

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

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## 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.

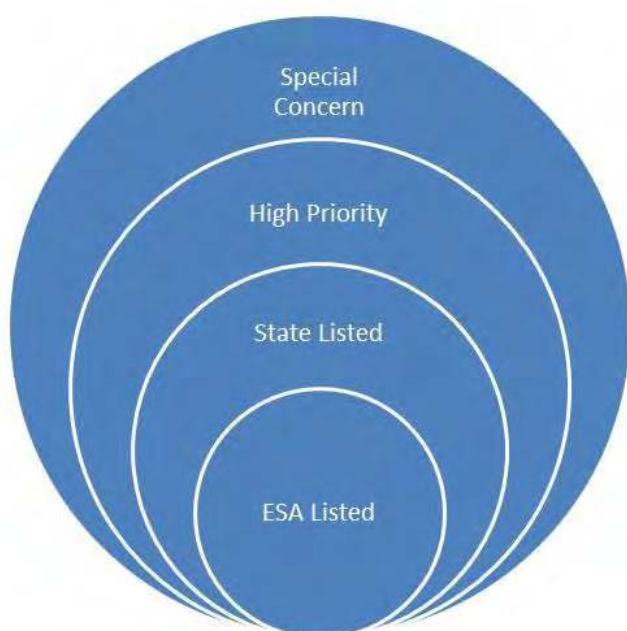
Species occurrence records used to make the conservation status assessment maps were compiled from the following sources: 1) GADNR Rare Species Database. This dataset includes records from research projects carried out by GADNR or its contractors, publications, consultant reports, and scientific collection 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.

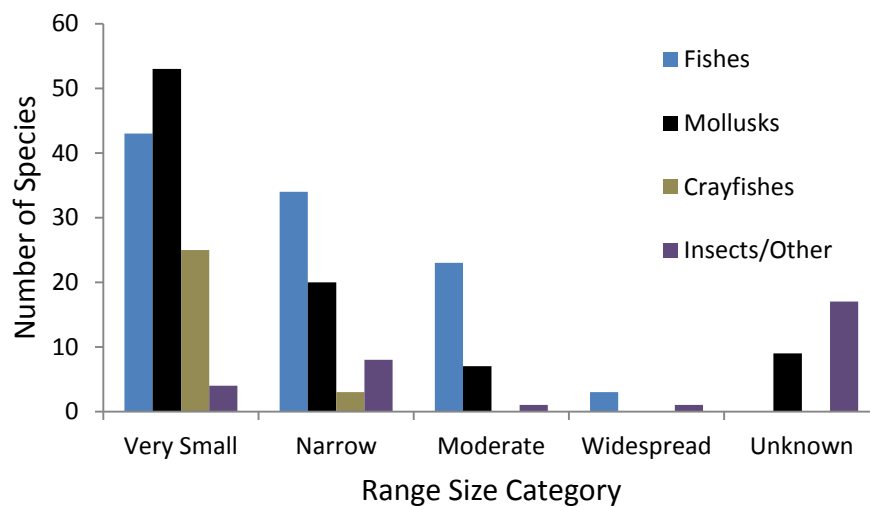
**Figure 1.** Hierarchy of frequently used conservation status categories in Georgia. Although there are rare exceptions (e.g., an ESA listed species that is not state-listed because it is considered extirpated), the figure shows how the more restrictive categories containing fewer species are nested 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

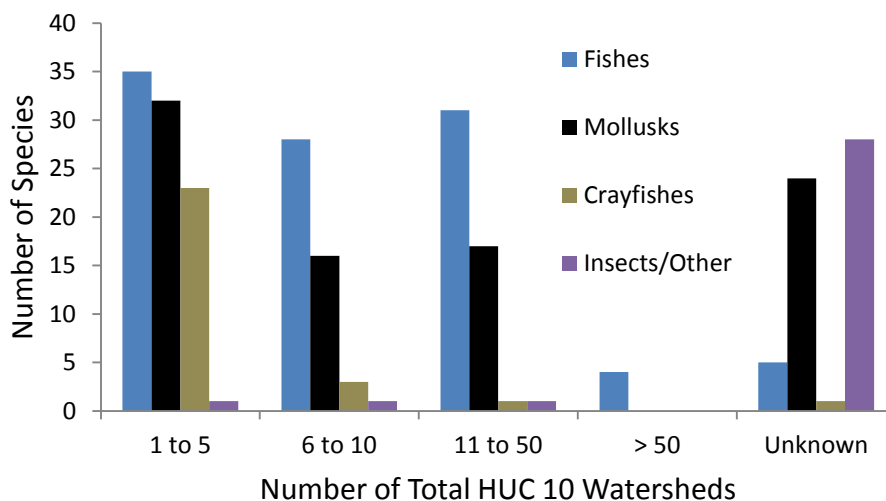
#### Categorical Assessment Criteria: Range, Georgia Importance, and Trends

