U. S. Fish and Wildlife Service
Draft Recovery Plan
For the Reticulated Flatwoods Salamander
(*Ambystoma bishopi)*

Photo Credit: Kelly Jones, Virginia Polytechnic Institute

Prepared by:
Harold Mitchell
U.S. Fish and Wildlife Service
Panama City Field Office
Panama City, FL

For:
South Atlantic – Gulf Region
U.S. Fish and Wildlife Service
Atlanta, Georgia

DRAFT March, 2021

ACKNOWLEDGEMENTS

The author would like to thank the following individuals and their respective organizations for their dedicated efforts to protect this amphibian. These include Carola Haas PhD, Thomas Gorman PhD, Nicholas Caruso PhD, George Brooks, Jennifer Smith PhD, Houston Chandler, David Bishop PhD, Kelly Jones, Brandon Rincon (Virginia Tech), Katie O'Donnell PhD, Jamie Barichivich (U.S. Geological Survey, Gainesville FL); The Staff and support of the San Antonio Zoo, Bekky Muscher-Hodges, Dante Fenolio PhD, Brooke Talley, PhD, Pierson Hill (Florida Fish and Wildlife Conservation Commission), John Himes PhD , Anna Farmer,(formerly Florida Fish and Wildlife Conservation Commission), John Palis (Palis Environmental Consulting), John Jensen PhD (Georgia Department of Natural Resources), Bruce Hagedorn (Eglin Air Force Base), Rodney Felix (Eglin Air Force Base), Kathy Gault (Eglin Air Force Base), Jeremy Preston (Eglin Air Force Base), Charlie Abeles (Longleaf Alliance), Vernon Compton (Longleaf Alliance),

Special thanks to Susan Walls, PhD (US. Geological Survey) and Anna Farmer (formerly of the Florida Fish and Wildlife Conservation Commission) for their tireless efforts in producing these documents.

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and/or protect the species. Plans are prepared by the U.S. Fish and Wildlife Service, sometimes with the assistance of recovery teams, contractors, State agencies, and others. Plans are reviewed by the public and subject to additional peer review before they are adopted by the U.S. Fish and Wildlife Service. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Recovery plans do not obligate other parties to undertake specific tasks. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks. By approving this document, the Regional Director certifies that the information used in its development represents the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the U.S. Fish and Wildlife Service's South Atlantic - Gulf Regional Office, Atlanta, Georgia.

Approved: ____

Regional Director, U.S. Fish and Wildlife Service

Date: ___________________________________

Suggested literature citation:
U.S. Fish and Wildlife Service. 2020. Draft Recovery Plan for the Reticulated Flatwoods Salamander (*Ambystoma bishopi*). South Atlantic - Gulf Regional Office, Atlanta, Georgia.

Draft Recovery Plan for the
Reticulated Flatwoods Salamander (*Ambystoma bishopi*)

This recovery plan describes criteria for determining when the reticulated flatwoods salamander should be considered for delisting, lists site-specific actions that will be necessary to meet those criteria, and estimates the cost for implementing recovery actions. Additionally, cursory information on the species' biology and status are included, along with a brief discussion of factors limiting its populations. A Species Status Assessment (SSA), which provides a more detailed accounting of the species status, biology, and threats, and a Recovery Implementation Strategy (RIS), which describes the activities to implement the recovery actions, are available at http://www.fws.gov/PanamaCity. The RIS and SSA will be updated on a routine basis, and include further information on status, habitat, limiting factors and threats.

CURRENT STATUS AND SPECIES BIOLOGY:
The flatwoods salamander (*Ambystoma cingulatum)* was listed in 1999 (64 FR 15691) as threatened under the Endangered Species Act of 1973 as amended (Act). In 2009 (74 FR 6700), *A. cingulatum* was split into two species; the reticulated flatwoods salamander, (*A. bishopi)*, as endangered, and the threatened frosted flatwoods salamander (*A. cingulatum*). Critical habitat was also designated for both species in 2009 (74 FR 6700) with 4,453 ac (1,803 ha) in 16 sub-units designated for the reticulated flatwoods salamander.

