

**A Species Action Plan for the
Georgia Blind Salamander
*Eurycea wallacei***

**Final Draft
November 1, 2013**



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GEORGIA BLIND SALAMANDER ACTION PLAN TEAM

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EXECUTIVE SUMMARY

The Georgia blind salamander (*Eurycea wallacei*) is known from Jackson, Washington, and Calhoun counties in northwestern Florida, and Decatur and Dougherty counties in southwestern Georgia. This species lives permanently underground within springs and flows of aquatic caves and aquifers, and cannot survive naturally outside this environment. In conjunction with its highly specialized habitat and lifestyle, this species does not undergo natural metamorphosis, but retains its aquatic larval body form throughout life. Because it is difficult to access and sample habitats in which the Georgia blind salamander may occur, it is probable that this species remains undocumented from additional sites within historically-occupied water basins.

In 2010, the Florida Fish and Wildlife Conservation Commission (FWC) directed a biological review group (BRG) to evaluate the status of all species state-listed as Endangered, Threatened, or Species of Special Concern that had not undergone a status review in the past decade, including the Georgia blind salamander. Using criteria developed by the International Union for Conservation of Nature, the BRG concluded that the geographic range of Georgia blind salamanders was characterized by a limited extent of occurrence ($< 20,000 \text{ km}^2$ [7,722 mi^2]), limited area of occupancy ($< 2,000 \text{ km}^2$ [772 mi^2]), and severe fragmentation (documented from < 10 locations). The BRG concluded that these limitations are exacerbated by projected decreases in water quality and increases in groundwater use to support a growing human population in Florida and Georgia (FWC 2011). Based on these findings and information received from independent reviewers, the BRG recommended that the Georgia blind salamander be listed as Threatened on the Florida Endangered and Threatened Species List.

The Georgia blind salamander will likely always meet listing criteria. Therefore, the goal of this plan is to address and mitigate the threats to this species and its habitat, which in turn should prevent further population declines (or enhance populations where practical) in Florida. To achieve this goal, the following objectives should be addressed: determine specific habitat needs of the Georgia blind salamander; maintain or enhance suitable habitat, inclusive of watersheds, at locations known to support this species; and promote education and outreach to benefit this species.

This plan details the actions necessary to improve the conservation status of the Georgia blind salamander. A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Chapter 68A-27, Florida Administrative Code, Rules Relating to Endangered or Threatened Species. The ISMP will address comprehensive management needs for 60 of Florida's imperiled species and will include an implementation plan; rule recommendations; permitting standards and exempt activities; anticipated economic, ecological, and social impacts; projected costs of implementation and identification of funding sources; and a revision schedule. The imperiled species management planning process relies heavily on stakeholder input and partner support. This level of involvement and support is also critical to the successful implementation of the ISMP. Any significant changes will be made with the continued input from stakeholders.

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GLOSSARY OF TERMS AND ACRONYMS

Aquatic Cave: A Florida Natural Areas Inventory classification defined as underground cavities ranging from shallow pools to completely inundated caverns. Aquatic caves are found statewide, and develop as water moves through underlying limestone, dissolving and eroding it, and creating fissures and caverns. They often support stygobitic fauna.

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (e.g., gravel, sand, or silt) from which groundwater can be extracted using a well.

Biological Status Review: The summary of the biological review group's findings. Includes a Florida Fish and Wildlife Conservation Commission (FWC) staff recommendation on whether or not the species status meets the listing criteria in Rule 68A-27.001, F.A.C. These criteria, based on International Union for Conservation of Nature criteria and guidelines, are used to help decide if a species should be added or removed from the Florida Endangered and Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

BRG: Biological review group, a group of taxa experts convened to assess the biological status of taxa using criteria specified in Rule 68A-27.001, Florida Administrative Code, and following the protocols in the Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1).

Conservation Easement: A power invested in a qualified private land conservation organization or government (municipal, county, state, or federal) to constrain, as to a specified land area, the exercise of rights otherwise held by a landowner so as to achieve certain conservation purposes.

DEP: Florida Department of Environmental Protection

DOACS: Florida Department of Agriculture and Consumer Services

EPA: United States Environmental Protection Agency

F.A.C.: Florida Administrative Code. The Department of State's Administrative Code, Register and Laws Section is the filing point for rules promulgated by state regulatory agencies. Agency rulemaking is governed by Chapter 120, Florida Statutes, the Administrative Procedures Act. Rules are published in the Florida Administrative Code.

Facultative: For the purposes of this plan, this term refers to wildlife that may inhabit caves, but are not dependent upon caves for direct survival.

FDOH: Florida Department of Health

GLOSSARY OF TERMS AND ACRONYMS

Floridan Aquifer: The Florida portion of the principal aquifer found in the coastal regions of the southeastern United States. The Floridan aquifer is one of the world's most productive aquifers and is located beneath all of Florida, most of coastal Georgia, and portions of coastal Alabama and South Carolina.

FNAI: Florida Natural Areas Inventory, a non-profit organization administered by Florida State University and dedicated to gathering, interpreting, and disseminating information critical to the conservation of Florida's biological diversity.

F.S.: Florida Statutes

FSI: Florida Springs Initiative, a program of the Florida Department of Environmental Protection, focused on scientific research, water quality testing, biological monitoring, education and outreach, landowner assistance projects, and springs restoration.

FWC: Florida Fish and Wildlife Conservation Commission, the state agency constitutionally mandated to protect and manage Florida's native fish and wildlife species.

GDNR: Georgia Department of Natural Resources, a state agency that is constitutionally mandated to sustain, enhance, protect, and conserve Georgia's natural, historic, and cultural resources for present and future generations.

Gravid: A biological term that refers to an impregnated animal that has not yet laid eggs or given birth.

Guano: The feces and urine of cave-dwelling bats.

IFAS: University of Florida Institute of Food and Agricultural Sciences

ISMP: Imperiled Species Management Plan

IUCN: International Union for Conservation of Nature, a professional global conservation network.

IUCN Red List: (IUCN Red List of Threatened Species) An objective, global approach for evaluating the conservation status of plant and animal species, the goals of which are to identify and document those species most in need of conservation attention if global extinction rates are to be reduced; and provide a global index of the state of change of biodiversity.

Karst: An irregular limestone region with sinkholes, underground streams, and caverns.

Marianna Lowlands–Dougherty Karst Plain: A region located in southwestern Georgia, southeastern Alabama, and the central Florida Panhandle, characterized by abundant limestone, caves, sinkholes, and springs. In Florida, it encompasses the northern portions of Bay and Calhoun counties, portions of Walton County, all of Jackson County, and

GLOSSARY OF TERMS AND ACRONYMS

most of Washington and Holmes counties. The Marianna Lowlands is a karst plain drained by the Chipola River, the largest tributary within the Apalachicola River Basin.

MFLs: Minimum Flows and Levels, the minimum water flows and/or levels adopted by the District Governing Board as necessary to prevent significant harm to the water resources or ecology of an area resulting from permitted water withdrawals. MFLs define how often and for how long high, average, and low water levels and/or flows should occur to prevent significant harm. When use of water resources alters the water levels below the defined MFLs, significant ecological harm can occur.

NFREC: North Florida Research and Education Center, one of the largest and the most diverse units of the University of Florida Institute of Food and Agricultural Sciences. The NFREC consists of research and education campuses in Quincy and Marianna, Florida that focus on enhancing agriculture, natural resources, and quality of life through science.

NRCS: Natural Resources Conservation Service, a branch of the United States Department of Agriculture.