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

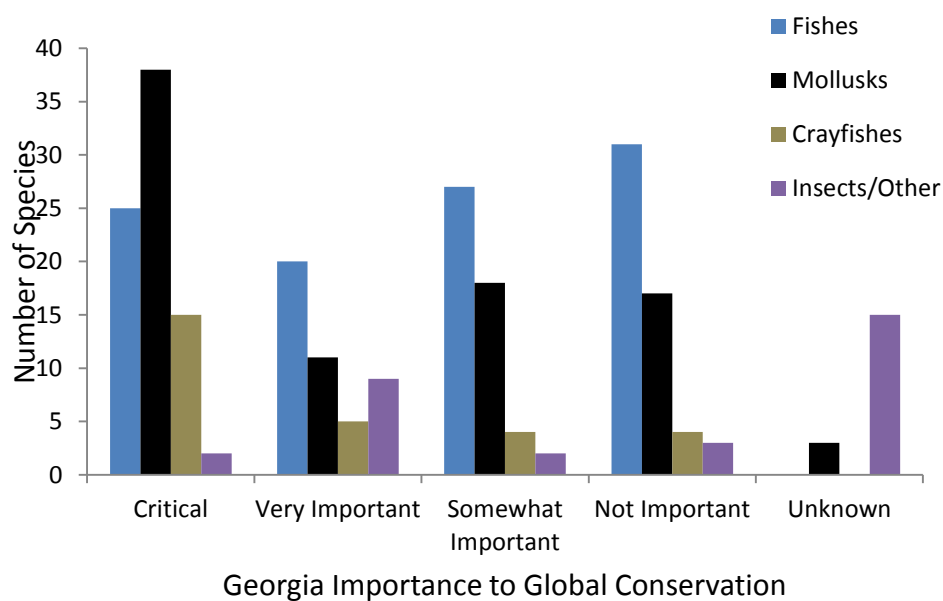
categorized as rapidly declining or declining but many crayfish species were categorized as stable. While some species are persisting in all or most of their historically-occupied watersheds, an alarming proportion of fishes (42%), mollusks (43%) and crayfishes (25%) have been documented from half or 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.



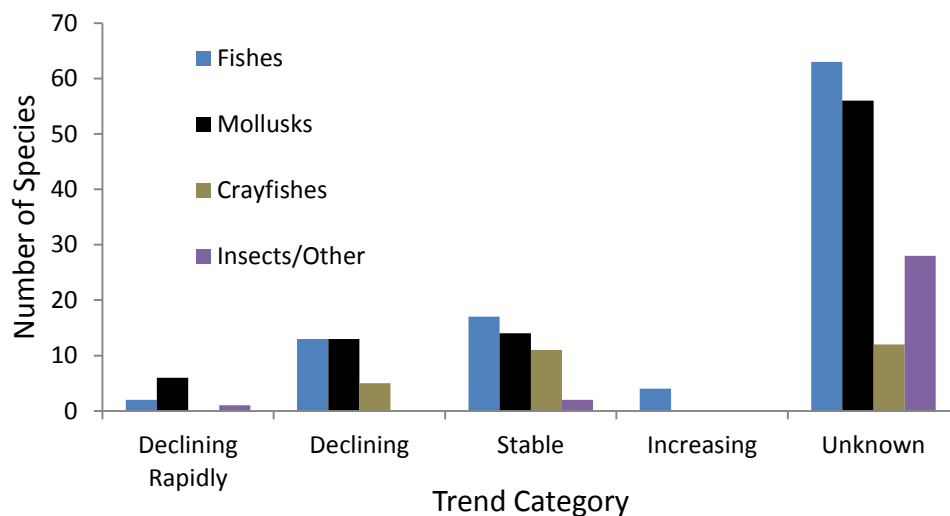
**Figure 2.** Range size category by taxonomic group as determined for Georgia’s 2015 SWAP revision.



