Introduction

The flatwoods salamander is a small, fossorial species that inhabits the coastal plain of Georgia, Florida, Alabama, and South Carolina (Figure 1). This is a relatively small salamander, reaching lengths of up to 5.5 inches (13.9 cm). They are jet black with white/grey lichen, or “net-like”, patterning all along the body. This salamander was recently split into two genetically distinct species: frosted flatwoods salamander (Ambystoma cingulatum), and reticulated flatwoods salamander (Ambystoma bishop). Although they are officially considered separate species, the life history characteristics remain identical to each other. In this paper, distinctions will be made between the two for the geographical range and conservation status. The rest of the information pertains equally to both. Although extensive conservation efforts have been taken to increase the population sizes, numbers appear to remain low. However, the natural history of this species does make it difficult to gather an accurate population count.

Taxonomy

Order: Caudata
Family: Ambystomatidae
Genus: Ambystoma
Species: cingulatum

The members of the family, Ambystomatidae, are known commonly as the mole salamanders. The name refers to their habit of spending the majority of their lives underground. Ambysomatid salamanders emerge only at certain times of the year in order to migrate to an ephemeral wetland for

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breeding purposes. This family is completely endemic to North America and contains about 30 different species. The four members besides the flatwoods salamander that are found in Georgia include: the tiger salamander (*Ambystoma tigrinum*), mole salamander (*A. talpoidium*), marbled salamander (*A. opacum*), and spotted salamander (*A. maculatum*). These species are recognized by their short, stocky bodies, and disproportionately large heads.

The flatwoods salamander was split into separate species in 2007 based on genetic and morphological data. As a rule, the frosted flatwoods salamander (*A. cingulatum*) is located east of the Apalachicola-Flint Rivers, and the reticulated flatwoods salamander (*A. bishopi*) is located west of this river basin. The two species will look identical if held next to one another.

**Status**

The frosted flatwoods salamander is listed as a threatened species in Georgia under the Endangered Species Act of 1973. The reticulated flatwoods salamander was listed as an endangered species under the Endangered Species Act in 2009. The species is historically known from only a few locations in Georgia and across southern Alabama, but is now limited to Eglin Air Force base in Florida. Because of this, it does not have a state status listing in Georgia or Alabama. The frosted flatwoods salamander is currently present at 80% of the historical sites where it was originally found. However, the reticulated flatwoods salamander is currently found in only twenty percent of the historical sites from which it was known. Unfortunately, only five breeding ponds make up the entire habitat of this species. Both of these species are listed as “vulnerable” under the International Union for Conservation of Nature (IUCN). Both species are also listed as G2 in the Natureserve ranking system which means that they are “globally imperiled.”

These species are listed primarily due to the modification or destruction of their habitat. The longleaf pine (*Pinus palustrus*) – wiregrass (*Aristida stricta*) ecosystem along with the longleaf pine (*P. palustris*) - slash pine (*P. elliottii*) ecosystem are the only places these species thrive. These ecosystems have been reduced to a mere fraction of the historical range, due mainly to destruction for agricultural or residential purposes. The remaining portions are fragmented and mostly made up of second-growth trees. Fire was a major part of this ecosystem and helped to maintain the open forest floor and native growth. Fire suppression has allowed growth of invasive plants, such as the autumn olive (*Eleagnus umbellata*) and sweetgum (*Liquidambar styraciflua*), which shade out native plants, such as the saw palmetto (*Serenoa repens*) and gallberry (*Ilex glabra*). This greatly impacts the abundance of ephemeral ponds, which are the primary breeding sites for the flatwoods salamander. The use of prescribed burning is a primary tool in the restoration and preservation of their native habitat.

Populations are influenced by the seasonal hydroperiod. These salamanders require that certain ephemeral ponds fill at the right time every year to stimulate the eggs to hatch, and then to remain filled with water until the larvae undergo metamorphosis. This has been a major issue with the restoration of
the species. Even if pristine habitat is restored, population and species survival are dependent on appropriate timing of rainfall events.

**Distribution**

Flatwoods salamanders are found throughout the coastal plain regions of the southeast (Figure 2). The frosted flatwoods salamander ranges from southern Georgia and northern Florida up into the southern portion of South Carolina. The reticulated flatwoods salamander is thought to have once ranged from extreme southern Alabama, throughout the panhandle of Florida and into the southwestern corner of Georgia. Currently however, it can only be found on Eglin Air Force base in Florida.

