Reticulated flatwoods salamander
(*Ambystoma bishopi*)

5-Year Review:
Summary and Evaluation

(Credit: Kelly Jones, Virginia Tech)

U.S. Fish and Wildlife Service
Southeast Region
Panama City Field Office
Panama City, Florida

5-YEAR REVIEW
Reticulated flatwoods salamander/*Ambystoma bishopi*

I. GENERAL INFORMATION

A. Methodology used to complete the review:

In conducting this 5-year review, we relied on the best available information pertaining to historical and current distributions, life history, threats to, and habitats of this salamander species. Our sources included the original final rule listing this species under the Endangered Species Act (Act) and the revised listing final rule issued in 2009; peer reviewed scientific publications; unpublished field observations by Service, State and other experienced biologists; unpublished survey reports; and notes and communications from other qualified biologists or experts. We announced initiation of this review and requested information in a published Federal Register notice with a 60-day comment period on September 23, 2014 (79 FR 56821). The completed draft review was sent to the other affected Service Field Office and peer reviewers for their review. Comments were evaluated and incorporated where appropriate into this final document (see Appendix A). We did not receive any public comments during the open comment period. No part of this review was contracted to an outside party. This review was completed by the Service's lead Recovery biologist in the Panama City Field Office, Panama City, Florida.

B. Reviewers

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C. Background

1. Federal Register Notice citation announcing initiation of this review:

79 FR 56821 (September 23, 2014)

2. Species status:

Overall decreasing. The number of individuals per population and the number of populations throughout the historic range have declined. Recent surveys demonstrate fewer extant populations of *Ambystoma bishopi*. Out of the original 20 populations described in the final rule (74 FR 6700, February 2009), only six currently occupied populations are known to exist on public land: Florida: two populations on Eglin AFB/Hurlburt Field, one at Yellow River Marsh State Park/Garcon Point Water Management Area, one on property owned by Santa Rosa County, one at Naval Outlying Landing Field (NOLF) Holley (but no larvae found since 2011; K. Buhlmann), and Georgia: one population at Mayhaw Wildlife Management Area (see Table 1). During the last 5 years, the remaining 6 populations have had detections of larvae in at least 1 year with 5 of the 6 having detections as recently as either 2013-2014 and/or 2014-2015 (T Gorman, pers. comm. April 14, 2015). We and our partners have had limited opportunity to evaluate private land populations since the final rule in 2009.

During the last five years, each of the remaining six populations have had detections of larvae in at least one year with five of the six having detections as recently as either 2013-2014 and/or 2014-2015 (T Gorman, pers. comm. 14 April 2015).

3. Recovery achieved: 1 (0 - 25% species recovery objectives achieved); recovery actions are ongoing

4. Listing history:

<u>Original Listing</u> **(of the flatwoods salamander)**
FR notice: 64 FR 15691
Date listed: April 1, 1999
Entity listed: species
Classification: threatened

Revised Listing: *Ambystoma cingulatum* was split into two distinct species in 2009 (74 FR 6700), the reticulated flatwoods salamander (*A. bishopi*) was listed as endangered, and the frosted flatwoods salamander (*A. cingulatum*) retained threatened status.

5. Associated rulemakings:
Not applicable

6. Review History:
Recovery Data Call: 1999 to 2014
5-year review: We initiated and announced a 5-year review to the public for flatwoods salamander in 2005 (70 FR 34492). Our evaluation of data ultimately resulted in us as the outcome of the review proposing the split into two distinct species and ultimately listing the reticulated flatwoods salamander in 2009.

7. Species' Recovery Priority Number at start of review: (48 FR 43098):
5. In 2009, when this species was listed as endangered, it was given a RPN of 5, which indicates there is a high degree of threat, and the recovery potential of this species is low. This RPN is being revised (see Section III, Results for the updated RPN discussion), to reflect the increased management, attention, funding, and new techniques geared to improve the recovery potential.

8. Recovery Plan or Outline
Neither a draft recovery plan nor an outline has been written for this species.

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

1. Is the species under review listed as a DPS? No.

2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy? No.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

No. At present, this species does not have an approved recovery plan.

C. Updated Information and Current Species Status

1. Biology and Habitat:

Reticulated flatwoods salamanders are moderately-sized (76 mm snout-to-vent length, 135 mm total length), slender salamanders with relatively short, pointed snouts and stout tails (Martof and Gerhart, 1965; Palis, 1996; Palis, unpublished data). Their heads are small and only about as wide as the neck and shoulder region (Petranka, 1998). They weigh from 4.5 to 11 grams (adult males and adult gravid [containing mature eggs] females), respectively (Palis, 1996; Palis, unpublished data). Their bodies (see photo on page 1) 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 some individuals, the gray pigment is widely scattered and "lichen-like." 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 a pond-breeding amphibian with a complex life cycle; i.e., there is an aquatic egg and larval life history stage, as well as a terrestrial metamorphosed juvenile and adult stage. As adults, flatwoods salamanders migrate to ephemeral (seasonally-flooded) wetlands to breed in the fall, where females lay eggs singly on bare mineral soil in small depressions that later fill with water (Anderson and Williamson 1976; Palis 1995a, 1997). 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 ponds shortly after metamorphosing, but may stay near ponds during seasonal droughts (Palis 1997). Juveniles, along with 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; 2 years for females) and return to their natal pond to breed during the fall months (Petranka, 1998).