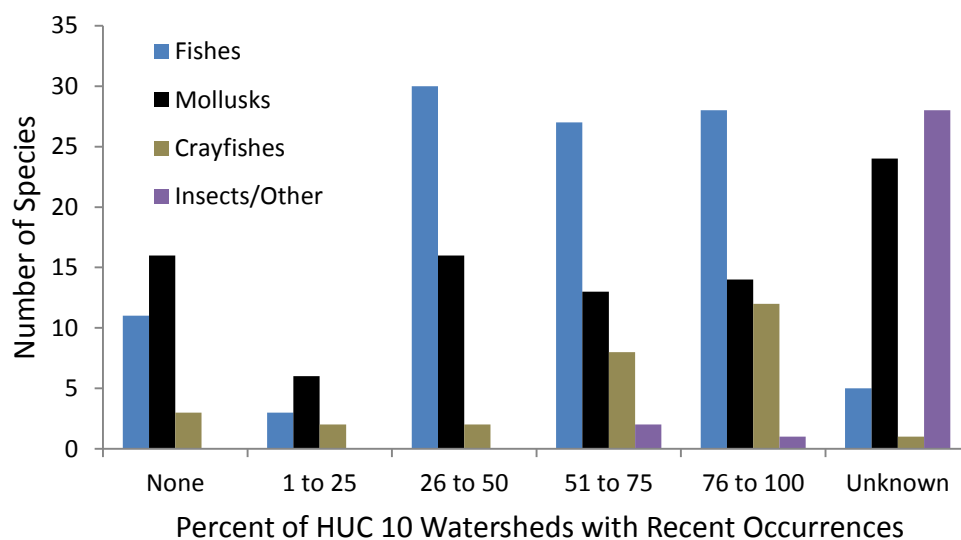
**Figure 3.** Total number of HUC 10 watersheds species have been documented from, summarized by taxonomic group for all species assessed during Georgia's 2015 SWAP revision.



**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>Carpiodes 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

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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 gutselli	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
Pleuronaia 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

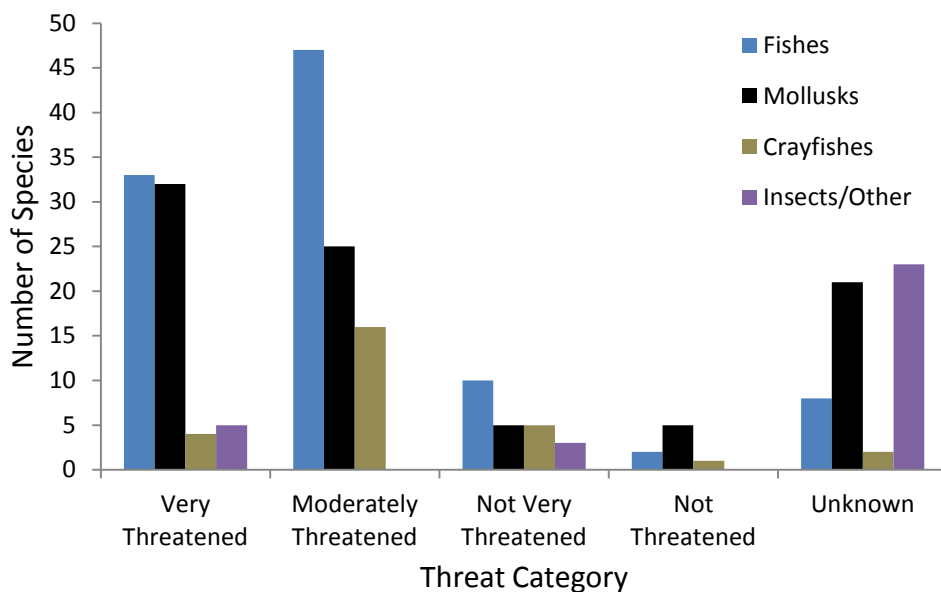
<u>SCIENTIFIC NAME/Group</u>	<u>COMMON NAME</u>	<u>GR</u>	<u>ESA</u>	<u>PETIT.</u>	<u>SR2005</u>	<u>SR2015</u>	<u>SP2005</u>	<u>SP2015</u>	<u>HP2005</u>	<u>HP2015</u>	<u>SC2005</u>	<u>SC2015</u>
Apobaetis etowah	A Mayfly	G5		NO	S1	S1			YES	NO	YES	YES
Beloneuria georgiana	Georgia Beloneurian Stonefly	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.