**Description**

These salamanders are relatively small in size (5.0-5.5 inches in length) and have a characteristically large head. The body is rather slender in comparison to other members of Ambystomatidae, and the females tend to be slightly larger than the males. These salamanders are easily identifiable by their black background with grey or white “net-like” patterning along their entire body, as well as their stout tall tail. They generally have between thirteen and sixteen costal grooves with fifteen being the average. Larvae of the flatwoods salamander typically have high tail fins, bushy red gills, and brown or olive-green background color to their bodies. The body is usually patterned with darker brown or black stripes that run horizontally down the length of the body. Unlike the similar larvae of the tiger salamander (*Ambystoma tigrinum*), their stripes are very prominent and have no mottling between the colors.

**Similar Species**

The marbled salamander (*Ambystoma opacum*) is sometimes confused with the flatwoods salamander (Figure 3). This salamander is a member of the Ambystomatidae family as well and has very similar coloration. However, instead of the net-like patterning of the white color all over, it has a bold “ladder-shaped” stripe running down the dorsal surface of its body. The slender shape and the coloration of the flatwoods salamander may also lead to some confusion, at first glance, with the slimy salamander (*Plethodon glutinosus*) (Figure 4). Unlike the flatwoods salamander, the slimy salamander
has a narrower head and white spots all over the body instead of thin lines. The slimy salamander also grows much longer, reaching lengths of up to 7.5 inches.

Ecology

Reproduction: Flatwoods salamanders reach sexual maturity at around one to two years of age. Breeding adults will migrate to familiar sites of ephemeral ponds when the rains come in late fall/early winter. They reach the breeding sites before the ponds fill, and initiate courtship on land. The flatwoods salamanders and the marbled salamander are the only members of Ambystomatidae that practice terrestrial courtship. The eggs will be laid either singly or in small clusters at the base of grass clumps or in sphagnum moss. A single female may lay up to 225 eggs. The eggs are stimulated to hatch when the ephemeral ponds fill due to continuing rain. The larvae will spend most of their early development in cover around the grass clumps or leaf litter, but will wander into the water column in search of food at night. Newly metamorphosed salamanders will emerge from the pond sometime around March or April. Once they leave the pond, they will seek out an underground refuge, such as a burrow, under a log, or even a crawfish tunnel. Flatwoods salamanders can travel up to one mile away from the breeding pond to find a refuge.

The reproductive strategy of the flatwoods salamander is basically a game of chance. The upside to their strategy is that the eggs are prepared to hatch as soon as the ponds fill and the larvae get an advantage on the other species of salamander larvae and predatory insect larvae. Since there are no fish in these ephemeral wetlands, they have less to worry about in the way of predators. This also allows the juveniles to emerge sooner from the pond in the event that the water levels dry up quicker than usual. The strategy also comes with a severe downside. Since the eggs are laid before the ponds actually fill, there is a chance that they can dry out and die if rains do not come until later in the winter. If this happens, then the entire annual reproductive output is lost. Rainfall patterns, both amount and timing, associated with changing climate, may further reduce available breeding wetlands and drive down overall flatwoods salamander populations.

Feeding: Due to the fossorial nature of these animals outside of breeding season, feeding habits are presumed and poorly documented. Flatwoods salamanders have been documented eating earthworms and are assumed to consume other invertebrates. The larvae are documented to eat aquatic invertebrates and small crustaceans. Adult salamanders do not come above ground to hunt prey so it is assumed that fossorial invertebrates are the primary source of food.

Behavior: There is little known about the many segments of the life history of this species due to its fossorial nature. It spends the majority of its life underground, emerging only to breed. It is believed
that they will use the same burrows year after year when returning from the breeding sites. They may use old, abandoned crawfish burrows and tunnels for their homes, but definitive evidence is lacking. They have been documented to travel up to a mile from the breeding sites back to their home.

**Habitat:** The flatwoods salamander inhabits the longleaf pine-wiregrass ecosystem as well as the longleaf pine –slash pine ecosystem. This habitat has very loose soil and generally abundant burrows and holes dug by other animals including invertebrates (crawfish), mammals (pocket gophers), or reptiles (gopher tortoise). These burrows become home to flatwoods salamanders, who lack the physical capabilities to dig their own.