NWFWMD: Northwest Florida Water Management District

Oligotrophic: A descriptive term for water bodies that lack plant nutrients such as phosphates, nitrates, and organic matter, consequently having few plants and a large amount of dissolved oxygen.

Sinkhole: A Florida Natural Areas Inventory classification defined as a cylindrical or steep-sided conical depression that is generally formed by the slumping of soil into subterranean cavities or the solution of limestone near the surface. They occur statewide, but are most common in areas of karst terrain in north and central Florida, where the underlying limestone is riddled with solution cavities.

Stygobitic: A descriptive term for organisms that live permanently underground within groundwater systems, such as caves and aquifers, and cannot survive naturally outside this environment. Unlike troglobitic organisms that live in caves and spaces above the water table, stygobitic fauna live within freshwater aquifers and pore spaces of limestone, calcrete, or laterite.

Subterranean: A Florida Natural Areas Inventory category that includes aquatic and terrestrial cave classifications. Subterranean is defined as the twilight, middle, and deep zones of natural chambers overlain by the earth's crust.

Take: As defined in Rule 68A-27.001(4), Florida Administrative Code. "To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct."

UGA/CE: University of Georgia Cooperative Extension, a county, state, and federally funded partnership.

GLOSSARY OF TERMS AND ACRONYMS

USACE: United States Army Corps of Engineers

USDA: United States Department of Agriculture

USFWS: United States Fish and Wildlife Service, the federal agency mandated to protect and manage the nation's native wildlife and freshwater fish resources.

USGS: United States Geological Survey

Voucher Specimen: A specimen that is retained as a reference to document an occurrence.

INTRODUCTION

Biological Background

The Georgia blind salamander (*Eurycea wallacei*; [Figure 1](#)) was originally described as *Haideotriton wallacei* by Carr (1939) from a 60-m (200-ft) deep artesian well in Albany, Georgia. Nineteen years later, Pylka and Warren (1958) discovered the species in an aquatic cave near Marianna, Florida. Recently, Frost et al. (2006) recommended the genus *Haideotriton* be synonymized with the genus *Eurycea* (Rafinesque 1822).



Figure 1. Juvenile Georgia blind salamander (*Eurycea wallacei*). Photograph by Nathanael Herrera, Florida State University.

The Georgia blind salamander is a stygobitic salamander (it lives permanently in underground water systems) known from subterranean springs and flows of aquatic caves and aquifers within the Marianna Lowlands–Dougherty Karst Plain physiographic region of the Floridan aquifer (Means 1992, Petranka 1998, Hammerson 2004; [Appendix 1](#)). In Florida, this species has been found within 2 river basins, the Chipola and Choctawhatchee, at 22 sites in Jackson County, 5 sites in Washington County, and 1 site in Calhoun County (Florida Natural Areas Inventory [FNAI], unpublished data; [Figure 2](#)). In Georgia, this species has been found within the Flint River basin, at 1 site in Decatur County and 2 sites in Dougherty County (Hammerson 2004). Because it is difficult to access and sample habitats in which the Georgia blind salamander may potentially occur, it is probable that this species remains undocumented from additional sites within historically-occupied water basins.

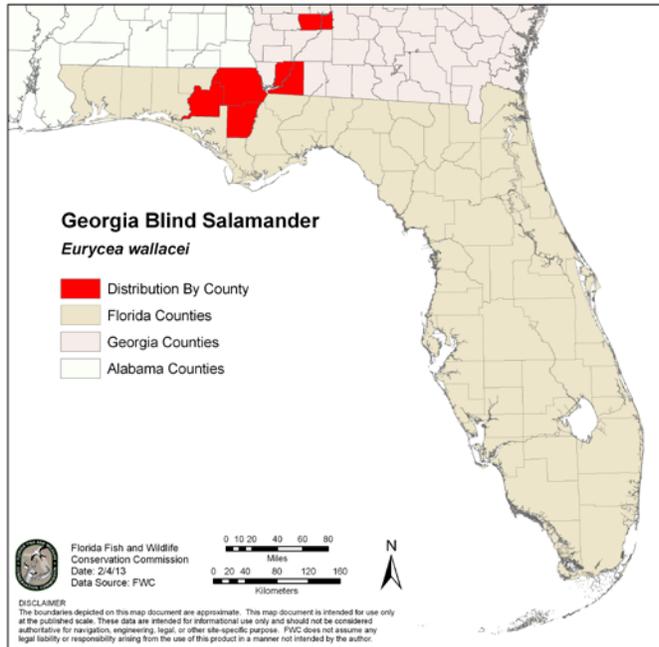


Figure 2: Counties in which the Georgia blind salamander (*Eurycea wallacei*) is known to occur.

eyes are vestigial (tiny, barely visible dark spots) and show no response to light. Body pigmentation is greatly reduced to a slightly translucent, pinkish-white color in adults (Figure 3); however, juveniles may have dark speckling (Pylka and Warren 1958, Valentine 1964, Brandon 1971; Figure 1). Adults are generally 25 to 50 mm (1 to 2 in), but can reach lengths of 76 mm (3 in) (Means 1992).

Gravid Georgia blind salamanders have been found in May and November (Carr 1939, Means 1977), suggesting aseasonal breeding, but the reproductive biology of this species is otherwise unknown (Means 1992). This species typically rests on bottom sediments and relies on tactile cues or smells to detect food (Petranka 1998). Prey consists of aquatic invertebrates, including small crustaceans (e.g., ostracods, amphipods, isopods, and copepods) and insects (Lee 1969, Peck 1973). Although observations are lacking, likely predators include cave crayfishes, eels, bullheads (*Ameiurus* spp.), and chubs (Means 1992). This species may be parasitized by nematodes in its digestive tract (Lee 1969). Other aspects of species life history and behavior are largely unknown due to difficulty of accessing its habitat and observing free-living individuals.



Figure 3. Adult Georgia blind salamander (*Eurycea wallacei*). Photograph © Barry Mansell.

Conservation History

The Georgia blind salamander has been found at 26 sites in Florida (FNAI, unpublished data; [Figure 4](#)) and 3 sites in Georgia (Jensen and Owers 2009). Currently, this species has no federal protection; however, it is state-listed in Florida as a Species of Special Concern and in Georgia as a Threatened species (Jensen and Owers 2009). In Georgia, suggested protective measures include the establishment of conservation easements, or acquisition of lands that contain suitable habitat by conservation agencies or organizations (Jensen and Owers 2009).