Reticulated flatwoods salamanders are moderately-sized (mean snout-to-vent length (SVL) = 59 mm, max SVL = 78 mm, mean total length (TL) = 105 mm, max TL = 143 mm), slender salamanders with relatively short, pointed snouts and stout tails (Martof and Gerhardt, 1965; Palis, 1997a; John Palis, Palis Environmental Consulting, 1995 unpublished data; Tom Gorman and Carola Haas, Virginia Tech, 2014 unpublished data). Their heads are small and only about as wide as the neck and shoulder region (Petranka, 1998). They weigh from approximately 1 to 12 g (adult males and adult gravid [containing mature eggs] females), respectively (Palis, 1997a; John Palis, Palis Environmental Consulting 1995 unpublished data; George Brooks and Carola Haas, Virginia Tech 2019, unpublished data). Their bodies are black to chocolate-black with fine, irregular, light gray lines or specks that form a reticulate or cross-banded pattern across the back in adults, and widely scattered and "lichen-like" in recently metamorphosed individuals. Melanistic, uniformly black individuals have been reported (Carr, 1940). The venter (underside) is dark gray to black with a scattering of gray spots or flecks.

The reticulated flatwoods salamander is an ephemeral wetland-breeding amphibian with a complex life cycle; i.e., there is a terrestrial egg and aquatic larval stage, as well as terrestrial juvenile and adult stages. As adults, flatwoods salamanders migrate to ephemeral (seasonally-flooded) wetlands to breed in the fall, where females lay eggs singly or in small clusters on litter, vegetation, or soil in small depressions that later fill with water (Anderson and Williamson, 1976; Palis, 1995a, 1997b; Gorman et al., 2014). Once inundated, well-developed embryos hatch into larvae in the winter and metamorphose between March and May after an 11- to 18-week larval period (Palis, 1995a). Juveniles normally disperse from wetlands shortly after metamorphosis but may stay in or near wetlands during seasonal droughts (Palis, 1997b).

Juveniles and adults are highly fossorial and spend much of their time in crayfish burrows or root channels until they reach sexual maturity (1 year for males; 1-2 years for females) and return to wetlands to breed during the fall months (Petranka, 1998; Powell et al., 2015; Brooks et al., 2019b).

HABITAT REQUIREMENTS:
Breeding wetlands are located within mesic (moderate moisture) to intermediate moisture- pine-dominated flatwoods/savanna communities where adults and juveniles spend the rest of the non-breeding season. Pine flatwoods/savannas are characterized by low flat topography, a high water table, and acidic, sandy soil that becomes seasonally saturated. In the past, this pine woodland ecosystem was maintained by frequent lightning season fires. Ignited by lightning or Native Americans, these flatwoods historically burned at intervals ranging from 1 to 4 years (Clewell, 1989). The groundcover of longleaf pine flatwoods/savanna ecosystem is typically dominated by wiregrass (*Aristida stricta* [= *A. beyrichiana*]) (Kesler et al., 2003) but with a highly diverse suite of grasses and forbs.

Flatwoods salamanders breed and deposit eggs in wetlands with dry basins, not yet inundated with water (Anderson and Williamson, 1976; Hill, 2013; Powell et al., 2013; Gorman et al., 2014); however, they are forced to oviposit high in emergent vegetation, or farther outside the wetland basin, in years when heavy early winter rains completely fill the breeding wetlands concurrent to or prior to salamander breeding activity (Carola Haas, Virginia Tech, 2018 unpublished data, Pierson Hill, Florida Fish and Wildlife Conservation Commission, 2018 unpublished data). Females select areas within breeding wetlands that have complex and diverse stands of herbaceous vegetation and concave depressions for egg deposition. Such small depressions likely minimize desiccation of developing embryos in the otherwise dry wetland (e.g., Gorman et al., 2009). As noted, management of breeding wetlands for this species should include a suite of management actions that increase the cover of herbaceous vegetation while maintaining bare mineral soils for egg-laying habitat (Jones et al., 2012, Gorman et al., 2014; Brooks et al. 2019a).