Breeding wetlands are located within mesic (moderate moisture) to intermediate-mesic longleaf pine (*Pinus palustris*)-dominated flatwoods/savanna communities where adults and metamorphosed juveniles spend the rest of their life outside of the breeding season. There are some variations in vegetation, geology, and soils among geographic areas within the range of the salamander; however, basic characteristics are fairly similar throughout. Longleaf pine flatwoods/savannas are characterized by low flat topography and relatively poorly drained, acidic, sandy soil that becomes seasonally saturated. In the past, this ecosystem was characterized by open pine woodlands maintained by frequent fires. Naturally ignited by lightning during spring and early summer, these flatwoods historically burned at intervals ranging from 1 to 4 years (Clewell, 1989). The topography can vary from nearly flat to gently rolling hills (the latter is true especially in the Dougherty Plain of SW Georgia).

The groundcover of the longleaf pine flatwoods/savanna ecosystem is typically dominated by wiregrass (*Aristida stricta* [= *A. beyrichiana*] Kesler et al., 2003). Other herbaceous plants often found in the groundcover include toothache grass (*Ctenium aromaticum*), bluestems (*Andropogon* spp.), beakrushes (*Rhynchospora* spp.), pitcherplants (*Sarracenia* spp.), meadowbeauties (*Rhexia* spp.), and a variety of legumes. Low-growing shrubs, such as saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), blueberries (*Vaccinium* spp.), and huckleberries (*Gaylussacia* spp.) co-exist with a highly diverse suite of grasses and forbs in the groundcover.

Flatwoods salamanders breed and deposit eggs in wetlands that are not yet inundated with water (Anderson and Williamson 1972, Hill 2013, Powell et al. 2013, Gorman et al. 2014). Adults select areas of complex and diverse stands of herbaceous vegetation within breeding wetlands for egg deposition. In this microhabitat, eggs are typically located in small depressions that likely minimize desiccation of developing embryos in the otherwise dry wetland. The selection by females of egg deposition habitat with complex herbaceous vegetation coincides with observations of all the other life stages of this species selecting habitat with complex and diverse stands of herbaceous vegetation within the breeding wetland (e.g., Gorman et al. 2009, Jones et al. 2012). As noted, management of breeding wetlands for this species should include a suite of management actions that increase the cover of herbaceous vegetation (Gorman et al. 2014).

Larval flatwoods salamanders occur in acidic (pH 3.4 to 5.6), tannin-stained ephemeral wetlands (swamps or marshes) that typically range in size from <1 to10 acres (ac) (0.4 to 4.0 hectares [ha]), but may reach or exceed 30 ac (12 ha) (Palis, 1997; Safer, 2001). Ponds are often round or oval, but larger breeding sites may be quite irregular in shape. The basins are bowl- or plate-shaped in profile and often perched above the normal water table on clay lenses (Wolfe et al., 1988). Water depth fluctuates greatly, but is usually 0.5 meters (m) (Palis, 1997) in areas where larval salamanders are found. Ponds typically fill in late fall or early winter, and dry in late spring or early summer. Summer thunderstorms may refill some ponds, but most of these dry again by early fall.

Under current conditions, the overstory within breeding ponds is typically dominated by pond cypress (*Taxodium ascendens* [=*T. distichum* var. *imbricarium*; Lickey and Walker, 2002)], blackgum (*Nyssa sylvatica* var. *biflora*) and longleaf pine, but can also include red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), sweetbay (*Magnolia virginiana*), loblolly bay

(*Gordonia lasianthus*), and pond pine (*Pinus serotina*). Canopy cover of occupied ponds is typically moderate and ranges from near zero to almost 100% (Palis, 1997b). The midstory, which is sometimes very dense, is most often composed of young of the aforementioned species, myrtle-leaved holly (*Ilex myrtifolia*), St. John's-worts (especially *Hypericum chapmanii* and *H. fasciculatum*), titi (*Cyrilla racemiflora*), sweet pepperbush (*Clethra alnifolia*), fetterbush (*Lyonia lucida*), vine-wicky (*Pieris phillyreifolius*), and bamboo-vine (*Smilax laurifolia*). 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 and midstory, the herbaceous groundcover of breeding sites can vary widely, although larvae are most often associated with higher amounts of herbaceous cover, (Gorman et al. 2009, Gorman et al. 2013) which, on average, is >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 vs. deeper portions of the pond. The groundcover is dominated by graminaceous species, including beakrushes, sedges (*Carex* spp.), panic grasses (*Panicum* spp.), bluestems (*Andropogon* spp.), jointtails (*Coelorachis* spp.), longleaf three-awned grass (*Aristida palustris*), plumegrasses (Erianthus spp.), nutrush (*Scleria baldwinii*), hatpins (*Eriocaulon* spp.), Characteristic forbs may include milkworts (*Polygala* spp.), meadowbeauties (*Rhexia* spp.), marsh pinks (*Sabatia* spp.), bladderworts (*Utricularia* spp.) and seedboxes (*Ludwigia* spp.). The basin of breeding sites generally consists of relatively firm mud with little or no peat. Burrows of crayfish (genus *Procambarus,* principally) are a common feature of flatwoods salamander breeding sites, which are typically encircled by a bunchgrass (wiregrass, Curtiss' sandgrass (*Calamovilfa curtissii*) and/or dropseed) dominated graminaceous ecotone.

These ponds often harbor small fishes; the most typical species include pygmy sunfishes (*Elassoma* spp.), Eastern mosquitofish (*Gambusia holbrookii*), and banded sunfish (*Enneacanthus* spp.) (Palis, 1997) Typical amphibian associates of flatwoods salamander larvae include southern leopard frog (*Rana sphenocephala*), ornate chorus frog (*Pseudacris ornata*), and dwarf salamander (*Eurycea quadridigitata*) larvae, as well as larval and adult newts (*Notophthalmus viridescens*) (Palis, 1997b).