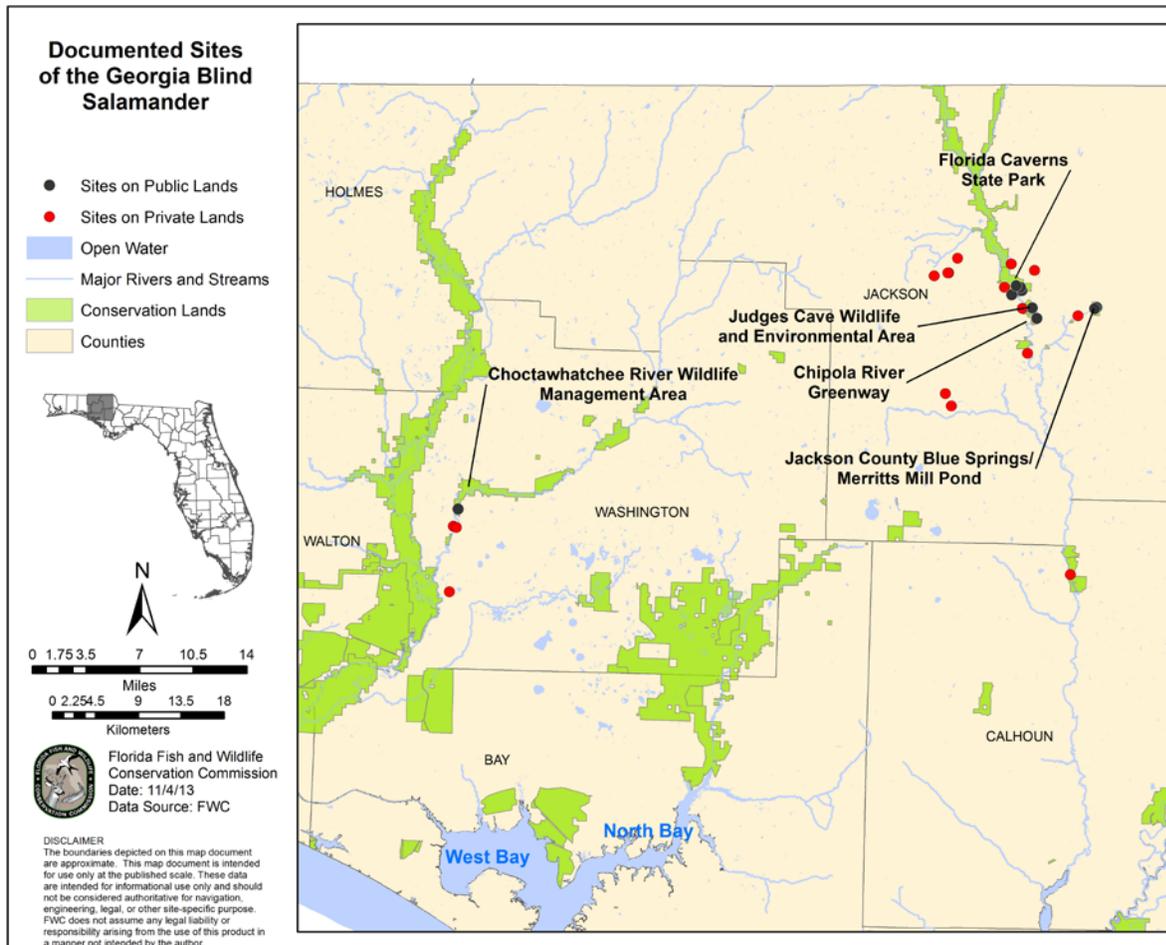


Figure 4. Documented sites of the Georgia blind salamander (*Eurycea wallacei*) on managed lands (black points) and private land (red points) in Washington, Calhoun, and Jackson counties, Florida.

In 2010, the Florida Fish and Wildlife Conservation Commission (FWC) directed a biological review group (BRG) to evaluate the status of all species state-listed as Endangered, Threatened, or Species of Special Concern that had not undergone a status review in the past decade through a biological species review. Using criteria developed by the International Union for Conservation of Nature (IUCN), the BRG concluded that the geographic range of Georgia blind salamanders was characterized by a limited extent of occurrence ($< 20,000 \text{ km}^2$ [$7,722 \text{ mi}^2$]), limited area of occupancy ($< 2,000 \text{ km}^2$ [772 mi^2]), and severe fragmentation (documented from < 10 locations).

The BRG concluded that these limitations are exacerbated by projected decreases in water quality and increases in groundwater use to support a growing human population in Florida and Georgia (FWC 2011). FWC staff developed an initial draft of a Biological Status Review, which included the BRG's findings, and a preliminary listing recommendation from staff. The draft was sent out for peer review and the reviewers' inputs were incorporated into a [final report](#).

Threats and Recommended Listing Status

The specialized habitat, physiology, and life history of the Georgia blind salamander render it vulnerable to water pollution, water level changes, and habitat disturbance. Sources of water pollution in caves, springs, and sinkholes include septic tank effluent, fertilizers, pesticides, hazardous wastes, runoff from impervious surfaces, waste from cattle ranches and farms, and siltation and erosion (Brandt and Jackson 2003). Most sites from which the species has been documented are associated with aquifers and underground streams located beneath private lands, and thus are at risk from one or more of these threats (Means 1992, Morris 2006).

Changes in water levels can be caused by groundwater withdrawal for human use, such as agricultural drawdowns and pumping from wells, and from decreases in precipitation caused by climate change or periodic drought. However, the specific hydrological effects of aboveground activities on belowground water levels remain to be determined.

Sea level rise may push the salinity gradient upstream in rivers, especially if the counteraction of freshwater flows from precipitation decreases ([Figure 5](#)). Conversely, storm intensity is expected to increase with climate change, potentially causing surges of water during heavy rain periods that could degrade habitat, wash Georgia blind salamanders into unsuitable sites, or decrease the abundance and variety of prey.

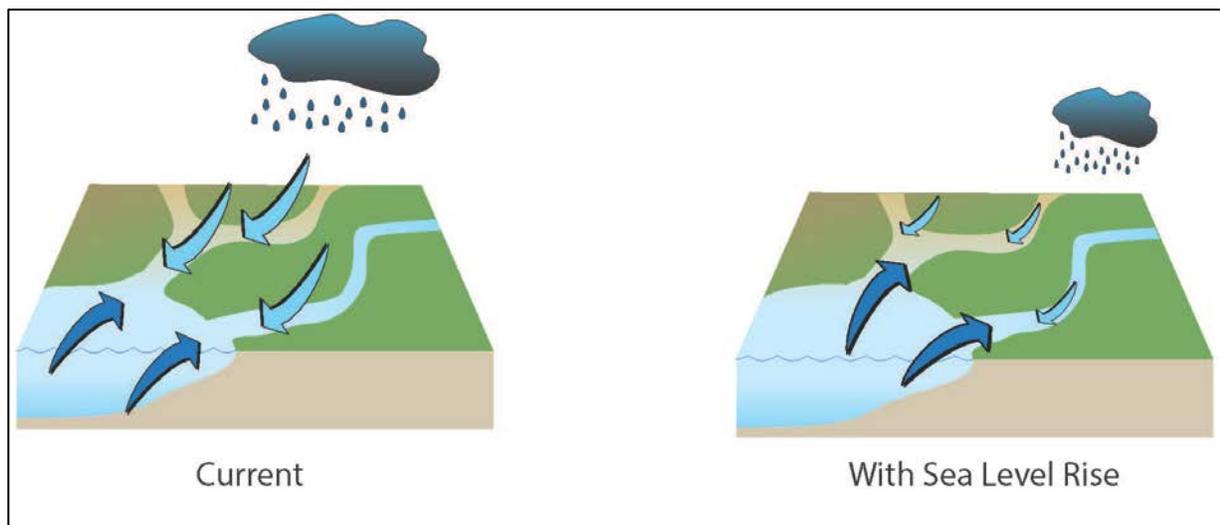


Figure 5. The potential effects of decreased precipitation levels and sea level rise on freshwater systems. Illustration by Whitney Gray, FWC.

In 2011, based on the BRG findings, a literature review of current threats to Georgia blind salamanders and their habitat, and information received from independent reviewers, the BRG recommended that the Georgia blind salamander be listed as Threatened on the Florida Endangered and Threatened Species List.

CONSERVATION GOALS AND OBJECTIVES

Goal

The conservation status of the Georgia blind salamander is improved to the point that the species is secure within its historical range in Florida.

Objectives

I. Determine specific habitat needs for the Georgia blind salamander.

Rationale

Little is known about the habitat requirements of the Georgia blind salamander. Collecting baseline data on habitat parameters within the accessible parts of the caves or springs, such as water depth, water and air temperature, dissolved oxygen content, turbidity, nutrient levels, and substrate composition, is necessary to better determine the range of environmental conditions under which this species typically occurs. These data will ultimately help to determine the vulnerability of this species to habitat degradation and how best to maintain or improve habitat quality across the historical range of the species.