Once wetlands are inundated, eggs hatch and within a few weeks, larvae can utilize other areas of the wetland. Larval reticulated flatwoods salamanders generally occur in acidic (pH 3.4 to 5.6), tannin-stained ephemeral wetlands (swamps and marshes) that typically range in size from <1 to 10 acres (ac) (0.4 to 4.0 hectares [ha]), but may reach or exceed 30 ac (12 ha) in areas where larval salamanders are found. (Palis, 1997b; Safer, 2001). Wetland depth fluctuates greatly, but is usually less than 0.5 meters (m) (Palis, 1997b; Bishop, 2005). Ponds typically fill in late fall or early winter, and dry in late spring or early summer. When dry, breeding ponds burn naturally due to periodic wildfires (especially during late spring and summer), thus fire scars are frequent on live trees within the basin, and smaller trees and shrubs are often killed or top-killed. Depending on canopy cover, midstory, and duff/litter accumulation, the herbaceous ground cover of breeding sites can vary widely, although larvae and their prey are most often associated with higher amounts of herbaceous cover, (Gorman et al., 2009; Gorman et al., 2013; Chandler et al. 2015; Brooks et al., 2019b) which, in occupied wetlands covers an average of 0.7 ha and was always at least 0.2 ha (Brooks et al., 2019b) and, on average, is greater than 40% coverage of the wetland (Gorman et al., 2009; Gorman et al., 2013). Most, but not all, breeding sites exhibit distinct vegetative zonation, with bands of different herbaceous plant assemblages in shallow versus deeper portions of the pond. The groundcover is dominated by graminaceous species but includes characteristic forbs. The basin of high-quality breeding sites generally consists of relatively firm mud and/or sand with little or no peat. Burrows of crayfish (genus *Procambarus*, principally) are a common feature of flatwoods salamander breeding sites and may be important physical elements to the salamander life history strategy.

LIMITING FACTORS:
Currently, the reticulated flatwoods salamander faces several limiting factors. These include low population density, restricted range, limited quality breeding and upland habitat, vulnerability to stochastic events (e.g., extended drought, storm surge from hurricanes, sea level rise), inadequate management (i.e., not enough growing season fire applied to the habitat to achieve meaningful restoration range wide, too little use of known restoration techniques, besides fire, to aid in the restoration of degraded former or potential breeding ponds), and inadequate funding to address recovery actions. Genetic bottlenecking could limit the ability for natural recovery in areas of extremely low population densities. Recovery actions identified in this plan are aimed at reducing or eliminating these factors. Increased survey effort, particularly in interstitial areas among known extant populations are necessary to reduce uncertainty of our understanding of potential populations in these areas.

RECOVERY STRATEGY**:**
The recovery goal is to conserve and protect the reticulated flatwoods salamander and its habitat so that its long-term survival is secured, populations are capable of enduring threats, and it can be removed from the list of threatened and endangered species. The initial strategy for recovery of the reticulated flatwoods salamander is to prevent the extinction and provide a path toward recovery of this species by restoring healthy, self-perpetuating populations throughout the historic range, while restoring and maintaining adequate high-quality breeding and upland habitat to the greatest extent possible. Periodic evaluations of the status of the recovery efforts, and extant populations will measure success as recovery actions go forward.

RECOVERY OBJECTIVES:
Recovery actions to achieve the recovery objectives over the next 20 years are to determine 1) if the species is progressing toward the overall goal of restoring adequate redundant populations to representative portions throughout its historic range where possible (Figure 1), and 2) whether the extant populations demonstrate resiliency to the extent that the species no longer require the protection of the Endangered Species Act. This will be accomplished by restoring and managing both breeding and upland habitat necessary to the complex life cycle, implementing successful reintroduction and translocation measures, and reducing anthropogenic threats that resulted in its current endangered status.