Flatwoods salamander adult and larval habitats represent high quality conditions. However, populations persist in less than ideal habitat which may differ from what is presented above. Appropriate management will be needed at most of these sites to prevent the populations from disappearing as habitat conditions worsen. For example, fire suppression at many sites has led to greater canopy closure in the overstory of both the flatwoods uplands and ephemeral ponds (Bishop and Haas 2005, Gorman et al. 2009, Gorman et al. 2013) and the shrub layers of both habitats have similarly increased (Gorman et al. 2013). This has resulted in a lower cover of herbaceous groundcover that is less diverse. In the absence or paucity of growing-season fire, slash and/or pond pine may become dominant over longleaf pine in the flatwoods uplands. Further, the ecotone between the breeding wetland and associated flatwoods may be obscured or non-existent, replaced with a dense layer of shrubs, such as titi, fetterbush, and dog hobble (*Leucothoe* spp.) due to fire suppression or exclusion (Gorman et al. 2013). Additionally, prescribed burns across the range of the species are conducted most often in winter and early spring when ponds would typically be flooded and less likely to burn (Bishop and Haas 2005). To increase effective burning of flatwoods salamander habitat, land managers should diversify burning strategies (Bishop and Haas 2005). Other options may include burning uplands during the dormant season and return in the growing season to burn wetlands when they are dry (Gorman et al. 2009). Mechanical treatments can be coupled with fire to restore sites that have become too overgrown for fire alone to restore the site (Gorman et al. 2013). Other types of suboptimal habitat, such as roadside ditches and borrow pits that have the physical and biotic characteristics of natural breeding sites may be used by flatwoods salamanders, especially when located near natural breeding ponds (Anderson and Williamson, 1976; Palis, 1995b; Stevenson, 1999; Gorman and Haas, unpubl. data).

a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

A more detailed description of the historic and current range of *A. bishopi* (Figure 2) is addressed in paragraph (d) below. However, historically *A. bishopi* occurred in Mobile, Baldwin, Covington, and Houston counties in Alabama, Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, and Gulf counties in Florida, and Seminole, Decatur, Early, Miller, Baker, Dougherty, and Lee counties in Georgia. Currently, *A. bishopi* is no longer known to be present in Alabama, and is only located in Santa Rosa and Okaloosa counties in Florida, and Miller County in Georgia.

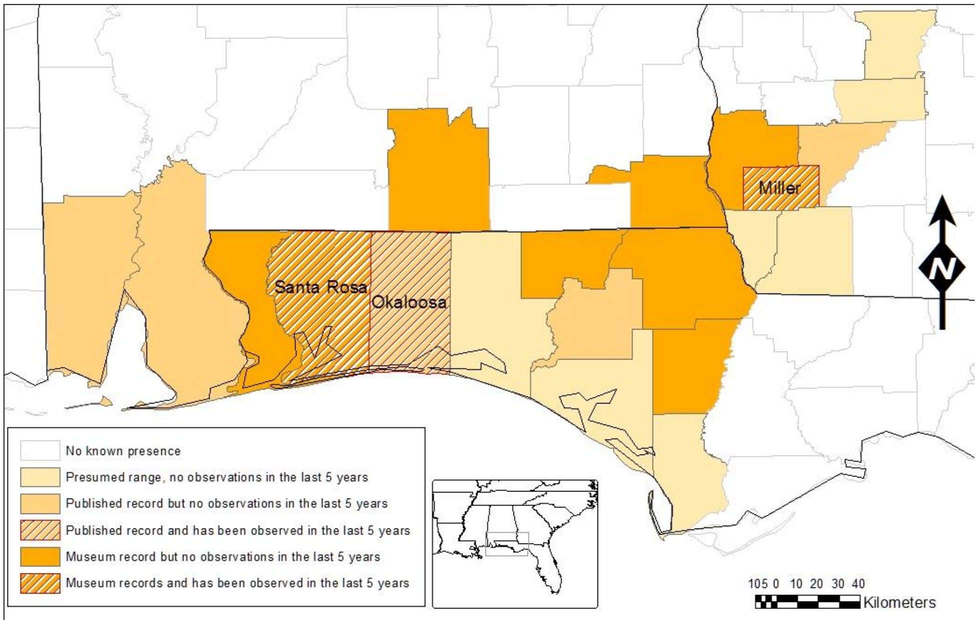

Figure 2 Geographic range of reticulated flatwoods salamanders. (Barichivich 2015.) Pers comm.)

Abundance:

While larval surveys are important to understand occupancy of sites, they do not always provide accurate estimates of abundance. An ongoing drift fence study at Eglin AFB has provided data on individually marked adults. Passive integrated transponder (PIT) tags were used to mark individual salamanders to note any recaptures. At two adjacent breeding wetlands, the minimum number of adults in a given year has ranged from a high of 115 salamanders at one site (in 2010-2011) and 54 at the second site (in 2011-2012) to lows of 23 and 14 (in 2014-2015), respectively (Gorman and Haas 2014; Gorman and Haas, unpublished data, 2015). The lows corresponded with 3 consecutive years of dry breeding seasons and reflects the decline of the adult population during this time (Gorman and Haas 2014). Fortunately, the 2013-2014 season was successful and collectively >200 metamorphs were documented leaving the wetlands in 2013-2014 and yearlings were documented returning in 2014-2015 (Gorman and Haas, unpublished data, 2015). We believe the 2015-2016 breeding season should document the rebound of the adult (>2 years old) population.

