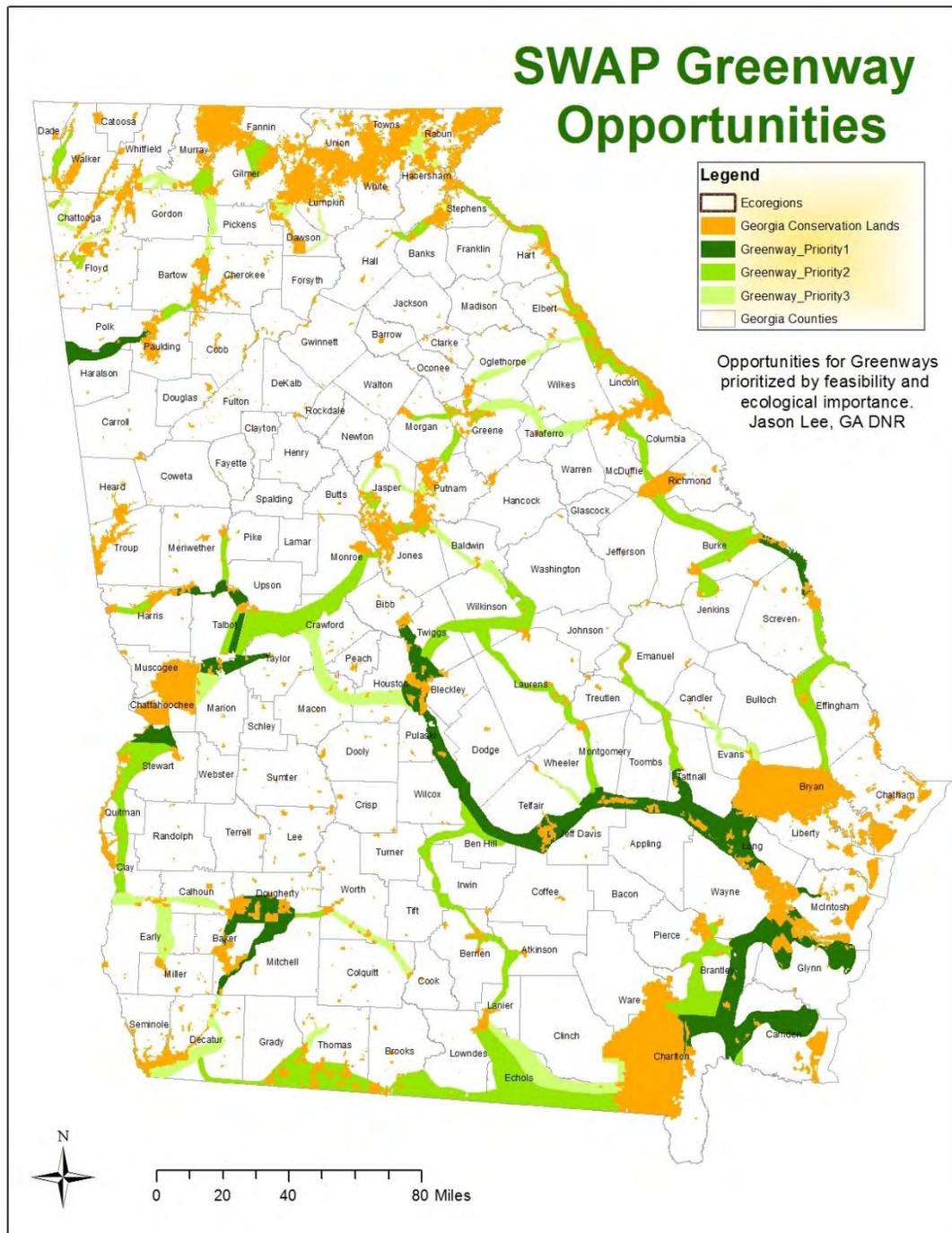
- Different species require different corridor types and sizes. Therefore, the best corridors will be large with diverse topography and land cover. Practically, this often means having significant adjacent uplands with riverine based corridors.
- Wetlands have layers of protection, both natural and regulatory (that must be accounted for in allocating limited conservation dollars.\* Although wetlands are being converted to uplands (primarily ditched and drained, permissible under CWA), overall they do have more protection than upland sites.
- High Connectivity values per modeled land cover metrics (Local Connectedness model from TNC, SALCC Circuitscape Black Bear and Pine Snake models.)
- Connectivity between areas with priority species that require large habitat patches (e.g., RCW, gopher tortoise, eastern indigo snake). This usually indicates that the areas are currently functioning as corridors.
- Areas of high biodiversity are a priority for connections.
- Existing land uses (agriculture/forestry) provide some connectivity. A designated corridor within a matrix of more compatible land uses is superior to one that is not.
- High priority streams and watershed delineated by the Fishes and Freshwater Invertebrates Team

- Coastal areas that provide migration routes for species and habitats affected by sea level rise
- Coastal and Southeastern Plain areas with diverse topography (landforms).
- Adjacent states' conservation lands and plans are important to further enhance connectivity at a regional scale.

*\*A significantly impactful piece of wetland protection, the Biggert-Waters Act of 2012, rolls back federal flood insurance subsidies for new development in flood prone areas. This lack of subsidy will substantially increase costs for flood insurance, and will undoubtedly have a dampening effect on construction in wetlands. This Act, combined with Clean Water Act regulations and the No Net Loss federal policy, could be a powerful deterrent to development in wetlands.*

It is worth noting that, in Georgia, habitat connectivity is highest in the Blue Ridge Ecoregion. New corridors are needed primarily in other parts of the state, with the Fall Line region, Southeastern Plain and Coast as optimum targets due to ample affordable and available opportunities, priority species requirements and projected impacts from sea level rise. Ideally, all major conservation areas within the State should be connected eventually.

There are multiple ways to achieve a biologically effective corridor, depending on the target species, land use, land condition, land prices, and other factors. At minimum, development should be avoided in these areas via easements, at maximum the land should be acquired by the state and restored to a natural condition. The range of options for between these two extremes should be considered carefully for any potential property. The Draft Greenway Opportunities map below reflects all of these considerations. Please contact [jason.lee@gadnr.org](mailto:jason.lee@gadnr.org) with any questions.

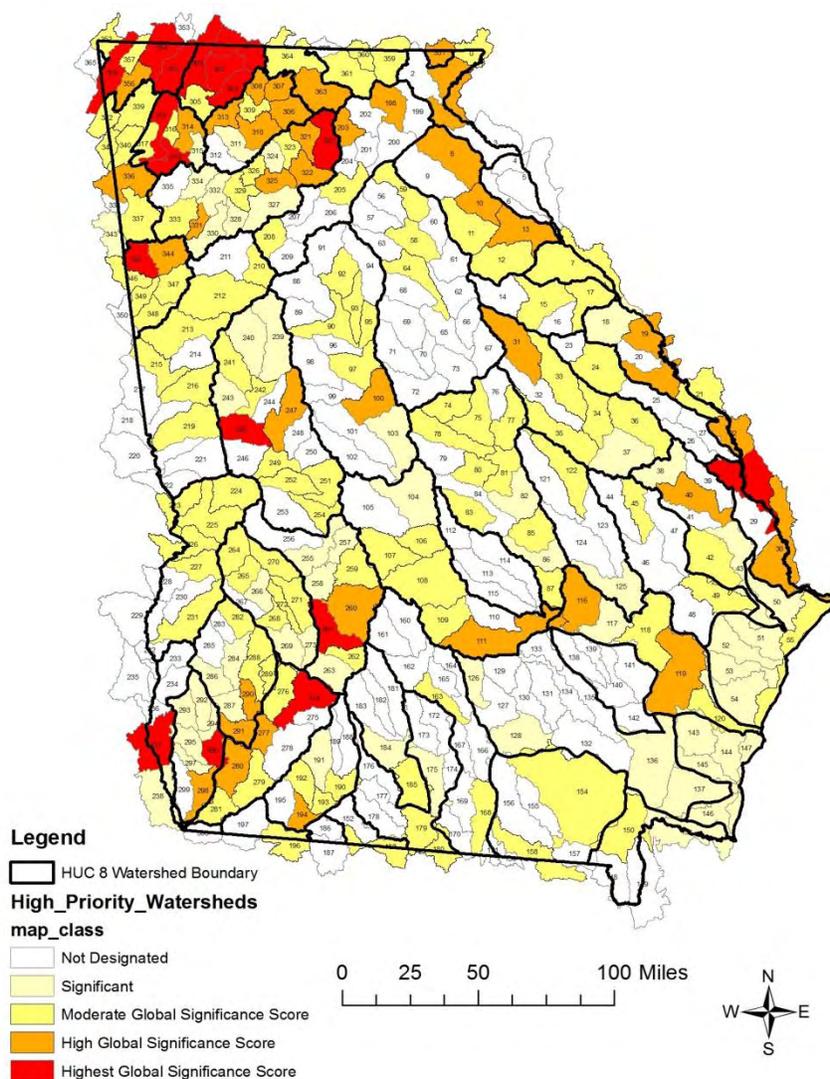


*Note that these do **not need to all be acquired and restored**; fully functioning natural landscapes, but could be a matrix of natural and working lands (forest) including some agriculture. Many of these exist and function currently as wildlife corridors, and so a primary goal is to retain that current land use. The Priority 1 area totals approximately 1 million acres. Thanks to Wade Harrison, Brett Albanese, Jon Ambrose, Matt Elliott and Brent Womack for edits and guidance.*

#### 4. Priority Watersheds

The SWAP Fishes and Freshwater Invertebrates Technical Team and the SWAP Aquatic Habitat Technical Team have developed and implemented a prioritization method for watersheds at the Hydrologic Unit Code 10 watershed scale based upon the number of important populations of high priority aquatic species they support, as well as the global rarity of each species. Important populations of high priority species were designated in watersheds based upon the date of species occurrences, existing protection (e.g., conservation lands), existing condition (e.g., land use) and future threats (e.g., projected urbanization).

The Habitat Modeling Team has assessed the results and intends to incorporate this valuable information into the overall conservation priority process. Please refer to the SWAP Aquatic Habitat Team report for more details or contact Brett Albanese at [Brett.Albanese@dnr.state.ga.us](mailto:Brett.Albanese@dnr.state.ga.us)



*High priority watersheds identified during the 2015 revision of Georgia's State Wildlife Action Plan.*

## 5. Conservation Lands

In order to efficiently strategize for conservation, a comprehensive inventory of current protected areas is essential. In addition to current locations and acreages of conservation lands, it is also necessary to know the level of protection (how permanently protected) and the type of protection (is it managed primarily for wildlife, for silviculture, or other uses?).

Currently, there are substantial gaps in obtaining all of these parameters in a timely fashion. Below is a description of the level of reporting by land acquisition partners:

### State of Georgia (Georgia DNR, GA Forestry Commission)

- Per the Georgia Land Conservation Act, GA DNR is required to maintain the State Land Conservation GIS
- Maintains an accurate, up to date GIS inventory of State of Georgia acquisitions and conservation easements acquired by the State or facilitated through the Georgia Conservation Tax Credit Program.
- Determines and records level of protection
- Partially successful in defining and recording the type of protection (often this is variable and dependent on uncontrollable variables)

### Federal (Fish and Wildlife Service, Department of Defense, Forest Service, National Park Service)

- Maintains accessible, accurate, up to date GIS inventory of acquisitions.
- Determines and records level of protection
- Partially successful in defining and reporting the type of protection.

### Land Trusts

- Some maintain accessible, accurate, up to date GIS inventory of acquisitions. Some updates are provided to GA DNR.
- Determines and records level of protection
- Partially successful in defining and reporting the type of protection.

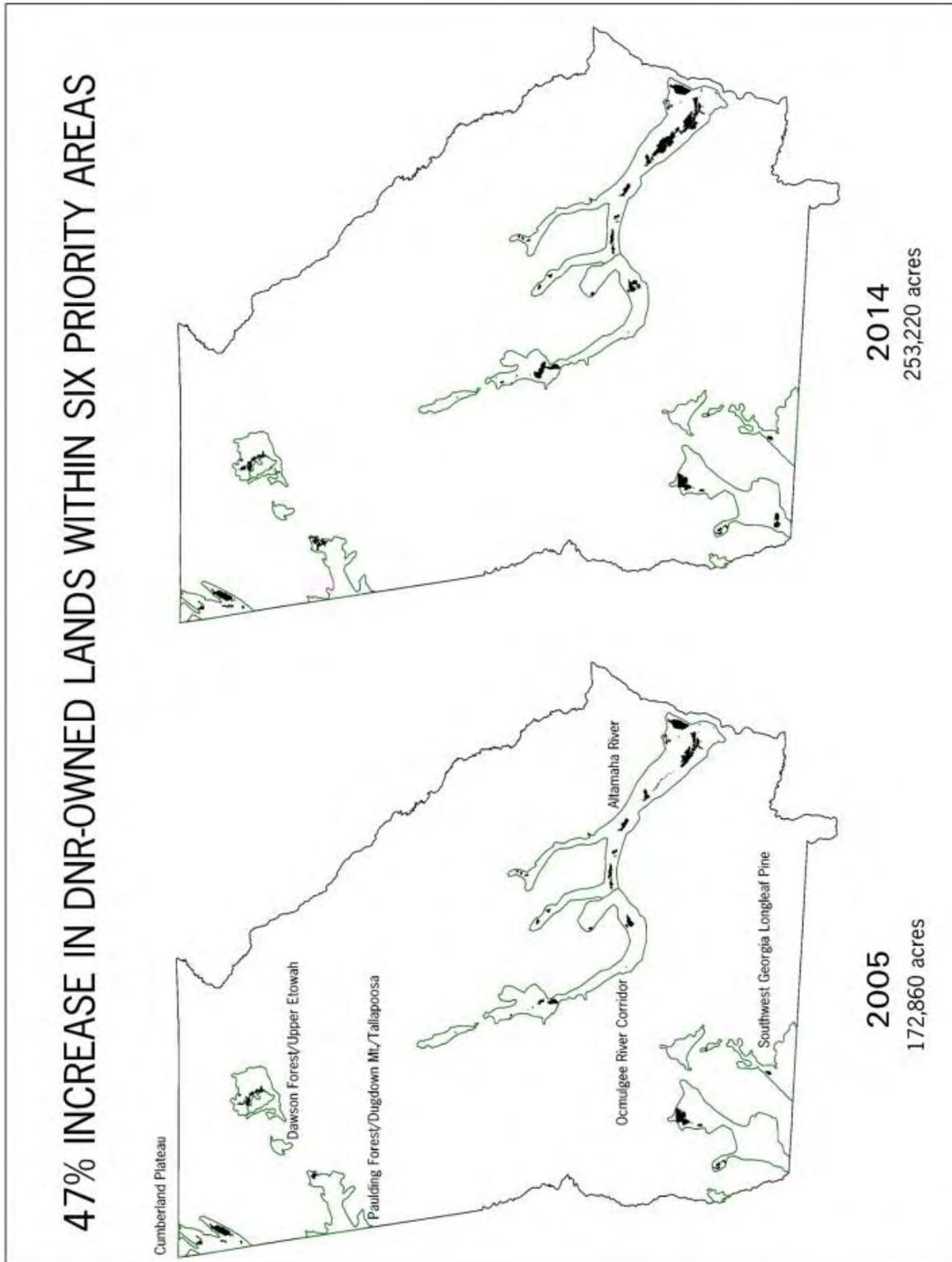
### Local Governments

- Some maintain accessible, accurate, up to date GIS inventory of acquisitions, but none regularly provide updates to a statewide layer
- Do not generally determine and record level of protection
- Not generally successful in defining and reporting the type of protection.

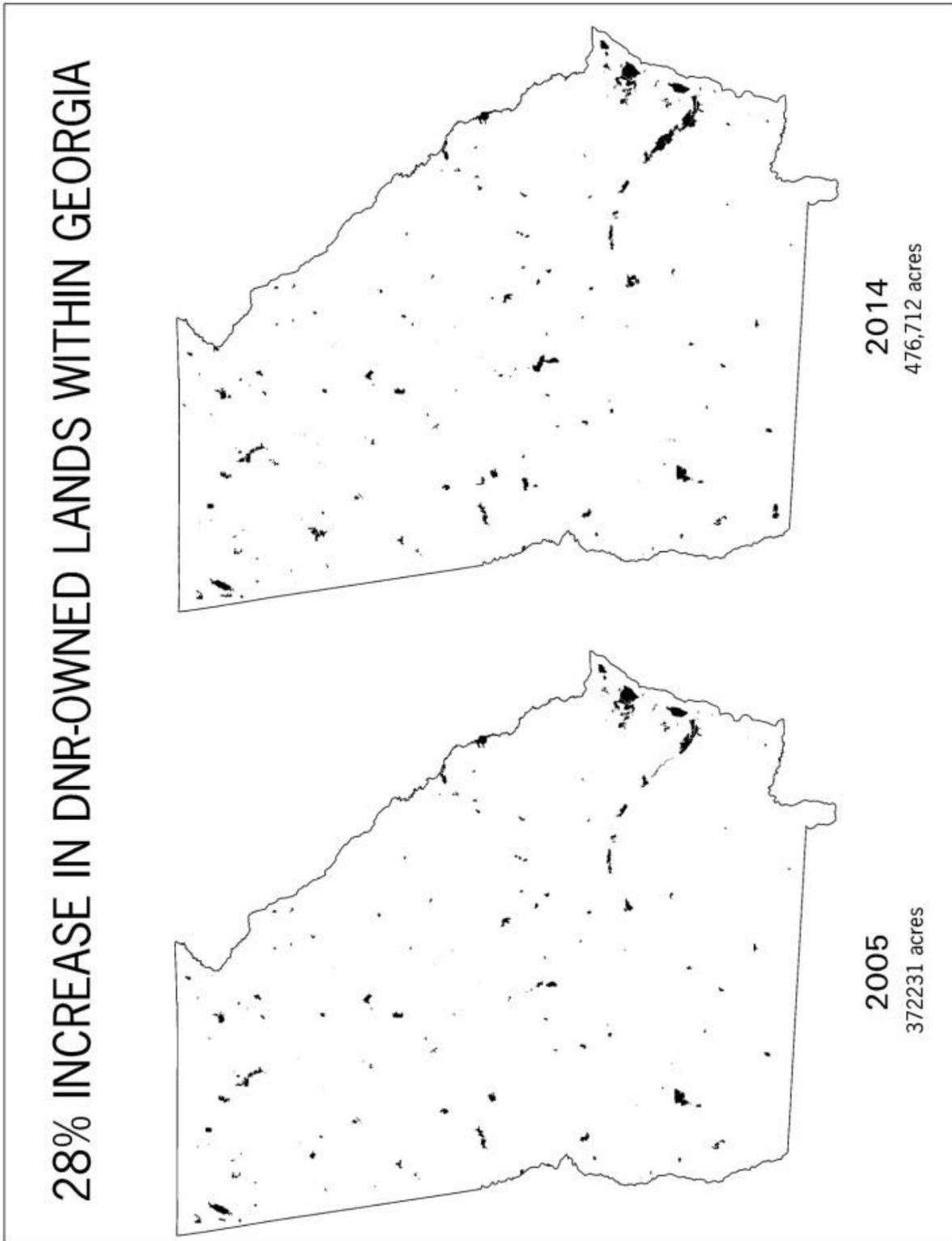
As evidenced by the above, it would be beneficial to have statewide coordination for conservation acquisition inventorying. It is also important to understand the impact of more

marginal conservation lands such as wetlands and areas zoned for non-urban uses (local land use zoning may be an important attribute for conservation lands, and currently, this is not accounted for in a statewide conservation lands database.) To that effect, spatial representations of both protected wetlands and zoning would also be helpful.

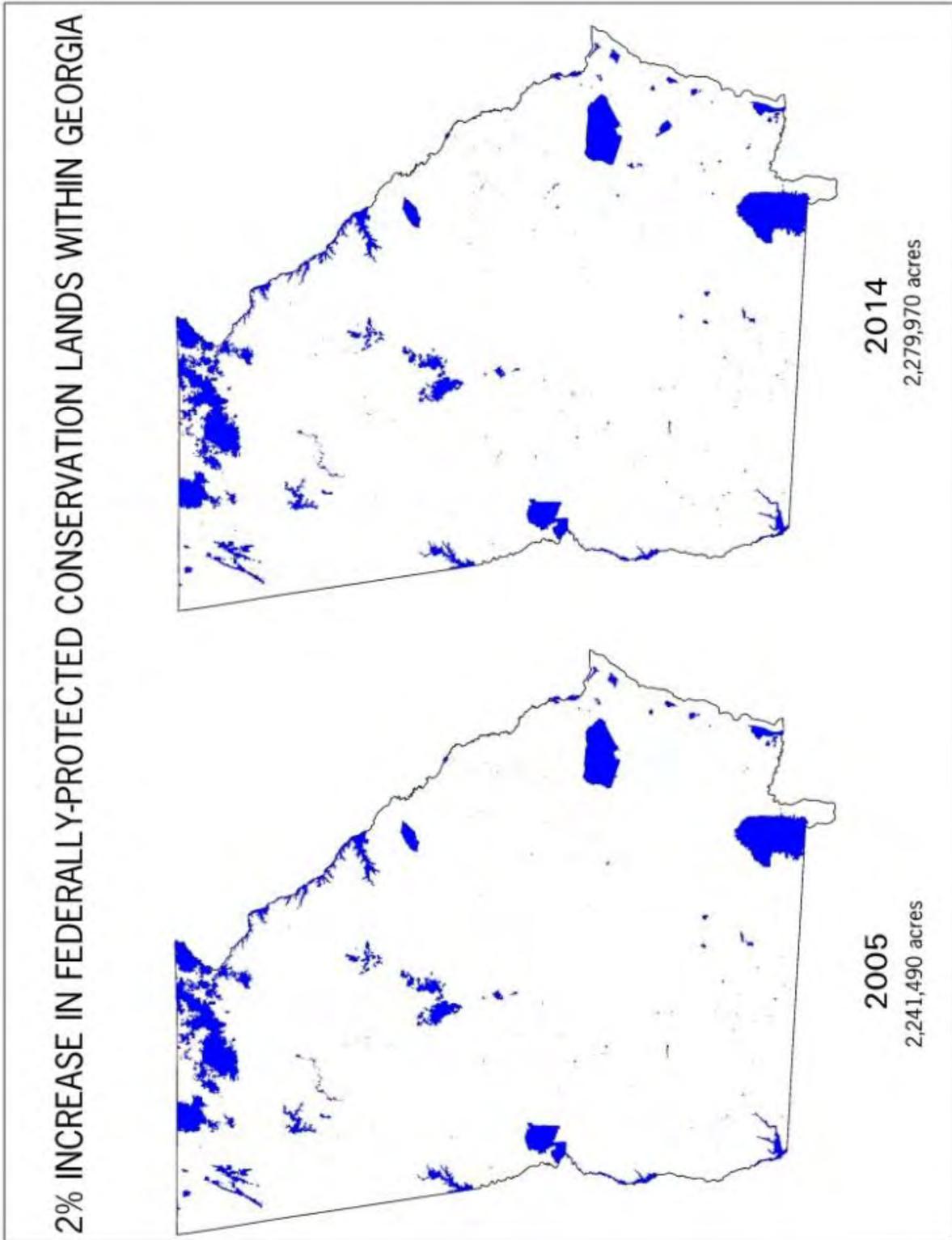
Progress of conservation acquisitions can be measured with several metrics. Below are maps showing accomplishments in Georgia land conservation over the past decade, encompassing 9 of the 10 years since the 2005 SWAP (all but the current year). Note that the Six Priority Areas shown in the following maps will be built upon, amended and ultimately supplanted by the overall results of the SWAP Habitat prioritization process.



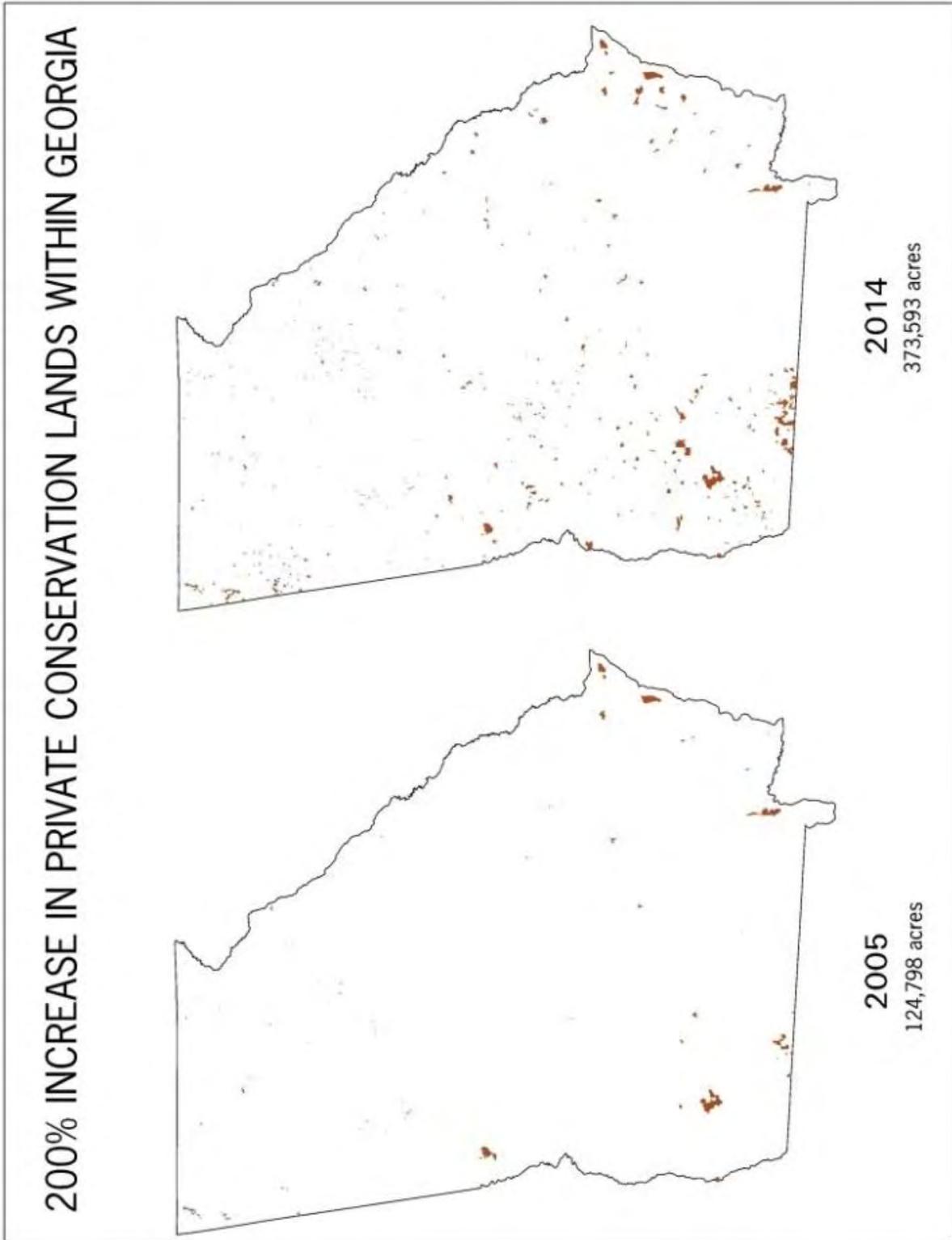
*2005 Priority areas were defined using the 2005 SWAP Opportunity Map as a guide. These do not include easements. Figures generated by Chris Canalos, NCS DNR.*



*Statewide acquisitions since 2005 SWAP. 6% of our acquisitions were in non-priority areas.*



*Federal land protected in Georgia over past decade.*



*Private land protected in Georgia over past decade.*

In the past 5 years alone, there have been 245,000 total acres (federal, state, land trust, local) protected. That totals 0.7% of the 37 million acres in Georgia.