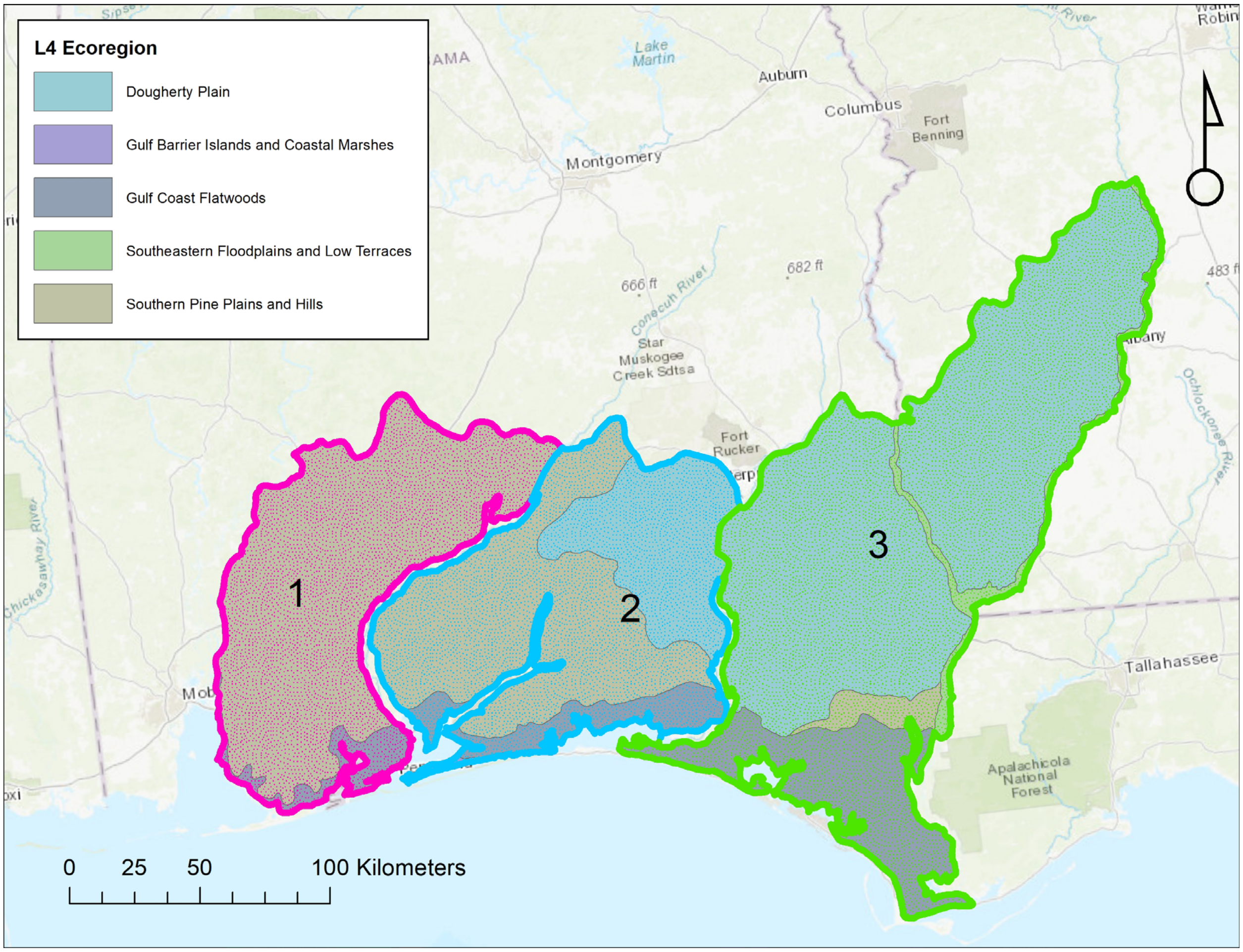

Figure 1. Recovery management units for the reticulated flatwoods salamander (courtesy of J. Barichivich, USGS). The RMU delineations illustrated are not precise lines, but bubbles based the ecoregions containing currently occupied sites and historic range.

Delisting Criteria

This recovery plan sets forth criteria which, when met, will increase the range of extant populations; will increase the number of individuals and populations; and will reduce threats to the species existence. Justification for these criteria is found below and in the accompanying RIS as well as section 3.4 of the SSA. We believe delisting may be considered when the following criteria are met:

(1) At least 101 resilient metapopulations exhibit a stable or increasing trend are extant or re-established as evidenced by natural recruitment, and multiple age classes.