Trend:

Historically, flatwoods salamanders (both species) occurred throughout the Coastal Plain of the southeastern U.S., across South Carolina, Georgia, Alabama, and the panhandle of Florida (Palis and Means 2005). Over time and despite recently increased efforts to survey historical locations and find new populations, the combined range of *A. bishopi* and *A. cingulatum* has dwindled from 458 historical locations (i.e. mostly individual breeding sites) prior to 1999 to only 49 locations over the last five years (89.3% loss; Semlitsch et al., in review).

When the 2009 final rule was published (74 FR 6700), there were 20 existing populations of *A. bishopi*. These populations were defined as those salamanders using breeding ponds within 3.2 km of each other, barring an impassable barrier such as a perennial stream (64 FR 15692). Ecologically, this legal definition best describes a metapopulation.

Of the 20 known populations in 2009, 11 exist on private lands (mainly designated critical habitat areas), and 9 on public lands. Most of the private lands have not been surveyed in recent years. Unfortunately, this created a gap in our known status of the majority of Critical Habitat ponds that occur on private lands during any recent breeding seasons. Subsequently, having limited breeding data on private ponds does not mean those populations have disappeared. However, we present several lines of evidence related to habitat of some private land sites and information on 1 private land site that has gone locally extinct. Overall, we have limited information on salamander occupancy on private lands, so our analysis of populations primarily focuses on public lands where sampling has been more rigorous since 2009.

Means (2013) was able to visit most of the critical habitat units including on private lands, but the year was dry and only limited dipnet sampling could be conducted. Hence, the current status of most of the privately owned sites within designated Critical Habitat remains unknown. Mean's visits to these Critical Habitat units were unable to yield any data on occupancy (due to the time of year she was able to visit the sites outside of the majority of the breeding season), but did provide insight into habitat quality. Many sites were no longer suitable and at least 1 private land population has had no detections since the early 2000's. Critical habitat units for *A. bishopi* are comprised of 19% public and 81% private lands. As of 2014, 54% of the designated critical habitats are comprised of vegetation types that are not suitable for *A. bishopi* (J. Barichivich, USGS, pers. comm.). Also, of the 16 critical habitat units, only 5 appeared to have suitable habitat characteristics for successful breeding by *A. bishopi* following on-site evaluations (Means 2013) and many were comprised of a single breeding wetland (74 FR 6700). Additionally, a well-managed breeding wetland on private land in Georgia has been sampled several times since 2010 and appears to have experienced a localized extinction of *A. bishopi* (J. Jensen, pers. comm.)..

As of the end of the 2014/15 breeding season, there are six known and currently occupied populations (Based on unpublished data from Gorman and Haas, Virginia Tech, K. Enge, FFWC, K. Buhlmann, UGA, and J. Jenson, GADNR,), at the Mayhaw WMA site, the pond in which larvae were found in 2001, did not yield any detections, but two other ponds within the same population, did have detections. The two detections in 2015 were from ponds never previously known to be occupied. These two ponds are considered part of the same population. It is important to note that 11 of the 20 populations (described in 74 FR 6700) are on private land, and nine on public land. However, compared to those included in the 2009 final rule, 3-4 populations (33-45%) on public lands have not had detection in recent years (Table 1).

Table 1. The number of populations from the 2009 final rule (74 FR 6700) and the status of those populations in 2010 and 2015. (Based on unpublished data from Gorman and Haas, Virginia Tech, K. Enge, FFWC, K. Buhlmann, UGA, and J. Jenson, GADNR).

Entity	**Populations according to 2009 listing**	**Occupied in 2010**	**Occupied in 2015**
Eglin AFB/Hurlburt Field	3	2	2
NOLF Holley	1	1	0
Pine Log State Forest	1	0	0
Mayhaw Wildlife Management Area	1	0	1
Northwest FL Water Man. Dist. (NWFLWMD) and Blackwater River State Forest	1	0	0
NWFLWMD and Yellow River Marsh Preserve SP	1	1	1
Santa Rosa County	1	1	1
Private property[#]	11	0	0
Total	20	5	5*

*Currently there are 6 known *A. bishopi* populations including the one at NOLF Holley, which has not had a detection since 2011.

[#] Many private land populations have not been effectively sampled between 2010 and 2015.

b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

The amount of genetic variation within the remnant populations of *A. bishopi* is currently unknown, but we in collaboration with Virginia Tech and Georgia Southern University are investigating population genetics at breeding sites in Okaloosa and Santa Rosa Counties, Florida. Habitat fragmentation, artificial barriers (e.g. agriculture, roads, and hydrological alteration), and distance may now prevent gene flow among isolated populations, because the distance between the breeding populations has extended beyond the dispersal capabilities of the species.

c. Taxonomic classification or changes in nomenclature:

The species was split into two distinct species in 2009, reticulated flatwoods salamander (*Ambystoma bishopi*) and frosted flatwoods salamander (*Ambystoma cingulatum*), based on findings of Pauley et al. (2007) (74 FR 6700, 2009).

d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range :

Ambystoma bishopi historically occurred west of the Apalachicola/Flint River system in Florida, southwest Georgia and southern Alabama (Figure 1). Comparison of historical locations with records since 2000 demonstrate that the distributions of *A. bishopi* and *A. cingulatum* have has been significantly reduced (Semlitsch et al., in review). The potential for metapopulation dynamics (i.e. the natural exchange of individuals among discrete populations [via migration or dispersal] in the same general geographical area: Akçakaya et al. 2007) has become extremely limited for most populations. For example, using locality data, Semlitsch et al. (in review) calculated that the average distance between neighboring flatwoods salamander (for both species combined) breeding ponds was 8.9 km prior to the species' listing in 1999, 12.7 km between 2000-2009, and 28.3 km from 2010 to present. Because individual salamanders probably do not disperse more than 1-2 km within a generation and multi-generation gene flow likely is limited to 5-10 km or less for most species (Semlitsch 2008; Peterman et al. 2015), loss of flatwoods salamander populations over time, even prior to 1999, has evidently created severe isolation that is a critical component of extinction (Semlitsch et al., in review).