II. Maintain or enhance suitable habitat, inclusive of watersheds, for the Georgia blind salamander.

Rationale

Georgia blind salamanders are currently known from 26 sites in Florida. Maintaining or improving suitable habitat by encouraging improved water quality and sufficient water quantity in areas known to support this species is essential towards preventing further population declines and ultimately improving the conservation status of this species. Interagency partnership-building and collaboration on research projects, pooling of resources, and sharing of data will further enhance the efficacy of these efforts, thereby enhancing the likelihood of conserving suitable habitat.

III. Promote education and outreach to benefit the Georgia blind salamander.

Rationale

It will be essential to educate law enforcement and the public, specifically cave recreationists, on the identification, biology, management requirements, and threats to Georgia blind salamanders. Similarly, outreach efforts with land and business owners, professional societies, and private organizations may be necessary to achieve plan objectives.

CONSERVATION ACTIONS

The following sections describe the conservation actions that will make the greatest contribution toward achieving the conservation objectives. Actions are grouped by category (e.g., Habitat Conservation and Management, Population Management). The Conservation Action Table ([Table 1](#)) provides information on action priority, urgency, potential funding sources, likely effectiveness, identified partners, and leads for implementation.

Habitat Conservation and Management

Aquatic caves, springs, and underground streams face many threats, including altered hydrologic regimes; agricultural, residential, and industrial pollution; erosion; and sedimentation, all of which lead to water quality degradation (FWC 2005). Because stygobitic species such as the Georgia blind salamander are uniquely adapted to survive in these habitats, they can be highly sensitive to shifts in environmental conditions.

Action 1 Monitor environmental conditions at specific sites known to support Georgia blind salamanders to identify parameters of suitable habitat and focus conservation efforts.

Environmental conditions, including water level, water and air temperature, dissolved oxygen content, water turbidity, nutrient and contaminant levels, and sediment composition, need to be determined at sites known to support Georgia blind salamanders. Maximum depth and distance to the cave entrance from the data collection site should also be recorded (Morris 2006). Collecting and analyzing environmental data will help researchers determine the range of conditions necessary for survival of this species, and in turn develop a baseline for suitable habitat ([Figure 6](#)).

Unprotected caves and watersheds within the range of this species that meet these conditions should be the focus of habitat conservation initiatives.



Figure 6. Georgia blind salamander (*Eurycea wallacei*) habitat at Florida Caverns State Park in Jackson County, Florida. Photograph by Amy Raybuck., FWC

All springs within the range of Georgia blind salamanders discharge from the Floridan aquifer and, depending on their geographical location, receive protection by the Florida Department of Environmental Protection (DEP) or the Environmental Protection Division of the Georgia Department of Natural Resources (GDNR). In Florida, the Northwest Florida Water Management District (NFWFMD) has partnered with the Florida Springs Initiative (FSI) in protecting springs within several river basins in the Florida Panhandle. This partnership has resulted in successful spring restorations in Washington County, one of the 3 counties that support populations of the Georgia blind salamander. One of the top objectives of the FSI is to research the biological effects of nutrient thresholds in the water column (FSI 2007). These

efforts could be expanded to include springs and flows inhabited by the Georgia blind salamander, resulting in a wealth of knowledge on water quality and the biological status of these sites. In 2008, the GDNR adopted a comprehensive statewide water management plan that includes regional resource assessments and water planning. One of these regions, the Lower Flint–Ochlockonee, covers 14 counties in southwestern Georgia, including the 2 counties where this species has been documented. Collaboration with GDNR on implementation of this plan will aid FWC in habitat conservation planning efforts for the Georgia blind salamander, ultimately improving the conservation status of this species.

Collaboration with other agencies and universities on habitat conservation and protection, environmental monitoring, and speleological (i.e., cave) research is essential. Potential partners include the Florida Department of Agriculture and Consumer Services (DOACS), DEP, Florida Department of Health (FDOH), North Florida Research and Education Center (NFREC), county extension offices within the University of Florida’s Institute of Food and Agricultural Sciences (IFAS) and the University of Georgia Cooperative Extension (UGA/CE), and The Nature Conservancy. Additionally, collaboration with federal agencies such as U.S. Environmental Protection Agency (EPA), U.S. Army Corps of Engineers (USACE), U.S. Department of Agriculture (USDA), U.S. Geological Survey (USGS), and the U.S. Fish and Wildlife Service (USFWS) would facilitate conservation of blind salamanders (see [Action 10](#)).

Action 2 Evaluate the impacts of human recreational activities within caves and springs, where the Georgia blind salamander is known to occur, and ensure that conservation goals are compatible.

Human activity in caves can adversely affect the Georgia blind salamander and its habitat through increased siltation, mortality of salamanders and their prey, introduction of invasive pathogens on caving equipment, and intentional removal of salamanders (Brandt and Jackson 2003, Jensen and Owers 2009; see [Rule and Permitting Intent](#)). These threats are even more significant in fragile or sensitive systems that experience high activity, particularly by cavers who are unaware of their potential impacts. Human disturbance may also displace colonies of cave-roosting bats, the guano from which can be an important source of nutrient input into some cave systems (Ludlow and Gore 2000). In springs, human-related impacts can include destruction of aquatic vegetation by overuse or misuse, and the introduction and proliferation of non-native plants and animals. Overuse is likely to increase because of the limited number of publicly-accessible springs, and increasing recreational pressure on these habitats (FNAI 2010).

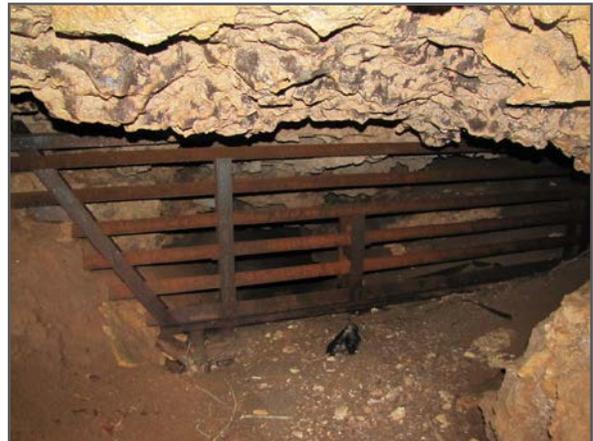


Figure 7. Bat-friendly cave gate protecting a sensitive cave system from unauthorized human entry, Jackson County, Florida. Photograph by Amy Raybuck, FWC.

As a last resort, damaging or unsustainable use of caves may be prevented by installation of specialized gates that inhibit access to human trespassers, without affecting accessibility to facultative cave-inhabiting wildlife, such as bats ([Figure 7](#)). However, there may be solutions for

agencies to avoid costly gate installation while protecting against water quality degradation and associated sources of potentially harmful recreational activities.

Potential solutions include the following:

- Collaborating with organizations and societies passionate about recreational caving activities to create partnerships in protecting and conserving Georgia blind salamander habitat (see [Education and Outreach](#)), as well as aiding in monitoring efforts (see [Monitoring and Research](#)).
- Evaluating success of setting maximum group sizes and daily visitation limits into caves. A self-registration booth could enable cavers to monitor themselves to avoid exceeding the daily visitation limit. Additionally, this could give researchers or state park staff an estimate of daily use.
- Where possible, establishing “show caves” for tourists, school children, and inexperienced cavers to reduce activity in more sensitive “wild” cave areas.
- Establishing information booths outside caves on public lands (e.g., Florida Caverns State Park) to educate visitors about cave fauna and threats, as well as ways to mitigate damage to the cave and its features.