As noted in the land cover section of this report, it is important to map which habitats are protected in the state, so that we can understand better where to focus our conservation efforts.

## 6. Species Habitat Modeling

To manage for individual high priority species, habitat requirements must be well understood. The function of the habitat modeling process is to translate those requirements into a spatial representation (a map) that accounts for current and potential habitat to identify areas for conservation targeting.

These models should be accurate and updatable and account for all Georgia species of concern. Our proposal in regards to this is three-fold:

First, we want to encourage a dynamic modeling process wherein researchers maintain models through time. As modeling assumptions shift, as land cover and climate changes, or as conservation lands are added, these changes should be incorporated into the model and new results produced. Although not always feasible, we intend to support this approach in a variety of ways to ensure that the habitat models stay current.

Secondly, these models should incorporate climate change and sea level rise projections where applicable. This would create a future habitat component to habitat models that will be beneficial for long term planning.

Thirdly, we are operating with limited budgets, and in order to produce more immediate, valuable results we have and will initially pursue species habitat models focused on “umbrella” or indicator species. These umbrella species have been chosen as representative of suites of species that associate with priority habitats, and are conducive to the modeling process (we have species occurrence data, we understand habitat requirements, and the species responds predictably to land cover data we have access too).

Our current umbrella list includes (\*models/maps we currently have or are in development by researchers):

- Mammals
  - Yellow Bat
  - Summer Range of the Indiana Bat
  - \*Black Bear (*SALCC*)
- Plants
  - Georgia aster
  - Relict trillium
  - Sandhills rosemary
  - Fringed campion

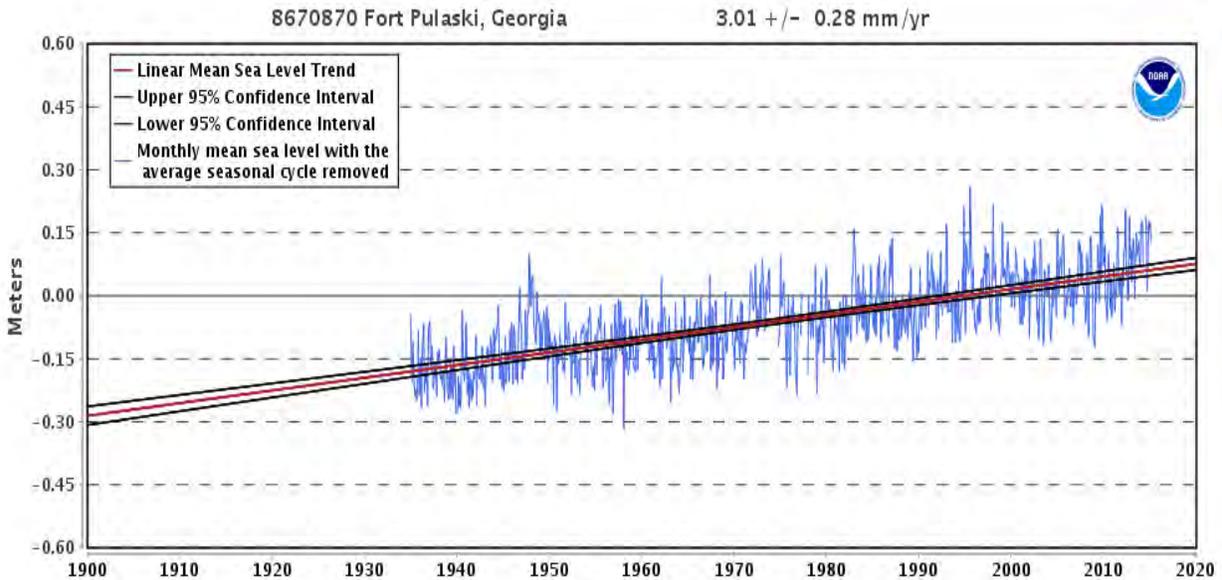
- Georgia plume
- Reptiles/Amphibians
  - Green Salamander
  - \*Bog Turtle
  - \*Gopher tortoise (*Clint Moore*)
  - \*Pine Snake (*Jeff Hepinstall-Cymerman*)
  - \*Indigo Snake
  - \*Striped Newt
  - \*Flatwoods Salamander
  - \*Southern hognose Snake (*Jeff Hepinstall-Cymerman*)
- Birds
  - \*Swallowtailed Kite (*Ken Myer*)
  - Henslow's Sparrow
  - Red Headed Woodpecker
  - \*American Kestrel
  - American Wood Stork
  - \*Birds of Pine Savannas/Woodlands (Northern Bobwhite, Red Cockaded Woodpecker, Bachman's Sparrow; *SALCC*)

As stated, over time we will add important species to the above list and begin to fill in species that may not be covered under any of these categories.

### **Sea Level Rise & Climate Change**

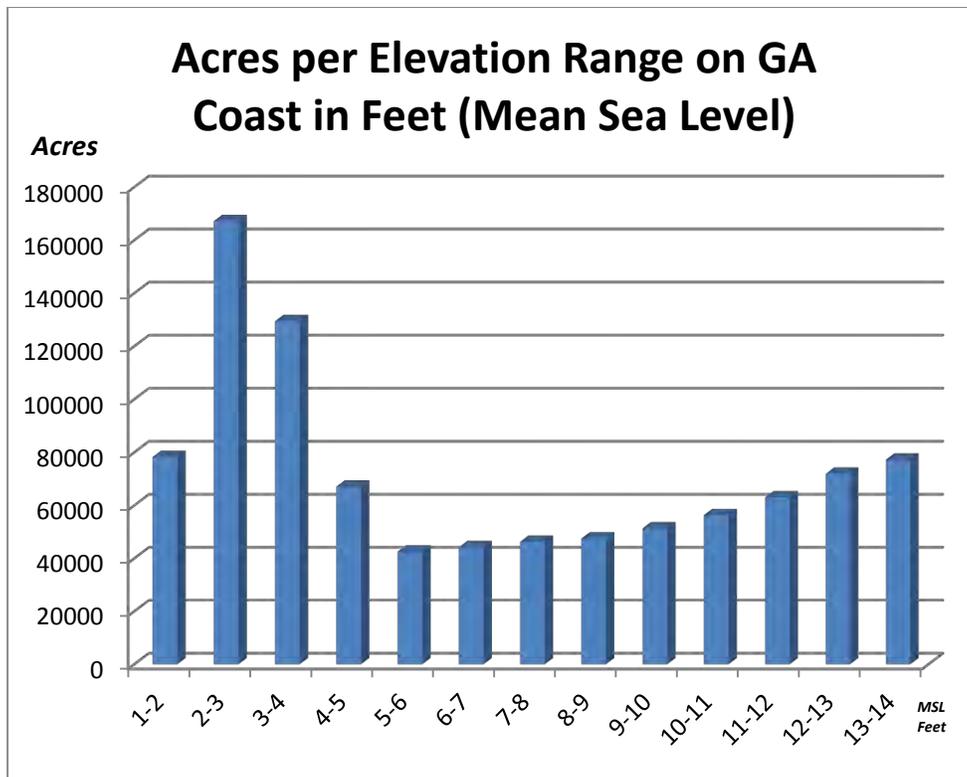
Climate change and sea level rise (SLR) are difficult to incorporate into the planning process. In addition to the uncertainty associated with understanding projections that reach far into the future, there is also considerable uncertainty inherent to the models themselves. However, it is important that the SWAP process begin to account for changes that may occur so that we are prepared.

## Recent Sea Level Rise on the Georgia Coast:



The past 80 years has seen 10 inches of recorded rise per the NOAA Fort Pulaski tidal gauge near Savannah. Most sea level rise models predict this to accelerate sharply over the next decade.

From a planning perspective, we have the Sea Level Rise Affecting Marshes Model (SLAMM) based on high accuracy, Lidar derived elevations. This dataset projects various scenarios of SLR over the coming 100 years, and should be utilized whenever considering coastal habitats response to SLR. Of note is that much of the coast of Georgia is well situated for the next 30 years due to the predominance of high elevations. However, the vast expanses of saltmarsh will begin fragmenting substantially over that period, and will be followed by marsh drowning on a large scale.



*Distributions of elevations on the Coast of Georgia, per Lidar.*

Other useful coastal datasets for understanding potential SLR impacts are Historical Shoreline Change (Chester Jackson, Georgia Southern), Hardened Shoreline dataset (Clark Alexander, SKIO) and the Coastal Habitat Map (GA DNR).

Based on our current understanding of projected trends, the four most significant habitat concerns for the Georgia coast are:

- Marsh drowning creating significant habitat degradation
- Volatile extreme tides through rising sea level (frequent flooding of marginal upland habitats and associated species)
- Long-term coastal habitat migration (ample conservation lands and time for habitats to shift upland to new optimal areas)
- New and expanding populations of invasive species

As mentioned previously, an optimal way to approach land conservation on the coast that accounts for sea level rise is to target diverse topographical areas on the near coast. This approach should also be biased towards land with substantial areas above 13 Foot Mean Sea Level, which is the initial zone of elevation in which we have the least protection. For areas below 13' MSL, there is adequate protection in various ways (considerable wetlands, floodplains and near coast areas that are somewhat undevelopable or are already in conservation). 13' MSL is the first missing link in the chain of habitat migration that is necessary for coastal habitats to respond to SLR.

One possible exception to the protection level of areas below 13' MSL is highlighted by the lack of mitigation options for areas that will become marsh in the future. Mitigation is an important conservation tool that is legally designed to account for current impacts to wetlands primarily by restoring other impacted wetlands. Unfortunately, in order to satisfy requirements that mitigation credits be scored between the time of impact and the time of restoration (i.e., lost years of wetland function), mitigating for current impacts with future marsh areas is not easy to quantify. When will that upland area become marsh, and what type of marsh will it become are central questions. Nevertheless, there are significant ecological gains to be realized if future marsh areas can be used in the mitigation process.

It is also important that climate predictions be incorporated into species models as future scenarios. The SWAP Climate Change committee will provide guidance for these purposes, including other areas of the State that may be affected.

### **Data Needs**

Identified data needs in addition to land cover:

- Lidar (statewide)
- Statewide tax parcel database
- Invasive species locations and projections
- Ecosystem services spatial layer

### **Summary**

In summary, Georgia DNR's plan for implementation of SWAP Habitat Modeling goals is to build a comprehensive, dynamic modeling process that will result in a weighted priority index to be utilized for land acquisition by DNR, federal, state, local and private partners for wildlife conservation. Final prioritization inputs will be:

- Priority Vegetation Communities
- Habitat Richness Vertebrates
- Landscape Suitability (Patch/parcel size & Natural land cover)
- Floodplains & Wetlands & Recharge areas
- SLEUTH (future development)
- SLR and climate change impacts
- Focal Species Habitat Suitability models
- Priority Watersheds
- Connectivity Corridor potential

Immediate action items to reach the goals are:

- Compile and crosswalk existing high resolution mapping for the State
- Initiate mapping Priority Areas and Communities
- Create and/or commission Landscape Suitability derivations

- Build Species Habitat Models for selected species
- Develop and implement a plan for expansion and improvement of the Conservation Lands database
- Compile existing datasets into priority index (map)
- Construct mapping web portal to show primary inputs and results

## Appendix O. Climate Change Adaptation Technical Team Report

Prepared by Mary Pfaffko and Jon Ambrose

### Technical Team Members

#### *Team Leaders*

Dr. Jon Ambrose, GADNR-Nongame Conservation Section  
Mary Pfaffko, GADNR-Nongame Conservation Section

#### *Team Members participating in the meeting*

Analie Barnett, The Nature Conservancy  
Fuller Callaway, Georgia Environmental Finance Authority  
Dr. Ronald Carroll, University of Georgia  
Dr. Jenny Cruse-Sanders, Atlanta Botanical Garden  
Megan Desrosiers, One Hundred Miles  
Matt Elliott, GADNR-Nongame Conservation Section  
Sarah Gottlieb, The Nature Conservancy  
Wade Harrison, The Nature Conservancy  
Dr. Jeffrey Hepinstall Cymerman, University of Georgia  
Elizabeth Herbert, Indiana University  
Elizabeth Hunter, University of Georgia  
Dr. Donald Imm, U.S. Fish and Wildlife Service  
Dr. Kay Kirkman, Joseph W. Jones Ecological Research Center  
Jennifer Kline, GADNR-Coastal Resources Division  
Jason Lee, GADNR-Nongame Conservation Section  
Eamonn Leonard, GADNR-Nongame Conservation Section  
Blake Lowery, Valdosta State University  
Alison McGee, The Nature Conservancy  
Dr. Nathan Nibbelink, University of Georgia  
Robert Ramsay, Georgia Conservancy  
Dr. Joshua Reece, Valdosta State University  
Will Ricks, GADNR-Game Management Section  
Todd Schneider, GADNR-Nongame Conservation Section  
Randy Tate, The Longleaf Alliance  
Jacob Thompson, GADNR-Nongame Conservation Section  
Dr. Seth Wenger, University of Georgia

#### *Invited but unable to participate in the meeting*

Clark Alexander, Georgia Southern University  
Andy Carroll, University of Tennessee at Chattanooga  
Chris Craft, Indiana University  
Kimberly Hayes, U.S. Fish and Wildlife Service  
John Hiers, U.S. Air Force  
Chester Jackson, Georgia Southern University  
Amy Keister, U.S. Fish and Wildlife Service

Christi Lambert, The Nature Conservancy  
 John Charles Maerz, University of Georgia  
 David Mixon, GADNR-Game Management Section  
 Robert Sutter, Enduring Conservation Outcomes

### **Approach**

As part of the 2015 revision of Georgia’s State Wildlife Action Plan (SWAP), the SWAP Climate Change Adaptation Technical Team was assembled to address the impact of climate change on fish, wildlife, and habitat, and identify research and conservation needs to address it. Understanding and adapting to the impacts of climate change is a process inherent with uncertainty and therefore requires a multi-jurisdictional, regional, partnership approach. The team was comprised of representatives from government agencies, nongovernmental organizations, and universities.

Team communications occurred electronically and through one in-person meeting in January 2015. The format of the two-day meeting was presentations followed by two hours of general discussion on both days. Presentation topics included:

- Overview of the SWAP and Climate Change Adaptation Technical Team goals
- Effects of climate change on migratory birds
- Coastal vertebrate susceptibility to sea level rise
- Role of safeguarding in rare plant conservation
- Integrating uncertain futures into conservation management
- Landscape resilience
- SIVVA: a tool for assessing the synergistic impacts of climate change, land-use change, sea-level rise, and other factors on species prioritization and conservation
- Freshwater fish responses to climate change
- Amphibian and reptile climate change vulnerability assessment
- Incorporating temperature/precipitation predictions into models

Discussion topics included:

- What do we know right now at the species and ecosystem levels to help us respond to climate change and sea level rise?
- What do we need to know?
- Where should research be focused to inform our responses?
- Where and how should we focus conservation efforts?

The impact of climate change reaches beyond state boundaries, exacerbates existing threats to wildlife, and affects each species differently. Consequently, climate change warranted being addressed in the 2015 revision of the Georgia SWAP as an emerging issue in Section V. Below is a list of research and conservation needs for climate change adaptation identified by the Climate Change Adaptation Team. This is not intended to be a stand-alone “Climate Change Action Plan,” but rather an acknowledgement of climate change as an important issue to be dealt with as part of the implementation of the SWAP, which includes continuing working with researchers, agencies, and organizations to elucidate potential impacts and implement climate smart conservation.

## Research and Conservation Needs

Below is a compilation of research and conservation needs for addressing the impacts of climate change on wildlife. Projected climate changes in Georgia by 2070 that are likely to impact wildlife include:

- Increased average day and night temperature with extreme maximum of 40-70 days above 95F (Melillo, Richmond, & Yohe, 2014)
- Greater rates of evaporation and evapotranspiration (Melillo, Richmond, & Yohe, 2014)
- Uncertain frequency changes in precipitation but with greater flood amplitude and deeper and longer droughts (Melillo, Richmond, & Yohe, 2014)
- Fewer but larger hurricanes and major storms (Melillo, Richmond, & Yohe, 2014)
- Sea level rise, especially important in low-relief coastal zones (Parris et al., 2012)

### Amphibian Responses to Climate Change

Identify priorities using models of amphibian response to climate change and structured decision making. Study the impacts of climate change on the flatwoods salamander and other species dependent on isolated wetland habitats. Use amphibian and reptile climate change vulnerability assessments to prioritize species, habitats, and sites. Identify protected areas that could provide management opportunities. This could be achieved by partnering with the University of Georgia and expert elicitation.

### Analyzing Moving Boundaries Using R (AMBUR)

Use the AMBUR package for analyzing and visualizing historical shoreline change. The baseline and transect method is the primary technique used to quantify distances and rates of shoreline movement, and to detect classification changes across time. A forecasting function also allows estimation of the future location of the shoreline.

### Coastal Incentive Grants

Apply for grants from the Coastal Resources Division for disaster resiliency and management to fund infrastructure and transportation on the coast.

### Conservation Blueprint

Use the South Atlantic Landscape Conservation Cooperative Conservation Blueprint, which is a spatially-explicit plan that describes the places and actions needed for the regional conservation community to respond to climate change and other changes.

### Freshwater Fish Response to Climate Change

Monitor water temperature to inform the understanding of freshwater fish response to climate change. Partner with Adopt a Stream, University of Georgia, Riverkeepers, and citizen science groups such as the Metro Atlanta Amphibian Monitoring Program. Develop a map of prioritized watersheds for temperature modeling. Start with Adopt-a-Stream areas, and then find gaps. Consult the Georgia River Network. Address this topic at the regional level to engage the Southeast Aquatic Resources Partnership (SARP), Landscape Conservation Cooperatives (LCCs), and Climate Science Centers (CSCs).

### Guide Land Protection

Identify conservation corridors informed by sea level rise projections. Use land acquisition mechanisms including fee simple acquisition or easements, as well as voluntary set-asides and local ordinances. Work with local county governments.

### Guide Policy

Inform wetland and salt marsh mitigation in the context of sea level rise. Provide policy guidance on how to protect future conditions. Partner with the NOAA Natural Resource Damage Assessment.

### Identify Species that May Lose Habitat to Increased Temperatures

Species particularly at risk from high temperatures include those restricted to high elevation micro-habitats (e.g., blue-winged warbler, rock outcrop plant relicts). High elevation cove and boulderfield forest species (e.g., long-tailed shrew, red squirrel, southern bog lemming, and water shrew) that have well-established populations in more northern states may require a triage decision and receive low-priority status.

### Migratory Species Response to Climate Change

For some species (e.g., painted bunting and ruby-throated hummingbird), Georgia may be their first significant landfall during spring migration. Georgia may contribute to rebuilding the monarch butterfly population, which is being considered for federal listing at the time of this writing. Conduct research and habitat management for transmission rights-of-ways (ROWs), which can provide a corridor of habitat that could accommodate major shifts in climate. Conduct pilot projects in partnership with University of Georgia (UGA) and Georgia Power Company to assess the feasibility of low-cost, low-maintenance Safe Passage management on ROWs. The two pilot projects include creating detention ponds and plantings in ROWs near UGA/Oconee River. Habitat would be managed and wildlife would be monitored by students. If the pilot projects are successful and effective, this action could be expanded to include other ROWs owned by the GA Power Company.

### Safeguard Rare Plant Species

The Safeguarding Database is a centralized, standardized, and updated repository for data pertaining to collaborative plant conservation projects. The database is a tool for tracking rare species in safeguarding and landscape management, and for communicating successes, methods, threats, and needs. Safeguarding sites are correlated to Element Occurrences (EO) so the database can be used to update the Biotics database, which is used by state natural heritage programs to track sensitive species and conservation actions. Reports (e.g., prescribed fire habitat management report) can be generated to facilitate communication across high-profile restoration and recovery projects. Safeguarding can help rare plants species cope with the effects of landscape change. The database provides details relevant to habitats that can serve as indicators for responses to climate change. The Georgia Plant Conservation Alliance (GPCA) keeps genetic material for rare plants should assisted migration become necessary. The database was developed by Atlanta Botanical Garden in conjunction with the Georgia Department of Natural Resources, the State Botanical Garden of Georgia, and the Chattahoochee-Oconee National Forest. The GPCA has coordinated safeguarding efforts since 1995, and restores and

introduces rare species into native habitat. Member organizations establish and maintain collections for rare plant species that represent invaluable genetic resources.

#### Sea Level Rise Affecting Marshes Model (SLAMM) and Species Niche Modeling

The coast of Georgia has SLAMM models based on high accuracy, LiDAR-derived elevations. This dataset projects various scenarios of sea level rise over the next 100 years. Use SLAMM when considering coastal habitat response to sea level rise. While much of the coast of Georgia is well situated for the next 30 years due to the predominance of high elevations, the vast expanses of saltmarsh will begin fragmenting substantially over that period, and will be followed by marsh drowning on a large scale. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

#### Southeast Resilient Landscapes Model

The Southeast Resilient Landscapes Model, developed by the Nature Conservancy (TNC), identifies key places for conservation in the face of climate change and other factors. The model is based on conserving complex landscapes that increase diversity and resilience. An estimated resilience score is assigned based on scores of landscape diversity and local connectedness, and ranked relative to the geophysical setting and ecoregion. Landscape diversity refers to the number of landforms, the elevation range, and the wetland density. Topographic diversity buffers against the impacts of climate change by providing a variety of microclimates. Local connectedness refers to the number of barriers and the degree of fragmentation within a landscape. A highly permeable landscape promotes resilience by facilitating range shifts and the reorganization of communities.

Using Doris Duke Charitable Foundation funds, TNC plans to implement Resilience 2015: Southeast Resilient Landscapes Model with the purpose of identifying a network of resilient sites and linkages for the eastern U.S., and communicating the results to agencies and partners. The model provides regional context for conservation actions. Some of the data from this model has been incorporated into the GADNR draft “Greenways” map.

The current and revised products of the project may continue to inform climate change adaptation going forward. Connect TNC’s models with niche models. Work with TNC and others to evaluate the model outputs and recommend improvements. Integrate uncertain futures into conservation management.

TNC invited the Georgia Department of Natural Resources (GADNR) to join the Steering Committee to identify resilient coastal areas impacted by Hurricane Sandy. Information from the project has been incorporated into the South Atlantic Landscape Conservation Cooperative’s datasets. Information has also been incorporated into a land conservation funding project coordinated by the Open Space Institute and supported by the Doris Duke Charitable Foundation. The initiative is designed to help land trusts and public agencies focus their conservation efforts on climate priorities. The initiative includes priority areas within Georgia.

#### Standardized Index of Vulnerability and Value (SIVVA)

The Standardized Index of Vulnerability and Value (SIVVA) is a tool for assessing the synergistic impacts of climate change, land-use change, sea-level rise, and other factors on

species prioritization and conservation. It is a standardized system for assessing extinction risk, vulnerabilities to threats, and values. Potential partners include Valdosta State University (VSU) to modify SIVVA for application to ecosystems of Georgia. This would be modeled after the approach used by VSU, Florida Natural Areas Inventory, University of Central Florida, and the University of Florida to assess the conservation value and vulnerability of 300 species to interacting threats for the Florida SWAP (Reece et al. 2013).

#### Statewide Landcover Map

Develop a statewide landcover map. Fine-scale mapping facilitates habitat prioritization and conservation planning, as was demonstrated with the mapping of habitats of 11 coastal counties in the Southern Coastal Plain of Georgia. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

#### [Statewide Light Detection and Ranging \(LiDAR\) Coverage](#)

Obtain statewide LiDAR coverage to inform habitat mapping. LiDAR is a remote sensing method that generates precise, three-dimensional information about the shape of the Earth and its surface characteristics. LiDAR produces high resolution digital elevation data that supports landcover mapping needs through refining the vegetation mapping process. (See the Ecosystems/Habitat Mapping Technical Team Report for more details).

#### Statewide Map of Priority Habitats and Landscape Features

Develop a habitat data layer to provide a detailed picture of the status of habitats across the state and inform conservation actions at multiple scales. Update these data periodically to detect change. Full coverage of the Coastal Plain of Georgia is a priority for habitat mapping. The current map of 11 counties took three years to complete so the approach needs to be modified in order to achieve mapping goals over a reasonable timeframe. The current map has been used widely by local governments, conservation organizations, and private landowners. Over the longer term, the map would enable strategic conservation, and partners would apply for grants from public or private sources to assist with mapping. Create an ecosystems services spatial layer.

#### Trophic Asynchrony Models

Incorporate temperature and precipitation predictions into trophic asynchrony models. Incorporate phenology into existing monitoring efforts. Standardize phenology monitoring with partners over time. Identify a network of sampling sites to monitor phenology. Inform Atlanta Botanical Garden's monitoring program on what to monitor to capture climate change data in terms of phenology.

#### Urban Wildlife Conservation

Improve forage quality, minimize mortality due to predation and disease, and link stopover sites in cities to broader greenspace campaigns (e.g., Gwinnett County park easements, Atlanta Beltline) to provide food resources for migrants and reduce storm water runoff, and educate the public about keeping bird feeders clean. Build partnerships for urban wildlife conservation. Build on the existing urban conservation programs of the Nature Conservancy and the Georgia Forestry Commission. Build on existing Georgia Power Company programs such as 1) the Species Management Areas program which helps protect endangered birds, and 2) Power of

Flight. Partner with Atlanta Botanical Garden to work with Atlanta schools on urban pollinator gardens. Incorporate urban areas into the Georgia SWAP. Include urban areas when modelling potential habitat. Urban areas may be on migration corridors, and are home to voters and potential citizen scientists and rain gardens. Revitalize the Georgia Department of Natural Resources backyard habitat program or collaborate with other organizations that can help in this effort, such as the Georgia Wildlife Federation and garden clubs. Implement public education programs. Provide easy access to a list of recommended nurseries for native plants. Understand habitat connectivity; model the aggregate impact of smaller greenspaces that could enhance the impact of larger greenspaces. Address fish passage in urban areas. Encourage use of the SWAP to guide grants to do urban conservation work. Work with local governments to establish recreational corridors that also provide wildlife habitat. Include urban areas in a statewide landscape resiliency to engage city dwellers. Use the SLEUTH Projected Urban Growth mapping to present data that represent the extent of urbanization predicted by the model.

#### Vulnerability Assessments and Potential Societal Impacts

Evaluate existing vulnerability assessment tools to determine potential priorities for wildlife conservation as well as potential societal impacts. Measures of climate change vulnerability can include exposure to environmental events (e.g., droughts, floods), sensitivity to factors affecting society, and capacity to adapt to changing physical conditions. Binita, Shepherd, and Gaither (2015) performed a county-based vulnerability assessment for the state of Georgia. Climatic, social, land cover, and hydrological components were combined to capture long-term and hydroclimatic events. An overall trend toward drying and warming was observed. Climate vulnerability was found to be highest in some metropolitan Atlanta and coastal counties, as well as part of the rural Black Belt region in southwestern Georgia.

#### Wildlife Conservation on Private Lands

Work with private landowners to make better use of funds from Farm Bill conservation programs (e.g., Working Lands for Wildlife for Gopher Tortoise).

## Appendix P. High Priority Conservation Actions

The SWAP technical teams and other stakeholders initially identified over 200 high priority conservation actions. These were sorted into the following twelve categories, which represent generally stated conservation goals or themes:

- Assess status of high priority habitats
- Assess status of high priority species
- Conserve high priority habitats
- Conserve high priority species
- Improve environmental education
- Improve private land management
- Improve public land management
- Improve SWAP communications
- Increase capacity for wildlife conservation
- Reduce impacts from development and other activities
- Implement climate change adaptation
- Engage in regional partnerships

The identified conservation actions included research and survey, habitat/species management, education, outreach, regulation, database, administrative, and funding efforts. For each conservation action, focal species/habitats, ecoregions, watersheds, funding sources, lead organizations, and partner organizations were identified. In addition, a brief description and comments/justification were outlined for each project. Finally, relevant data to be collected and performance indicators were identified for each project as a first step toward developing monitoring programs to facilitate adaptive management.