Currently, *A. bishopi* occurs in isolated populations scattered across the historical range in remnants of suitable habitat. Recent surveys suggest that its distribution has been significantly reduced when comparing historic records to detections that occurred from 2010-2015 (see Figure 1). Without data from historically known ponds on private lands (Critical Habitat designated areas) we can only attempt to estimate whether those ponds remain suitable and/or occupied. Even if we presume all of them to still contain a population of salamanders, the current status of the reticulated salamander remains at best, unchanged.

In Alabama, the flatwoods salamander was historically known to occur in four southern counties (Wright, 1935; Mount, 1975; Mount, 1980; Jones et al., 1982). Despite more recent survey effort (Godwin, 1994, 2003), the last observation of the species (of what we now have determined is the reticulated flatwoods salamander) in Alabama was in Houston County in 1981 (Jones et al., 1982).

In Georgia, *A. bishopi* was recently found in two wetlands on the Mayhaw Wildlife Management Area (John Jensen, pers. comm., 2015), Miller County.

Prior to 2015, this species had not been detected in Georgia since 2001, but in some cases surveys were limited.

In Florida, recent surveys have detected *A. bishopi* in Santa Rosa and Okaloosa Counties (Table 1). Within these counties, 16 breeding wetlands on Eglin Air Force Base have had at least one detection from 2010 – 2015, with most being occupied during multiple years within this time frame (Gorman et al. 2013, Haas et al. 2014b). Additionally, larvae were detected at one site on Hurlburt Field and one site on property owned by Santa Rosa County in 2014 (Haas et al. 2014a). Larvae were detected at Garcon Point in 2014 (P. Hill, FWC, pers comm.) and, in 2015, larvae were detected at a breeding wetland at Yellow River Marsh Preserve State Park for the first time since 2006 (K. Enge, FWC, pers. comm., 2015). Lastly, *A. bishopi* were detected at one site on NOLF Holley in 2010 and another site in 2011, but no salamanders have been detected since 2011 (K. Buhlmann, UGA. pers. comm., 2015).

e. Habitat:

Habitat conditions have continued to decline, primarily from suppression or exclusion of prescribed fire, but also because of an increase in drought conditions (Chandler 2015). Increased cover from woody vegetation in breeding ponds and some uplands can contribute to a decrease in both herbaceous vegetation and hydroperiod (Bishop and Haas 2005, Gorman et al. 2013). Unfortunately, prescribed burns are often conducted during the dormant season, rather than the lightning season (Bishop and Haas 2005). Dormant season fire may not be ideal for these salamanders as the breeding season occurs during this time. Dormant season fire can remove cover used by salamanders during ingress and egress from breeding ponds, expose areas that would provide cover for egg deposition sites, and may even cause direct or indirect mortality when it coincides with salamander movements. Prescribed fire should be modified to occur during the lightning season or, alternatively, during the dormant season when wetlands are dry and fire will successfully carry through the dry wetland. Under this scenario, the conditions needed for successful salamander egg and/or larval development are not adequate and fire will pose minimal threat to survival of these developmental stages. Further, to increase herbaceous vegetation and open the canopy, burning of the uplands during the dormant season to create a ‘‘safety’’ strip to prepare for a growing season fire that targets the basin of the wetland may be necessary at some sites (Gorman et al. 2009). Mechanical treatments with handheld equipment (e.g., brush saws and chainsaws) may also be used to successfully reduce canopy cover and facilitate herbaceous vegetation growth (Gorman et al. 2013).

f. Other: In August 2014, a structured decision making workshop was held specifically to discuss the potential for developing captive populations of this salamander and a captive breeding program and, if done, how to implement such a program (Walls *et al*. 2015). This workshop addressed the very important need to dramatically increase reproductive success (from egg to metamorphosed individuals). Animals have been brought into captivity to figure out the most efficient husbandry techniques so that salamanders can be reared to sexual maturity to become part of an assurance colony. Most species of the genus *Ambystoma* have not been bred successfully in captivity, but it is necessary to try to work out captive methods in case it becomes an option of last resort to prevent extinction. If these techniques are successful it is deemed the most likely approach to acquire sufficient numbers of salamanders to conduct any real recovery efforts beyond habitat recovery. It is unlikely, given the current disjunct populations that any meaningful progress toward recovery can happen without some form of reintroduction or translocation. The common denominator in all potential recovery actions, is having enough animals to do something with.

A subsequent structured decision making workshop was held in February 2015 in which participants discussed specific management actions in the near term for the sibling species, *A. cingulatum*, at St Marks National Wildlife Refuge.(O'Donnell *et al*. 2015) The techniques developed for the refuge will be applicable to restoration efforts for *A. bishopi*.