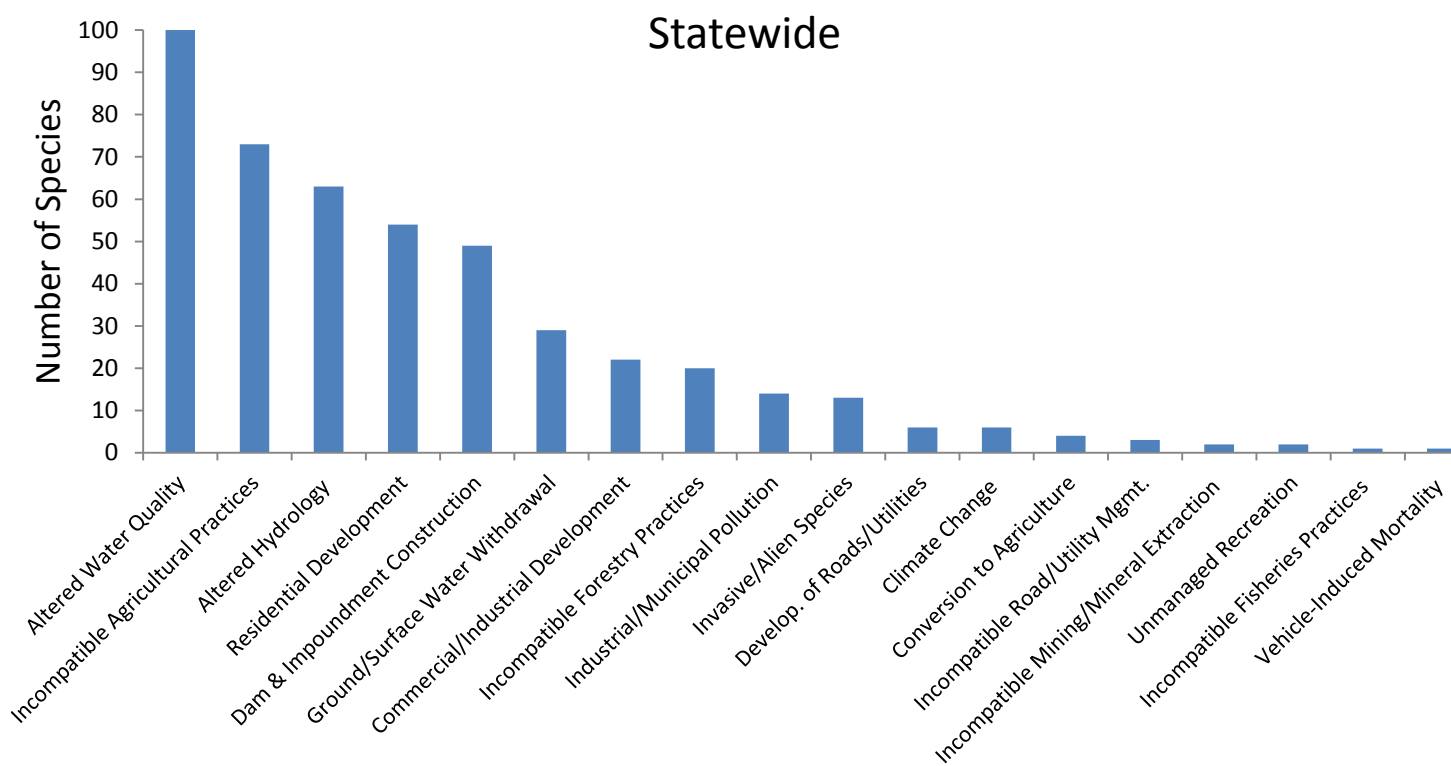
<b>Group</b>	<b>G1-G2 (%)</b>	<b>S1-S2 (%)</b>	<b>SH or SX (%)</b>	<b>ESA</b>	<b>PETIT.</b>
Fishes	16 (6)	58 (21.9)	6 (2.3)	10	12
Mollusks	43 (20.4)	58 (27.5)	38 (18.0)	13	20
Crayfishes	13 (18.6)	25 (35.7)	0 (0.0)	0	11
Insects/Other	14 (?)	11 (?)	4 (?)	0	5
Total	86 (?)	152 (?)	48 (?)	23	48