Action 3 Collaborate with the NFWFMD to determine the potential for establishing minimum water flows and levels (MFLs) in areas of Georgia blind salamander occurrence.

As the human population increases, aquifers in southwestern Georgia and northwestern Florida will experience increased water withdrawal for commercial, farm, and residential use (e.g., irrigation of crops and lawns, sanitation, and general consumption). Water withdrawal threatens Georgia blind salamanders through changes in environmental conditions (e.g., decreased water levels can lead to super-saturation of calcium, carbonates, and other ions), as well as decreased amount of suitable habitat (see [Action 1](#)). Loss of suitable habitat could lead to decreased prey abundance, increased predation and competition, as well as direct mortality of this species following complete withdrawal of water (Lee 1969). Moreover, a significant drop in the aquifer’s water level could potentially reduce naturally-occurring nutrient input into aquatic caves.

In addition to monitoring water levels of aquifers within the Marianna Lowlands–Dougherty Karst Plain, collaboration with a variety of agencies, landowners, organizations, and universities to monitor groundwater withdrawal and protect springs within the range of the Georgia blind salamander ([Figure 4](#)) is crucial (see [Action 10](#)). The current method for protecting springs in Florida includes issuing consumptive use permits and establishing MFLs for springs or rivers that contain springs (FSI 2007). The MFL program established by the NFWFMD ensures that water withdrawals will not be “significantly harmful to the water resources or ecology of the area” (s. 373.042[1] of the Florida Statutes [F.S.]), which includes protection of non-consumptive uses (e.g., Threatened species conservation).

In 2002, the Florida Legislature amended Chapter 373, F.S., requiring NFWFMD to include all first-magnitude (≥ 64.6 million gallons per day [mgd]) and significant second-magnitude springs (6.46 to 64.6 mgd) on their priority lists for the development of MFLs (FSI 2007). In Jackson County (which contains 79% of Georgia blind salamander sites in Florida; [Figure 4](#)), Jackson

Blue, a first-magnitude spring ([Appendix 2](#)), was ranked number 5 out of 7 on the NFWFMD's 2011 priority list (NFWFMD 2011). However, Jackson Blue is surrounded by numerous springs and cave systems, some of which are inhabited by the Georgia blind salamander. Collaborating with NFWFMD to explore the benefits of establishing a MFL in Jackson County could result in a higher ranking on the MFL priority list. The annual priority list and schedule for the development of MFLs are submitted to DEP for review and approval each November (NFWFMD 2011).

Population Management

No actions specific to the Georgia blind salamander have been identified for this category.

Monitoring and Research

Action 4 Conduct regular monitoring for Georgia blind salamanders at known and potential sites.

In southern Georgia and northern Florida, 267 caves were deemed biologically significant for cave-dwelling fauna by Franz et al. (1994). However, not all of these systems were within the range of the Georgia blind salamander. Nonetheless, from 2002 to 2006, Morris (2006) conducted a comprehensive biological inventory of aquatic caves, springs, and sinks across Florida, which led to the discovery of this species at 5 sites within the Choctawhatchee River Basin in Washington County. Follow-up surveys of the sites surveyed by Morris (2006) would aid monitoring efforts and potentially identify additional occurrences. Collaboration with the [Florida Museum of Natural History](#) to catalog and store voucher specimens would also be beneficial (see [Education and Outreach](#)).

During surveys, researchers should estimate the diversity and abundance of other stygobitic species (several of which may be predators or prey of the Georgia blind salamander), and the general location of faunal concentrations within the cave system (Morris 2006). Georgia blind salamanders are commonly found in the same location as Dougherty Plain blind crayfish (*Cambarus cryptodytes*; Pylka and Warren 1958; Means 1977, 1992). Presence of these crayfish may indicate suitable habitat for Georgia blind salamanders and could potentially influence future planning of reintroduction or restocking efforts.

The FWC will need to collaborate with federal and state agencies, as well as groups that specialize in recreational cave activities, to aid in conservation and protection of the Georgia blind salamander (see [Action 2](#) and [Education and Outreach](#)). In particular, partnering with the USFWS through the USFWS Florida–Georgia Coordinated Candidate Species Assessment Grant will help to further develop state conservation strategies to conserve this species. Research that focuses on baseline status surveys, habitat modeling, and genetics of the Georgia blind salamander will be beneficial for all agencies involved. Because identification of this species is fairly simple (visually dissimilar to any other salamander within its range), cave recreationalists could be requested to document occurrences of blind salamanders, as well as other cave-dwelling species. FNAI should be considered as a collaborative partner in receiving, storing, and processing such data.

Rule and Permitting Intent

Action 5 Protect the Georgia blind salamander from take.

The Georgia blind salamander may be desirable as a pet due to its rarity. This species is currently protected by the FWC as a Species of Special Concern. However, it is proposed to remain state-listed as a Threatened species following approval of the Imperiled Species Management Plan, which will result in increased protections against unauthorized possession or take.

Protections

The Georgia blind salamander is provided protection in accordance with Rule 68A-27.003, Florida Administrative Code (F.A.C), in which it is illegal to take, possess, or sell this species without an authorized permit, where the definition of *take* means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct.”

Permitting

Designation of Threatened Species; Prohibitions; Permits — Provisions for permits to take Georgia blind salamanders are provided in Rule 68A-27.007, F.A.C. This rule authorizes intentional take of Threatened species for “scientific or conservation purposes which will benefit the survival potential of the species except for species that have a permitting standard for intentional take in Rule 68A-27.003, F.A.C., and then that standard will apply. For purposes of this rule, a scientific or conservation purpose shall mean activities that further the conservation or survival of the species, including collection of scientific data needed for conservation or management of the species.”

Requirements for permit requests must include an assessment of the following:

- Adequate justification for taking Georgia blind salamanders from the wild
- Probable direct or indirect effects on Georgia blind salamander populations in the wild
- Potential conflicts with other activities or programs intended to enhance the survival of Georgia blind salamanders in the wild
- Ability of the proposed work to reduce the threat of extinction to Georgia blind salamanders in the wild
- Input from subject matter experts on Georgia blind salamanders
- Whether the expertise, facilities, or other resources available to the applicant are adequate to successfully accomplish the objective(s) stated in the permit application

Criteria for granting permit requests include considerations of the following:

- Foreseeable long-range impacts to Georgia blind salamander populations in the wild
- Impacts to other fish and wildlife species
- Extent of injury, harm, or loss of Georgia blind salamanders
- Reasonable steps taken to avoid, minimize, or mitigate incidental take of Georgia blind salamanders (DOACS 2011)
- Land management activities that benefit wildlife and are in accordance with this plan
- Other factors relevant to the conservation and management of Georgia blind salamanders
- Concurrence and cooperation of appropriate land manager(s) or owner(s)

Law Enforcement

Action 6 Educate FWC law enforcement officers on the identification, distribution, biology, and threats to the Georgia blind salamander.

The FWC’s Division of Law Enforcement, in conjunction with federal, state, and local partners, is responsible for enforcing Florida’s wildlife and fisheries laws. FWC biologists and other subject matter experts can educate law enforcement officers through the development, circulation, and interpretation of Georgia blind salamander informational materials and distribution maps. FWC law enforcement officers should be educated on the basic biology of and threats to blind salamanders, as well as be familiar with all applicable wildlife laws, to be able to effectively enforce violations caused by the unauthorized take of this species. In turn, an important component of the enforcement strategy is ensuring compliance through public education (see [Education and Outreach](#)).