(2) Approximately one third of the 101 (roughly 34) resilient metapopulations are present in each of the three Recovery Management Units (RMUs; Figure 1) that represent the spatial distribution of historic range: RMU 1 (Western Complex), RMU 2 (Eglin Complex), and RMU 3 (Eastern Complex). The precise number in each RMU is dependent on habitat suitability and

availability, but an approximate equal distribution will allow for sufficient redundancy across the historic range.

(3) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future. Breeding and adjacent upland habitats within the resilient metapopulations are protected long-term though management agreements, public ownership, or other means, in sufficient quantity and quality to support growing populations.

<u>Justification for Delisting Criteria</u>

Criterion 1. The delisting criteria were developed based on a population viability analysis (George Brooks, Virginia Tech, 2019, pers. comm.) and the distribution of currently and previously occupied wetlands on Eglin Air Force Base (EAFB) (George Brooks and Nick Caruso, Virginia Tech, 2019, unpublished data)." Greater detail of the development process is found in section 3.4 of the accompanying Species Status Assessment.

Criterion 2. A resilient metapopulation describes the ability of a species to withstand stochastic disturbance. It is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally speaking, populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance. This definition of a metapopulation is based on Brooks et al. (2019b) who indicated that wetlands within 1.5 km of other occupied wetlands were most likely to be occupied and genetic data (Wendt 2017) confirmed the small scale of connectivity (<1 km).

Resilient metapopulations in most cases are defined as those with multi-generation demographic stability as indicated by regular evidence of breeding and stable adult population size, or increasing effective population size (N_e), encompassing a number of occupied wetlands supported by appropriately managed upland and wetland habitats that are not separated by barriers or great dispersal distances. Management agreements or plans with landowners supporting each population are in place to ensure habitat management occurs.

Criterion 3. When the major threats to this species have been significantly reduced or eliminated as to no longer pose a threat to its continued survival. Lack of regular lightning season fire to maintain suitable breeding and upland habitats, feral swine, disruptions to hydrology including ditching and addition of impervious surfaces, forestry operations that result in substantial soil disturbance, road construction or increased traffic near breeding wetlands, invasive plants, disease, improper or overuse of pesticides and herbicides, effects of climate change on wetland hydrology and upland soil moisture and temperature, and unnatural presence of predatory fish in breeding ponds, are all threats that must be ameliorated to the greatest extent possible.

ACTIONS NEEDED:
The actions identified below are those that, based on the best available science, we believe are necessary to bring about the recovery of the reticulated flatwoods salamander. We have included an estimated cost to complete the action and ordered in terms of priority for implementation. Specific goals and details are expanded upon in the Recovery Implementation Strategy.

Recovery Action	Estimated costs	Priority
Ensure adequate, high quality habitat is available to support resilient reticulated flatwoods salamander populations	$38,025,000	1
Increase the number of resilient reticulated flatwoods salamander populations to the extent possible of its historic range, within the three RMUs	$5,140,000	2
Improve knowledge needed to increase the number of resilient reticulated flatwoods salamander populations through research and adaptive management	$108,000	3
Estimated acquisition of habitat in private sector	$7,000,000	
Research needs and data gaps	$2,960,000	
Total Estimated Cost: 20 years	**$53,233,000**	

DATE OF DOWNLISTING AND DELISTING: If all actions are fully funded and implemented as outlined, including full cooperation of all partners needed to achieve recovery, delisting is expected to take at least 20 years. We anticipate that recovery criteria for delisting could then be modified and met by 2040.

COST ANALYSIS:
Costs are projected toward our 20-year goal. We anticipate reaching recovery success resulting from this plan assuming full funding and support from all applicable agencies and partners; lower funding levels will extend the anticipated time to recovery.

By far the largest costs associated with the recovery of the reticulated flatwoods salamander deals with the recovery and maintenance of its habitat through the use of prescribed fire, mechanical vegetation management, and use of herbicides. Cost estimates are a pooled average of costs estimated by land managers throughout the range of the salamander on a "per acre" basis.