### Summary of Threats

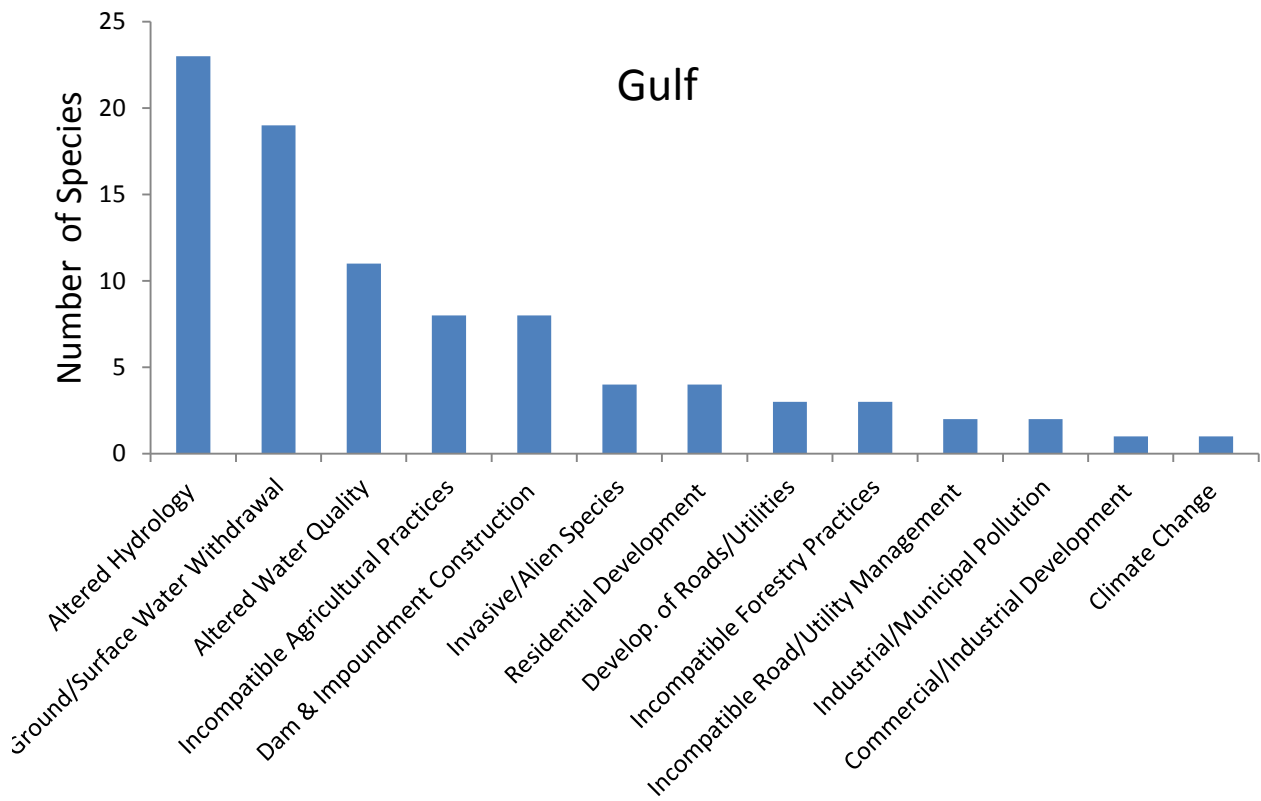
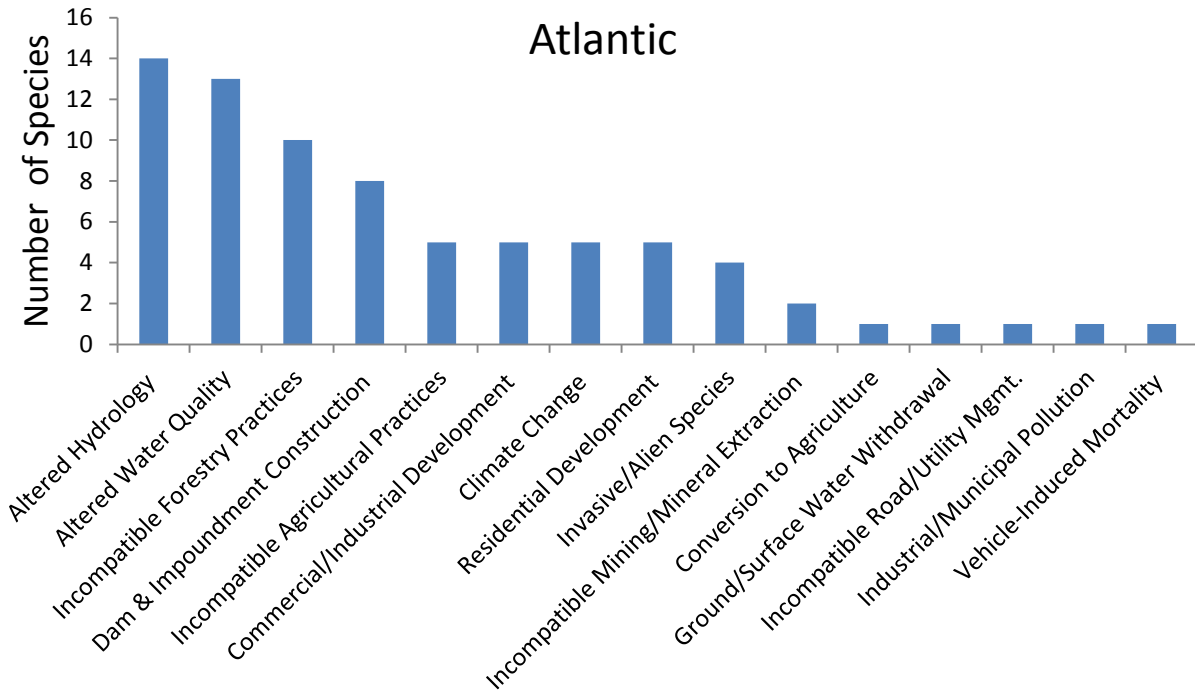
The majority of fishes, mollusks, and crayfishes were categorized as moderately to very threatened ([Figure 7](#)). Altered water quality, incompatible agricultural practices, altered hydrology, residential development, and dam and impoundment construction were identified as the top five threats to the 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.