FWC law enforcement officers actively pursue and recommend prosecution for those who intentionally violate wildlife laws. FWC law enforcement officers also educate the public on how to identify and report violations. The Division of Law Enforcement administers the Wildlife Alert program, to which the public can call about potential wildlife violations via a toll-free number (888-404-3922) that is answered 24 hours a day, 7 days a week. Cash rewards are offered to callers who provide information about any illegal activity resulting in an arrest. Callers may remain anonymous.

Incentives and Influencing

Action 7 Encourage private landowners and businesses to conserve and enhance Georgia blind salamander habitat, inclusive of watersheds.

Of the 26 documented Georgia blind salamander sites in Florida, 38% are on conservation or managed areas, whereas 62% are located on private lands (FNAI, unpublished data; [Figure 4](#)). Therefore, coordination and partnership with private landowners and businesses is necessary to conserve suitable habitat and ultimately improve the conservation status of this species.

Providing information, advice, and assistance to private landowners and businesses on the following topics would benefit Georgia blind salamanders and their habitat:

- Environmentally-friendly landscaping including fertilizing, managing pests, mulching, recycling, reducing stormwater runoff, limiting lawn watering, using recirculation systems, reclaiming water, or finding alternate water sources to reduce overall water consumption and the threat of commercial and residential pollutants. Additionally, landowners can contact their county extension offices in [Florida](#) and [Georgia](#) through the IFAS and UGA/CE, respectively (see [Education and Outreach](#)).
- Aquatic cave, sink, spring, and underground stream protection. Private landowners and businesses with aquatic caves, sinks, or springs on their property should be encouraged to find alternative sources of waste removal and refrain from blocking cave entrances. Liability limitations or cost-sharing incentives could encourage landowners to protect

caves occupied by Georgia blind salamanders and secure cave entrances with bat-friendly gates where needed (see [Action 2](#) and [Figure 7](#); FWC 2005).

- Alternatives for wastewater treatment, septic tank maintenance, and stormwater management (see [Education and Outreach](#)).
- Disposal of hazardous wastes. Hazardous wastes can be a potential threat to blind salamander habitat by degrading water quality. Private landowners and businesses should be encouraged to use permanent collection facilities to dispose of paints, solvents, automotive wastes, mercury- or refrigerant-containing wastes, electronics, aerosols, and batteries. Underground storage tanks that contain gasoline, oil, chemicals, or other types of liquids should be inspected regularly for leaks, emptied, and removed, as required by law.

Private landowners should be encouraged to contact the USDA Natural Resources Conservation Service (NRCS) and USFWS on how to participate in federal cost-share programs. At present, the [Environmental Quality Incentives Program](#) and [Wildlife Habitat Incentive Program](#), both offered through the NRCS, provide technical and financial assistance to help plan and implement conservation practices that address natural resource concerns and improve fish and wildlife habitat. Similarly, [Partners for Fish and Wildlife](#) (administered by the USFWS) can provide technical and financial assistance on natural resources issues, including soil and water quality improvement and pesticide-use reduction. Cost-share programs will help landowners reach their management goals, and may in turn enhance conservation efforts for the Georgia blind salamander.

Additionally, private landowners may choose to put Georgia blind salamander-inhabited caves on their property into conservation easements that provide certain protections against disturbance and other adverse, human-induced impacts. Alternatively, FWC or other land management agencies may attempt to purchase private lands with caves inhabited by this species in order to provide the necessary protections thereafter.

Action 8 Encourage the use of best management practices in areas of suitable Georgia blind salamander habitat.

Georgia blind salamander habitat is threatened by declining water quantity (see [Action 3](#)) and quality as a result of agricultural, residential, and industrial practices. In fact, approximately 65% of Florida is in some form of agricultural land use. Sources of chemical pollution include fertilizers, pesticides, herbicides, fungicides, and hazardous wastes. With excessive or unregulated use, these chemicals may seep from the ground surface into aquifers that support stygobitic species including the Georgia blind salamander ([Figure 8](#)).



Figure 8. A harvested cotton field in Jackson County in close proximity (~15 to 20 m [50 to 65 ft]) to a cave known to support Georgia blind salamanders. Photograph by Amy Raybuck, FWC.

Chemical applications, waste treatments, and spills on the surrounding uplands require close monitoring to determine their impacts on subterranean aquatic habitats and potential mitigation measures. Because caves and sinkholes (which are commonly used as dumpsites) serve as large, natural, underground conduits of water, contaminants in these habitats can be carried directly into karst-landscape aquifers. The opportunity for natural breakdown and dilution of chemicals applied into a thick surface-soil layer is lacking. Therefore, the negative impacts caused by pollutants entering caves and sinkholes can be potentially devastating.

To protect Georgia blind salamander habitat from the above-mentioned threats, residential and commercial landowners and businesses are encouraged to follow best management practices adopted by the DOACS Office of Agricultural Water Policy (DOACS 2011). These voluntary measures address water quality and quantity on agricultural lands and can potentially avoid or minimize take of state-listed species.

[Actions 7](#) and [8](#) can be facilitated through collaboration with government agencies and universities, including the DEP, FDOH, DOACS, GDNR, NFREC, IFAS, UGA/CE, EPA, USFWS, USACE, USDA, and USGS, as well as non-profit agencies and organizations. Throughout Florida, DEP monitors groundwater for contaminants that can produce adverse health effects, and it also delineates pesticide-contaminated areas by reviewing groundwater data from a variety of sources (DEP 2013a). Similar efforts from other agency initiatives such as the FSI and the [National Water Quality Initiative](#) (administered by the NRCS) could provide valuable water quality information to FWC. In February 2013, DEP adopted pollution-reduction goals affecting approximately 250 springs, including Jackson Blue Spring and Merritts Mill Pond in Jackson County, which are within the range of the Georgia blind salamander. In fact, over the past 2 years, DEP has committed \$11.5 million to spring restoration, outreach, monitoring, and research, and plans to commit an additional \$6.5 million for spring restoration and protection in the 2013-2014 fiscal year (DEP 2013b).

Education and Outreach

Action 9 Educate the public about identification, distribution, biology, threats, conservation value, and management requirements of Georgia blind salamanders.

Georgia blind salamanders are seldom encountered and little known by most people. Therefore, FWC will continue to update its biological species profile on the [FWC's imperiled species webpage](#) with photos and improved distribution maps as they become available. Coordination with FWC community relations staff can broaden outreach efforts using websites, social media, field trips, and workshops. FWC can assist in developing exhibits of this species for presentations, activities, and special events, such as the informative cave exhibit with ecological interpretations currently on display at the [Florida Museum of Natural History](#) in Gainesville. Cave enthusiasts (and associated organizations) educated about the plight of cave fauna, including Georgia blind salamanders, can help improve the conservation status of this species by helping to monitor unsustainable cave use and assisting with research efforts (see [Monitoring and Research](#)). Additionally, information booths could be erected outside caves with high numbers of visitors, such as those on Florida Caverns State Park, to help educate the public about caves and cave-dwelling species (see [Action 2](#)).

In areas of known Georgia blind salamander occurrence, information can be distributed through utility bills, brochures, fliers, and word-of-mouth on reducing groundwater waste and pollution threats. Certification programs that promote effective, prevention-based pest control and green landscaping should be highly publicized across northwest Florida, especially in watersheds occupied by this species. In addition, industrial and commercial entities should ensure compliance with [pesticide certification laws and use](#) (see [Incentives and Influencing](#)).