Each conservation action on the list was evaluated and assigned an importance score using the following seven criteria:

- 1) Providing Multiple Benefits for High Priority Species/Habitats  
The conservation action provides direct, measurable benefits for several high priority species and/or globally rare natural communities.  
(Rating =1 to 3; Weight: = 2)
- 2) Addressing Un(der)funded Needs:  
The conservation action represents a significant improvement or advance in wildlife conservation in that it provides support for a conservation effort that is not addressed by other funding sources, programs, or organizations.  
(Rating =1 to 3; Weight = 1)

- 3) Overall Importance of Georgia Efforts  
The conservation action addresses wildlife conservation needs that are unique to Georgia (e.g., endemic species) or for which Georgia serves a key role geographically or strategically.  
(Rating =1 to 3; Weight = 3)
- 4) Timeliness or Urgency  
The conservation action addresses a problem that is particularly urgent. If this specific action is not implemented or continued in the next ten years, Georgia will experience a significant loss of biological diversity or habitat quality.  
(Rating =1 to 3; Weight = 3)
- 5) Connections with Other Conservation Actions  
The conservation action serves as a critical component that enables or facilitates one to several other important conservation measures. Without this component, other efforts will be crippled or made ineffectual.  
(Rating =1 to 3; Weight = 2)
- 6) Building Public Support for Wildlife Conservation  
The conservation action is likely to increase overall public support for wildlife conservation. The benefits of the action will be readily apparent to the public, or the project itself will focus on increasing public support for conservation.  
(Rating =1 to 3; Weight = 2)
- 7) Probability of Success  
The conservation action is likely to succeed because it employs tested methodologies, has strong support from stakeholders, and has clearly identified and readily achievable objectives.  
(Rating =1 to 3; Weight = 2)

[NOTE: Rating reflects relative contribution or significance of a conservation action for a particular factor (1 = Low; 2 = Medium; 3 = High). Weight is a multiplier of the rating and indicates relative contribution of that criterion to the total score. Maximum total score = 45 points.]

The technical teams assessed the contribution of each conservation action for each of these criteria and assigned scores based on those assessments. The resulting point totals were used to sort the conservation actions into three categories: very high priority (41-45 points), high priority (36-40 points), and medium priority (27-35 points). Conservation actions scoring less than 27 points were deleted from the list.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
<b>1</b>	Assess Status of High Priority Habitats	Implement statewide habitat mapping effort and conduct assessments of rare natural communities and habitats that support species of conservation need.	Survey	Proposed	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants other federal sources, private foundations	DNR, contractors	NatureServe, TNC, public and private landowners
<b>2</b>	Assess Status of High Priority Species	Conduct surveys for rare plants known historically from Georgia	Survey	Proposed	Numerous	All	All	Nongame Wildlife Fund, USFWS	DNR	Contractors and taxonomic specialists
<b>3</b>	Assess Status of High Priority Species	Conduct surveys for undersampled high priority mammals (e.g. spotted skunk, humpback whale) and assess conservation needs.	Survey	Proposed	Spotted skunk - essentially statewide in a variety of habitats; Humpback whale - marine habitats	All	All	State Wildlife Grants, USFS, UGA, NMFS	DNR	USFS, UGA, NMFS, Provincetown Center for Coastal Studies

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
1	Implement a statewide habitat mapping initiative to inform conservation efforts at multiple scales. Assess the status and distribution of natural communities using revised natural community classification system. Survey known existing, historic, and probable locations of rare natural communities, assessing conservation status and conducting botanical and zoological surveys	VH	Although there are coarse landcover analyses for Georgia, none have thoroughly assessed fine-scale natural community types at a state level. Few of the rarest natural communities in Georgia have been adequately described using the ecological framework developed by NatureServe. In particular, very little is known about the current distribution and abundance of rare wetland habitats in NW Georgia. These wetland communities are currently under increased threat due to residential and commercial development. Systematic surveys and assessments of these and other high priority habitats are needed to better determine the distribution and condition as well as protection and management priorities. A statewide habitat data layer is needed to inform local, state and regional land conservation efforts.	GIS coverages and descriptions of natural communities, assessments of abundance and condition, addition of natural community records into Biotics.	Statewide GIS coverage and descriptions of natural communities; assessments of threats and status, addition of community records into Biotics, recommendations for protection and management of high priority natural communities
2	Conduct field surveys for rare plants known to occur in Georgia but not observed in recent years.	H	Many of these species have not been observed in the state for more than 25 years and are in need of current status surveys to determine whether they have indeed been extirpated.	Distribution, habitat, and abundance data; documentation of sites visited and species observed; reports of status and condition of observed rare plant species populations and associated habitats; management recommendations	Number of updated records on the distribution and condition of globally rare plants in Georgia. Specific recommendations for protection and management of these populations.
3	Spotted skunk -- document occurrence using camera traps (citizen science effort). Humpback whales - document spatial and temporal extent of occurrence in Georgia waters	M	Spotted skunk -- there are growing recent concerns about this species throughout its range; very few records from Georgia, rarely encountered. Humpback whale - small numbers of humpback whales are observed in Georgia waters annually; need to assess whether numbers are increasing and if there are potential impacts that need to be managed; most of this work can be done opportunistically during existing right whale surveys	Spotted skunk -- occurrence locations, habitat and landscape data. Humpback whales - photo-identification data, genetics and effort-corrected aerial sighting data.	Spotted skunk -- occurrence records and survey effort coverage. Humpback whales - identification of whales utilizing Georgia waters seasonally, threats, identification of stock these whales belong to through photo-ID and genetics by cooperating with NMFS and Provincetown Center for Coastal Studies.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
4	Assess Status of High Priority Species	Assess Middle Georgia black bear population and habitat conservation needs; develop conservation plan for Ocmulgee River corridor	Survey, Conservation planning	Ongoing	<i>Ursus americanus</i> / Ocmulgee River floodplain	SP	Ocmulgee	DNR	DNR	UGA, NPCA, USFS, USFWS, Georgia Wildlife Federation, Georgia Land Conservation Center, local governments, land trusts
5	Assess Status of High Priority Species	Assess populations of high priority terrestrial birds in the Coastal Plain (e.g. swallow-tailed kite, southeastern American kestrel, painted bunting, Henslow's sparrow).	Survey	Ongoing	<i>Elanoides forficatus</i> , bottomland hardwood forests <i>Falco sparverius paulus</i> ; <i>Passerina ciris/scrub-shrub</i> , maritime forest, interdune scrub; <i>Ammodramus henslowii</i> , <i>Aimophila aestivalis</i> , other grassland birds; various early successional habitats	SP, SCP	Numerous	Nongame Wildlife Fund, USFWS, State Wildlife Grants, Altamaha River Cooperative for Stewardship & Research (ARCSR), USGS, UGA	DNR, USGS	Avian Research & Conserv. Institute; ARCSR; UGA; University of Georgia, Georgia Southern University, Georgia Power; University of Georgia, USFWS, Georgia Southern University, USGS-Patuxent, private barrier islands, SC DNR, NC Museum, NCWildComm, FL WCC
6	Assess Status of High Priority Species	Assess status of high priority bryophytes, lichens, and graminoids in Georgia.	Survey	Proposed	Numerous (all high priority bryophytes and graminoids)	All	All	Nongame Wildlife Fund, USFWS	DNR	University System of Georgia, contractors, taxonomic specialists

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
4	Periodically assess black bear population size and habitat utilization. Utilize model of habitat suitability and use to develop a conservation plan for this and associated species in the Ocmulgee River corridor.	H	This small, isolated black bear population is being pressured by surrounding development, resulting in loss of habitat. Opportunities to protect habitat for this species should be assessed in the context of providing protection to a broader complex of habitats in this portion of the Ocmulgee River corridor.	Numbers of bears, locations of home ranges and utilized habitats. Locations of other high priority species and habitats that could benefit from conservation efforts in this area.	Bear numbers, acreage used; estimates of amount of habitat needed to maintain population. Conservation objectives for Ocmulgee River corridor.
5	Use aerial/ground surveys and sightings to determine distribution and abundance of STKIs in GA., and identify critical nesting, roosting, and foraging areas. Monitor nests and radio-tag birds to evaluate nesting success, habitat use, site fidelity, threats, etc. Assess population of southeastern American kestrels nesting along powerline corridors and evaluate replacement nest structure. Conduct a status assessment of the Atlantic Coastal population of the painted bunting exploring factors affecting its survival and how to best manage habitat for it on public lands. Assess importance of Georgia as a wintering area for Henslow's Sparrow. Evaluate factors critical to sustaining populations of Bachman's Sparrow during the breeding season and winter.	H	Swallow-tailed kite surveys were initiated in 1997, and the data collected are instrumental in working toward the conservation and management of Georgia's STKI population, and the long-term protection of this imperiled species. The southeastern American Kestrel is a species of high conservation concern, having lost much of its original nest habitat. This project explores various population parameters and use of various artificial nest cavities in a population nesting in power poles along a powerline in south Georgia. The Coastal Plain of Georgia may be a critical wintering area for Henslow's Sparrow and represents the center of the Bachman's Sparrow range. Evidence suggests that the Atlantic Coast population of Painted Bunting is very likely a separate species or subspecies from the interior breeding population. Both populations have undergone tremendous declines over the last few decades, particularly the Atlantic Coast population. This population likely numbers in the low 100,000s making it highly vulnerable to extirpation.	Swallow-tailed kites - sightings, nests and site fidelity, estimates of productivity, nesting and foraging habitats, movement patterns, diet. Kestrel - nesting success and fecundity, preferences in nesting structures. Painted bunting - abundance, levels of predation, parasitism; habitat parameters; Henslow's Sparrow - presence, abundance, habitat preferences; Bachman's Sparrow - relative abundance, density, population size, and habitat quality.	Swallow-tailed kites - distribution, abundance, productivity, and survival, identification of nesting and foraging habitats, land-use or habitat associations. Southeastern American kestrel - number of nest sites surveyed, nesting success with replacement structures. Painted bunting - estimated number of breeding pairs or population size, population trends, effects of habitat management efforts. Henslow's Sparrow - Number of sites surveyed and relative abundance/density. Bachman's Sparrow - breeding population size estimate, micro-habitat feature determination.
6	Survey known existing and historic sites, as well as likely habitat for high priority mosses, liverworts, lichens, and graminoids. Conduct field surveys for recognized rare species and herbarium work to determine historic locations. Consult with taxonomic experts and knowledgeable field botanists on range, habitat needs, and conservation status of these species.	H	Little is known about the current distribution and abundance of mosses, liverworts, lichens, and graminoids in the state. Based on the SWAP evaluation of rare plants, it is clear that there are numerous globally rare species in need of current status surveys.	Distribution, habitat, and abundance data. Documentation of sites visited and species observed; reports of status and condition of observed rare plant species populations and associated habitats; management recommendations	Updated data on the distribution and condition of globally rare plants in Georgia. More specific recommendations for protection and management of these populations.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
7	Assess Status of High Priority Species	Conduct aerial surveys for federally listed birds (bald eagle nesting surveys; wood stork nesting and roosting surveys).	Survey	Ongoing	<i>Haliaeetus leucocephalus</i> , <i>Mycteria americana</i>	All	All	Nongame Wildlife Fund, ESA Section 6	DNR	USFWS, University of Georgia, Others
8	Assess Status of High Priority Species	Conduct Armuchee Creek aquatic species surveys	Survey, Monitoring	Proposed	Numerous	SA-RV	Oostanaula	State Wildlife Grants, other Federal Funds	DNR or USFWS	TNC
9	Assess Status of High Priority Species	Conduct assessments of federal petitioned and candidate species, as well as undersampled high priority species not currently under federal review. Work with other state agencies in the region to implement the Southeast At-Risk Species Plan	Survey, Database	Ongoing	Numerous	All	All	Section 6, State Wildlife Grants, other federal grants, Nongame Wildlife Fund.	DNR, USFWS, other Southeastern states	UGA, Joseph Jones Ecological Research Center, private contractors
10	Assess Status of High Priority Species	Conduct disease testing of vulnerable amphibians and reptiles	Research, Survey	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Section 6	DNR	SCWDS, University of Tennessee
11	Assess Status of High Priority Species	Conduct Gulf Slope mussel surveys	Survey, Monitoring	Proposed	Suwannee Moccasinshell, Ochlockonee Moccasinshell, Suwannee Pigtoe, Oval Pigtoe, and Shinyrayed Pocketbook.	SP	Numerous	State Wildlife Grants	DNR, USFWS	

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
7	Conduct statewide monitoring of nesting bald eagles, relying primarily on helicopters surveys. Conduct aerial surveys for wood storks each spring to identify and monitor nesting colonies; develop techniques for aerial estimates of colony productivity using low altitude digital photography. Work with landowners to manage nest sites.	H	These survey projects are needed for monitoring recovery efforts for federally listed species nesting in Georgia. The bald eagle survey efforts have been deemphasized in recent years, but wood stork survey efforts continue to be an important component of WRD's recovery efforts.	Bald eagles - nest occupancy, specific nest site locations, fledglings per nest. Wood storks - number of nests, nest and chick survival to fledging, productivity estimates, number of colonies.	Number of active colonies (wood storks); number of nests constructed; number of birds hatched and fledged per year. Productivity estimates for wood storks developed regionally to give U.S. Wood Stork productivity for Recovery Plan goals.
8	Survey for fishes, mussels and crayfish in the Armuchee Creek system. The goal would be to document full diversity and establish a baseline for long-term monitoring	M	Armuchee Creek is a high quality tributary in the Coosa drainage, with the potential to support several high priority aquatic species. It has only been surveyed at a few sites. The system is threatened by nutrient pollution, development, and the development of springs for water supply.	Species presence at survey sites	Number of high priority species persisting in the watershed; number of new high priority species discovered during survey.
9	Georgia is home to over 100 species that are under federal review by USFWS as candidate species or species that have been formally petitioned for listing. We will be assisting the Service by conducting status surveys, providing status reports, and providing input into range-wide conservation plans for these at-risk species.	VH	The current status of many of these species is unknown or poorly known. To properly inform any listing decisions, status surveys on these species are necessary.	Various, including population estimates, catch per unit effort, relative abundance, threats to viability.	Information on distribution, overall abundance, and viability of populations in state; number of species listings precluded and conservation plans implemented.
10	Potentially or known-to-be vulnerable high priority amphibians and reptiles will be sampled for emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.	H	Newly emerging diseases are a growing conservation concern for many of our priority species, some of which are known to be highly susceptible while others have been unchallenged thus far but are potentially vulnerable. Diseases and disease-causing pathogens include Snake Fungal Disease (potentially harmful to all snake species), Upper Respiratory Tract Disease (affects gopher tortoises and box turtles), ranavirus (affects many amphibians and some turtles; gopher frogs are highly vulnerable based on laboratory trials), and amphibian chytrid fungi (Batrachochytrium dendrobatidis and B. salamandrivorans).	Positive and negative detections, health status	Number of positive detections per species sampled, population effects
11	Survey mussels in poorly sampled stream reaches in the Ochlockonee, Withlacoochee and Suwannee basins. Species of interest include Suwannee Moccasinshell, Ochlockonee Moccasinshell, Suwannee Pigtoe, Oval Pigtoe, and Shinyrayed Pocketbook.	H	There are many streams in Gulf Slope drainages of Georgia with the potential to harbor unknown populations of high priority mollusks. Documenting new or updated occurrences of these species is needed for status assessment and to plan conservation efforts. This area has been much less surveyed than the	Species presence, species relative abundance, habitat quality	Number of species with completed surveys and status assessments

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
12	Assess Status of High Priority Species	Conduct midwinter waterbird survey and piping plover winter survey; conduct research and surveys on southeastern red knot and whimbrels; investigate American oystercatcher ecology and demographics	Survey	Ongoing	33 species of outer barrier beach affiliated wintering waterbirds, emphasis on <i>Charadrius melodus</i> , <i>Calidris canutus</i> , <i>Limosa fedoa</i> , and <i>Haematopus palliatus</i>	SCP	Atlantic Coastal Plain	Nongame Wildlife Fund	DNR, Audubon, NC State University	USFWS, ACOE, St. Catherines Island Foundation, Sapelo Estuarine Research Reserve, Ogeechee Audubon, Coastal Audubon, TNC, Sea Island Company, Cumberland Island Homeowners Association., NPS
13	Assess Status of High Priority Species	Conduct surveys for Black Rails in high marsh areas of saltmarsh and possibly other shallowly flooded freshwater habitats	Survey	Ongoing, Proposed	Black Rail	SP, SCP, PD	All SP, SCP, and PD drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	Black Rail working group, Little St. Simons Island, U.S. Fish and Wildlife Service, Center for Conservation Biology
14	Assess Status of High Priority Species	Conduct surveys for high priority bats	Research, Survey	Ongoing	<i>Corynorhinus rafinesquii</i> , All <i>Myotis</i> spp., <i>Lasiurus intermedius</i> , <i>Perimyotis subflavus</i>	All	All	State Wildlife Grants, GDOT, UGA	DNR	USFS, USFWS, GDOT, UGA, GA Museum of Natural History, Eco-Tech, Ecological Solutions

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
12	Complete winter beach survey conducted in late January, over a period 1.5 hrs. before and after high tide. Also, continue red knot surveys by researchers from Manomet, USFWS, volunteers and DNR, as well as surveys of whimbrels conducted by DNR staff. For American oystercatcher - promote, support, coordinate local and regional studies examining migration patterns, life history parameters, recruitment, longevity, age and sex ratios and identify important range-wide population centers.	VH	Annual midwinter survey incorporates International Winter Piping Plover Survey conducted by the USFWS every 5 years. Georgia is the only state to conduct this type of survey targeting shorebirds. The Altamaha River Delta is the only major fall staging area for Red Knots on the Atlantic coast. Although the Eastern Arctic population of red knots has declined by more than 50% in the last ten years, the entire SE population (12,000) stages on the Altamaha prior to dispersal to other SE states. This group is showing insular qualities and appears to be more stable. Continued studies are needed to determine the ecological and biological parameters that support this unique group of knots. American oystercatcher is a high profile estuarine inhabitant and beach nester. Management protocols for this species will have implications for large assemblage of beach nesting obligate species.	Distribution of wintering shorebirds and seabirds; location data for shorebird roosts. Red knot - numbers, habitat use, age ratios, band resight data, sex ratios, body weights, physical condition, temporal use and turnover, contaminant exposure, forage species, feeding rates. Whimbrel - flock counts at Gould's Inlet. American oystercatcher - life history, population demographics, disturbance and depredation, migration, wintering, nesting ranges, health parameters.	Reports from each island are generated with regional priority species highlighted. Peer review of manuscripts and publication expected. Data made available to the public through the GOS website and used toward species trend assessment in Program for Regional and International Shorebird Monitoring Program (PRISM)
13	Continuation and possible expansion of survey work started recently under Imperiled Species funding from USFWS. This would include vocalization playback surveys in appropriate high marsh habitats and possible expansion of these surveys to shallowly flooded freshwater habitats inland in the Coastal Plain and Piedmont.	VH	This species has been decline for over a century. More recent surveys in the mid-Atlantic indicate that it may have declined by as much as 75-90% over the last two decades. This bird is considered one of the highest priority bird species in need of conservation action in the U.S. Sea level rise and other factors are the most significant threats.	Presence and abundance data over several years.	Number of sites where Black Rails are present as well as number of individual birds present.
14	Survey within suitable habitat for presence of species of concern, track individuals to roost sites, formulate conservation strategy	H	More information is needed to better determine the range and abundance of these high priority species. Better distribution information will allow for more targeted sampling and a focus for potential mitigation efforts in high priority bat habitats.	New locations of occurrence, identification of important foraging and roosting sites, threats, movements, document declines from WNS	Number of new occurrence records, number of roost sites, number of threats addressed

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
15	Assess Status of High Priority Species	Conduct surveys for Yellow Rail in pine flatwoods and similar sites as well as other shallowly flooded habitats	Survey	Proposed	Yellow Rail	SP, SCP	All SP and SCP drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	
16	Assess Status of High Priority Species	Conduct Upper Coosa mollusk surveys	Survey, Monitoring	Proposed	Numerous	RV, BR	Numerous	State Wildlife Grants	DNR, USFWS	TNC, Kennesaw State University
17	Assess Status of High Priority Species	Conduct Upper Nottely River aquatic species surveys	Survey, Monitoring	Ongoing	Sicklefin Redhorse	BR	Hiwassee	State Wildlife Grants	DNR	Young Harris College, USFWS-Asheville
18	Assess Status of High Priority Species	Continue calling frog survey routes as part of the North American Amphibian Monitoring Program	Survey, Monitoring	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants	USGS-Patuxent, DNR	USGS-Patuxent, DNR, volunteers
19	Assess Status of High Priority Species	Continue Conasauga River fishes monitoring	Survey, Monitoring	Ongoing	Numerous	RV, BR	Conasauga	USFWS, Nongame Wildlife Fund	DNR	GMNH
20	Assess Status of High Priority Species	Continue Etowah River aquatic species and water quality monitoring	Survey and Monitoring	Ongoing	Numerous	PD, BR	Etowah	Section 6	DNR, USFWS	GMNH

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
15	This would be a preliminary effort to assess where Yellow rails occur in the state and in what numbers. Most effort would be concentrated in shallowly flooded to mesic pine flatwoods and similar habitats at night. Researchers in Alabama and Mississippi have developed a technique similar to the one we use for Henslow's Sparrow surveys (flush netting) that is effective at night for Yellow Rails. They have captured many birds in areas similar to those where we catch Henslow's Sparrows during the daytime.	H	This would be the first attempt in the state to quantify Georgia's importance to wintering habitat of this rare and declining species. At several sites survey logistics could be piggy-backed on those for Henslow's Sparrows, basically running Henslow's surveys at a site during the day and then a Yellow Rail survey at the same site at night.	Presence and abundance data over several years.	Number of sites where Yellow Rails are present as well as number of individual birds present.
16	Implement occupancy sampling for freshwater mussels and snails in the under sampled reaches of the upper Coosa, including Coosawattee, Oostanaula, and Chattooga rivers. We will use our Conservation Status Assessment Maps, and other data sets, to identify under-sampled reaches in the Coosa system.	H	There are many stream reaches in the upper Coosa system in Georgia with the potential to harbor unknown populations of high priority mollusks. Documenting new or updated occurrences of these species is needed for status assessment and to plan conservation efforts.	Species presence/absence at sites throughout the Coosa. Estimate of species occupancy, corrected for incomplete detection.	Number of new or updated occurrences documented.
17	Survey for rare fishes, mussels, and crayfishes in Nottely River mainstem, upstream of Lake Chatuge. This reach has not been thoroughly surveyed for rare aquatic species. Assess potential for stream to support Sicklefin Redhorse.	M	The Upper Nottely River still maintains moderate to high quality mountain river habitat. It has not been extensively surveyed and could support undocumented populations of rare aquatic species. It is within the historic range of the Sicklefin Redhorse, and the upper Nottely could be a potential reintroduction site.	Lists of species at multiple sites on the mainstem Nottely River, habitat data	Number of new populations documented, report documenting habitat quality for Sicklefin Redhorse
18	Continue coordinating NAAMP in GA and recruit new surveys in an effort to increase the number of routes.	H	NAAMP is the primary source for information on population trends of frog species on state, regional, and national scales. Increasing the number of routes run each year will improve the statistical power to detect significant changes in frog populations, allowing quicker and more accurate detection of changes thereby speeding up subsequent conservation actions.	5-minute point counts at 10 stops per route.	Number of volunteers and routes added.
19	Continue Conasauga River mainstem monitoring of fishes and water quality. Expand project to include mussels and other rare aquatic species as appropriate. Integrate results with ongoing water quality and contaminant studies in this watershed.	H	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. Long-term monitoring of high priority aquatic species is needed to ensure that species persist and are responding positively to management actions. The GMNH has been monitoring fishes in this watershed since the late 1990s and we plan to continue this monitoring with Section 6 funds	Species occupancy, habitat and water quality data, estimates of abundance, etc.	Proportion of native species with stable or increasing occupancy rates across sites
20	Continue Etowah River mainstem monitoring of fishes and water quality. Consider expansion of project to include other rare aquatic species (such as the Etowah Crayfish) as appropriate.	M	The Etowah River System is one of the richest drainages in Georgia (and the US) and provides habitat for several globally imperiled species. Long-term monitoring of high priority aquatic species is needed to ensure that species persist and are responding positively to management actions. The GMNH has been monitoring fishes in this watershed since the late 1990s and we plan to continue this monitoring with Section 6 funds	Species occupancy, habitat and water quality data, estimates of abundance, etc.	Proportion of native species with stable or increasing occupancy rates across sites

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
21	Assess Status of High Priority Species	Continue Flint River and Sawhatchee Creek mussel monitoring	Survey, Monitoring	Ongoing	Numerous	SP	Lower Flint, Lower Chattahoochee	State Wildlife Grants	DNR, USFWS	Flint Riverkeeper
22	Assess Status of High Priority Species	Continue Line Transect Distance Sampling (LTDS) of gopher tortoise populations	Survey, Monitoring	Ongoing	<i>Gopherus polyphemus</i>	SP, SCP	Numerous	State Wildlife Grants, Section 6	DNR	Joseph Jones Ecological Research Center
23	Assess Status of High Priority Species	Continue long-term monitoring of Pigeon Mountain salamander and other cave-inhabiting salamander populations; conduct surveys for other high priority cave and outcrop species.	Survey, Monitoring	Ongoing	<i>Plethodon petraeus</i> ; other cave and outcrop inhabiting salamander species, including <i>Aneides aeneus</i>	SA-RV	Tennessee	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6	DNR	Piedmont College
24	Assess Status of High Priority Species	Continue monitoring hellbender and eastern indigo snake occupancy	Survey, Monitoring	Ongoing	<i>Cryptobranchus alleganiensis</i> , <i>Drymarchon couperi</i>	SA-RV, BR, SP, SCP	All Coastal Plain watersheds, Tennessee drainage	State Wildlife Grants, Section 6	DNR	The Orianne Society
25	Assess Status of High Priority Species	Continue to explore use of eDNA sampling to survey for cryptic amphibian and fish species	Research, Survey	Ongoing, Proposed	<i>Eurycea aquatica</i> , <i>Urspelerpes brucei</i> , <i>Gyrinophilus pallescens</i> , <i>Ambystoma cingulatum</i> , <i>Ambystoma bishopi</i> , <i>Enneacanthus chaetodon</i> , others	All	All	State Wildlife Grants, Section 6	DNR	DOD, USFS, USGS, The Orianne Society, Warm Springs Fish Technology Center, Charles H. Wharton Conservation Center