Given the long-term nature and challenge of developing a captive breeding program for both reticulated and frosted flatwoods salamanders (Fenolio et al. 2014), the participants of this second workshop explored additional methods to significantly increase survival of eggs and larvae of flatwoods salamanders to metamorphosis. Existing methodologies that are known to improve larval survival in other ambystomatid salamanders will be used in this effort. By rearing amphibian larvae in mesocosms (cattle tanks), the extremely low survival that has been observed in nature (e.g., from egg to metamorphosed juvenile, < 1.0% survival for *A. annulatum* and *A. maculatum* [Semlitsch et al. 2014; Anderson et al. 2015] and as low as 1.0-3.3% for *A. maculatum* [Shoop, 1974]) can be increased to as high as 90% (in the absence of predators) in mesocosms (R. D. Semlitsch, pers. comm. Februrary 2015; T. L. Anderson, pers. comm. 25 March 2015; Anderson and Semlitsch 2014; Anderson and Whiteman 2015).

2. Five-Factor Analysis -

a. Present or threatened destruction, modification or curtailment of its habitat or range:

The main threat to the flatwoods salamander is loss of both its longleaf pine/slash pine flatwoods terrestrial habitat and its isolated, seasonally inundated breeding habitat. The combined pine flatwoods (longleaf pine-wiregrass flatwoods and slash pine flatwoods) historical acreage was approximately 32 million ac (12.8 million ha) (Wolfe *et al*., 1988; Outcalt, 1997). The combined flatwoods acreage has been reduced to 5.6 million ac (2.27 million ha) or approximately 18% of its original extent (Outcalt, 1997). These remaining pine flatwoods (non-plantation forests) areas are typically fragmented and degraded, with second-growth forests.

Many ecologists consider fire suppression to be the primary reason for the degradation of remaining longleaf pine forests. The disruption of the natural fire cycle has resulted in an increase in hardwood midstory and understory and a decrease in herbaceous ground cover (Wolfe et al., 1988; Gorman et al. 2013). Ponds surrounded by pine plantations and protected from the natural fire regime may become unsuitable flatwoods salamander breeding sites due to canopy closure and the resultant reduction in herbaceous vegetation needed for egg deposition and larval development sites (Palis, 1993, Gorman et al. 2014). In addition, lack of fire within the pond during periods of dry-down may result in chemical and physical (vegetative) changes that are unsuitable for the salamander (Bishop and Haas 2005, Gorman et al. 2013). Large scale prescribed fire is often accomplished in the dormant season, and can have negative effects on salamander habitat (Bishop and Haas 2005). However, these burns are important for reducing woody fuels and decreasing wildfire danger, but more effort should be placed on burning the sites when they are dry, avoiding burning when salamanders may be migrating to and from the pond, and follow-up burns should be used to ensure wetlands benefit from fire.

Fragmentation of the longleaf pine ecosystem, resulting from habitat conversion, threatens the survival of the remaining flatwoods salamander populations. Large tracts of intact longleaf pine flatwoods habitat are fragmented by roads and pine plantations. Most flatwoods salamander populations are widely separated from each other by unsuitable habitat. Studies have shown that the loss of fragmented populations is common, and recolonization is critical for their regional survival (Fahrig and Merriam, 1994; Burkey, 1995). Amphibian populations may be unable to recolonize areas after local extinctions due to their physiological constraints, relatively low mobility, and site fidelity (Blaustein *et al*., 1994).

Road construction in the last two decades destroyed an historic breeding pond in Escambia County, Florida. Roads also contribute to habitat fragmentation by isolating blocks of remaining contiguous habitat. They may disrupt migration routes and dispersal of individuals to and from breeding sites. In addition, vehicles may also cause the death of flatwoods salamanders during migrations across roads (Means, 1996). Road construction is also a recurring threat in the remaining flatwoods salamander habitats on Eglin AFB and Hurlburt Field. Roads can cause disruptions to groundwater and sheet flow, and have serious direct and indirect impacts on the breeding ponds.

Conversion of natural pine flatwoods to intensively managed (i.e., impacted by heavy mechanical site preparation, high stocking rates, and low fire frequencies) slash or loblolly pine plantations often degrades flatwoods salamander habitat by creating well-shaded, closed-canopied forests with an understory dominated by shrubs or pine needles (Means *et al*. 1996). Disturbance-sensitive groundcover species, such as wiregrass, dropseed, and perennial forbs are either greatly reduced in extent or are replaced by weedy pioneering species (Schultz and White, 1974; Moore et al., 1982; Outcalt and Lewis, 1988; Hardin and White, 1989). Wiregrass is an herbaceous species often lost in habitat conversion and considered an indicator of site degradation from fire suppression and/or soil disturbance (Clewell, 1989). It also appears to be absent from areas where flatwoods salamanders no longer occur (Palis, 1997). Past pine plantations were created on natural pine sites, whereas future pine plantations will increasingly be created on former agricultural land (Wear and Greis, 2002); thus this type of habitat conversion is not considered an on-going threat to the flatwoods salamander. However this could limit recovery potential from changes to the upland habitat.

Land use conversions to urban development and agriculture eliminated large acreages of pine flatwoods in the past (Schultz, 1983; Stout and Marion, 1993; Outcalt and Sheffield, 1996; Outcalt, 1997). Urbanization and agriculture resulted in the destruction of flatwoods salamander localities in Mobile and Baldwin counties, Alabama; Jackson and Washington counties, Florida; and Berrien, Chatham, Early, and Effingham counties, Georgia. State forest inventories completed between 1989 and 1995 indicated that flatwoods losses through land use conversion were still occurring (Outcalt, 1997). Urbanization, especially in the panhandle of Florida and around major cities, is reducing the available pine forest habitat. Wear and Greis (2002) identified conversion of forests to urban land uses as the most significant threat to southern forests. These authors predicted that the South could lose about 12 million forest acres (about 8% of its current forest land) to urbanization between 1992 and 2020.