Potential partners for education and outreach include the Apalachicola Regional Stewardship Alliance, Defenders of Wildlife, East Gulf Coastal Plain Joint Venture, DEP, Florida Wildlife Federation, Georgia Speleological Survey, Gulf Coastal Plain Ecosystem Partnership, IFAS, Audubon Society, National Wildlife Federation, The Nature Conservancy, National Speleological Society, National Caves Association, Partners in Amphibian and Reptile Conservation, Southeastern Cave Conservancy, Inc., and The Wildlife Society.

Coordination with Other Entities

Action 10 Collaborate with other agencies, county extension offices, universities, and local governments regarding implementation of this plan.

A multi-agency collaborative effort across Florida and Georgia, including partnerships with local governments, universities, organizations, and societies, will help to accomplish the objectives and actions outlined in this plan. Cooperation on research projects, pooling of resources, and sharing of data will further enhance the efficacy of these efforts, thereby further enhancing the likelihood of conserving the Georgia blind salamander and its habitat (see [Habitat and Conservation Management](#) and [Education and Outreach](#)).

The FWC offers conservation planning services to local governments during consideration of growth management plan amendments and associated development proposals. Opportunities exist to educate officials, such as municipal and county planners, through presentations at regularly scheduled meetings. In turn, regional FWC staff will be further educated on existing conservation land management practices to enable them to more effectively work with local governments and other stakeholders on issues involving Georgia blind salamanders.

Chapter 163.3177, F.S., requires that county comprehensive growth management plans include a conservation element that identifies areas within the county that support important fish, wildlife, or habitat resources. The conservation element must include the identification of areas within the county that are locations of important wildlife or habitat resources, including state-listed species. This element must contain principles, guidelines, and standards for conservation that restrict activities known to adversely affect the survival of these resources. The FWC is identified as a state agency authorized to review county growth management plans and plan amendments to ensure important state fish, wildlife, and habitat resources are adequately considered. Further, local government land development regulations require conditions that specify how land and water uses will be administered to be consistent with the conservation element of the county growth management plans. Therefore, interagency collaboration on the review and development of the conservation element of these plans is essential for ensuring that they consider wildlife habitat within the county.

Table 1. Georgia Blind Salamander (*Eurycea wallacei*) Conservation Action Table

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
1, 2	1	1	Monitor environmental conditions at specific sites known to support Georgia blind salamanders to identify parameters of suitable habitat and focus conservation efforts.	Habitat Conservation & Mgmt	EXPANDED	NO	YES	\$0-25k	FWC, DEP	FWRI, SCP	DEP, Georgia Department of Natural Resources, DOACS, NFWFMD, universities, landowners	Likely	Practical, but not as feasible; highly contingent upon availability of necessary resources and relationships.	NO; Immediate survival is not under threat. However, this action is critical for long-term survival.
2, 3, 4	3	2	Evaluate the impacts of human recreational activities within caves and springs where the Georgia blind salamander is known to occur, and ensure that conservation goals are compatible.	Habitat Conservation & Mgmt, Monitoring & Research, Protections & Permitting, Education & Outreach, Coordination with Other Entities	EXPANDED	NO	YES	\$0-25k	FWC, DEP, NFWFMD	SCP	DEP, Georgia Department of Natural Resources, NFWFMD, caving societies, landowners	Likely	Feasible and practical with the proper resources and relationships.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.
2, 4	4	3	Collaborate with the Northwest Florida Water Management District to determine the potential for establishing minimum water flows and levels (MFLs) in areas of Georgia blind salamander occurrence.	Habitat Conservation & Mgmt, Coordination with Other Entities	NEW	NO	YES	TBD	FWC, NFWFMD	FWRI, SCP	NFWFMD, DOACS	Moderately likely	Practical, but not as feasible; highly contingent upon availability of necessary resources and relationships.	NO; Immediate survival is not under threat. May be completed following successful implementation of all higher priority actions, and availability of adequate resources.
1, 2, 4	2	4	Conduct regular monitoring for Georgia blind salamanders at known and potential sites.	Monitoring & Research, Coordination with Other Entities	EXPANDED	NO	YES	\$0-25k	FWC, DEP, universities	FWRI, SCP	DEP, universities, caving societies, landowners	Likely	Practical, but not as feasible; highly contingent upon availability of necessary resources and relationships.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.
3, 4	3	5	Protect the Georgia blind salamander from take.	Protections & Permitting, Law Enforcement, Education & Outreach	ONGOING	YES	YES	\$0-25k	FWC	LE	Not Applicable	Likely	Highly feasible and practical; practices ongoing in some areas.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.
3	3	6	Educate FWC law enforcement officers on the identification, distribution, biology, and threats to the Georgia blind salamander.	Law Enforcement, Protections & Permitting, Education & Outreach	NEW	YES	YES	TBD	FWC	SCP, LE	Not Applicable	Likely	Feasible and practical with the proper resources and relationships.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.
2, 3	1	7	Encourage private landowners and businesses to conserve and enhance Georgia blind salamander habitat, inclusive of watersheds.	Incentives & Influencing, Habitat Conservation & Mgmt, Education & Outreach	NEW	YES	YES	TBD	FWC	CPS	Universities, DEP, NRCS, USFWS, DOACS	Likely	Feasible and practical with the proper resources and relationships.	NO; Immediate survival is not under threat. However, this action is critical for long-term survival.
2, 3	1	8	Encourage the use of wildlife conservation guidelines in areas of suitable Georgia blind salamander habitat.	Incentives & Influencing, Habitat Conservation & Mgmt, Education & Outreach	EXPANDED	YES	YES	\$25-50k	FWC	SCP, CPS	Universities, DEP, NRCS, USFWS, DOACS	Very Likely	Highly feasible and practical; practices ongoing in some areas.	NO; Immediate survival is not under threat. However, this action is critical for long-term survival.
2, 3, 4	3	9	Educate the public about identification, distribution, biology, threats, conservation value, and management requirements of Georgia blind salamanders.	Education & Outreach, Coordination with Other Entities	NEW	YES	YES	\$0-25k	FWC	SCP	DEP, caving societies	Likely	Feasible and practical with the proper resources and relationships.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.
2, 3, 4	2	10	Collaborate with other agencies, county extension offices, universities, and local governments regarding implementation of this plan.	Coordination with Other Entities, Habitat Conservation & Mgmt, Monitoring & Research, Incentives & Influencing, Education & Outreach	EXPANDED	YES	YES	TBD	FWC	SCP	Agencies, universities, local governments, landowners, businesses	Very Likely	Feasible and practical with the proper resources and relationships.	NO; Immediate survival is not under threat. However, this action is beneficial for long-term survival.