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
21	Continue monitoring freshwater mussel populations in key sites in the lower Flint River Basin and Sawhatchee Creek (lower Chattahoochee). This work has been ongoing by WRD and partners since the mid 2000s.	H	Mussel populations in this part of the state are impacted by low stream flows associated with drought and human water use. Monitoring is necessary to ensure that species persist and also to identify the flows needed for mussel survival and recruitment	Mussel survival, growth, recruitment and occupancy rates	Number of mussels with stable or increasing populations
22	LTDS is the standard rangewide method for estimating gopher tortoise population sizes and age distribution. The Candidate Conservation Agreement (CCA) in which WRD is a part requires periodic (every 7-10) population monitoring of tortoises on state lands using this methodology.	VH	This is required by the CCA and will allow us to evaluate the reponse of our habitat management and conservation efforts for the tortoise on state lands and select private lands over time.	Number of tortoises detected per site, burrow occupancy rates, burrow widths as a refernce for age class distribution, population estimates, high priority burrow commensal presence	Stable or increasing population sizes, representation of all size classes indicating good recruitment
23	Seasonal counts of salamanders at Pigeon and Lookout mountains will provide information on species stability over time.	H	The Pigeon Mountain Salamander is a very restricted species and thus is especially vulnerable to endangerment or extinction in the event of significant, localized disturbance. Monitoring known populations will allow for detection of status changes and permit timely conservation actions to be implemented if necessary.	Time or area constrained counts of individual salamanders, habitat quality evaluation	Relative abundance of Pigeon Mountain and other cave-inhabiting salamanders between sites and over time; changes in habitat quality
24	Eastern indigo snake occupancy monitoring has been employed at selected sites in the sandhills of the lower Altamaha River basin and will be periodically (every 2-3 years) continued here and expanded to other areas (likely Alapaha and Satilla river sandhills). Similarly, occupancy modeling has been used to monitor eastern hellbender populations in select mountain streams and will be continued every three years.	H	A critical component of successful conservation efforts involves monitoring to evaluate the population stability of the target organisms. Eastern indigo snakes and hellbenders are relatively easy to sample for and lend themselves well to this approach	Observations/captures per site, per year	Stable or increasing occupancy trends
25	Many amphibians and fishes are difficult or unreliable to detect with standard techniques. DNA from sloughed skin cells can be filtered from water, run through PCR, and identified to species.	M	eDNA analyses allow easy detection of species presence for species that are difficult to catch, occur in inhospitable habitats, or only spend a limited time in a site of interest. This technology has the potential to discover new populations of rare species that are otherwise difficult to document. We are currently attempting this with Blackbanded Sunfish in southwest Georgia	Number of positive eDNA detections in known (control) and new locations; number of eDNA samples required for a high probability of detecting the species when present	Number of new populations discovered

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
26	Assess Status of High Priority Species	Determine population demographics (size, nesting success, productivity, etc.) for MacGillivray's Seaside Sparrows	Research, Survey	Ongoing, Proposed	Seaside Sparrow	SCP	All Atlantic drainage watersheds	State Wildlife Grants, Nongame Wildlife Fund	DNR	UGA, other universities, U.S. Fish and Wildlife Service, SE saltmarsh bird working group, possibly National Audubon
27	Assess Status of High Priority Species	Evaluate status and distribution of high priority snails	Survey, Monitoring	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR	USFWS, Kennesaw State University
28	Assess Status of High Priority Species	Expand Breeding Bird Survey routes	Survey	Ongoing	Numerous	All	All	Nongame Wildlife Fund	USGS-Patuxent, DNR	USGS-Patuxent, DNR, GOS and Audubon volunteers
29	Assess Status of High Priority Species	Explore use of detection dogs to survey for cryptic reptile species	Research, Survey	Proposed	<i>Heterodon simus</i> , <i>Ophisaurus mimicus</i> , others	SP, SCP	Numerous	State Wildlife Grants, Section 6	DNR	DOD, The Orianne Society, private contractors
30	Assess Status of High Priority Species	Implement Altamaha mussel monitoring	Survey, Monitoring	Proposed	Altamaha Spiny mussel	SP, SCP	Numerous	State Wildlife Grants or other federal funds, Nongame Wildlife Fund	DNR	USFWS, Academia, Altamaha Riverkeeper
31	Assess Status of High Priority Species	Implement Tallapoosa aquatic species monitoring	Survey, Monitoring	Proposed	Numerous	PD	Tallapoosa	State Wildlife Grants	DNR, USFWS	TNC, Kennesaw State University, GMNH, Auburn

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
26	This would be a study to look at key demographics for nesting MacGillivray's Seaside Sparrow in the Georgia saltmarsh. Preliminary work is being done by a UGA graduate student using a special Imperiled Species allocation. This work should be expand to include additional sites and look at additional demographics that affect the long-term productivity and survivorship of this saltmarsh obligate bird.	VH	This work would allow us to better understand the factors that limit Seaside Sparrow reproduction along the coast and would be a key piece of information aiding long-term efforts to mitigate the affects of sea level rise on this species as well as other species that use the saltmarsh for all or a portion of their life cycle.	Annual population estimates. Nesting success and productivity at several index sites.	Breeding population numbers.
27	This project would examine historic and potential new sites for high priority snail species, documenting information on species presence, relative abundance and potential threats.	VH	Survey needs for 16 globally imperiled (G1-G2) snails were identified during the SWAP revision. Many of these species occupy unique habitats and may not necessarily be conserved due to co-location with other imperiled species.	Species presence, species relative abundance, habitat quality	Number of species with completed surveys and status assessments
28	Expand number of BBS routes and maintain at roughly 85-90 implemented per year. Utilize network of citizen scientists to provide data that will inform conservation efforts for birds.	M	The BBS is the major source for information on population trends of bird species. By increasing the number of routes to about 100, we could reasonably expect to have 85-90 run each year. With this many routes run each year the statistical power to detect significant changes in bird populations would be increased to a level that would allow quicker and more accurate detection of changes thereby speeding up subsequent conservation actions.	3-minute point counts at 50 stops per route. Adding about 40 routes would give us 2000 more sampling points per year with very little effort invested.	Number of routes added and maintained.
29	Some reptile species are very difficult to detect because they spend much of their time under cover or below the ground. Specially trained dection dogs have been useful for determining presence of rare animals and plants.	M	Detection dogs can be trained to smell the presence of species that are difficult to find by standard techniques. Positive detections will inform biologists of areas where to concentrate more standard survey efforts.	Positive and negative detections; habitat at detection sites	Presence of high priority species documented
30	Continue Altamaha mussel occupancy surveys that were carried out in mid 2000s, focusing on the Altamaha Spinymussel.	M	The Altamaha Spinymussel has an extremely restricted range and is Federally Endangered. In addition to monitoring, this study could also find specimens needed for host-fish trials.	Proportion of sites occupied, corrected for incomplete species detection	Proportion of sites occupied by Altamaha Spinymussel and other co-occurring mussel species.
31	Continue Tallapoosa aquatic community surveys that were carried out in the 1990s and early 2000s by UGA and Auburn. Continuing this decadal monitoring data set will help WRD track the status of a large number of imperiled aquatic species	M	Continuing this decadal monitoring data set will help us track the status of a large number of imperiled aquatic species	Proportion of sites occupied by each target species	Number of species with stable or increasing proportion of sites occupied

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
32	Assess Status of High Priority Species	Implement the 2013 Georgia White Nose Syndrome Response Plan.	Monitoring, Research, Management	Ongoing	Bat species	SA-RV, SP, BR	Numerous	State Wildlife Grants, USFWS, USFS, Nongame Wildlife Fund	DNR, USFWS, USFS	USFWS, USFS, other federal agencies, GFC, other state agencies, GA Museum of Natural History, BCI, Eco-Tech, Ecological Solutions, SCWDS, universities
33	Assess Status of High Priority Species	Monitor populations of gray bats and southeastern bats in caves	Monitoring	Ongoing	<i>Myotis grisescens</i> , <i>Myotis austroriparius</i> ;	SA-RV, SP	Numerous	State Wildlife Grants, Southern Wildlife Consultants, UGA	DNR	Southeastern Cave Conservancy, Joseph Jones Ecological Research Center, UGA, Clemson, Southern Wildlife Consultants
34	Assess Status of High Priority Species	Monitor reproductive activity at known, recently extant ponds used by pond-breeding amphibians	Survey, Monitoring	Ongoing, Proposed	<i>Rana capito</i> , <i>Notophthalmus perstriatus</i> , <i>Ambystoma cingulatum</i> , <i>A. bishopi</i> , <i>A. tigrinum</i>	SP, SCP, SA-RV	All Coastal Plain watersheds, Tennessee, Coosa	State Wildlife Grants, Section 6	DNR	DoD, Joseph Jones Ecological Research Center
35	Conserve High Priority Habitats	Conduct Aquatic Conservation Planning Meetings for Coosa, Tennessee, Atlantic Slope and Gulf drainages	Conservation Planning	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR	USFWS, TNC, River Basin Center, stakeholder groups in each region
36	Conserve High Priority Habitats	Conduct aquatic species outreach in high priority watersheds	Outreach, Education	Proposed	Numerous	All	Numerous	State Wildlife Grants, private foundations	DNR, USFWS, Georgia River Network	Local governments and watershed groups

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
32	Conduct white nose syndrome monitoring and research. Annual monitoring of caves with populations of bats currently affected or likely to be affected by WNS. Count bats and coordinate with researchers studying the disease and potential treatment options. Other actions may include increase awareness, prevent spread of disease, early detection, increase baseline information on bat populations, management and regulatory actions, and communication.	H	WNS is causing significant declines in cave dwelling bats in N. GA. The disease is continuing to spread south and may eventually move into caves in S. GA. It is critical to document the spread, declines and help with research to study and potentially treat this disease. The 2013 WNS Response Plan outlines a coordinated multi-agency response to WNS in the state.	Numbers of and species of bats at cave sites, samples of fungus, documentation of condition of survivors, temperature and humidity data, estimates of mortality from WNS	Documentation of numbers of surviving bats, successful treatment of WNS, population trends over time, recommendations from the plan relevant to the next 10 years implemented
33	Annual summertime monitoring of known caves that serve as regular summer roosts	H	Small disturbances at cave sites could result in large changes in populations of bats.	Numbers of bats of these two species in each cave, potential threats	Estimated population sizes and trends of these bats
34	These species have been reduced to few sites within the state that provide adequate habitat. All or a subset of the breeding sites for each species will be annually sampled to assess persistence.	H	Because the number of sites where these species persist are few, it is important that they be monitored regularly to evaluate their status and continued suitability and to identify any conservation actions that may be needed to better ensure persistence	Number/presence of egg masses, number/presence of calling frogs, number/presence of larvae or aquatic adults	Number of sites sampled that continue to harbor target species
35	Host regular aquatic conservation planning meetings for major basins in the state, similar to the Coosa Summit. Workshops would include presentations on major research and conservation projects as well as a meeting to discuss future conservation priorities. Meetings would be held at least once every 5 years in each basin. The initial meeting could review results of SWAP and help identify specific actions for high priority watersheds. Participants would include agencies, watershed groups, and other stakeholders. Smaller meetings with key partners could take place annually to stay coordinated on active projects.	VH	If you include all of the partners in the state, there is substantial capacity for aquatic conservation. However, there is no framework for deciding which group will take the lead on a particular issue. In addition to increased coordination, these meetings will provide an opportunity to share SWAP priorities and projects with a broader group of stakeholders and gather input for future projects	None	One major meeting every five years in each basin.
36	Hold at least one aquatic species and habitat outreach event in the top 10 high priority watersheds in the state before the next SWAP revision. Events would target government officials, watershed groups, and children. Present live animals to the public.	H	Most people have no idea what is swimming in their backyard. If we can get people excited about native aquatic species, then they are more likely to become stewards of aquatic resources and support efforts to protect rivers	Number of outreach events, number of attendees	Level of understanding of native species conservation needs in local watersheds.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
37	Conserve High Priority Habitats	Conduct aquatic species stressor study	Research	Proposed	Numerous	All	Numerous	State Wildlife Grants	USFWS or DNR	USGS, UGA, River Basin Center
38	Conserve High Priority Habitats	Conduct field inventory and landowner outreach to conserve coastal plain seepage bogs	Research, Survey, Management, Habitat Protection	Proposed	<i>Sarracenia spp.</i> , <i>Balduina atropurpurea</i> , <i>Hypericum erythrae</i> , <i>Macranthera flammea</i> , <i>Rhynchospora solitaria</i> , <i>Sporobolus teretifolius</i> , others	SCP	Numerous	Nongame Wildlife Fund, State Wildlife Grants, ESA Section-6, other USFWS funds	DNR	GPCA and its member institutions
39	Conserve High Priority Habitats	Conserve key Swallow-tailed Kite nesting habitat along the Satilla River.	Habitat Protection	Proposed	Swallow-tailed Kite and suite of bottomland forest species that would benefit from habitat conservation	SCP	Satilla	State Wildlife Grants, Nongame Wildlife Fund	DNR	Satilla RiverKeeper, Plum Creek Timber, Ivanhoe Hunt Club
40	Conserve High Priority Habitats	Construct artificial isolated wetlands or improve existing ones by increasing hydroperiod	Management	Ongoing, Proposed	Pond-breeding amphibians/ isolated wetlands	SP, SCP	All Coastal Plain watersheds	State Wildlife Grants, Nongame Wildlife Fund	DNR	Private contractors, private landowners
41	Conserve High Priority Habitats	Continue Conasauga River water quality and contaminants study	Research	Ongoing	Numerous	RV	Conasauga	USFWS, State Wildlife Grants	USFWS	UGA, USGS

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
37	Examine relationships between stressors identified by SWAP aquatic habitat committee and conservation targets. For example, could examine relationship between landuse variables and occurrence probability of high priority species or groups of sensitive species such as fluvial specialists. The purpose of this project would be to identify key drivers of changes in aquatic diversity. It may also help identify the best groups of indicator species for monitoring of biotic integrity.	H	Understanding the landscape scale factors that affect aquatic communities is necessary for both preservation and restoration of aquatic communities. For example, if a goal is to improve biotic integrity of an impaired stream, this project could help identify which aquatic stressor should be addressed.	Extensive fish community data for this project has already been collected by the Georgia DNR Stream Survey Team. USFWS-Athens has already compiled data on landscape scale stressors.	A complete report documenting key stressors in different ecoregions. An interactive tool that can show how aquatic communities will change as stressors increase or decrease within a watershed
38	Develop a protocol for inventory of coastal plain herbaceous seepage bogs. Work in collaboration with biologists of other taxonomic groups, especially herpetofauna, birds, and terrestrial invertebrates to procure funding for an inventory of this high priority habitat and associated landowners within the longleaf pine sandhill ecosystem. Follow up with management of select high quality examples found during the survey.	VH	Coastal plain herbaceous seepage bogs are a high priority habitat for conservation. High or even medium quality examples of these bogs are few in the Atlantic and Gulf Coastal Plains of Georgia. Most are privately owned. Systematic inventory of known sites, strategic survey for new sites, and associated landowner contacts are essential components of this project. Collaborative surveys to meet needs of other taxonomic groups with priority species from the longleaf sandhill ecosystem would increase survey efficiency, funding opportunities, and learning among biologists. A standardized biological sampling protocol would be developed in collaboration with other biologists.	Location, plant community characteristics, species lists, habitat condition, threats, landowner contact, rare species data for Biotics	Number of bogs surveyed, number of landowners contacted
39	Work to conserve important stretches of the Satilla River based upon known long term nesting clusters for Kites, as well as important roosting areas through easements, WRP, purchase, working forest easements.	H	The Satilla River is one of the most important rivers in the state for nesting STKI. Because of their social structures (semi-colonial) and long term site fidelity, protecting known nesting areas is the most important step in the conservation of STKI in Georgia	Currently have years of nest location data on the river, as well as 3 years of roost data	Maintenance of breeding clusters. Stable to increasing state-wide population.
40	Excavate short-hydroperiod depressional wetlands and/or install flexible plastic liners to increase hydroperiod	M	Prolonged drought has been implicated in local extirpations of several high priority pond-breeding amphibians and declines in other pond-breeders. Climate models suggested increased duration and frequency of droughts. Increasing the hydroperiods of breeding wetlands, or creating new ones with long hydroperiods, will help mitigate against the loss of available natural breeding sites.	Hydroperiod of created and improved wetlands; species use and recruitment rates	Successful annual breeding and increased recruitment
41	Continue assessment of water quality and contaminants in the Conasauga River system. Identify major toxicological stressors and the tributaries or mainstem reaches that provide the greatest concentrations of stressors. Continue evaluation of ditches as a source for nutrients and herbicides (e.g., Round-Up)	VH	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. Species are declining in reaches impacted by agricultural activities, but precise mechanisms are unknown. Identification of stressors will help identify the best management practices to reduce water quality impacts associated with agricultural activities.	Concentrations of contaminants in water and sediment at sites along the length of the river, rates of intersex condition, growth and survival of species exposed to contaminants	Report documenting key stressors and suggested bmps

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
42	Conserve High Priority Habitats	Continue cooperative management for golden-winged warbler and other species requiring mid- to high-elevation early successional habitats in the Blue Ridge	Management	Ongoing, Proposed	<i>Vermivora chrysoptera</i>	BR	Tennessee, Savannah, Conasauga, Chattahoochee	Nongame Wildlife Fund, NCWC, USFS	USFS	DNR, NCWC, Cherokee National Forest
43	Conserve High Priority Habitats	Continue oyster reef restoration and enhancement	Research, Management	Ongoing	Eastern Oyster	SCP	All Coastal	State and Federal Funds, Private donations	CRD	EPA, NOAA, SFR, CCA, SARP, Oatland Island Wildlife Center, Americorps, UGA, CCGA, Isaak Walton League
44	Conserve High Priority Habitats	Continue Raccoon Creek Watershed Project	Habitat Protection	Ongoing	Etowah Darter, Cherokee Darter	PD	Etowah	Recovery Land Acquisition Grants, Local Governments, Partners for Fish and Wildlife	TNC	USFWS, WRD (NCS, GM), Paulding County, Georgia Power
45	Conserve High Priority Habitats	Control populations of feral hogs to conserve high priority habitats and species.	Management	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Funds	DNR	NPS, USFS, USFWS, DoD, Georgia Wildlife Federation, private landowners, hunting public

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
42	Implement habitat management including burning regime to create and maintain breeding habitat (open oak woodlands as well as young forest stands interspersed with open, grassy patches) for golden-winged warblers. Conduct surveys to determine metapopulation status and response to management activities.	M	The golden-winged warbler is quickly losing its breeding habitat in the Southern Appalachians due to lack of a natural fire regime. Creation of suitable habitat through prescribed fire and timber harvest is necessary to conserve this unique metapopulation assemblage which occurs at very localized sites in Georgia and North Carolina.	Data on fire intensity, periodicity, and response of vegetation to prescribed fire. Response of golden-winged warblers to habitat manipulations through point counts and surveys that determine productivity and fecundity.	Number of acres of suitable breeding habitat restored and maintained. Estimates of population sizes for golden-winged warbler and other habitat associates.
43	Continue restoring and enhancing oyster reef communities along the coast through targeted restoration efforts outside of shellfish harvest areas, enhancements within shellfish harvest areas, and living shoreline implementation to restore oyster communities as well as salt marsh plant species.	VH	Oysters are a keystone species in tidal systems on the Georgia coast. It is believed that reefs have been negatively impacted over time for various reasons. CRD's Habitat Workgroup is focused on oyster restoration through various efforts such as living shorelines, restoration in public harvest areas and restoration for fish habitat.	Areal extent of oyster reef, areal extent and composition of vegetation, fixed benthic faunal composition, oyster recruitment availability, water quality metrics	Acreage of successful restoration efforts.
44	Continue land acquisition, restoration, and conservation actions in the Etowah River's Raccoon Creek basin. Continue to monitor target species populations as needed.	H	Raccoon Creek occurs within a high priority watershed in the current SWAP (high global significance score) and contains important populations of Etowah and Cherokee Darters. This project has been very successful at watershed-level conservation in an urbanizing landscape.	TNC has compiled information on fish passage problems, stream bank and channel stability, and other threats. We have been monitoring populations of Etowah and Cherokee Darter since 2009.	Number of stream miles restored, number of acres protected through easement and acquisition, persistence of target species throughout system
45	Increase hunting pressure on public and private lands and implement trapping and shooting programs in especially sensitive sites (e.g., barrier island beaches).	H	Feral hog depredation is a significant threat to sea turtle hatchling production. In addition, feral hogs can significantly impact herbaceous species composition in many natural communities and cause substantial declines in rare plant populations.	Number of hogs removed, effort data (hogs/trap night, hogs/hunting hrs.), sex, location of capture, age. Herbaceous species composition of selected natural communities.	Number of hogs removed. Amount of sea turtle nest depredation, Amount of hog sign in sensitive wildlife habitats. Herbaceous species composition and rare plant population size.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
46	Conserve High Priority Habitats	Develop a comprehensive action plan to control invasive exotic species on public and private lands. Increase public awareness of problems caused by invasive exotic plants; reduce use of exotic species and increase use of native plants in erosion control and landscaping	Conservation Planning, Education, Outreach	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, USGS, NPS, NFWF, NRCS	DNR, GFC, UGA, USFS, USFWS, NPS, NRCS	DoD, Georgia Exotic Pest Plant Council, TNC, APHIS, USGS, GDA, GDOT, Georgia WaterWise Council, Georgia Power, GSWCC, NatureServe, local volunteers
47	Conserve High Priority Habitats	Develop and implement water conservation measures to reduce need for new water supply reservoirs	Regulation, Education	Ongoing	Numerous	All	All	State and Federal Funds, Private donations	USFWS	EPA, EPD, WRD, USACE, Georgia Wildlife Federation, private conservation organizations
48	Conserve High Priority Habitats	Develop environmental flow recommendations	Regulation, Policy	Proposed	Numerous	All	Numerous	Unknown	Unknown	USGS, USFWS, DNR, Georgia Wildlife Federation, SIFN, UGA
49	Conserve High Priority Habitats	Develop Little Tennessee River System Watershed Plan	Conservation Planning	Ongoing	Greenfin Darter, Fatlips Minnow, Eastern Hellbender, Sicklefin Redhorse, Silver Shiner	BR	Tennessee	319 Grant Program, administered by EPD	EPD, City of Dillard	DNR, USFWS, Rabun Gap Nacoochee School, Orianne Society, Broadfork Environmental, Land Trust for the Little Tennessee, private landowners

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
46	Assess threats from invasive exotic species on public lands and prioritize specific sites and habitats for control efforts. Conduct field assessments on public lands. Coordinate control efforts with other land managing agencies and adjacent landowners where feasible. Work with partners to develop protocols for assessing, documenting, and addressing invasive exotic species on conservation lands. Provide training to public land managers and seek funding for specific exotic species control efforts. Work with local volunteer groups to implement control and monitoring programs for exotic species on conservation lands. Develop educational messages focusing on regional examples of problems caused by invasive exotic species. Work with nurseries to reduce trade in invasive exotic plants and develop recommendations for use of native plants in erosion control and landscaping. Review and update agency guidance on E&S control to remove references to noxious exotic plants and emphasize use of native plants or noninvasive exotics.	VH	Invasive exotic species represent one of the most serious threats to habitat quality and native species viability statewide. Control efforts for these species are generally expensive and/or labor-intensive. This problem must be addressed in a strategic manner to maximize local benefits to native species and natural habitats and avoid costly delays or excessive expenditures of limited resources. Emphasis should be placed on control efforts that will benefit high priority species and natural habitats (especially globally rare species and communities). Sharing technical expertise between managing agencies is another important objective of this effort. Establishing baseline data on existing exotic species populations and assessing relative threats based on best available data is the logical first step.	Exotic species occurrence data; size and extent of populations. Information on life history characteristics, control methods, etc. Assessments of threat and likelihood of control based on experiences in other states or locales. Impacts on natural habitats and rare species populations; control measures and alternatives to exotic species in landscaping, wildlife habitat enhancement, and erosion control.	Reduction in overall range or impacts of highest priority (most noxious) exotic species. Improved species composition of habitats on public lands and reduced impacts on native species populations. Increased awareness of exotic species control techniques by conservation land managers. Number of educational messages (brochures, web site links, FAQ sheets, etc.) provided to educational facilities, land managers, nurseries, and the general public. Number of projects utilizing native plant species for erosion control and landscaping.
47	Protect aquatic connectivity by finding alternatives to new reservoir construction, emphasizing water conservation measures and protection of high quality free-flowing streams.	VH	Reservoirs destroy lotic habitat and fragment populations of aquatic species.	Water conservation measures, purpose and need evaluation, alternative sites, and models of downstream and cumulative impacts.	Per capita water consumption rates; implementation of water conservation measures; number of new water supply reservoirs
48	Support development of environmental flow recommendations for southwest Georgia and other regions throughout the state. Identify the magnitude and timing of flows required to sustain ecosystems and humans.	VH	Stream flow has an overriding influence on water quality, aquatic habitat, and the availability of water for human uses. Low stream flows in southwest Georgia threaten the persistence of several globally imperiled freshwater species.	Various hydrological indicator variables	Maintenance of stream flows through drought, other indicators need to be developed
49	The city of Dillard has contracted with Jenny Sanders (Broadfork LLC) to develop a 319 Watershed Plan for the Little Tennessee River system in GA. The goal of the plan is to identify on-the-ground conservation projects that will improve water quality for people and aquatic species. USFWS and GADNR are serving on the Technical Advisory Committee for the plan.	H	The Little Tennessee Watershed provides habitat for a large number of aquatic species in GA and NC. Intensive planning and conservation efforts are ongoing in NC, but their success depends upon protection and restoration of the headwaters, which are in Georgia. Completing the plan will make the watershed eligible for additional 319 grant funding.	GIS layers of recent landuse, conservation lands, etc. Visual observations of potential impacts to water quality, such as cattle access, ditching, and reduced riparian buffers.	Number of on the ground conservation projects identified, Number of local stakeholders actively participating in the project.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
50	Conserve High Priority Habitats	Develop stream geomorphology database for Cherokee darters	Database, Conservation Planning	Proposed	Cherokee Darter	PD	Etowah	USFWS	USFWS	Stream Geomorphologists, Consulting Firms
51	Conserve High Priority Habitats	Experiment with sand fencing to increase elevation on key offshore bars	Research, Management	Proposed	Beach nesting birds that utilize off-shore bars to nest. Least Tern, Black Skimmer, Gull-billed Tern, American Oystercatcher and Wilsons Plover	SCP	Several	State Wildlife Grants, Nongame Wildlife Fund	DNR	
52	Conserve High Priority Habitats	Implement Conasauga River habitat conservation	Habitat Protection	Ongoing	Numerous	RV, BR	Conasauga	Recovery Land Acquisition Grants	USFWS	DNR, NRCS, TNC, Land Trusts
53	Conserve High Priority Habitats	Implement Lower Altamaha River habitat and water quality study	Research	Proposed	Numerous	SCP	Numerous	State Wildlife Grants	DNR	Academia, Altamaha Riverkeeper
54	Conserve High Priority Habitats	Implement Shoal Creek Watershed Project	Habitat Protection	Ongoing	Etowah Darter, Cherokee Darter, Etowah Crayfish	PD	Etowah	USFWS	USFWS	TNC, DNR
55	Conserve High Priority Habitats	Implement Smithwick Creek Watershed Project	Habitat Protection	Ongoing	Cherokee Darter	PD	Etowah	USFWS	USFWS	TNC, DNR
56	Conserve High Priority Habitats	Implement strategic habitat conservation in high priority watersheds to maintain aquatic diversity;	Conservation Planning, Habitat Protection	Ongoing	Numerous	All	Numerous	Recovery Land Acquisition Grants, Local Governments	USFWS, DNR, TNC	Local governments, conservation organizations, land trusts, private landowners