Cost estimates to implement recovery actions and activities for the 20-year projection of this plan is $53,233,000

A more detailed breakdown of the first five years costs are found in Table 1 of the Recovery Implementation Strategy. Figures above are rounded to the nearest 1000, dollar figure, and therefore may not match exactly the more precise estimates given in Table 1 of the Recovery Implementation Strategy. For the top 3 recovery actions, the 5 year costs were multiplied by 4 to give a 20 year total for recovery. This was done to reflect the recurring needs for ongoing habitat and population work. Two items, land acquisition and research needs, were "one time" items and not multiplied by 4 for the 20 year totals and were therefore separated out in the table above.

REFERENCES:

Brooks, G. C., J. A. Smith, E. Frimpong, T. A. Gorman, H. Chandler, and C. A. Haas. 2019a. Indirect connectivity estimates of amphibian breeding wetlands from spatially explicit occupancy models. Aquatic Conservation: Marine and Freshwater Ecosystems 29:1815–1825. DOI: 10.1002/aqc.3190.

Brooks, G. C., J. A. Smith, T. A. Gorman, and C. A. Haas. 2019b. Discerning the environmental drivers of annual migrations in an endangered amphibian. Copeia 107:270-276.

Carr, A. F., Jr. 1940. A contribution to the herpetology of Florida. University of Florida Publication, Biological Science Series 3:1-118.

Clewell, A.F. 1989. Natural history of wiregrass (*Aristida stricta* Michx., Gramineae). Natural Areas Journal 9:223-233.

Gorman, T. A., C. A. Haas, and D. C. Bishop. 2009. Factors related to occupancy of breeding wetlands by flatwoods salamander larvae. Wetlands 29:323-329.

Gorman, T.A., C.A. Haas, and J.G. Himes. 2013. Evaluating methods to restore amphibian habitat in fire-suppressed pine flatwoods wetlands. Fire Ecology 9:96-109.

Gorman, T. A., S. D. Powell, K. C. Jones, and C. A. Haas. 2014. Microhabitat characteristics of egg deposition sites used by Reticulated Flatwoods Salamanders. Herpetological Conservation and Biology. 9:543-550.

Martof, B.S., and H.C. Gerhardt. 1965. Observations on the geographic variation in *Ambystoma cingulatum*. Copeia 1965:342–346.

Palis, J. G. 1993. A status survey of the flatwoods salamander, *Ambystoma cingulatum*, in Florida. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Palis, J. G. 1995a. Larval growth, development, and metamorphosis of *Ambystoma cingulatum* on the Gulf Coastal Plain of Florida. Florida Scientist 58:352-358.

Palis, J. G. 1995b. A survey of flatwoods salamander (*Ambystoma cingulatum*) breeding sites east of the Apalachicola River, Florida. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Palis, J. G. 1996. Element stewardship abstract: flatwoods salamander (*Ambystoma cingulatum* Cope). Natural Areas Journal 16:49–54.

Palis, J.G., M.J. Aresco, and S. Kilpatrick. 2006. Breeding biology of a Florida population of *Ambystoma cingulatum* (flatwoods salamander) during a drought. Southeastern Naturalist 5:1–8.

Palis, J.G., 1997a. Breeding migration of *Ambystoma cingulatum* in Florida. *Journal of Herpetology* 31: 71-78.

Palis, J. G. 1997b. Distribution, habitat, and status of the flatwoods salamander (*Ambystoma cingulatum*) in Florida, USA. Herpetological Natural History 5:53-65.

Palis, J. G. and D. B. Means. 2005. *Ambystoma cingulatum*. Pp. 608-609 in: Status and conservation of U.S. amphibians. Vol. 2, Species Accounts. M. J. Lannoo, ed. University of California Press, Berkeley, California.

Petranka, J.W. 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.

U.S. Fish and Wildlife Service (USFWS). 2014. Technical/Agency Draft Recovery Plan for the Dusky Gopher Frog (*Rana sevosa*). Atlanta, Georgia. 90pp.

U.S. Fish and Wildlife Service (USFWS). 2015. Reticulated flatwoods salamander (*Ambystoma bishopi*) 5-year review: Summary and evaluation. Panama City, Florida. 46pp.

U.S. Fish and Wildlife Service (USFWS). 2016. USFWS Species Status Assessment Framework: an integrated analytical framework for conservation. Version 3.4 dated August 2016.