This habitat is open with tall pine trees and low-growing vegetation, such as saw palmetto or wiregrass. The canopy is usually open, allowing plenty of light through. This ecosystem is primarily maintained by fire. Low-intensity fires will spread throughout the habitat burning off all dead material and opening the landscape. This eliminates invasive plant species that are not fire tolerant. These fires are necessary for the retention of ephemeral wetlands and ponds as it opens up the forest floor and stimulates new growth of emergent vegetation around and in the pond.

**Predators:** Even though flatwoods salamanders are predators, they are also prey. However, due to their fossorial nature, only one species has been documented to prey on them: the common garter snake (*Thamnophis sirtalis*) (Figure 5). It is highly likely that other species of fossorial snakes, mammals, and wading birds will opportunistically eat them. Red imported fire ants (*Solenopsis invicta*) are also believed to prey on the flatwoods salamanders, especially in disturbed areas. In the event of a predator attack, adult salamanders will tuck its head down under its body and raise its tail toward the aggressor. They will then secrete a noxious, milky substance from glands near the tail. This action will deter some potential predators.

**Lifespan:** The lifespan of flatwoods salamanders in the wild is not known. It has been proposed to be ten years. The lifespan for captive individuals has been documented as four years.

**Disease and Parasites**

There have not been any documented disease outbreaks directly impacting the flatwoods salamander. However, there are several diseases that have had a major impact on other salamander species and have the potential to decimate what is left of these small populations. Red-legged disease (*Aeromonas hydrophila*), a pathogenic bacteria, causes severe congestion in the ventral surface of the skin followed by ulceration and hemorrhaging under the skin. This will lead to eventual seizures, coma,
and death. This disease was documented to cause mortality of mole salamanders at a breeding site in Miller County, Georgia. Although flatwoods salamanders were known to breed there, after the disease outbreak none were ever found again. A parasitic nematode (*Hedruris siredonis*) has been found in some larvae of frosted flatwoods salamanders. This nematode will cause the adult to be small and thin which in turn reduces the overall fitness of the individual. Two other diseases biologists are on the lookout for are *Ranavirus* and chytrid fungus (*Batrachochytrium dendrobatidis*). These two diseases have not been seen in these populations, but they have caused massive die-offs in several species of frogs and western populations of the closely related tiger salamander. As seen in many different case studies, once these diseases enter an ecosystem they cause unstoppable die-offs and some local extinctions or extirpations. Diseases are considered to be of extremely high importance for the conservation of the reticulated flatwoods salamander, especially because seventy percent of populations are supported by a single breeding site.

**Economic Value**

There is no known economic value for these species.

**Medicinal Value**

There is no known medicinal value for the flatwoods salamanders.

**Damage**

Flatwoods salamanders cause no damage to the habitats where they are found. They are also very closely tied to the specific habitat conditions in which they live; therefore, they pose no threat at all of becoming an invasive species.

**Legal Aspects**

The flatwoods salamander is listed in Georgia as a threatened species. In South Carolina this species is listed as an endangered species. In the state of Florida both species of flatwoods salamanders hold the same status as federally listed. The state of Alabama does not have a status for the flatwoods salamander. It has been noted that this species has not been seen in the state since 1981. It is presumed to be extirpated from the state of Alabama; however, due to the fossorial nature of this species, it has been hard for researchers to ascertain the exact status. In Georgia, weak nongame wildlife regulations place “spring lizards” (all salamanders) on the unprotected species list unless otherwise listed as threatened or endangered. Revision of Georgia nongame statutes are critically needed.

**Management to Enhance**

In order to conserve these species, steps have been taken to restore the natural habitat in areas where they have been historically found and maintain historic habitats that hold the remaining populations. The habitat where they live is critical for several other species that are in peril as well,
including the eastern indigo snake (*Drymarchon couperi*) and the gopher tortoise. Because this is such an important ecosystem, both the federal and state governments have concentrated on its restoration.

Efforts to conserve remaining populations of reticulated flatwoods salamanders have included the harvest of eggs in order to hatch them and raise juveniles in captivity. The Atlanta Botanical Garden, along with several college students, collected all of the eggs from Eglin Air Force base this past year (2011) and they were hatched at the botanical garden. The larvae are growing and maturing there and will be returned to the wild once they metamorphose.

**Human Uses**

There are no human uses for this species.

**Further Information**