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
50	Develop a baseline database of stream geomorphic characteristics in high quality Cherokee Darter streams. Use these data to revise stream restoration methods commonly used in the Etowah basin. Ensure that development of habitat for benthic shoal-dwelling fishes is a primary restoration project component (where applicable).	H	There are substantial opportunities and required mitigation throughout the range of the Cherokee Darter. There is a need to ensure that stream restoration projects are effective.		
51	Low off-shore bars provide important nesting habitat for many beach nesting birds die to the lack of mammalian predators. These sites are often prone to flooding however. Short biodegradable sand fencing may be effective at building the elevation enough during the non-breeding season that nesting birds have less chance of losing their nests to flooding.	H	With sea level rise and the increased frequency of high tide events, off shore bars are threatened with higher flooding rates, leading to greater nest loss among some of our highest priority birds	Compare elevations of similar off-shore bars with and without fencing over time. Evaluate use of these bars by beach-nesting birds	Nest success on treatment sites vs. control sites
52	Protect critical reaches of the Conasauga River system through targeted acquisition and easements with willing landowners. Provide targeted outreach and technical transfer to farmers to help minimize agricultural impacts to river.	H	The upper Conasauga River supports more high priority aquatic species than any other watershed in Georgia. There are historic and emerging threats (e.g., contaminants) associated with agriculture, but these can be minimized through implementation of best management practices		Area of land protected through easements and acquisition, area of land utilizing best practices to minimize impacts to streams.
53	Evaluate fish and mussel habitat and water quality in the lower Altamaha River.	M	This reach of the river has historically supported important populations of fishes and mussels. The discovery of juvenile Robust Redhorse in the lower Savannah River raises prospects that the lower Altamaha River could also be supporting this species. This reach has been well surveyed for sport fishes.	Water quality, fish and mussel density, and physical habitat data	Report or publication
54	Continue land acquisition, restoration, and conservation actions in the Etowah River's Shoal Creek basin (Dawson County), upstream of the City of Atlanta's Dawson Forest.	VH	Shoal Creek occurs within a high priority watershed in the current SWAP (Highest Global significance score). It contains important populations Cherokee and Etowah Darters and Etowah Crayfish. It is a direct tributary to a critical reach of the Etowah River where several high priority species occur. It is threatened by urbanization	USFWS has been working in this watershed for several years. Not sure what data already exists.	Number of stream miles restored, persistence of target species throughout system.
55	Continue land prioritization, acquisition, restoration, and conservation actions in the Etowah River's Smithwick Creek basin.	H	Smithwick Creek occurs within high priority watershed in the current SWAP (High Global significance score). It contains an important population of Cherokee Darters	USFWS has been working in this watershed since 2009. Not sure what data already exists.	Number of stream miles restored,, persistence of target species throughout system.
56	Following model used in Raccoon Creek Basin, protect critical parcels of land by acquiring land or conservation easements from willing sellers in high priority watersheds	VH	Targeted land acquisition, particularly in areas threatened by development, can avoid impacts to aquatic systems that can be difficult to reverse	GIS coverages of species locations, existing landcover, and conservation lands	Proportion of watershed protected; number of local populations conserved at viable levels

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
57	Conserve High Priority Habitats	Protect high priority species and habitats through the Statewide Water Planning Process	Conservation Planning	Proposed	Numerous	All	Numerous	State and Federal Funds, Private donations	DNR (EPD and WRD), GSWCC, Local governments, ARC, Metropolitan North Georgia Water Planning District, industries, county governments	River Basin Center, USFWS, TNC, numerous stakeholders
58	Conserve High Priority Habitats	Resolve the current difficulty in protecting newly created or emerging beach nest bird habitat	Management, Regulation	Ongoing, Proposed	All beach nesting birds. Least Tern, Gull-billed Tern, Black Skimmer, Royal Tern, Sandwich Tern, Brown Pelican, American Oystercatcher, Wilsons Plover	SCP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	DNR LED, Nongame, other coastal partners	St Catherines Island, Little St Simons Island, Little Cumberland Island, Cumberland Island National Seashore
59	Conserve High Priority Habitats	Restore mountain bogs; restore or enhance populations of rare bog plants; continue bog turtle headstart and population establishment efforts; monitor bog turtle populations	Management, Research, Education	Ongoing	Mountain bogs; <i>Glyptemys muhlenbergii</i> ; <i>Helonias bullata</i> , <i>Sarracenia purpurea</i> ssp. <i>venosa</i> var. <i>montana</i>	BR	Ocoee, Hiwassee, Tugaloo, Upper Little Tennessee	ESA Section 6, Nongame Wildlife Fund, State Wildlife Grants	DNR	USFWS, USFS, Chattahoochee Nature Center, Tennessee Aquarium, Atlanta Botanical Garden, State Botanical Garden of Georgia, other GPCA members, Charles H. Wharton Conservation Center, volunteers

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
57	A substantial effort was made to highlight rare aquatic species in each of the water planning regions of the state, with rare species information included in the state water plan. However, its not clear how this information will be used. We need to find additional opportunities for engagement and provide the councils with information on high priority watersheds for aquatic conservation.	VH	The development of water resources will have a large impact on high priority species and habitats as Georgia continues to grow into the future. The extent of the impact will depend on what practices are implemented by the water planning councils (e.g., reservoirs, withdrawals, conservation measures. Conservation goals for high priority species and habitats should be taken into consideration in the development of water resource plans.	Meetings and correspondence with water councils. Information and datasets provided.	Number of councils that can be briefed on SWAP goals to protect high priority watersheds and species.
58	While the Bird Island Rule protects several important nesting sites for beach nesting birds, there are newly created sites (Brunswick Dredge Island, Hupps Bar) that have become highly important to beach nesting birds, but since they are not listed in the Bird Island Rule, closures on these sites is difficult to enforce.	H	These sites are highly vulnerable to a number of threats. Natural sites tend to be very low, and prone to over wash. Since these sites are isolated however, they are free of mammalian predators, which means that productivity can be very high if human disturbance can be controlled.	Colony monitoring, posting and roping.	Increased productivity for beach nesting birds.
59	Restore mountain bog communities, augment or establish rare bog plant populations and continue restoration efforts for the bog turtle. Objectives include the headstarting of bog turtles and the restoration and maintenance of mountains by woody plant control and removal. A long-term goal of releasing approximately 20 juveniles per year is realistic and within the range necessary to successfully establish a population over a five to ten year period of releases.	H	Many of the characteristic species of mountain bogs have declined significantly due to lack of active management. The bog turtle is currently known from less than 10 sites in the state, only two of which are on public land and capable of sustaining a long-term viable population (with continued restoration and management). Few high-quality mountain bogs remain in Georgia, and most of these are in private ownership. Ensuring the continued survival of bog turtles and other bog species in Georgia may depend on protection and enhancement of the few remaining mountain bogs on public lands. If opportunities emerge to enhance bogs on private lands, these landowners will be offered regulatory relief and financial incentives.	Measures of vegetation structure and composition; population estimates for rare bog species; genetic samples of wild Georgia bog turtles; radio telemetry data on turtle movement, habitat utilization, and microhabitat preference at both recipient and donor sites; size and weight of turtles released and recaptured at recipient sites.	Restoration of mountain bog habitats including reduction of woody cover, expansion of Sphagnum, establishment / augmentation of rare species, and restoration of natural hydrology. Number of turtles released and maintained in restored habitat.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
60	Conserve High Priority Species	Conserve estuarine bottlenose dolphin stocks	Management, Research, Survey	Ongoing, Proposed	Bottlenose dolphins; estuarine and nearshore marine waters	SCP	All estuarine and nearshore marine waters	Nongame Wildlife Fund, NMFS, Additional Funding Needed	NMFS, DNR	NMFS, NOAA NOS, UGA, Savannah State University, Georgia Sea Turtle Center, etc.
61	Conserve High Priority Species	Implement manatee recovery plan	Management, Research, Survey	Ongoing	Manatees, Estuaries, Tidal Freshwater Rivers, Nearshore Marine	SCP	All tidal waters	USFWS ESA Section 6, U.S. Navy	USFWS, DNR	USFWS, DNR CRD & LED, USGS, Florida FWC, Navy, Sea to Shore Alliance, Georgia Aquarium
62	Conserve High Priority Species	Address problems with state law (O.C.G.A. 27-1-28) permitting unregulated and unrestricted commercial take of eastern diamondback rattlesnakes, and develop appropriate regulations.	Regulation	Proposed	<i>Crotalus adamanteus</i>	SP, SCP	N/A	N/A	DNR	PARC, Georgia Wildlife Federation

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
60	Monitor estuarine dolphin stocks (estimate abundance, distribution, stock boundaries and population vital rates; document causes of mortality and serious injury by maintaining stranding network; assess health of Brunswick stock with biopsy sampling and capture health assessments); reduce and manage anthropogenic impacts (persistent environmental contaminants; commercial and recreational fisheries, dolphin feeding and harassment; implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities); conduct targeted research (satellite telemetry); educate stakeholders and user groups	M	Brunswick stock is high monitoring priority due to high levels of persistent environmental contaminants and potential ecosystem-level effects; New funding, additional staff and/or cooperative partnerships will be needed to implement Brunswick and coast-wide monitoring; Maintaining the stranding network is critical for monitoring human impacts to estuarine and coastal stocks; Maintaining the stranding network will indirectly benefit other marine mammal species that strand in Georgia	Photo-identification, effort-corrected boat-based surveys, genetics from live and dead animals, stranding and necropsy data, entanglement and fishery effort data, telemetry, blubber contaminant concentrations and health parameters of free-swimming animals	Abundance of estuarine stocks estimated to support NMFS management; impacts of contaminants on Brunswick dolphins determined to support stock restoration efforts and ecosystem-level monitoring; dolphin feeding and harassment identified and reduced; human-related mortality and injury at historic and low levels; stranding data collected and submitted to NMFS databases; Stranding network maintained with cooperation from barrier island managers and other cooperators throughout coastal Georgia
61	Monitor manatee population (estimate abundance, distribution and population vital rates; document causes of mortality and serious injury); reduce and manage anthropogenic impacts (assess impacts of watercraft, fishery entanglements and artificial warm water outfalls, implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities); conduct targeted research (satellite telemetry); educate stakeholders and user groups	M	GPS telemetry data are needed to identify high use habitats and movement corridors to manage watercraft impacts; The Atlantic manatee subpopulations was increasing during the 2000s, but recent mass mortalities and future uncertainties regarding warm water refugia and climate change may reverse this trend; Georgia monitoring data are of limited value on their own, they are most valuable when contributed to existing USGS, USFWS and FL FWC databases	Varies according to task; Photo-identification, effort-corrected aerial surveys, individual genotyping, necropsies, entanglement and fishery effort data, outfall data, recreational and commercial watercraft data, satellite telemetry	Continued use of Georgia waters during warm season; Identify high-use areas and movement corridors; Human-related mortality remains low and similar to historic levels; Monitoring data submitted to USFWS, FL FWC and USGS; Recovery efforts coordinated with governmental, non-governmental and private groups
62	Existing state law does not require permitting, reporting, limits, seasons, or anything useful to monitor impacts and regulate take of this declining species. However, it does allow for promulgation of regulations relating to take. The best long-term solution would be to amend the state law to exclude this species. In the short term, DNR should promulgate regulations requiring permits and harvest records for rattlesnake roundups and prohibiting the take of venomous snakes without a permit.	M	Eastern diamondback rattlesnakes are harvested for "sport", the skin trade, the venom trade, and entertainment at rattlesnake roundups. In order to assess the impact of this take and trade, and adjust regulations accordingly, permitting and harvest reporting is necessary.	Number of rattlesnake take permits issued and number of rattlesnakes taken/sold.	Estimated population changes over time.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
63	Conserve High Priority Species	Address the lack of regulation regarding the use of set-lines ("bush-hooks") and the indiscriminant shooting of basking freshwater turtles in waters of the state	Regulation	Proposed	All freshwater turtles, other wildlife	All	All	N/A	DNR	PARC
64	Conserve High Priority Species	Apply the North American Model for Wildlife Conservation to herpetofauna	Regulation, Policy	Proposed	All reptiles and amphibians	All	All	N/A	DNR	PARC
65	Conserve High Priority Species	Assess the need and feasibility of extending disease testing of vulnerable species to taxa other than amphibians and reptiles.	Research, Monitoring	Proposed	Numerous	All	All	TBD	DNR	SCWDS, UGA, APHIS, CDC, SEAFWA, GWF
66	Conserve High Priority Species	Assist USFWS with development and implementation of Candidate Conservation Agreements (CCA) CCAs with Assurances (CCAA), and other conservation strategies under the Southeast At-Risk Species Program.	Research, Survey, Regulation, Habitat Protection	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, ESA Section-6, other USFWS funds	DNR, USFWS, GPCA, other conservation organizations and agencies	Private and public landowners
67	Conserve High Priority Species	Conduct <i>Elliptio</i> taxonomic studies	Research	Proposed	Numerous	All	Numerous	Multi-State State Wildlife Grants	DNR (for GA component of project)	Agencies, Museums
68	Conserve High Priority Species	Conduct Gulf Slope mussel physiology study	Research	Proposed	Numerous	SP	Numerous	State Wildlife Grants	DNR	Academia
69	Conserve High Priority Species	Conduct Halloween Darter status assessment	Research	Proposed	Halloween Darter	PD, SP	Upper Flint, Lower Flint, Middle Chattahoochee, Upper Chattahoochee	State Wildlife Grants, other USFWS or USGS funds	DNR or USFWS	UGA, GMNH

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
63	Existing state laws or rules do not address the attendance, placement, labelling, and immediate removal following fishing efforts of set-lines. Existing state law also does not prohibit the shooting of non-listed freshwater turtles. However, it does allow for promulgation of regulations relating to take.	M	Unattended set-lines incidentally capture or snag, and often kill, untargeted turtle species, including several state-listed species. Those that shoot basking turtles in waters of the state do so indiscriminately. State-listed map turtles, especially, are unfortunate victims of this practice, which has been identified as a threat to map turtles	Information on take of turtles by set-lines and shooting.	Reduction in take of protected and other turtles by set-lines and indiscriminant shooting.
64	The North American Model of Wildlife Conservation is a set of principles that has guided wildlife management and conservation decisions in the United States. The North American Model of Wildlife Conservation rests on two basic principles – fish and wildlife are for the non-commercial use of citizens, and should be managed such that they are available at optimum population levels forever.	M	This model has guided conservation of game species for decades, but in 2014 AFWA formally approved the application of this model to all amphibians and reptiles to ensure their sustainable use.	N/A	Regulatory changes that will eliminate commercial use of herpetofauna and guide their management with the goal of maintaining optimum population levels.
65	Determine whether potentially or known-to-be vulnerable high priority species of taxa should be sampled for emerging infectious diseases mostly as a component of on-going population surveys and monitoring efforts.	M	Emerging wildlife diseases may require additional testing of species that may be vulnerable. Priority will be given to species that are currently imperiled and for which disease susceptibility has been reported.	Reports of new disease outbreaks in other states; literature on susceptibility of rare or imperiled taxa to diseases.	Determination made about the need and feasibility of extending testing to additional high priority taxa.
66	Assist the USFWS with data collection, coalition/concensus-building among potential CCA signatories , development of management and monitoring protocols for the CCA , and drafting of the CCA.	H	The USFWs will be exploring the use of CCAs and CCAAs as a conservation action, in-lieu of listing under the ESA, with regard to the species being evaluated as part of the At-Risk Species Program. The USFWS must rely heavily on the expertise of DNR staff and the wealth of information in the Biotics database to accomplish this task. DNR will assist as resources allow. Additional funding provided by the USFWS would allow for greater DNR involvement.	Collect and /or update Biotics database information on new and existing rare plant EOs, populations, sites. Gather locational and status info from other sources (experts and herbariums).	Successful development and execution of CCA/CCAAs.
67	Complete taxonomic revision of the mussel genus Elliptio. Management of this group is difficult given current taxonomic uncertainties.	M	Management of this group is difficult given current taxonomic uncertainties. Some species may actually be more widespread than currently recognized while others may be more imperiled	Standard genetic and morphological characters to diagnose species, synonyms	Publication documenting results
68	Evaluate temperature, dissolved oxygen, and desiccation tolerance of high priority mussels (and host fish) from the ACF – Ochlockonee Basin.	M	Understanding the physiological limits of species is necessary when identifying appropriate stream flows for survival and recruitment	Measures of survival and growth for each parameter in controlled lab studies	Report or publication detailing findings on survival and growth parameters
69	Assess Halloween Darter population and genetic status in all four population areas (Lower Flint, Upper Flint, Middle Chattahoochee, Upper Chattahoochee)	M	The Halloween Darter is petitioned for listing, but only limited data is available to assess the status of each population. Genetic data is needed to assess genetic health of each population and to eliminate confusion with cryptic congeners. Mary Freeman has drafted a proposal for this study	Number of sites with recent occurrences of species, comparison of recent vs. historic distribution where data is available	Completed Status Assessment Report

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
70	Conserve High Priority Species	Conduct museum mussel identification project	Research	Proposed	Numerous	All	Numerous	State Wildlife Grants	DNR (for GA component of project)	Other state wildlife agencies, natural history museums, natural heritage programs
71	Conserve High Priority Species	Conduct outreach to decision makers and the public about the impact, transmission, and prevention of diseases. Propose regulations to address wildlife diseases as needed.	Education, Outreach	Ongoing	Numerous	All	All	TBD	DNR, SCWDS	GWF, APHIS, CDC, sportsmen's groups, legislators
72	Conserve High Priority Species	Continue Georgia marine mammal stranding network	Management	Ongoing	Cetaceans/estuarine and marine habitats	SCP	All coastal estuarine and nearshore marine waters	Nongame Wildlife Fund, NOAA Prescott Grant	DNR	NOAA Fisheries, UGA, USFWS, Tybee Is. Marine Science Ctr., Cumberland Is. Museum, NPS, Skidaway, et al.
73	Conserve High Priority Species	Continue sea turtle stranding and salvage network.	Survey	Ongoing, Proposed	<i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Dermochelys coriacea</i> , <i>Lepidochelys kempii</i> , <i>Lepidochelys olivacea</i> , <i>Eretmochelys imbricata</i>	SCP	All Coastal Plain estuaries and offshore waters	ESA Section 6, Nongame Wildlife Fund; Jekyll Island Authority, Caretta Research project, USFWS, Sea Island Co, the Lodge at Little St. Simons Island, Little Cumberland Homeowners Assoc., Cumberland Island National Seashore	DNR	USFWS, NMFS, NPS, UGA, Caretta Research Project, St. Catherines Foundation, Sea Island Co., Jekyll Island Authority, L. Cumberland Island Homeowners Assoc., The Lodge at Little St. Simons Island, Tybee Marine Science Center
74	Conserve High Priority Species	Continue Waterbird Conservation Initiative	Research, Management	Ongoing	67 species of waterbirds	SP,SCP	Coastal Plain	Nongame Wildlife Fund	DNR	Federal and Private land owners, NGO's

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
70	Inventory and validation of museum records for high priority mussel species. This would involve visiting museums with significant mussel collections and may be coordinated with other southeastern states. A grant proposal for this study has already been developed	M	Records of high priority mussel species may have been entered into distributional databases without proper verification. In addition, unsorted material in some collections could contain new distributional records.	Characteristics of specimens used to confirm identifications, locality data	Number of confirmed records of high priority mussel species
71	Continue to conduct outreach to the public and decision makers about activities that contribute to disease transmission. Monitor commercial animal trade and translocation of wildlife to determine potential impacts. Propose regulations as appropriate to reduce risks of importation or transmission of wildlife diseases.	M	Commercial pet trade, transport of native wildlife, and the deliberate or accidental introduction of invasive species may contribute to outbreaks of diseases that can result in significant mortality. Outreach is needed to minimize human activities that will cause or exacerbate disease outbreaks.	Information on messages developed and distributed and number of organizations and individuals contacted.	Number of decision-makers, organizations, and people contacted
72	Coordinate response to live and dead stranded marine mammals; collect data on stranded marine mammals, document human/cetacean interactions; assess cause of death if possible	M	DNR is only organization in Georgia with a Letter of Authorization from NOAA to perform task; level of priority may decrease over time if other organizations increase involvement	Species, life history, physical measurements, histopathology, virology, serology, parasitology, human interaction, etc.	Long-term data collection mandated by Marine Mammal Protection Act; data reported to NOAA within 30 days of each stranding event.
73	Conduct standardized surveys for sick, injured or moribund sea turtles. Conduct gross necropsies to determine cause of death.	H	Shrimp trawling is the largest known source of mortality in Georgia. The Georgia coast has consistently recorded some of the highest stranding densities in the U.S. Stranding totals have increased over the last 16 years. Strandings are the primary index of nearshore mortality for sea turtles. Stranding totals will be used to assess the effects of human activities (commercial and recreational fishing, environmental contamination, recreational boating) on sea turtle populations and react quickly to minimize sources of mortality.	Spatial and temporal distribution of strandings, species composition, size frequency, sex ratios, cause of death, human interactions.	Stranding trend data will be used in management decisions.
74	Identify population trends, stresses, nesting areas, staging sites, and wintering habitat. Work within North American Waterbird Conservation Plan and U.S. Shorebird Conservation Plan recommendations to promote recovery and maintain waterbird populations.	H	Worldwide declines in waterbirds have prompted international and national efforts to stem population losses and maintain regional population stability.	Population bottlenecks identified. Georgia's role in long-term maintenance and recovery of waterbirds recognized. Individual studies encouraged and supported.	Partnerships with academic institutions, NGO's, other state agencies, federal agencies and programs, are established. Population goals met.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
75	Conserve High Priority Species	Determine the demographic patterns and habitat use of juvenile sea turtles in coastal waters.	Research	Ongoing, Proposed	<i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Dermochelys coriacea</i> , <i>Lepidochelys kempii</i> , <i>Lepidochelys olivacea</i> , <i>Eretmochelys imbricata</i>	SCP	All Coastal Plain estuaries and offshore waters	ESA Section 6	DNR	UGA
76	Conserve High Priority Species	Develop aquatic species field guides	Outreach, Education	Proposed	Numerous	All	Numerous	Private donors?	DNR, GMNH	
77	Conserve High Priority Species	Develop guidelines for captive propagation, reintroduction, and translocation of rare aquatic species	Research, Policy	Proposed	Blue Shiner, Sicklefin Redhorse, possibly others	All	Numerous	State Wildlife Grants, Nongame Wildlife Fund	DNR, USFWS	Conservation Fisheries, Tennessee Aquarium
78	Conserve High Priority Species	Develop Sicklefin Redhorse Conservation Agreement	Conservation Planning	Ongoing	Sicklefin Redhorse	BR	Tennessee	State Wildlife Grants	DNR (for GA component of project)	USFWS-Asheville/Atlanta, Cheorkee Tribe, Young Harris College, NCWRC
79	Conserve High Priority Species	Enforce and monitor trawl fisheries for impacts to sea turtles	Regulation	Ongoing, Proposed	<i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Dermochelys coriacea</i> , <i>Lepidochelys kempii</i> , <i>Lepidochelys olivacea</i> , <i>Eretmochelys imbricata</i>	SCP	All Coastal Plain estuaries and offshore waters	Section 6	DNR	NMFS
80	Conserve High Priority Species	Identify Altamaha Spiny mussel host	Research	Proposed	Altamaha Spiny mussel	SP, SCP	Numerous	State Wildlife Grants	DNR	UGA

## High Priority Conservation Actions

	Description	Priority (V,H,H,M)	Comments/Justification	Data Collected	Performance Indicators
75	Develop an in-water index of abundance to assess spatial and temporal patterns of sea turtle abundance. Assess adult survival using a mark-recapture model.	H	Understanding patterns in seasonal abundance of juvenile sea turtles is critical for assessing the impacts of coastal offshore development projects and other activities such as vessel interactions.	Number and location of turtles recaptured. Survival of adult turtles	Monitoring juvenile abundance and survival is critical for assessing population status and modeling exercises.
76	Support development of field guides and comprehensive books to document the state's aquatic fauna, such as fishes and mussels. Guides would include photographs, keys, range maps, and species accounts and would be published in collaboration with websites such as Fishes of Georgia, Crayfishes of Georgia, and Rare Species Profile pages.	H	Comprehensive distributional guides have been published for fishes and mussels in all surrounding states, but are not available for Georgia. This information is needed for accurate identification and as reference for biological information. These books would be of interest to students, anglers, consultants, professors, and natural history enthusiasts.	Information compiled and formatted for production of guides; completion dates, publication dates, sales	Number of guides produced and purchased
77	Following the steps outlined by George et al (2009), guidelines will require development of a written plan that considers habitat, genetics, source populations, conservation benefit and other factors.	H	There are some habitats that could support reintroduction of aquatic species into portions of their native range in Georgia and would help reduce the overall risk of extinction/extirpation of the species. Examples are Sicklefin Redhorse in the Nottely River and Blue Shiner into the upper Coosawattee/Talking Rock Creek	Genetic diversity and abundance of source populations, MaxEnt model of suitable habitat, monitoring of survival and recruitment of new population	Number of self-sustaining populations restored
78	Support development and actively participate in a multi-partner effort to conserve the Sicklefin Redhorse. The U.S. Fish and Wildlife Service has already drafted a memorandum of agreement for this project.	H	Georgia provides important spawning habitat for the Hiwassee population of Sicklefin Redhorse, which we have been monitoring since 2005. The species could potentially be reintroduced into the Nottley River system and the Little Tennessee River system. The rest of this project will take place in NC	DNR has funded Young Harris College to monitor this population in 2013-2014 will support additional monitoring in the future.	Linear extent of spawning habitat used each year, effective population size, survival and recruitment in any populations that are reintroduced
79	Shrimpers are required to use Turtle Excluder Devices (TEDs) in all trawl nets to reduce incidental capture and drowning of sea turtles. In addition, a limited-entry system for the shrimp trawl fishery should be developed. other trawl fisheries (whelk, jellyfish) should be monitored for sea turtle mortality and conservation measures should be put in place if mortality is observed.	H	The shrimp trawl fishery is the primary source of mortality for sea turtles in Georgia. Poor TED compliance rates have hampered sea turtle recovery efforts in Georgia. Assuring high compliance with TED regulations is necessary for population recovery. The impact of other trawl fisheries may also be significant and thus needs monitoring.	TED use compliance; number of turtles captured and killed in trawls	Reduction in the number of drowned sea turtles
80	Re-attempt host fish research for Altamaha Spiny mussel. This work could be completed in conjunction with the proposed Altamaha Mussel monitoring study	M	Identification of the host fish will help us understand why the Altamaha Spiny mussel has declined. This information could also be used for propagation	Glochidia transformation rates on potential host fishes	List of suitable host fishes

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
81	Conserve High Priority Species	Implement diadromous fish restoration projects	Research, Survey	Ongoing	Shortnose sturgeon, Atlantic sturgeon, American shad, Alabama shad, hickory shad, blueback herring, American eel, striped bass	PD, SP, SCP	All but Tennessee and Coosa	State Wildlife Grants, FM Section, others	DNR	USFWS, NOAA-Fisheries, ASMFC, GCMFC, SC DNR, AL DNR, FL FWCC,
82	Conserve High Priority Species	Implement red-cockaded woodpecker conservation on private lands	Management	Ongoing	<i>Picoides borealis</i>	PD, SCP, SP		Nongame Wildlife Fund, USFWS, Tall Timbers Research Station, Turner Endangered Species Fund, Georgia Power, Joseph W. Jones Ecological Research Center	DNR	USFWS, TTRS, Joseph W. Jones Ecological Research Center