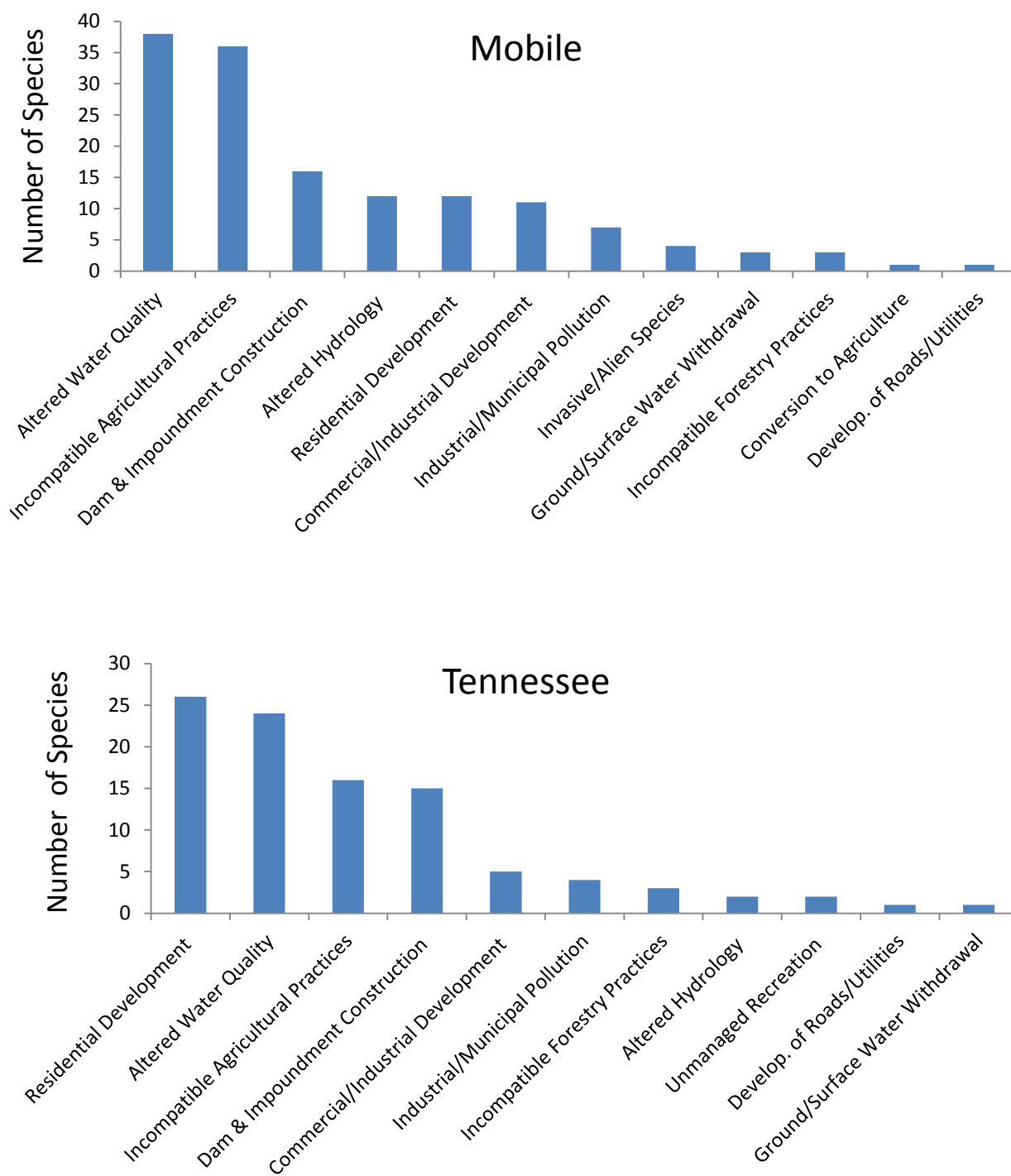
**Figure 7.** Degree of threat affecting species considered in Georgia’s 2015 SWAP revision, summarized by taxonomic group.