Forestry management which includes intensive site preparation may adversely affect flatwoods salamanders both directly and indirectly (Means et al., 1996). Bedding (a technique in which a small ridge of surface soil is elevated as a planting bed) alters the surface soil layers, disrupts the site hydrology and often eliminates the native herbaceous groundcover. This can have a cascading effect of reducing the invertebrate community that serves as a food source for flatwoods salamander adults. Intensive site preparation also negatively impacts subterranean voids such as crayfish burrows and root channels that are the probable fossorial habitats of terrestrial salamanders and may result in entombing, injuring, or crushing individuals.

Flatwoods salamander breeding sites have also been degraded or altered. The number and diversity of these small wetlands have been reduced by alterations in hydrology, agricultural and urban development, incompatible silvicultural practices, shrub encroachment, dumping in or filling of ponds, conversion of wetlands to fish ponds, domestic animal grazing, and soil disturbance (Vickers et al., 1985; Ashton, 1992). Hydrological alterations, such as those resulting from ditches created to drain flatwoods sites or fire breaks and plow lines, for example, represent one of the most serious threats to flatwoods salamander breeding sites.

Lowered water levels and shortened hydroperiods at these sites may prevent successful flatwoods salamander recruitment.

Off-road vehicle (ORV) use within flatwoods salamander breeding ponds and their margins severely degrades wetland habitat. Continued use of sites by ORVs can completely degrade the integrity of breeding sites by killing herbaceous vegetation and rutting the substrate, which can alter hydrology. There is also the potential for direct injury and/or mortality of flatwoods salamanders by ORVs at breeding sites. Habitat loss from agricultural conversion or commercial development, pond alteration and additional introduction of predatory fish, fire suppression leading to altered forest habitat and crayfish harvesting comprise the most serious threats to *A. bishopi* populations (Palis and Hammerson 2008).

A. bishopi selectively breeds in open canopy, longleaf pines which are particularly fire-adapted. However, fire suppression may lead to changes in the coverage and wetland composition that this species selects for. Further growth could crowd the ecosystem and destroy historical breeding ponds (Bishop and Haas 2005). Though this has not been proven, the potential exists if no consideration is given.

Due to the burrowing nature of the species, adult population numbers are difficult to enumerate. However, no more than 10,000 adults in twenty populations are estimated within the entire range. The population is assumed to be declining rapidly given deforestation, silviculture, and general habitat degradation and fragmenting (Palis and Hammerson 2008).

b. Overutilization for commercial, recreational, scientific, or educational purposes: We shared in our listing rule where we listed both of these salamanders that over collecting does not appear to be a threat to the reticulated flatwoods salamander at this time. The pet trade still deals in wild caught amphibians. Rarity drives up the value and price of these creatures, so that as these animals become rarer, they become more valuable in the pet trade. With the relatively few (20) populations known in 2009, this is a potential threat that we will continue to closely monitor. At this time, though, we continue to have no evidence of collection of this species. We will also closely work with partners and monitor intensive survey work to ensure it has no negative effect on small populations of this species. We have determined though that overutilization for commercial, recreational, scientific, or educational purposes is not a threat to the reticulated flatwoods salamander at this time. .

c. Disease or predation:

Disease

Disease is currently unknown in natural populations of reticulated flatwoods salamanders. However, Whiles et al. (2004) found a parasitic nematode

(*Hedruris siredonis*, family Hedruridae) in larvae of the closely related frosted flatwoods salamander from South Carolina and Florida. This parasite has been found in other ambystomatids and can cause individuals to be become undersized and thin, thus reducing their fitness (Whiles et al., 2004). The infestations were not considered heavy and were probably not having a negative impact on the larvae studied (Whiles et al., 2004). However, environmental degradation may change the dynamics between salamander populations and normally innocuous parasites (Whiles et al., 2004). "Red-leg" disease (*Aeromonas hydrophilia*), a pathogen bacterium, caused mortality of the mole salamander (*A. talpoideum*) at the breeding pond of the reticulated salamander in Miller County, Georgia (Maerz 2006), and reticulated flatwoods salamanders have not been observed at this site since the disease was reported.

Ranaviruses in the family *Iridoviridae* and chytrid fungus may be other potential threats, although the susceptibility of the reticulated flatwoods salamander to these diseases is unknown. Ranaviruses have been responsible for die-offs of tiger salamanders throughout western North America and spotted salamanders (*A. maculatum*) in Maine (Daszak, et al. 1999). The chytrid fungus (*Batrachochytrium dendrobatidis,* or Bd), which causes chytridiomycosis in many amphibians, has been discovered and associated with mass mortality in tiger salamanders in southern Arizona and California, and the Santa Cruz long-toed salamander (*A. macrodactylum croceum*) (Vredenburg and Summers, 2001; Davidson, et al. 2003; Padgett-Flohr and Longcore, 2005). This chytrid fungus has been found at an *A. bishopi* breeding wetland on Eglin Air Force Base and at a site near occupied breeding wetlands. Recently, a new species of chytrid fungus, *Batrachochytrium salamandrivorans* (Bsal), was isolated from a mortality event that caused the near extinction of a population of fire salamanders (*Salamandra salamandra*) in Europe (Martel et al. 2013; Spitzen-van der Sluijs et al. 2013). Currently, it is not known whether any amphibian mortality events in the U.S. are attributable to this pathogen, or whether this new species even occurs in this country. Efforts to begin sampling for Bsal in the U.S. are currently underway. This discussion of disease in other species of closely related salamanders indicates the potential existence of similar threats to reticulated flatwoods salamander populations that we will monitor for.