# High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
81	Evaluate existing population status, commercial and recreational fisheries, and habitat limitations. Look for opportunities to enhance habitat through suite of alternatives.	H	Current diadromous fish populations are greatly reduced compared to historic levels.	American shad harvest statistics, American eel population measures, striped bass population estimates, Alabama shad population estimates, Atlantic and shortnose sturgeon population estimates and telemetry studies	Population stability as measured by reproduction/recruitment. Restoration of species to historic ranges.
82	Implementation of statewide HCP including safe harbor management agreements and mitigated take from small, isolated populations. Also, administration of landowner incentive program for safe harbor participants, participation in consortium for conservation of RCW in Red Hills region; establishing mitigation populations at Ichauway and Moody Forest; providing management assistance to landowners and managers.	H	Recovery plan for this species includes efforts on private lands. However, very few private tracts still suitable. Red Hills population is largest private land population in world and exists in best remaining habitat. Conservation of this RCW population and its habitat will benefit many other species as well.	Nestling RCWs are banded each spring. Some birds are translocated in the fall to help establish potential nesting pairs within this population and within other populations. Other data include number of groups and amount of habitat enrolled in safe harbor agreements, incentive funding utilized, acres impacted by incentive payment contracts.	Number of nests monitored, number of nestlings banded, number of nestlings translocated, number of recruitment clusters installed, number of groups in population, number of recruitment sites occupied, number of acres burned under contract.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
83	Conserve High Priority Species	Implement right whale recovery plan in the Southeast U.S.	Management, Research, Survey	Ongoing, Proposed	Right Whales, marine habitats	SCP	Atlantic Ocean waters	NMFS ESA Section 6	NMFS, DNR	NMFS, DNR CRD & LED, Florida FWC, Sea to Shore Alliance, New England Aquarium, Center for Coastal Studies, Southeast Implementation Team and North Atlantic Right Whale Consortium members
84	Conserve High Priority Species	Improve citizen and volunteer involvement in monitoring projects	Monitoring, Outreach	Ongoing and Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants, other USFWS funds	DNR	Georgia Wildlife Federation, Numerous volunteers and citizen science groups
85	Conserve High Priority Species	Incorporate Henslow's Sparrow habitat management into management plans on all WMAs that have confirmed wintering sites	Management	Proposed	Henslow's Sparrow. Habitats often used by other high priority species, so management activity (e.g. prescribed fire) will likely benefit many other species of concern	SP, SCP	All SP and SCP drainages	State Wildlife Grants, Nongame Wildlife Fund	DNR	The Nature Conservancy, Plum Creek Timber Company, U.S. Fish and Wildlife Service

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
83	Monitor right whale population (estimate abundance, distribution and population vital rates; document causes of mortality and serious injury); reduce and manage anthropogenic impacts (assess impacts of watercraft and fishery entanglements, implement policies to reduce impacts); protect habitat (review federal and state permits and proposals, assess impacts of emerging activities such as energy development); conduct targeted research (satellite telemetry, passive acoustic detection, photogrammetry, assess ambient and anthropogenic noise and impacts); educate stakeholders and user groups	VH	This conservation action includes a variety ongoing and proposed recovery activities in accordance with the right whale recovery plan; Ship strike reduction efforts appear to be working; Future activities should focus on reducing entanglements and protecting wintering habitat; Most Georgia monitoring data are of limited value on their own, they are most valuable when contributed to existing cooperative databases using data from Canada, Northeast U.S., mid-Atlantic and other Southeast U.S. states	Photo-identification, effort-corrected aerial and boat-based surveys, individual genotyping, necropsies, entanglement fishing gear analysis, fishery effort data, recreational and commercial watercraft data, telemetry, acoustic recordings (whale vocalizations, ambient ocean noise, anthropogenic noise), whale behavior data, photogrammetric images	Population trends; use of Southeast habitat for calving and overwintering; mortality, low injury and entanglement rates in Southeast U.S.; questions about right whale movement, distribution and migration addressed; Assess cumulative impacts of ocean noise, watercraft and other anthropogenic impacts on whales and Southeast wintering habitat; Habitat remains protected from existing and emerging threats; Monitoring data submitted to NMFS and North Atlantic Right Whale Consortium partners; Recovery efforts coordinated with governmental, non-governmental and private groups via the North Atlantic Right Whale Consortium and Southeast Implementation Team for Right Whale Recovery;
84	Technology should be used to increase efficiency of engaging and training citizens and volunteers to assist with monitoring projects. This includes using online tools, social media, and smart-devices to aid training, share protocols, and collect data. Monitoring needs should be shared with Master Naturalist programs and K-12 teachers. A reward program should be initiated for participants' monitoring efforts.	H	DNR has helped organize or has been a key partner in many citizen-science or volunteer-based monitoring projects in the past ten years. In particular, successful programs have involved monitoring of bats, frogs, birds, and invasive species. These projects have been useful in tracking species populations and have allowed for public involvement in DNR conservation projects.	Monitoring data collected by citizen scientists and volunteers	Increase in volunteer-based monitoring programs and participants, successful use of online tools and other technology for monitoring, successful implementation of a monitoring rewards program
85	Work with partners to include habitat management for Henslow's Sparrows in 50-year and annual management plans for WMAs where they are known to occur (Paulk's Pasture, Moody Forest, Townsend WMAs) or likely to occur. This could be extended to national wildlife refuges, other agency lands, and private lands. Much of the management could be conducted on power line right-of-ways and similar areas.	H	Habitat management for this species is relatively straight forward and mostly includes prescribed fire at the appropriate time and occasionally other management tools. Often grassy power line corridors can provide suitable habitat with appropriate management. Damp flatwoods and pitcher plant bogs also can provide habitat.	Number of WMAs and other conservation lands with prescribed burning and other land management activities that benefit Henslow's Sparrows.	Percentage of suitable WMAs and other conservation lands with Henslow's management incorporated into long-term land management plans.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
86	Conserve High Priority Species	Incorporate Swallow-tailed Kite management into management plans on all WMA's that have confirmed or probable nesting STKI	Management	Proposed	Swallow-tailed Kite and suite of bottomland forest species that would benefit from habitat conservation	CP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	Nongame, Game management, Forest Resources	ARCI, Swallow-tailed Kite working group
87	Conserve High Priority Species	Maintain Robust Redhorse Conservation Committee	Conservation Planning, Management	Ongoing	Robust Redhorse	PD, SP	Numerous	State Wildlife Grants	DNR	All RRCC members
88	Conserve High Priority Species	Manage coyote populations on barrier islands to reduce impacts to beach nesting birds	Management	Ongoing, Proposed	All beach nesting birds that nest along beach fronts on Georgia islands. Least Tern, Gull-billed Tern, Black Skimmer, American Oystercatcher, Wilsons Plover	SCP	Numerous	State Wildlife Grants, Nongame Wildlife Fund	Cumberland Island, Little St. Simons Island, DNR, USFWS	Cumberland Island, Little St. Simons Island, DNR, USFWS
89	Conserve High Priority Species	Propose a list of species to supplement the list of wild animals set forth in Georgia Code for which a permit or license, or both, is required.	Regulation	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	GWF, GFC, UGA
90	Conserve High Priority Species	Reduce impact of crab-pot fisheries and vehicle-induced mortality on diamondback terrapins; develop a statewide index of abundance for terrapins	Research, Management, Education	Ongoing, Proposed	<i>Malaclemys terrapin</i>	SCP	All Coastal Plain estuaries and offshore waters	State Wildlife Grants, Nongame Wildlife Fund, TERN, Project-Specific GDOT Funds	DNR	Diamondback Terrapin Working Group, GDOT, county road departments, crabbers, landowners, UGA

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
86	Known nesting areas on state lands need to be protected from timber harvest and fire. Buffers need to be set up around these sites. Silvicultural prescriptions can be generated to leave some trees along hard wood edges to produce future nesting habitat for STKI. (details through Plum Creek). artificial nest platforms may be useful in some cases.	H	A tremendous amount of work has been conducted on the Altamaha river to conserve land. We know need to insure that these protected lands are managed in a way to protect one of our highest priority bird species	Years of nest site location data. 3 years of roost data,	Longevity of STKI nesting clusters on state lands.
87	Continue participation in the RRCC. Nongame Conservation has agreed to provide a representative to the RRCC. Our role includes monitoring GA populations, managing contracted studies, and workign with stakeholders to conserve the species.	H	While much has been accomplished through the RRCC, the Robust Redhorse still has significant conservation needs. Successful recruitment of stocked populations has not yet been documented. The Oconee population has declined considerably. Only the Savannah population is considered currently stable.	Visual observations at spawning sites, genetic data to document recruitment, surveys for juveniles in lower reaches of river/reservoir habitats	Number of self-sustaining populations
88	Once coyotes discover beach nesting birds they rapidly and significantly reduce nest productivity. Coyote predation on Cumberland Island National Seashore has transformed this site from one of the highest productivity American Oystercatcher beaches to a site that rarely produces a single chick. Coyotes have also decimated beach nesting birds on Little Cumberland Island, and are now significantly reducing productivity on Little St Simons Island. Recently they have been sighted on Blackbeard Island.	VH	Coyotes on Cumberland and Little St Simons Island are likely the highest threat to nesting American Oystercatcher on the coast.	Nest loss and nest productivity data for Oystercatcher, Least Tern and Wilson's Plover.	Reduction in predation and increased nest productivity for beach nesting birds
89	The list could include non-native invasive species used in the pet trade and likely to impact Georgia native species or natural habitats. Suggest recommendations for specific restrictions or guidelines for issuing permits.	M	Some nonnative invasive species, such as the Cuban treefrog, are in the pet trade and can be legally sold in Georgia. DNR can promulgate rules to add species to the list of wild animals for which permits or licenses, or both, are required.	Information on nonnative species currently sold online that represent threats to native species or natural habitats in Georgia.	Supplemental list developed and submitted for approval by DNR Board.
90	Drowning in crab traps is perhaps the single greatest threat to diamondback terrapins. Develop and implement a terrapin conservation plan for commercial and recreational crab pot fisheries. The terrapin conservation plan should include the use of Terrapin Excluder Devices (TEDs), pot soak time requirements, closure areas, removal of abandoned pots, and monitoring of effectiveness of conservation efforts. The shoulders of causeways and roads through and adjacent to coastal marshes are attractive nesting sites for diamondback terrapins. Develop management guidelines to reduce mortality of terrapins on coastal roadways including techniques for installing seasonal barrier fences (< 10").	M	Commercial crab fishermen capture and drown large numbers of diamondback terrapins. In some areas, terrapin populations have declined precipitously due to crabbing activity. Requiring use of appropriate BRDS and excluders is necessary to reduce incidental take of terrapins. It is also necessary to determine if such devices should be required on both commercial and recreational traps. Vehicle-induced mortality of nesting female and hatchling diamondback terrapins is a seasonal problem in several areas along the coast. Population sustainability depends on high female survivorship and successful recruitment.	Number of terrapins lost to crab pots or on roadways over time; Index of abundance should be designed to assess trends over time (e.g. occupancy model using terrapin head counts from randomly selected tidal creeks).	Reduction in the number of roadkilled terrapins. Reduction in terrapin capture rates in pots without influencing the blue crab size or abundance. Established protocol for assessing terrapin abundance

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
91	Conserve High Priority Species	Review recovery plans for all federally listed species known to occur in Georgia and identify state-specific objectives	Research, Management	Ongoing	All federally listed species in Georgia	All	All	USFWS Section 6, NMFS, Nongame Wildlife Fund	USFWS, NMFS, DNR	NWF, others
92	Conserve High Priority Species	Update and complete the Fishes of Georgia website.	Outreach, Education	Proposed	Numerous	All	Numerous	State Wildlife Grants	GMNH, WRD	Other Museums and Data Contributors
93	Conserve High Priority Species	Complete taxonomic descriptions of high priority fish species	Research	Proposed	Coosa Madtom, Sicklefin Redhorse, Holiday Darters, Coosa Chub	All	Numerous	Unknown	Academia	GMNH, FLMNH, Roanoke College
94	Conserve High Priority Species	Conduct surveys of southwest Georgia isolated wetlands	Survey	Proposed	<i>Dichantheium hirstii</i> , <i>Lindera melissifolia</i> , <i>Croton elliotii</i> , <i>Fimbristylis perpusilla</i> , <i>Lythrum curtissii</i> , <i>Scirpus hallii</i> , others	SP	Ochlockonee, Kinchafonee/Muckalee Flint Middle, Flint Lower, Ichawaynocho way, Spring, Chattahoochee Upper South	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6, other USFWS funds	DNR	Various academic institutions, private contractors and botanical specialists, GPCA and its member institutions
95	Conserve High Priority Species	Coordinate terrestrial invertebrate surveys and conservation efforts in Georgia	Research, Survey, Monitoring	Proposed	Terrestrial invertebrates in various high priority habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund, USFWS, private foundations,	DNR	Academia (nationwide specialists), TNC, NatureServe, USFWS, other state wildlife agencies.

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
91	Review and assess adequacy of recovery plans for all federally listed species	M	Recovery plans for some listed species (e.g., loggerhead turtle) are known to be out of date. Recovery objectives and methods should be reassessed in the light of recent of research and conservation efforts.	Extensive literature review and individual research findings.	Number of recovery plans reviewed.
92	Some maps need to be completed for taxonomically problematic species. There is also a need to update maps with new distribution records since the website was completed in 2007. Finally, development of a web application could generate conservation funding and broaden use of the application	H	This website has remained about 90% done since 2007. Maps for taxonomically problematic species have never been developed. Additional resources (funding and staff time) are needed to complete this effort.	Information needed for completion of species maps; number of maps completed	Number of distribution maps updated, number of new distribution maps completed
93	Complete taxonomic description of imperiled aquatic species, such as Coosa Madtom, Sicklefins Redhorse, Holiday Darters, Coosa Chub, and other high priority species as needed.	M	Accurate recognition of species diversity is necessary for the prudent investment of conservation resources and will also determine what conservation actions are appropriate for each taxon. For example, if Coosa populations of the Frecklebelly Madtom are distinct, then there is only a single source population that could be used for re-stocking the Conasauga River population if it is declared extinct.	standard morphological and genetic data used in species descriptions	Number of species described
94	Work in collaboration with biologists of other taxonomic groups, especially herpetofauna, birds, and terrestrial invertebrates, to procure funding for an inventory of this high priority habitat and associated landowners. Use GIS resources and aerial imagery to prioritize ponds to visit. Assess sites for potential suitable habitat for high priority species of conservation concern. Obtain landowner contacts and conduct rare species survey at sites with high potential.	VH	Southwest Georgia depressional wetlands are critical habitat for numerous species. Most are privately owned and they are numerous on the landscape; therefore they are undersurveyed. Collaborative effort among biologists of various specializations would increase survey efficiency, funding opportunities, and learning among staff.	Location, vegetation community characteristics, species lists, habitat condition, threats, landowner contact, rare species data for Biotics	Number of wetlands surveyed, number of landowners contacted
95	Coordinate and encourage terrestrial invertebrate research and conservation efforts in Georgia and in the SE. Bring together various experts across major taxonomic groups and coordinate survey efforts, monitoring, and research.	M	There is currently no coordinated research and conservation effort for terrestrial invertebrates in Georgia, and little or no contact between various experts on conservation of terrestrial invertebrates	Ranges and occurrence of rare terrestrial invertebrates of concern	New or updated occurrence records of rare terrestrial invertebrate populations and invertebrate communities associated with high priority habitats; prioritized lists of species and habitats for conservation.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
96	Conserve High Priority Species	Monitor effects of climate change on sea turtles and their nesting habitat; Monitor trends in adult female sea turtle abundance through nest monitoring programs and genetic mark-recapture sampling.	Research, Monitoring	Ongoing, Proposed	<i>Caretta caretta</i> , <i>Chelonia mydas</i> , <i>Dermochelys coriacea</i>	SCP	N/A	ESA Section 6, Nongame Wildlife Fund; Jekyll Island Authority, Caretta Research project, USFWS, Sea Island Co, the Lodge at Little St. Simons Island, Little Cumberland Homeowners Assoc., Cumberland Island National Seashore	DNR	USFWS, NMFS, NPS, UGA, Caretta Research Project, St. Catherines Foundation, Sea Island Co., Jekyll Island Authority, L. Cumberland Island Homeowners Assoc., The Lodge at Little St. Simons Island, Tybee Marine Science Center
97	Conserve High Priority Species	Support research on life history, natural history, taxonomic status, etc. of high amphibians and reptiles	Research	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Section 6, Nongame Wildlife Funds	DNR	Private and university contractors
98	Conserve High Priority Species	Update State-protected species list and work with partners to improve management for these species.	Regulation, Management	Proposed	All state protected animals and plants	All	All	Nongame Wildlife Fund	DNR	SWAP technical teams, other experts on status and distribution; state, federal, and local government land managers.
99	Conserve High Priority Species,	Conduct floristic inventories of undersurveyed state-owned conservation lands with high potential for high priority plant species occurrences	Survey	Ongoing	All	All	All	Nongame Wildlife Fund, State Wildlife Grants	DNR	Private contractors and botanical specialists

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
96	Monitor the length of incubation for all sea turtle nests in the state. Additionally, continue periodic qualitative surveys of sea turtle nesting habitat on all barrier island beaches, categorizing each 100 m section as erosional or depositional based on beach and dune morphological characteristics. Nest counts provide an index of abundance for adult female sea turtles. Genetic sampling can provide robust estimates of female abundance as well as important reproductive parameters such as clutch frequency, remigration intervals, and site fidelity.	H	Sea turtles exhibit temperature-dependent sex determination, so increasing temperatures during nest incubation resulting from climate change may skew sex ratios. Length of incubation is significantly correlated with incubation temperature and thus sex ratios. Another consequence of climate change is sea level rise, so annual surveys will be compared to determine changes in the erosional state of sea turtle nesting habitat. The collection of trend data and estimates of reproductive parameters are critical for assessing population recovery.	Length of incubation; characterization of beach dynamics. Spatial and temporal distribution of nests, hatch success, hatchling production, nest relocation, nests washover, incubation durations, nest depredations, hatchling disorientation, sex ratios, habitat use.	Changes in length of incubation as a correlate for skewed sex ratios; amount of available nesting habitat; numbers of nesting turtles and successful hatches are prime indicators of conservation success.
97	In many cases, such research will be a component of survey and monitoring efforts, but dedicated research may be required to answer important questions that will help guide conservation efforts.	M	Research is an integral part of many amphibian and reptile conservation efforts, in-part because for many of these species we still have more questions than answers about aspects of their life history, natural history, taxonomic status, etc.	Various	Increased knowledge on priority species needs that will improve conservation efforts
98	Conduct a review of Georgia's protected species list at least once every five years. Engage key partners to improve management for state protected species.	H	The state list of protected species was last revised in 2006. Because the list influences conservation priorities for many key partners, it should be based upon the most-up-to-date and scientifically reliable information	Up to date status information on all state protected species and species that should be considered for addition to the list. Number of species added to the list; number of species removed from the list.	Number of times the list of State-protected species is reviewed and revised over the next ten years.
99	Prioritize specific state conservation lands for targeted survey for rare plant occurrences. Examples of high priority properties include Silver Lake WMA and Chickasawhatchee WMA. Determine locations for high potential habitats to target by topographical map and aerial photo. Develop a standard format for submitting results digitally so data can be entered efficiently into the rare species database. Conduct survey with DNR staff or by contracting with qualified botanists. Share data and consult with local site managers to ensure management needs of any high priority rare species and habitats are incorporated into management plans.	H	Certain state conservation lands have high potential for rare plant species occurrences, but have not yet been surveyed. Local site managers need better information about locations of high priority rare plants and habitats for management planning.	Rare species data for Biotics, plant species lists, plant community types and locations	Number of conservation lands surveyed, number of high quality habitats located, number of management plans amended with rare species management needs

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
100	Engage in Regional Conservation Partnerships	Help implement the Southeastern At-Risk Species (SEARS) program.	Conservation planning, Management, Outreach	Ongoing	At-risk species	All	All	State Wildlife Grants, other federal grants, Nongame Wildlife Fund	WMI	SEAFWA Wildlife Diversity Committee (WDC), USFWS, other regional wildlife conservation organizations
101	Engage in Regional Conservation Partnerships	Help revise and implement the South Atlantic Conservation Blueprint.	Conservation Planning, Management	Ongoing	Numerous	PD, SP, SCP	Numerous	USFWS	South Atlantic LCC	DNR, USFS, GFA, others
102	Engage in Regional Conservation Partnerships	Support secure funding for regional conservation efforts.	Funding	Ongoing	At-risk species	All	All	State Wildlife Grants, other federal grants	DNR	AFWA, SEAFWA, federal agencies (e.g., USFWS, DOD), neighboring state fish and wildlife agencies
103	Implement Climate Change Adaptation	Create an updated map to help guide land acquisition and identify future greenway projects. Acquire LiDAR and other data to enhance conservation planning and management.	Conservation Planning, Habitat Protection, Management	Ongoing, Proposed	Numerous	All	All	TBD	DNR, USFWS, DoD, USFS	TNC, GDOT, RDCs, local governments, land trusts, Georgia Land Conservation Center, Oconee Rivers Greenway Commission, land trusts
104	Implement Climate Change Adaptation	Develop a comprehensive, dynamic habitat modeling process that includes projected landscape changes and demographic patterns. Incorporate climate change into landscape and species models and use these to inform conservation plans.	Research, Conservation Planning	Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR, USFWS, DoD, USFS	UGA, other research institutions, TNC, land managers

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
100	Includes actions needed to address petitioned and candidate species to help minimize the need for federal listings under the Endangered Species Act. Develop and promote data sharing procedures between state fish and wildlife agencies and the U.S. Fish and Wildlife Service so that the best available data is used in listing decisions during the critical points in the decision making process. Identify the highest priority species, coordinate data, and identify funding mechanisms.	VH	Implement the Southeast At-Risk Species Plan by compiling and analyzing data from field surveys, conducting range-wide status assessments of petitioned species, developing proactive conservation plans to address threats, collaborating on data sharing and outreach activities, and providing technical assistance that will inform the listing process. Reach out to stakeholder groups, including private landowners, sportsmans groups, civic groups, and legislators to help them understand the goals and objectives of the SEARS program.	Data from surveys, status assessments and habitat models, etc. Information from datasets shared with other states, meetings, and reports.	Level of participation in the program; number of status assessments completed; number of conservation plans completed and implemented; number of species removed from petitioned list.
101	Help revise and implement the regional plan that describes the places and actions needed to meet conservation objectives in the face of future change. Provide data on Georgia conservation priorities, identify research and conservation needs, solicit new regional partners, and test ecological indicators and species/habitat models.	H	The SALCC Conservation Blueprint provides a regional context for implementation of the Georgia SWAP and plans of other participating states and agencies. This blueprint will be tested, revised and implemented in a series of iterative steps involving input from state and federal agencies and other conservation organizations.	Data provided to SALCC database; interactions with SALCC staff; number of projects implemented using the Conservation Blueprint	Level of participation in the revision and implementation of the blueprint; number of state and regional projects that benefit from the Conservation Blueprint.
102	Assist with applying for competitive and other grants to secure greater funding for conserving species of shared responsibility. Provide input to and support for the efforts of the Blue Ribbon Panel on Sustaining America's Diverse Fish and Wildlife Resources (BRP) to identify a dedicated source of funds for nongame fish and wildlife conservation.	H	Additional resources are needed for completion of SEARS program and other regional conservation initiatives. Competitive grant programs and funds from private foundations may be needed. In addition, federal funding must be increased in order for the SEARS program and similar regional conservation efforts to be successful.	Funding initiatives pursued by state, federal and nongovernmental organizations in support of regional conservation programs such as SEARS.	Number of appropriate funding initiatives pursued; funding received and applied to SEARS program and related regional conservation efforts.
103	Refine the existing draft greenways map and state wildlife habitat map by incorporating information from sources such as the Southeast Resilience Landscapes Project and DNR species distribution models. Create new conservation opportunities map to guide land protection. Use LiDAR data to help create the statewide map of habitats, show topography, delineate wetlands, and develop strategies for protection and management of coastal plain wetlands. Prioritize management practices on those lands projected to be most resilient to change to minimize risk.	VH	An updated conservation opportunities map that reflects current distribution information on high priority species, habitats, and landscape features as well as outputs from species distribution models and models of landscape diversity and permeability is needed to inform future conservation efforts in Georgia. This will be an iterative process informed by new data from field surveys and modeling approaches that take into account projected climate change, development, and demographic changes in Georgia and the Southeast.	Updated information on all priority species; data from species distribution models and landscape resiliency models; projected trends in climate change, development patterns, demographic changes, and land use.	Statewide LiDAR coverage acquired. Updated conservation priorities map developed. Management priorities developed with potential climate-related changes incorporated.
104	Changes can be incorporated into the model as modeling assumptions shift, land cover and climate changes, and conservation lands are added. This would create a future habitat component to habitat models that will be beneficial for long term planning. Final prioritization inputs will include sea level rise and other climate change impacts. Review data from Southeast Resilient Landscapes model and other models to identify resilient landscapes. Emphasize management actions that maintain and enhance connectivity in priority areas and avoid fragmenting habitats.	H	Dynamic habitat and landscape models that take into account projected trends in urbanization, demographic changes, and direct and indirect impacts of climate shifts are needed for prioritization of conservation and habitat management efforts.	Data from Southeast Resilient Landscapes Project, SLEUTH, SLAMM, and other models of landscape change; updated coverage of high priority species and habitats	Dynamic models for species distribution that incorporate landscape changes, including projected climate change, development, demographic changes, and land use changes

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
105	Improve Environmental Education	Assess the current level of wildlife conservation literacy among Georgia citizens.	Education	Proposed	All	All	All	Could be minimal - possibly utilize graduate students for the analysis and reporting. DNR has Survey Monkey account.	DNR with a university	EE groups, Georgia Wildlife Federation, colleges, PTAs, nature oriented groups, GPB, SWAP Communications Team
106	Improve Environmental Education	Create educational core concepts with key messages that support the main SWAP themes.	Education	Proposed	All	All	All	In-kind or part of current organization budgets.	DNR	For Content: SWAP technical teams, EPA, EPD, GFC, NRCS, USFWS, USFS. For Readibility: SWAP Communications Team, EEA of Georgia, Georgia Dept. of Education, Georgia Science Teachers Association, and higher education professionals.