**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.

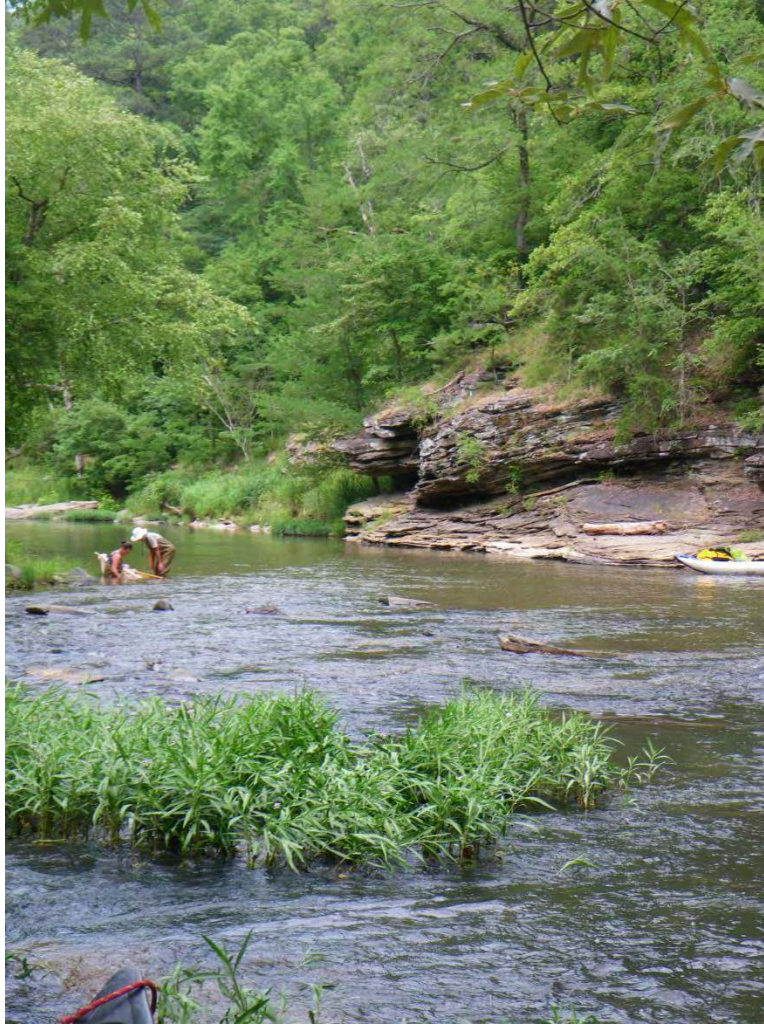
Clearly, there is a need to focus on protection and restoration of aquatic habitats supporting multiple species. To that end, we have attempted to identify conservation actions that would benefit multiple species and habitats. For example, monitoring large river aquatic communities and water quality 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