Acronyms used in this table:

- CPS: Conservation Planning Services, a Section of the Florida Fish and Wildlife Conservation Commission's Division of Habitat and Species Conservation
- DEP: Florida Department of Environmental Protection
- FWC: Florida Fish and Wildlife Conservation Commission
- FWRI: Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
- LE: Law enforcement
- MFL: Minimum flows and levels
- NRCS: National Resource Conservation Service
- NFWFMD: Northwest Florida Water Management District
- TBD: To be determined
- USFWS: United States Fish and Wildlife Service

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CONSERVATION ACTIONS

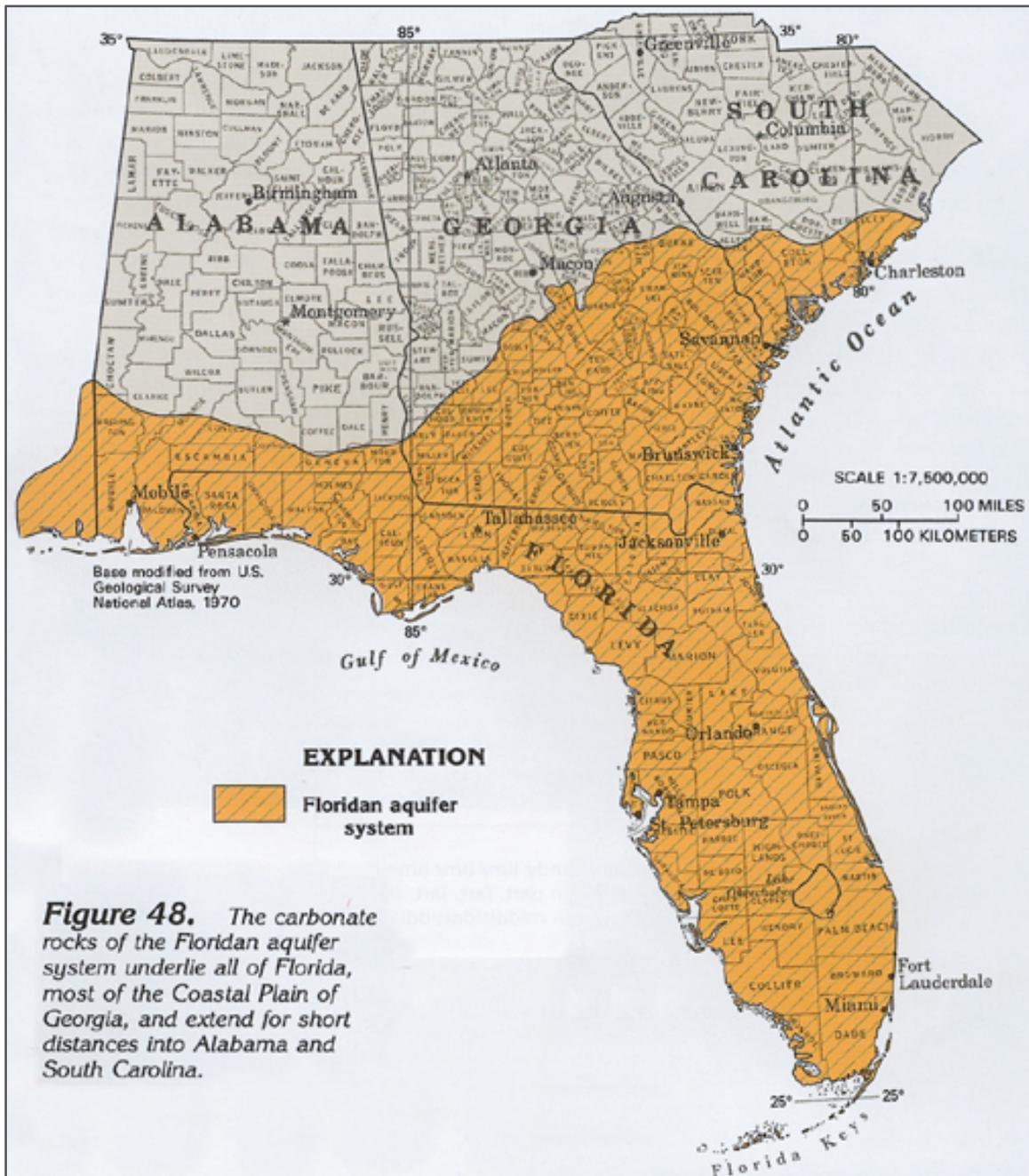
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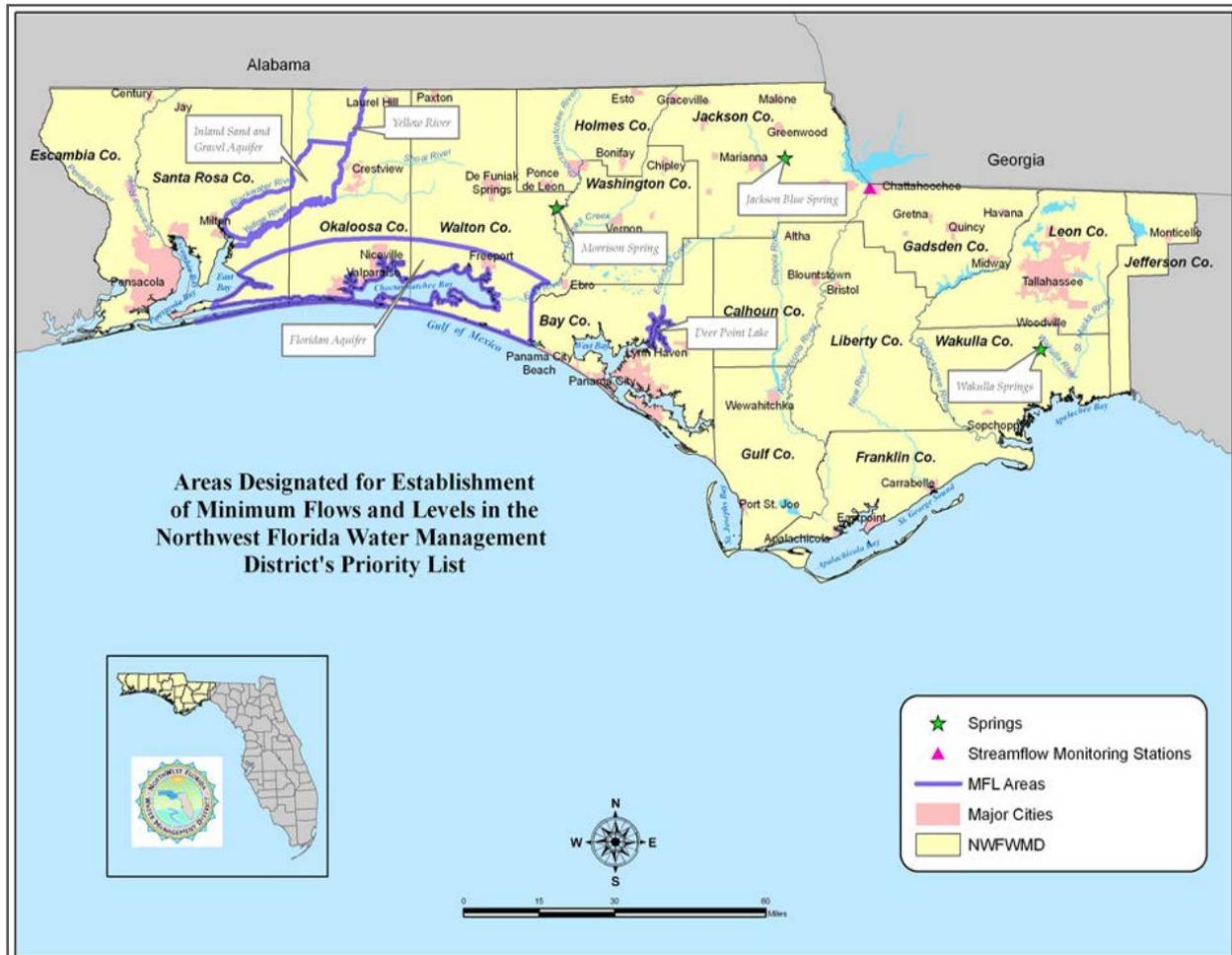
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APPENDICES

Appendix 1. Map of the Floridan aquifer system from the U.S. Geological Survey.



Appendix 2. Florida’s 2011 top-priority areas designated for establishment of minimum flows and levels (shown in blue) by the Northwest Florida Water Management District.



Source: <http://www.nwfwmd.state.fl.us/rmd/mfl/mfl.htm>