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
105	<p>Assess the current level of Georgia citizens' awareness about native wildlife and wildlife conservation needs. Data collection to be done online possibly using Survey Monkey or like software. Includes a baseline survey of various ages and audience types (possibly separated as 15 &amp; older vs. 15 &amp; under) as well as subsequent measuring of efforts by DNR &amp; partners to promote SWAP themes/messages (Measure = Collect, Analyze, &amp; Report).</p>	VH	<p>A survey of wildlife conservation literacy is needed to establish baseline data for future assessments of progress in current environmental education programs and the creation of new programs. To get the number of responses needed to accurately reflect GA citizen's knowledge, attitude and behavior we will need to work with the SWAP Communications team to conduct a massive email campaign through numerous organizations. We also recommend there is an incentive for participants completing the survey (ie., entered into a random drawing for gift certificates).</p>	<p>Various measures of current public knowledge, attitudes and behaviors regarding wildlife conservation issues and challenges in Georgia.</p>	<p>Ideally 250,000 responses received; analysis and summary of evaluation results.</p>
106	<p>Develop a SWAP logo with 'slogan' and five educational core concepts with key messages that support the main SWAP themes and are geared toward all Georgia citizens (messages can be tailored for specific audiences through educational materials). The messages will focus on conserving all of Georgia's natural resources including plants, wildlife and their habitats, prompting awareness, appreciation and responsible action -- not only for the resources' benefit but for human needs.</p>	VH	<p>Common, consistent messaging shared by all conservation agencies and other stakeholders more effectively reaches and resonates with all Georgians. Messages will stress that everyone can be involved in improving and protecting the quality of their environment, realizing that human actions impact all natural resources.</p>	<p>No new data will be collected. The messages will be created using existing information from partners.</p>	<p>Messages are agreed upon and approved by partners.</p> <p>Stakeholders have incorporated these messages into their communications, materials, and conservation work.</p> <p>A future environmental literacy survey, when compared to a baseline survey, could reveal if these messages have had an impacted the behavior of Georgia citizens.</p>

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
107	Improve Environmental Education	Improve communication of SWAP messages to regional education networks and community groups.	Education	Proposed	Numerous	All	All	Mostly in-kind or part of current organization budgets, but may need assistance from TERN or other grants.	DNR Wildlife Resources (Public Affairs and Education Staff)	Nature centers, regional education centers, partner agencies and organizations. Utilize partners who have public affairs staff and can include SWAP messages in their own communications when consistent with their mission (EEA in Georgia, EMCs, Georgia Power, GWF, sportsman organizations, etc.)
108	Improve Environmental Education	Through the SWAP Advisory Board, implement the resolution to develop an Environmental Literacy Plan in Georgia.	Education	Proposed	All	All	All	Private and local sources must be sought. Possible hunter education funding.	Office of the Governor, GA Dept. of Education, DNR	Georgia Wildlife Federation, Relevant Governmental and Non-Governmental Environmental Education Organizations

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
107	<p>SWAP educational messages are best disseminated through leaders/moderators in each ecoregion and via existing networks. Virtually or in-person, ecoregion representatives spread the word by incorporating SWAP messages and materials into their programming and current communications. Use the DNR Nongame e-newsletter and/or develop a GovDelivery bulletin to better disseminate SWAP messages. For two-way communication, a Facebook page should be developed. Also consider creating a SWAP clearinghouse website, separate from or part of the GA DNR Wildlife Resources Division website. In addition to the general public, target audiences include school children, teachers (including pre-service), and community groups that affect land use (private property owners, business leaders, government officials, etc.). To encourage buy-in by these groups, community programming could integrate SWAP strategies with local issues, thereby creating a common educational strategy.</p>	VH	<p>Conservation issues vary between ecoregions. Having groups and contact lists from each ecoregion can make dissemination of information more productive. This delivery would be done in the sense of long-tail marketing by getting the most relevant, popular, newsworthy and interesting topics to leaders/moderators for them to relay to community members. Partners will be asked to endorse the SWAP as evidence of outreach to a broad group of stakeholders.</p>	<p>Contact lists will be compiled through the SWAP working group and EEinGA.org. Leaders/moderators will be a representative of the GA DNR or from a partner agency/organization.</p>	<p>Downloads of educational materials and other website analytics; additional open online environmental education resources and technical information available through eeingeorgia.org or DNR webpages; requests for information resulting from personal interaction at festivals, meetings, trainings; results of short instant surveys at targeted websites and outdoor places where people visit, to measure awareness of SWAP-related educational materials such as GA DNRs e-newsletter, Dragonfly Gazette (Project Wet), Junior Rangers (state parks) and eeingeorgia.org; development of new materials to fill gaps as needed.</p>
108	<p>The SWAP Advisory Committee should support the Georgia Department of Education in creating an Environmental Literacy Plan (ELP). Through a partnership, the Department of Natural Resources, Wildlife Resources Division can advise the Georgia Department of Education on how to best address wildlife conservation concepts in the ELP. Since no federal funds currently are available in regards to the No Child Left Inside Act, the SWAP Advisory Board could become involved in the development of the Next Generation Science Standards as a near-term goal.</p>	M	<p>Georgia's citizens must have a basis for understanding the environmental issues we face if we are to make informed decisions about our state's environmental health. Creating an environmental literacy plan will provide the framework for school systems and other organizations to expand and improve their environmental education programs in order to improve environmental literacy for Georgia's citizens.</p>	<p>Devise a method of measuring baseline data and increased time spent in nature by children. Devise a method of measuring baseline children's health data and explore correlations between time spent in nature by children and children's health. Survey to assess literacy upon graduation.</p>	<p>Resolution signed by the Governor, a functioning Georgia Partnership for Children in Nature (GPCN), a completed ELP, and annual assessment of progress towards becoming an environmentally literate adult.</p>

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
109	Improve Environmental Education	Educate beachgoers and boaters about the plight of beach nesting birds and passage migrants that use Georgia beaches and offshore bars	Education	Ongoing/Proposed	Beach nesting Birds, as well as migrants and overwintering species that build up critical energy reserves foraging on our coast during spring and fall. Include Red Knot, and Piping Plover	SCP	Several	State Wildlife Grants, Nongame Wildlife Fund	DNR	USFWS, Little St. Simons Island, Cumberland Island, St. Catherins Island, Audubon chapters, American Bird Conservancy
110	Improve Environmental Education	Identify and develop targeted educational materials to facilitate the delivery of SWAP conservation messages to the public.	Education	Ongoing, Proposed	All. To be specified by users.	All	All	Possible TERN grant as well as existng resources	DNR	Captain Planet Foundation, EEA of Georgia, Flint Riverquarium, Georgia Aquarium, Georgia 4-H, Georgia Dept. of Education, GDOT, GFC, GDA, Georgia Forestry Foundation, GWF, NPS, Project WET, Project WILD, Project Learning Tree, State Botanical Garden of Georgia, Turner Foundation, USFWS, UGA, Zoo Atlanta
111	Improve Private Land Management	Assist DNR Private Lands Program biologists with technical support and outreach to private landowners owning significant botanical sites	Education, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, NRCS and USFWS funds	DNR (PLP) will lead; DNR (NCS) will assist	GPCA and its member institutions

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
109	Develop a strategic outreach and education plan to reach beach users and boaters about the challenges faced by beach nesting/foraging/roosting birds. Combination of signage, outreach programs, PSAs, press releases, and other methods.	H	Human disturbance is a major threat to beach nesting birds. Human and canine presence can keep adults off nests where they become vulnerable to exposure and depredation.	Levels of human and canine use in beach nesting habitats.	Increased nest success due to less human disturbance, dog closures on certain beaches
110	Enhance environmental education through development or increased awareness of innovative resources, tools, materials and models incorporating the knowledge, expertise, and resources contained in the SWAP. Correlate SWAP's main themes to core concepts (to be developed), and then tailor educational materials to specific ecoregions and audiences. Disseminate SWAP info via DNR websites, EEinGeorgia website, and other partner websites.	VH	The health and well-being of Georgia's plants, wildlife, and people depends on the quality and integrity of the environment. Loss, degradation, and fragmentation of habitat are the greatest problems facing fish and wildlife. To effectively protect Georgia's natural heritage, the public must be aware of and engaged in conservation.	Collect data on use of EEinGeorgia and other partners' websites.	Click rates, downloads of education materials and other website analytics; number of print-outs of files containing lesson materials; results of short instant surveys at targeted websites and outdoor places.
111	NCS botanists will continue to support the Private Lands Program (PLP) and PLP biologists with technical botanical assistance focusing on general vegetation and rare plant communities, as well as rare plant species information. NCS botanists will continue to promote the various aspects of the PLP, numerous Farm Bill programs (e.g., EQUIP, WHIP, CRP, and PFW), and other options (e.g., conservation easements, GA Conservation Tax Credit Program, and CUVA) to private landowners throughout the state. In addition to the "standard" duties listed above, NCS botanists and PLP biologists will work for the protection of special botanical "small sites".	H	The PLP has a need for technical botanical assistance and NCS botanists will continue to provide it. However, rare plant conservation frequently requires a focus on small isolated populations, sites, and EOs. The PLP typically focuses on larger acreages that have a broader, mixed-use focus that includes agriculture, silviculture, recreation, and historic/cultural preservation. Efforts need to be made to identify special small botanical sites and to work with the private landowners to ensure their protection. This may require special collaborations between NCS botanists and PLP biologists, new training for PLP staff, and/or the hire of a designated PLP botanical professional.	Lists and descriptions of properties and landowners, and rare plant species/communities inhabiting these properties. PLP biologists will be collecting additional data.	Number of at-risk, threatened botanical sites protected, acquired, or put under easement.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
112	Improve Private Land Management	Coordinate utilization of and training for implementation of Georgia's Best Management Practices for Agriculture and improve wildlife conservation guidelines	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	GSWCC, DNR	UGA Cooperative Extension Service, Georgia Cattlemen's Association, Georgia Dept. of Agriculture, Georgia Farm Bureau, GWF
113	Improve Private Land Management	Coordinate utilization of and training for implementation of Georgia's Best Management Practices for Forestry and improve wildlife conservation guidelines	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	GFC, DNR	GFC, PARC, PIF, GFA, Forestry for Wildlife Partners, UGA, Southeastern Wood Producer's Association, SFI Implementation Committee, Master Timber Harvester Program
114	Improve Private Land Management	Develop guidelines for wildlife habitat management for high priority species	Management, Education	Proposed	All High Priority Species and Habitats	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	USFWS, GFC, PARC, PIF, Forestry for Wildlife Partners, UGA, GDA, NRCS, SFI Implementation Committee, Georgia Power, other corporate landowners

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
112	Provide information and technical assistance to develop a wildlife conservation component for agricultural BMPs that addresses needs and opportunities for wildlife habitat protection. Provide assistance with development of educational outreach and training programs relating to existing BMPs as well as more specific guidance on conservation or enhancement of wildlife habitat and protection of sensitive sites.	H	Georgia's Best Management Practices (BMPs) for Agriculture address specific water quality issues. However, specific impacts of certain land management practices on wildlife and sensitive habitats are not adequately addressed, nor are opportunities to avoid or minimize these impacts. A multidisciplinary review team should assess current BMPs and develop additional guidance for wildlife conservation that can be incorporated in the next version of Georgia's BMPs for agriculture, or included in a separate document for a wide variety of landowners and managers.	Comparison of other state BMP's for agriculture; development of a wildlife conservation component that addresses needs and opportunities for conservation or enhancement of wildlife habitat and protection of sensitive sites.	Number of high priority habitats and species protected through enhanced BMPs
113	Review wildlife management, protected species, and sensitive sites components of existing BMPs (Section 7 of forestry BMPs) and recommend improvements for the next revision of Georgia's BMP's. Recommend monitoring protocol for existing BMPs. Develop educational outreach programs and training programs relating to existing BMPs as well as more specific guidance on conservation or enhancement of wildlife habitat and protection of sensitive sites.	M	Georgia's Best Management Practices (BMPs) for Forestry address specific water quality issues and generally address wildlife habitat conservation. However, specific impacts of certain land management practices on wildlife and sensitive habitats are not adequately addressed, nor are opportunities to avoid or minimize these impacts. A multidisciplinary review team should assess current BMPs and develop additional guidance for wildlife conservation that can be incorporated in the next version of Georgia's BMPs for forestry, or included in a separate document for a wide variety of landowners and managers.	Comparison of other state BMP's for forestry; recommendations from Master Timber Harvester Program, SFI, and similar programs. Development of an "Elements of Wildlife Conservation" component that addresses needs and opportunities for conservation or enhancement of wildlife habitat and sensitive sites.	Number of high priority habitats and species protected through enhanced BMPs.
114	Develop habitat-specific management guidelines to address conservation needs of high priority species in each ecoregion of the state and provide these to landowners and managers. Develop educational programs and materials emphasizing opportunities for receiving technical support and/or financial incentives to maintain or enhance rare species populations and significant natural communities.	VH	There are few land management guidelines for the various landowners/managers in the state (county departments of transportation, mining, agricultural, and forestry interests) that satisfactorily address wildlife habitat conservation objectives. Commonly used land use practices that affect high priority species are not adequately addressed in existing Forestry or Agricultural BMPs or other management guidelines. Improved guidelines that address general wildlife conservation objectives as well as recovery objectives for listed species and other high priority species would be a significant improvement.	Comparison of other state wildlife management guidelines and recovery objectives for listed and other high priority species. Development of management guidelines that address conservation of significant natural communities and high priority wildlife species, techniques for habitat restoration or enhancement, and opportunities to receive technical or financial support to undertake these activities.	Number of high priority habitats and species protected through management guidelines. Number of landowners provided technical guidance for conservation of high priority habitats and species.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
115	Improve Private Land Management	Encourage use of prescribed fire as a habitat management tool on private lands. Provide information and technical assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats.	Management, Education, Outreach	Ongoing	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, National Fish & Wildlife Foundation, USFWS, NRCS	DNR, GFC, NRCS, TNC, USFWS	Joseph W. Jones Ecological Research Center, GWF, PARC, PIF, UGA-WSFR, GFA, Prescribed Fire Council, Longleaf Pine Alliance, private landowners and managers.
116	Improve Private Land Management	Collaborate on the revision and implementation of the Georgia Forest Action Plan.	Conservation planning	Ongoing	Numerous	All	All	GFC, DNR	GFC	DNR, USFS, GFA, others
117	Improve Public Land Management	Continue to implement rare plant restoration, enhancement, and safeguarding program. Identify needs, develop horticultural guidelines, and initiate rare plant propagation efforts; continue to develop/improve and implement Safeguarding protocols; continue monitoring populations.	Research, Management, Monitoring	Proposed	Numerous	All	All	Nongame Wildlife Fund, ESA Section-6, GPCA and its member institutions	GPCA, DNR, USFWS, USFS, SBG, ABG	GPCA member institutions

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
115	Provide information and technical and/or financial assistance to landowners to encourage appropriate use of prescribed fire as a management tool to enhance and maintain wildlife habitats. Work with EPD to maintain reasonable burning windows to allow proper management of fire-dependent habitats while meeting air quality standards. Utilize Interagency Burn Team approach to share expertise and costs associated with prescribed burns on ecologically significant sites.	VH	Many of Georgia's high priority habitats and species are fire-dependent. The long-term viability of these species and habitats hinges on increased emphasis on prescribed burns conducted under conditions that mimic natural fire regimes. Significant opportunities exist to restore or enhance fire-dependent habitats on private land, but landowners and managers need information, technical support, and in many cases, financial support to initiate and maintain these management efforts.	Location and condition of high priority sites and habitats for prescribed burns. Number of landowners willing to undertake habitat restoration or enhancement projects. Presence and condition of populations of high-priority species.	Improved structural and compositional characteristics of fire-dependent habitats. Enhanced viability of populations of high-priority species in restored or enhanced habitats. Acres of wildlife habitat maintained primarily through prescribed burns. Number of landowners employing growing season burns.
116	The Georgia Forestry Commission will be assessing and revising the Forest Action Plan in the near future. DNR will contribute to the wildlife conservation component in the Plan and identify opportunities for future collaboration on conservation	H	The Forest Action Plan provides the framework for forest-related programs and activities by GFC and its conservation partners. DNR will provide input on wildlife conservation needs and opportunities, attend planning meetings, and participate in outreach and other activities to facilitate the plan revision.	Information on Forest Action Plan data requests, data provided, meetings attended, and wildlife conservation objectives incorporated.	Level of participation in the revision and implementation of the plan; timely completion of the plan revision and incorporation of SWAP conservation objectives
117	Propagate rare plants identified as being most at risk of extinction and likely to benefit most from a coordinated propagation and reintroduction effort. Make use of and modify (for Georgia) existing protocols employed by other states and countries. Safeguarding sites (incl. reintroduction, enhancement, and newly created sites) would be identified from the available mix of public, and private lands within the state. Habitat maintenance plans and long-term monitoring program would also be developed for each Safeguardingf site.	VH	Because opportunities for rare plant site acquisition are limited, greater emphasis must be placed on augmenting populations of critically threatened plants on existing protected areas. One area that offers promise is the propagation and planting of rare, endangered and special concern plants for the reintroduction of historical populations, enhancement of existing populations, and the establishment of new safeguarding populations in suitable habitat.	Prioritized list of rare plants that can be successfully propagated and reintroduced over a 10 year period. Protocols and guidelines used by other state and federal programs and agencies will be reviewed. Number and location of plants, ecotypes represented, population size, reproductive effort, areal extent, threats, etc.	List of plants prioritized based on the potential for propagation and reintroduction; guidelines for collection, notation, and horticulture; plants produced from ex situ propagation. Identification of numerous suitable sites for reintroduction, enhancement, or safeguarding Stable/growing populations with reproductive effort and recruitment level necessary to provide for long-term viability.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
118	Improve Public Land Management	Create DNR online database of monitoring projects. Conduct periodic meetings to share data, coordinate efforts, and address problems. Hire a DNR monitoring program coordinator.	Monitoring, Database, Administration	Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants, other USFWS funds	DNR (WRD, PRHSD, EPD)	USFWS, U.S. Geologic Survey, USGS Cooperative Fish and Wildlife Unit, U.S. Forest Service, The Nature Conservancy, National Park Service
119	Improve Public Land Management	Develop an adaptive management approach for high priority plants and natural communities on public lands	Monitoring, Research, Habitat Protection	Ongoing, Proposed	<i>Ceratiola ericoides</i> , <i>Echinacea laevigata</i> , <i>Elliottia racemosa</i> , <i>Lindera melissifolia</i> , <i>Oxypolis canbyi</i> , <i>Rhus michauxii</i> , <i>Xerophyllum asphodeloides</i> , Oaky Woods Prairies, herbaceous seepage bogs, longleaf pine sandhill, others as need arises	All	All	Nongame Wildlife Fund, State Wildlife Grants, ESA Section 6, other USFWS funds	DNR	GPCA and its member institutions, USGS Cooperative Fish and Wildlife Research Unit, various colleges and universities

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
118	<p>The database will be a tool to share monitoring reports, provide a standardized system to store protocols, data, qualitative information regarding land management results, and metadata about projects. Implementation would likely occur as a two-phase process, with the first phase to develop the system for posting project reports and qualitative management results, and the second to develop the system for storing and accessing protocols, data, and metadata. Monitoring meetings are a venue for staff to share ideas on monitoring in a peer-review environment for improving monitoring and conservation projects. A monitoring coordinator would review and compile monitoring plans, facilitate communication between partners to facilitate collaboration, set standards for protocol development, protocol documentation, data management, and reporting, communicate with academic institutions to develop opportunities for collaborative adaptive management projects, and provide venues for sharing of results, technologies, and ideas.</p>	VH	<p>Within DNR, there is lack of awareness of monitoring projects and associated challenges, even among biologists studying the same groups of species and ecological systems. Improving coordination of monitoring within DNR will serve as a model for coordination of monitoring among partners state-wide. Improving coordination and standardization is critical to improving rare species and habitat monitoring, which provides knowledge needed to determine optimal conservation and management actions. Monitoring occurs over many specializations and roles in Georgia. A person dedicated to coordinating monitoring within DNR and its partners is necessary to bridge the complex monitoring network in the state, and to facilitate communication about monitoring results to decision makers and natural resource managers.</p>	<p>Monitoring project protocols, metadata, results. Inventory of rare species and habitat monitoring by DNR and partners. Incorporation of monitoring protocols, results, and metadata on DNR monitoring projects into a unified database.</p>	<p>Implementation of a system to easily store and access information about rare species and habitat monitoring. Improved coordination of monitoring programs within DNR.</p>
119	<p>Design and carry out adaptive management projects for focal rare species and habitats where they are being managed on public conservation lands and the effects of management are uncertain or there is risk to the rare element. Monitoring results feedback directly to land managers so management actions can be improved in future iterations.</p>	VH	<p>Landscape scale management may conflict with micro-site management needs for certain rare plant species, or effects of management for certain rare plants and habitats may be uncertain. In these cases there is risk of management negatively impacting the rare plants and habitats and monitoring is a high priority. Monitoring projects will be prioritized according to the species affected and the uncertainty or risk of management to be enacted. Monitoring will be designed so only critical variables are measured and results feedback directly into determining subsequent management actions.</p>	<p>Critical population and habitat data to indicate status of the focal elements, related environmental variables, management events</p>	<p>Number of projects where monitoring results directly inform land management decisions, Documentation of improved communication among rare species biologists and public land management staff.</p>

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
120	Improve Public Land Management	Implement integrated resource management of federal lands and waters (including oceanic habitats), emphasizing restoration and maintenance of natural communities and rare species populations. Work with DNR and other conservation organizations to enhance ecosystem functions and address regional conservation needs.	Management	Ongoing, Proposed	Numerous	All	All	Federal agency operating funds; DoD Legacy Management Program; DoD Encroachment and Buffering funds; State Wildlife Grants, Nongame Wildlife Fund	DoD, USFS, USFWS, NPS, NOAA, CRD	DNR, TNC, NatureServe, USGS
121	Improve Public Land Management	Implement integrated resource management of state lands and waters (fresh, brackish, and salt), emphasizing restoration and maintenance of natural communities and rare species populations (i.e., ecosystem management). Work with other conservation organizations to address regional conservation needs.	Management	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund, other WRD operating funds, NFWF,	DNR	GFC, TNC, Joseph W. Jones Ecological Research Center, UGA-WSFR, UGA-NARSAL, NESPAL, private landowners

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
120	<p>Conduct surveys of federal lands to determine distribution and status of rare species and natural communities. Map location and extent of high priority habitats and landscape features using systems that are compatible across agency boundaries. Incorporate management recommendations for these features in long term management plans. Exchange information on rare species and natural communities with Georgia DNR and other organizations that maintain biodiversity databases. Contribute to ecoregional strategies for control of exotic species and restoration of natural communities. Share information and expertise relating to inventory, mapping, management, and monitoring of species and communities.</p>	VH	<p>Federal lands (national parks, wildlife refuges, and forests; military bases) contain some of the most significant habitats and populations of rare species in the state. Continued collaboration between DNR, federal land managing agencies, and private conservation organizations is critical for improvements in capacity to maintain Georgia's natural diversity. Increased collaboration and coordination of conservation efforts can result in protection of wildlife corridors and landscape features necessary for long term ecosystem maintenance. This collaboration should include oceanic habitats under federal jurisdiction</p>	<p>Location and condition of high priority species and habitats. Information on minimum viable population sizes, historic vegetation and land use patterns, restoration potential, management alternatives, and threats to species/habitats. Opportunities for protection of edgeholdings and inholdings through fee-simple acquisition or easements. Opportunities for collaborative research and management projects</p>	<p>Improved condition of wildlife populations and habitats on federal lands. Increased connectivity and protection of wildlife corridors and landscape features. Greater interagency exchange of information and expertise regarding rare species and natural community inventory, management, and monitoring.</p>
121	<p>Revise and update management plans for WMAs and other state lands as needed to address specific restoration objectives. Emphasize restoration of former pine plantations to stands that closely resemble natural forest and savanna communities and reintroduction of fire as a management tool wherever appropriate and feasible. Utilize information from historic aerial photos and land lot survey data from the 1800s to identify historic vegetation. Continue collaboration with partners to determine and implement appropriate methods for restoration of natural habitats, including restoration of groundcover in longleaf pine ecosystem. Monitor results of restoration efforts. Coordinate with CRD to protect coastal marshes, waterways and rare upland habitats</p>	VH	<p>Many state-owned WMAs (especially in the Coastal Plain) are former industrial forest lands. Restoration of these stands to uneven aged pine forests and savannas would benefit many high priority species. Integrated resource management of state properties for a wide range of nongame species will complement ongoing management for game species. Greater use of prescribed fire as a management tool for restoration and management of natural communities will provide numerous benefits for high priority species. Historic aerial photos and models of historic vegetation derived from land lot survey witness tree data can help identify restoration objectives.</p>	<p>Various measures of stand density, vegetation structure, and community composition. Population sizes of high priority species associated with these habitats. Information from historic aerial photos, historic vegetation models, soil surveys, and other sources. Information on condition of potential donor sites used for harvesting native groundcover species, as well as potential recipient sites.</p>	<p>Improved structural and compositional characteristics of former industrial timber stands within each WMA. Total number of stands/acres restored. Increased population sizes and overall viability of high priority species. Acres planted with native groundcover species harvested from donor sites; native groundcover species diversity and abundance in recipient sites</p>

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
122	Improve Public Land Management	Strengthen and expand the fire photo monitoring program	Monitoring	Ongoing and Proposed	All	All	All	Nongame Wildlife Fund, State Wildlife Grants	DNR	Georgia State Parks Division, Interagency Burn Team
123	Improve Public Land Management	Survey state-owned lands for federal and state protected species and other species of concern and incorporate conservation objectives into management plans	Survey, Management	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, Nongame Wildlife Fund	DNR	State Botanical Garden, Georgia Botanical Society, Audubon Society, local volunteers.
124	Improve Public Land Management	Establish or augment populations of gopher frog, striped newt, gopher tortoise and other high priority species on protected lands	Management	Ongoing, Proposed	<i>Rana capito</i> , <i>Notophthalmus perstriatus</i> , <i>Gopherus polyphemus</i> , <i>Ambystoma cingulatum</i> , others	SP, SCP	All	State Wildlife Grants, Nongame Wildlife Fund, Section 6	DNR	USFWS, UGA, Zoo Atlanta, Atlanta Botanical Garden
125	Improve SWAP Communications	Increase awareness of the SWAP among partner organizations.	Communications, Outreach	Proposed	Numerous	All	All	Nongame Wildlife Fund	DNR	Communications Team members
126	Improve SWAP Communications	Promote the conservation actions, themes and goals of the SWAP to five priority stakeholder groups to increase stakeholders' support for wildlife conservation; awareness of the SWAP, its importance, themes and successes; and, awareness of the partnership effort involved.	Communications, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund	DNR	SWAP Communications Team members (WRD, TGC, GDOT, GFA, GFC, Georgia Power, TNC, DoD, USFWS, USFS and NRCS). Other potential partners include CRD, UGA, Botanical Garden of Georgia and others.

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
122	Photo monitoring of prescribed fire effects has been installed at 25 sites state-wide. Tasks for improvement include: develop efficient software mechanisms to submit, catalogue, view, and quantitatively analyze photos; expand sites to monitor different management types, WMA's, and reference habitats; and incorporate quantitative data into the protocol at high priority sites.	VH	A statewide fire monitoring program was initiated in 2009 to improve documentation of the prescribed fire program, indicate whether long-term burning objectives are being met, and involve local site managers in monitoring their management activities. The photographs are the only readily available documentation of fire effects at many managed conservation lands and, with these improvement to the program, they will be better organized, more accessible, and an excellent resource for demonstrating long term change.	Systematized photographs and associated land management events; fire effects and vegetation community data	Number of sites with fire monitoring conducted at least biennially, ability to submit and easily catalogue photos, ability to query photos and generate cleanly formatted layouts.
123	Determine location and distribution of protected species and species of concern on Wildlife Management Areas, Natural Areas, Public Fishing Areas and State Parks.	H	The status of many species is unknown on state-owned lands. Protection and management of these species can not be accomplished without accurate and up to date occurrence information.	High priority species found on a WMA, NA, PFA, or State Park, specific locations of populations, colonies, or individuals, estimate of numbers of individual when feasible.	Number of WMAs, NAs, PFAs, and State Parks thoroughly surveyed for all high priority species.
124	Establish or augment populations of high priority animal species on protected lands in the Coastal Plain. Candidate species include gopher frog, striped newt, flatwoods salamander, gopher tortoise, and red-cockaded woodpeckers	H	The gopher frog and gopher tortoise have been proposed for federal listing. The need for listing these species may be minimized if proactive conservation measures can be implemented on protected lands. Other listed or candidate species should be evaluated. for establishment or augmentation on public lands	Potentially suitable habitats for establishment or augmentation of populations will be evaluated. Population levels will be monitored.	Establishment of viable populations of high priority animal species on public land.
125	This "in-reach" will mimic communications with the five stakeholder groups but with the focus on SWAP partner organizations. Work with individual partners will identify best ways to reach their staffs on specific messaging.	VH	In-reach is important, considering that partners are the face of the SWAP. Raising awareness and understanding of the plan among our staffs will better prepare them to address the topic with constituents and fellow workers, and can widen the base of support for the SWAP.	Data collected will vary according to the particular "in-reach" initiatives, but may include number of messages and surveys of recipients.	Online surveys of willing partner organizations can set benchmarks to monitor changes in knowledge of the SWAP. Partners' use of products can also be reported.
126	Create messaging, including calls to action, from the SWAP revision themes and technical team needs. Match communication options and products (social media posts, news releases, video, events, etc.) to the audience and situation or issue targeted. Share messaging through the partners network. Continue development of audience contact lists.	H	As noted, this effort will feed from overall SWAP focal points set by the Advisory Committee, as well as specific priority communication needs identified by the individual technical teams.	None, except for any data resulting from use of surveys and possibly web analytics to gauge impacts.	Use of online surveys to set baseline support and awareness will be explored, along with follow-up surveys to measure effects. Where appropriate, analytics can be used to gauge traffic at related websites.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
127	Improve SWAP Communications	Work with the SWAP Education Team as needed to achieve its recommendations. Specifically: 1) Help create an online survey supporting an assessment of Georgians' wildlife conservation literacy; 2) help with the content of core educational concepts, related messaging and educational materials; 3) help identify SWAP stories per ecoregion for use in regional education networks and community groups.	Communications, Education	Proposed	Numerous	All	All	See individual environmental education conservation action items.	DNR	See individual environmental education conservation action items.
128	Increase Capacity for Wildlife Conservation	Establish a consistent source of state funding for land protection to support wildlife conservation	Funding	Ongoing, Proposed	Numerous	All	All	TBD	TNC, TGC, TCF, TPL, GWF, State Legislature, Governor's Office	DNR, UGA, Georgia Land Conservation Center, NWF, others
129	Increase Capacity for Wildlife Conservation	Expand DNR Nongame Conservation Section Aquatic Program	Administration	Proposed	Numerous	All	Numerous	State Wildlife Grants, Nongame Fund, NOAA grants	DNR	USFWS, TNC,
130	Increase Capacity for Wildlife Conservation	Facilitate DNR Law Enforcement Division officer training to address nongame wildlife law enforcement needs.	Education, Regulation	Ongoing, Proposed	Numerous	All	All	Nongame Wildlife Fund, state appropriations	DNR	UGA-GMNH, NatureServe

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
127	Work with members of the SWAP Education Team and partner organizations to identify areas in which coordinated communication efforts are needed. Specifically: 1) Help create an online survey supporting an assessment of Georgians' wildlife conservation literacy; 2) help with the content of core educational concepts, related messaging and educational materials; 3) help identify SWAP stories per ecoregion for use in regional education networks and community groups. Utilizing key messages drafted by Education	H	See individual environmental education conservation action items.	Data collected will vary according to the particular communication initiatives, but will include metrics associated with development and distribution of key messages and surveys conducted as components of these communication campaigns.	Various metrics related to communications objectives, including messages developed and distributed, number of recipients, survey results, etc.
128	Provide guidance and support for establishment of a consistent and stable source of state funding for land protection, including fee-simple acquisition, acquisition of conservation easements, and other forms of permanent habitat protection	VH	This conservation action is a critical component for the achievement of species and habitat conservation objectives outlined in this document. Georgia must have a consistent, long-term source of funding for land protection to conserve critical habitats and populations of high priority species. No such funding source exists at the state level. Georgia has relied on a combination of federal grants, private donations, and short-lived state funded efforts to protect wildlife habitat. This approach has been only partly effective in addressing conservation needs for the wide array of imperiled species and habitats in the state.	Information on funding mechanisms used in Georgia and other states, laws and regulations needed to establish funding programs, and level of public support for wildlife habitat acquisition. Assessment of public awareness of wildlife conservation needs and current lack of consistent state funding to address these needs.	Identification, public approval, and establishment of a funding mechanism to provide long-term support for land protection for wildlife conservation. Development of specific criteria to ensure that the fund is used to address critical wildlife conservation needs identified through an iterative assessment process based on best available scientific data.
129	Expand DNR Nongame Conservation Section aquatic program so that each major basin in the state has an aquatic species conservation coordinator. Each coordinator would work with key partners to conserve and monitor high priority aquatic species and watersheds in each basin. Four basins are Atlantic, Gulf Slope, Coosa, and Tennessee	VH	The state only has 2 dedicated biologist positions to inventory, protect and recover 165 high priority species. Our work load is increasing due to our involvement with monitoring and conservation of candidate and petitioned species as well as coordination of DNR efforts on the Robust Redhorse Conservation Committee.	N/A	Full time biologist dedicated to Coosa, Tennessee, Mobile, and Gulf Slope drainages.
130	Provide additional training on laws and regulations established to protect nongame wildlife. Provide technical support and staff resources to address enforcement of nongame and protected species regulations.	VH	Increasing familiarity with laws and regulations pertaining to nongame and endangered wildlife and providing regionally relevant data on distribution of these species will help staff assess and address enforcement needs in each region. Providing additional staff resources will be necessary to fully address enforcement needs in many areas.	Number of programs/refreshers courses given and training material provided. Number of cases involving nongame or endangered species investigated.	Number of cases investigated involving illegal nongame activities; overall awareness of nongame conservation issues and regulations.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
131	Increase Capacity for Wildlife Conservation	Improve biodiversity databases and increase data-sharing with conservation partners	Database	Ongoing	All	All	All	State Wildlife Grants, other federal grants, matching funds from landowners, Nongame Wildlife Fund	DNR	University System of Georgia; USFWS, TNC, NatureServe, biological consulting firms, conservation planners, private landowners
132	Increase Capacity for Wildlife Conservation	Improve capacity to work with corporate landowners to protect wildlife habitat; provide technical support through additional staff or contractors	Administration	Ongoing	Numerous	All	All	Nongame Wildlife Fund, State Wildlife Grants, other federal grants, matching funds from landowners	DNR, NatureServe, corporate landowners	The Conservation Fund, TNC, NWF, biological consultants
133	Increase Capacity for Wildlife Conservation	Increase availability and use of federal funds for land acquisition (fee-simple and conservation easements) and land management	Funding	Ongoing, Proposed	Numerous	All	All	LWCF, WSFR, Forest Legacy, DoD, Recovery Land Acquisition, Coastal Wetland Grants, NAWCA Grants	USFWS, DNR, DoD, GFC, NRCS, NPA	NFWF, TNC, TCF, NWF

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
131	Develop protocol for electronic submission of rare species datasets to WRD. Establish formal data-sharing agreements with UGA and other conservation partners; develop a system for providing on-line access to biodiversity data; assess and update database records for all high priority species. Develop a database to document sites where surveys were conducted but target species were not detected (This information helps identify future survey needs and also better informs status assessments). Rank occurrences of all high priority species and habitats for conservation purposes.	VH	Continued development and improvement of WRD biodiversity databases is necessary in order to more accurately assess the distribution and condition of rare species and natural communities and prioritize conservation actions accordingly. Established data sharing agreements provide for responsible and appropriate use to achieve conservation objectives while protecting sensitive habitats, rare species populations, and private property rights. Ranking of occurrences helps ensure that the most important populations are addressed first and that resources are not wasted on populations with limited potential viability.	Records on location & condition of rare species populations and significant natural communities; biodiversity data users; information requests handled.	Number of new/updated database records; number of data use agreements; number of information requests handled; number of occurrences of high priority species in WRD databases.
132	Develop strong cooperative relationships with major corporate landowners; exchange data on rare species and significant natural communities; rank properties based on biodiversity value and provide technical assistance in land management; develop options for long-term protection, including fee-simple acquisition, conservation easements, and incentive programs.	H	Need to be able to provide timely technical assistance to avoid loss or degradation of critically important wildlife habitats and respond to imminent large-scale divestiture of properties. This will require additional staff or contractors to provide technical assistance to implement biological inventories and conservation programs and explore options for long-term protection.	Presence/absence data for rare species on corporate lands; indices of biodiversity value based on rare species and significant natural communities.	Number of surveys conducted on lands of corporate partners. Acres of natural habitat and number of populations of high-priority species conserved through long term management plans or permanent land protection.
133	Improve coordination between conservation organizations to obtain and use federal funds for long-term protection of high-priority habitats and species. Assess funding programs and potential land protection projects and obtain necessary matching funds through innovative partnerships.	VH	Several federal programs provide significant opportunities for land protection, but the ability to obtain and use these funds depends on many factors, including providing nonfederal matching funds. Better coordination of conservation organizations and nonfederal funding sources in Georgia can result in more effective use of federal funds to protect high priority habitats and species.	Types of federal funding programs and amount of federal funds available. Criteria for application of funds. Availability of nonfederal matching funds or other forms of match. Location and availability of high priority properties.	Number of high priority species and habitats protected or enhanced through use of federal funds. Acreage of high priority sites protected through federal funding programs.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
134	Increase Capacity for Wildlife Conservation	Increase state funding to support WRD's nongame wildlife conservation programs	Funding	Proposed	All High Priority Species and Habitats	All	All	State appropriations	State Legislature	GWF, TNC, other conservation organizations
135	Increase Capacity for Wildlife Conservation	Strengthen network of support for wildlife conservation programs and initiatives	Administration	Proposed	All High Priority Species and Habitats	All	All	In-kind or part of current organization budgets.	TNC, GWF, TGC, Georgia River Network, Georgia Conservation Voters, 100 Miles	Georgia Land Conservation Center, Georgia Water Coalition, National Wildlife Federation
136	Reduce Impacts from Development and Other Activities	Conduct studies and distribute findings on impacts to wildlife and effectiveness of mitigation efforts for solar and wind energy projects.	Research, Outreach	Ongoing, Proposed	Numerous	All	All	State Wildlife Grants, other federal funds, private foundations	DNR, Georgia Power, Georgia Southern University, UGA, USFWS	Georgia Power, EMCs, MEAG, GA Solar Energy Association, AFWA
137	Reduce Impacts From Development and Other Activities	Conserve populations of rare plants in transmission line corridors; maintain or enhance native vegetation for pollinators and migratory birds	Management	Ongoing	Numerous	All	All	Nongame Wildlife Fund, federal grants, private foundations, private landowners	DNR, Georgia Power, local EMCs,	State Botanical Garden, Georgia Botanical Society, UGA,

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
134	Increase state appropriated funds for support of WRD's nongame wildlife conservation efforts, including staff, equipment, and operating expenses. This funding would provide support primarily for the Nongame Wildlife & Natural Heritage Section, but could also support nongame conservation efforts by other WRD Sections as well as DNR's conservation partners.	VH	In 2015 the Georgia legislature approved a \$300,000 appropriation for nongame conservation projects by WRD, the first in more than a decade. The largest source of private funding for the Section is the sale of nongame license plates. Revenue from the sale of these license plates is variable and uncertain. The ability to obtain federal funding for many conservation programs depends on availability of nonfederal matching funds. In addition, few state funds are available to support environmental education programs by WRD; many of these efforts are supported by private donations to the Nongame Wildlife Fund, TERN, and other entities. Expanding state funding for the Nongame Conservation Section of WRD would free up additional funds for education-related efforts and provide more matching funds for federally funded projects.	Information on current levels and sources of funding for nongame wildlife conservation efforts, including staff, equipment, and project-related expenses. Information on funding needed to support future efforts to conserve high priority species and habitats, provide education and outreach programs to the public, and meeting matching fund requirements for grants.	Amount of state funding for nongame wildlife conservation programs in WRD; number of conservation and education programs funded.
135	Strengthen coalition of environmental organizations to communicate SWAP objectives and work for improvements in policies, fundng, and capacity for wildlife conservation.	VH	A stronger and more coordinated coalition of conservation partners is needed to call attention to wildlife and habitat conservation needs statewide.	Number of wildlife conservation initiatives proposed and discussed with decision makers.	State policy and funding to support wildlife conservation and habitat protection.
136	Use standard protocols to improve comparability to other studies, enhance coordination among states, and provide a consistent message to managers, decision makers, and the public.	M	Two projects are currently underway that will provide useful information on small-scale solar and wind generation projects. DNR will collaborate with Georgia Power, USFWS, and Georgia Southern University on a wind energy demonstration project on Skidaway Island, and with Georgia Power, USFWS, and UGA on a solar power demonstration project on the UGA campus in Athens.	Wind power: Impacts on birds, bats, and other target taxa. Solar power: impacts on native groundcover, birds, pollinators.	Studies conducted; results distributed to solar power companies, states, managers, decision makers, and the public to inform best management practices
137	Identify, delineate, and develop management plans for populations of high priority plants occurring in transmission line corridors. Communicate with management crews to ensure that vegetation management techniques are compatible with maintenance of rare plant populations. Offer technical assistance and financial incentives to landowners to restore habitat adjacent to transmission corridors. Monitor use of sites by pollinators and migratory birds	H	Several populations of rare plants occur under powerlines maintained by Georgia Power or local EMCs. The most important of these populations need to be delineated with special management signs and management guidelines developed to avoid unintended impacts from vegetation management. Opportunities to restore or enhance adjacent habitat will be explored. These habitats are also important for many migratory birds and pollinators.	Location, condition and extent of rare plant populations. GPS coordinates, management requirements, potential site viability, land ownership. Use of native vegetation by pollinators and migratory birds.	Number of rare plant populations delineated and protected through special management guidelines. Number of natural communities protected and/or enhanced. Use by pollinators and migratory birds documented.

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
138	Reduce Impacts From Development and Other Activities	Continue to expand the knowledge base and use of native plants	Education, Outreach	Ongoing	Numerous	All	All	Nongame Wildlife Fund, NRCS and USFWS funds	DNR, GPCA and its member institutions	GAEPPC, GPCA and its member institutions
139	Reduce Impacts from Development and Other Activities	Develop procedures for engaging with developers in solar, wind, and biomass energy, and collaborate on the development of best practices. Provide technical assistance to avoid or minimize impacts to high priority species and habitats. Conduct outreach to the public and decision makers about potential impacts to wildlife and potential solutions.	Conservation planning, Outreach	Ongoing, Proposed	Numerous	All	All	Nongame Wildlife Fund, USFWS, private foundations	DNR, Georgia Power, USFWS, GA Solar Energy Association	EMCs, MEAG, U.S. Industrial Pellet Association, AFWA
140	Reduce Impacts From Development and Other Activities	Expand use of WRD biodiversity data for environmental review, public outreach, permitting, and development of site management plans to minimize impacts on rare species and sensitive habitats	Database	Ongoing	Numerous	All	All	State Wildlife Grants, Nongame Fund	DNR (WRD)	TNC, UGA, USFWS, Forestry for Wildlife Partners, NatureServe, DOD, USFS, NPS, GDOT, biological consulting firms, conservation planners

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
138	Work with DNR partners to educate the public and the green industry with regard to the dangers of using non-native plants and the benefits of using native alternatives. Work to encourage the use and sale of natives by the public and green industry. Help DNR's partners, especially the GPCA and GAEPPC, research and document the benefits of native plants	M	Use of non-native plants by the public and the green industry continues to be a primary cause of environmental degradation, as well as an on-going threat for even more disastrous future problems. Any reduction in the use of non-natives and any increase in the use of natives (which provide a myriad of positive benefits for wildlife) is very important.	Lists of non-native plant species sold by green industry in GA and lists of native plant alternatives available. Industry data on sales on native and non-native species.	Sales of native vs. non-native plants by green industry members. Responses to public surveys addressing invasive species issues and use of native plants.
139	Develop procedures for engaging developers in the siting, permitting, mitigation, and implementation stages of solar and wind energy development. Help develop and promote a voluntary best practices one-pager. Promote early consultation with the Nongame Conservation Section of Georgia Department of Natural Resources as the first step during the site selection process to avoid impacts to known species/habitats of conservation concern. Participate in meetings and workshops with energy industry and wildlife agency representatives to identify ways to engage in all stages of the solar development process. Develop a "Risk Map" to be used as an early planning tool for solar, wind, and biomass energy project siting.	VH	Solar and wind energy project developments provide benefits for energy diversification but can result in negative impacts to native wildlife species. Careful planning and technical assistance are needed to ensure that impacts to at-risk species and sensitive habitats are avoided or minimized. DNR will work with partners to develop voluntary best practices, participate in consultation on species and habitats of concern, and develop tools to help with planning.	Information on siting, mitigation, and implementation practices that are compatible with wildlife conservation. Information from other state and regional programs that interact with solar and/or wind energy developers.	Procedures developed; risk map and other resources developed; number of entities receiving technical assistance; number of meetings and workshops attended
140	Make data available by multiple mapping units on WRD website; post high priority streams on GIS clearinghouse; incorporate high priority watershed into information request procedures; post pictures and accounts for all protected species on WRD website; support development of taxonomic guides for rare species; develop EO ranks for elements on lands of Forestry for Wildlife Partners and other land managers	VH	These efforts will help ensure greater awareness of rare species concerns among planners, consultants, land managers, and the general public, and will help ensure that these concerns will be addressed in environmental review of projects and development of site management plans.	Life history data, location data; information on types of data users and needs;	Number of contacts to WRD website for rare species information; number of EO ranks for high priority species on Forestry for Wildlife Partner lands; number of taxonomic guides produced; number of pictures and species accounts for protected species on WRD website

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
141	Reduce Impacts From Development and Other Activities	Facilitate training for and compliance with Best Management Practices for erosion & sedimentation control, stormwater runoff, and stream buffer protection	Management, Education, Regulation	Ongoing	Numerous	All	All	Land disturbing activity fees, state, federal, and local government funds	DNR (EPD), GSWCC, Local governments, ARC, Metropolitan North Georgia Water Planning District, industries, county governments, River Basin Center	USFWS, TNC, Georgia River Network, developers, site managers, property owners, neighborhoods, property associations, county governments
142	Reduce Impacts From Development and Other Activities	Help minimize the impacts to high priority species and habitats from petroleum pipeline development and other state or regional projects.	Conservation Planning, Regulation	Ongoing	Numerous	All	All	State funds, Nongame Wildlife Funds, USFWS	DNR	GDOT, FERC, USFWS, pipeline companies, local governments
143	Reduce Impacts From Development and Other Activities	Implement targeted dam and culvert removal/replacement projects and mitigation projects to restore and conserve stream banks and channels	Management	Ongoing	Numerous	All	Numerous	USFWS, SARP, USACE, FEMA, FWHA	USFWS, DNR, Georgia Wildlife Federation	SARP, TNC, American Rivers, UGA, USACE, County road departments, consulting firms
144	Reduce Impacts From Development and Other Activities	Minimize impacts to high priority species and habitats from the exploration and potential development of energy resources off the coast of Georgia.	Conservation Planning, Regulation	Ongoing	Marine and coastal species	SCP	Marine waters	State funds, Nongame Wildlife Fund, USFWS, NOAA	DNR (CRD, WRD), USFWS, NOAA	Bureau of Ocean Energy Management, energy developers and contractors

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
141	Includes a wide variety of training, monitoring, and enforcement activities pertaining to erosion and sediment control, stormwater management, wastewater management, and stream buffer protection for activities relating to construction and development. Provide technical information on BMPs through websites, workshops, and publications.	H	A variety of BMPs and training programs have been developed to provide protection for water quality. These BMPs can provide protection for high priority aquatic and terrestrial species as well, depending on the local setting. Continued emphasis on training industrial site managers, utility workers, county officials, and the general public is needed to ensure that all persons involved in land development or other land-disturbing activities are aware of regulations and methods to reduce resulting impacts to aquatic habitats. Monitoring and enforcement activities are also critical to ensure compliance with state and local standards.	Number of training programs provided; level of compliance with BMPs and stream buffer ordinances; number of stormwater pollution prevention plans for industrial sites; number of municipalities with stormwater management programs, including local ordinances and public education activities. Annual progress reports submitted to EPD.	Full compliance with erosion and sedimentation control standards; control of stormwater flows to minimize impacts on aquatic habitats; maintenance of intact stream buffers; control or treatment of wastewater and stormwater within state water quality standards. Increased awareness of and compliance with regulations and BMPs for protection of water quality.
142	DNR will work with GDOT, FERC, USFWS, and pipeline companies to avoid or minimize impacts of pipeline projects on rare species, natural communities, and conservation lands. DNR will also work with local governments and regulators to avoid or minimize impacts from landfills and similar projects.	H	Major petroleum pipeline projects cross multiple habitats and have the potential to impact numerous high priority species and habitats. Involvement by DNR staff in reviews of proposed projects and interaction with pipeline developers and state and federal regulators is critical for protection of wildlife habitats and public and private conservation lands. Involvement in environmental review is also needed for more local projects such as landfills.	Proposed pipeline routes; locations of rare species, natural communities, and public and private conservation lands.	Level of engagement with agencies and companies to minimize impact to wildlife of proposed petroleum pipelines and other projects.
143	Use barrier inventories and models to strategically target barriers for removal. Monitor aquatic communities before and after removal. Continue working with the Corps of Engineers to select mitigation properties that restore and conserve stream reaches in high priority Georgia watersheds.	VH	Barriers fragment aquatic species populations and prevent movements to spawning, feeding, refuge, and nursery habitats. Barriers also block colonization after local extinction. In order to achieve watershed level benefits, mitigation projects must be strategically located and adequately designed. Mitigation is expensive, so it is important that resources are invested to achieve maximum benefits for rare species and habitats.	Species distributions above and below barriers before and after project completion, assessment of unintended consequences associated with invasive species, sediment and contaminants.	Miles of stream re-connected; proportion of stream habitat restored or protected.
144	Provide timely reviews of proposed projects related to energy exploration and potential energy resource development in marine waters. Collaborate with federal and state agencies and local governments to address potential impacts to high priority species and other important natural resources	H	Off-shore energy exploration and development has the potential to impact species of conservation concern. DNR involvement in reviews of proposed projects and collaboration with federal regulators are critical for protection of wildlife resources in marine and coastal environments.	Information on proposed projects, areas of potential impact, high priority species and habitats, and other resources of concern.	Level of engagement with agencies and companies to minimize impact from offshore energy exploration

## High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
145	Reduce Impacts from Development and Other Activities	Participate in regional efforts to understand impacts to wildlife and develop strategies to minimize the impacts of biomass energy development. Identify and apply relevant lessons from other states and regions. Promote biomass energy guidelines consistent with wildlife conservation.	Conservation Planning, Education, Outreach	Ongoing	Numerous	All	All	State Wildlife Grants, other federal grants, private foundations	DNR	DOE, USDA, GFC, AFWA, SFI, US Industrial Pellet Association, landowners, public
146	Reduce Impacts From Development and Other Activities	Provide technical assistance to farmers to protect streams in high priority watersheds	Management	Ongoing	Numerous	All	Numerous	Farm Bill Programs, 319 grants, Partners for Fish and Wildlife Program	NRCS	USFWS, DNR, TNC, GSWCC
147	Reduce Impacts From Development and Other Activities	Reduce impacts of ATV use on streams and other sensitive habitats.	Management and Education	Proposed	Primary emphasis is on aquatic species and habitats, but includes other sensitive habitats	All	All, but especially Ochoopee River and Altamaha River	Unknown	DNR, GON	Georgia Water Coalition, ATV manufacturers
148	Reduce Impacts From Development and Other Activities	Reduce impacts of unpaved roads, parking lots, boat ramps, and camping areas on aquatic habitats	Management, Education	Proposed	Aquatic species	All	All	Federal highway ROW funds, local transportation funds	DNR, USFS	County road departments
149	Reduce Impacts From Development and Other Activities	Update Freshwater Mussel Survey Protocol for the Southeastern Atlantic Slope and Northeastern Gulf Drainages in Florida and Georgia.	Survey and Monitoring	Proposed	Numerous	All	Numerous	Unknown	USFWS, DNR	GDOT

## High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
145	Promote adherence to AFWA's Guidelines for the Integration of Fish and Wildlife Conservation with Biomass Production; the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS) standards during the development of field trials of engineered high energy crops; and, any guidelines from NCS that are applicable to local conditions. Guidelines may include avoiding conversion of native habitat to establish bioenergy crops, avoiding introductions of invasive species, minimizing the use of water for bioenergy production, and following harvest guidelines that minimize impact to fish and wildlife.	M	Biomass energy production is a growing field and provides great opportunities for economic development in Georgia. Guidelines should be developed for use of materials and sites that do not contribute to loss or decline in at-risk species or natural communities. AFWA and other organizations have developed guidelines that could be adopted and modified as needed to ensure that biomass energy production is aligned with wildlife conservation goals.	Data on biomass energy production practices that are compatible with wildlife conservation, as well as those methods and materials that contribute to loss or decline in species diversity and habitat quality.	Number of available regional efforts in which GADNR participates; Relevant lessons identified and applied to outreach efforts and development of best practices; messages developed and delivered on alignment of biomass energy and wildlife conservation goals.
146	Work with partners to help target programs to high priority watersheds. Examples are riparian restoration, plugging ditches, streambank stabilization, alternative water sources for cattle, etc.	VH	Agricultural activities can contribute significant amounts of sediment, nutrients, and pesticides to streams, with negative impacts to species and habitats.	Sediment, nutrient, and pesticide levels in streams before and after restoration practices are implemented	Miles of riparian buffers restored, miles of ditches plugged or improved, number of practices implemented
147	Educate citizens about the impact of ATV's on streambank stability and shoreline habitats through commercials, fliers, etc. Provide information about other sensitive habitats that should be recognized and avoided by ATV users.	M	ATV misuse was frequently cited by technical team and stakeholders as a threat to aquatic habitat quality. Direct impacts from physically crushing freshwater mussels is also likely in some areas. ATVs also impact other sensitive habitats such as wet prairies and granite outcrops.	Information on specific impacts in various watersheds or ecoregions; number of ATV riders and manufacturers	Number of messages produced and distributed through fliers, commercials, etc. Number of ATV companies that supply info on responsible riding to customers.
148	Acquire funds to pave frequently used dirt roads that contribute significantly to sediment loads in adjacent streams. Close infrequently used and eroding dirt or gravel roads, or re-engineer turnouts to decrease sediment losses. Improve deteriorating boat ramps as needed to reduce local sediment losses. Renovate or relocate camping areas or trails that contribute to sedimentation or streambank destabilization	M	Unpaved roads can add large volumes of sediment to streams. These impacts must be assessed in relation to the impacts of impervious surfaces from paved roads. In some cases, little-used roads can be closed by the landowner (e.g., USFS). In other cases, changes in placement of turnouts or maintenance methods may adequately address problems of sedimentation.	Information on high priority roads for paving or closure, high-traffic areas near campgrounds, deteriorating boat ramps, and other problem areas adjacent to high-priority streams.	Reduced local erosion/sedimentation rates and improved streambank stability.
149	Update the mussel sampling protocol. This protocol was developed in the mid-2000's and needs to better address the probability of detecting mussels during surveys. Protocols for gastropod surveys should be also be addressed.	H	A major issue with rare species surveys is the problem of incomplete species detection. If the species is not found during a survey, it may still be present. Models can be developed that estimate the probability of detecting a mussel or snail species for different sampling methods	Detection history for target species for different sampling methods	Updated protocol shared with partners

# High Priority Conservation Actions

	Goal	Conservation Action	Type	Ongoing or Proposed	Focal Species/Habitats	Ecoregion(s) (SA-RV, BR, PD, SP, SCP, All)	Watershed (HUC8)	Funding Source(s)	Lead Organization(s)	Partners
<b>150</b>	Reduce Impacts From Development and Other Activities	Continue to work with Georgia Department of Transportation and federal agencies to minimize impacts from highway construction and facilitate protection and mitigation of high priority habitats.	Database, Management, Habitat Protection	Ongoing, Proposed	All	All	All	Federal Highway funds; State Wildlife Grants, Nongame Wildlife Fund, Georgia Wetland Trust Fund	DNR, GDOT, FWHA	USFWS, COE, EPA, TNC, Georgia Land Conservation Center, EPD, UGA, land trusts

# High Priority Conservation Actions

	Description	Priority (VH,H,M)	Comments/Justification	Data Collected	Performance Indicators
150	Continue collaborative efforts between DNR and GDOT to minimize impacts from road construction projects to high priority species and habitats. Share information on locations of rare species and significant natural communities and sites that are suitable for mitigation activities. Emphasize protection of sites that will conserve high priority species and habitats and expand public recreational opportunities.	VH	Ongoing and future road construction projects have potential to impact high priority species and habitats in many areas of the state. Efforts to continue and expand collaboration between DNR and GDOT will be critical for protection of high priority species and habitats and expansion of state properties that provide diverse opportunities for public recreation.	Locations of high priority highway construction projects and associated wetland and stream mitigation needs. Locations of rare species and natural communities in need of protection, and properties that could provide appropriate and meaningful mitigation opportunities.	Number of mitigation sites protected through fee-simple acquisition or other means and managed to preserve, restore, or enhance wetland and/or stream habitats. Minimized impacts to high priority species and habitats through coordination of planning and assessment efforts.