Predation

Exposure to increased predation by fish is a potential threat to the reticulated flatwoods salamanders when isolated, seasonally ponded wetland breeding sites are changed to, or connected to, more permanent wetlands inhabited by fishes that are not typically found in temporary wetlands. Wetlands/ponds may be modified specifically to serve as fish ponds or sites may be altered because of drainage ditches, firebreaks, or vehicle tracks which can all provide avenues for fish to enter the wetlands from other water bodies. Studies of other ambystomatid species have demonstrated a decline in larval survival in the presence of predatory fish (Semlitsch, 1987; 1988).

Red imported fire ants (*Solenopsis invicta*) are potential predators of reticulated flatwoods salamanders, especially in disturbed areas. This species has been seen in areas disturbed by the installation of drift fences at known breeding sites (T. Gorman, pers. comm., 2015). Controlling fire ants in areas with a high degree of disturbance can be accomplished by using hot water rather than pesticides (Tschinkel and King 2007), so on a small scale fire ants can be controlled around breeding sites. Further study on the effects of fire ants on flatwoods salamanders is recommended because the severity and magnitude, as well as the long term effect of fire ants on reticulated flatwoods salamander populations is currently unknown. We consider predation to be a threat to the reticulated flatwoods salamander at this time. Over half the documented ponds with the range are on private land, increasing the probability of fish being introduced into a breeding site.

d. Inadequacy of existing regulatory mechanisms:

There are no existing regulatory mechanisms for the protection of the upland habitats where reticulated flatwoods salamanders spend most of their lives. Section 404 of the Clean Water Act is the primary Federal law that has the potential to provide some protection for the wetland breeding sites of the reticulated flatwoods salamander. However, due to recent case law (Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers 2001; Rapanos v. U.S. 2006), isolated wetlands are no longer considered to be under Federal jurisdiction (not regulatory wetlands). Wetlands are only considered to be under the jurisdiction of the Corps if a ‘‘significant nexus’’ exists to a navigable waterway or its tributaries. Currently, some Corps Districts do not coordinate with us on flatwoods salamanders and, since isolated wetlands are not considered under their jurisdiction, they are often not included on maps in permit applications (Brooks 2008). We are aware of two isolated wetlands that supported flatwoods salamander populations that have been lost since 2006 under this scenario.
Longleaf pine habitat management plans have been written for public lands occupied by the reticulated flatwoods salamander. They include management plans for State-owned lands and integrated natural resource management plans (INRMPs) for Department of Defense lands. Most of the plans contain specific goals and objectives regarding habitat management that would benefit reticulated flatwoods salamanders including prescribed burning. However, because multiple-use is the guiding principle on most public land, protection of the flatwoods salamander may be just one of many management goals including timber production and military and recreational use. Implementation of the plans has often been problematic due to financial and logistic constraints. In addition, the plans do not provide assured protection from habitat destruction or degradation from land use changes such as the proposed road on Eglin AFB and Hurlburt Field (see Factor A, above).
At the State and local levels, regulatory mechanisms are limited.
Although not listed as threatened or endangered in Alabama, the reticulated

flatwoods salamander is listed among those nongame species for which it is ‘‘unlawful to take, capture, kill, or attempt to take, capture or kill; possess, sell, trade for anything of monetary value, or offer to sell or trade for anything of monetary value’’

The Clean Water Act (CWA) covers ephemeral wetlands, when they impact downstream waters and, in many cases, wetlands used by flatwoods salamanders are connected to downstream waters. However, it is unclear how these newly released regulations will aid in recovery of flatwoods salamanders. On 21 April 2014, the US Environmental Protection Agency and the US Army Corps of Engineers, in response to the SWANCC and Rapanos decisions, proposed clarifications to the CWA that would affect which types of waters would be considered jurisdictional under the Act (see US Army Corps of Engineers and US Environmental Protection Agency "Definition of Waters of the United States under the Clean Water Act," CFR Docket ID No. 79 FR 22188). The clarifications (as of this writing) include reasserting CWA jurisdiction to wetlands adjacent to (i.e., bordering, contiguous, and neighboring) jurisdictional lakes, rivers, and streams. Furthermore, wetlands that are other waters, or those that are nonadjacent to waters of the United States, will have jurisdiction assessed on a case-by-case basis. The proposed regulations also allow the evaluation of other waters either alone or in combination with other similarly situated waters in the region to determine whether they significantly affect the chemical, physical, or biological integrity of traditional navigable waters, interstate waters, or the territorial seas. Other waters are similarly situated when they perform similar functions and are located sufficiently close together or sufficiently close to a water of the United States. The fact that CWA jurisdiction may be extended to geographically isolated wetlands (GIWs) on the basis of a watershed assessment of connectivity and the effect of GIWs on downstream waters suggests that watersheds in regions with large amounts of functioning GIWs (such as the prairie pothole region of the Upper Midwest and Canada, California vernal pools, Carolina bays and cypress ponds of the southeastern United States and other GIWs) may gain CWA protections under these new rules should they be finalized.

There are few, if any, mechanisms in place to adequately protect ephemeral wetlands, like those necessary for successful flatwoods salamander breeding. This includes the breeding ponds themselves as well as the surrounding upland habitat. The exceptions to this are the federally designated Critical Habitat Units for *A. bishopi* but this only applies to federal actions, not to state or private sector actions.

Enforcement of, and compliance with, endangered species laws remains a challenge.

.e. Other natural or manmade factors affecting its continued existence:

Nonindigenous feral swine can significantly impact reticulated flatwoods salamander breeding sites through rooting, so intensive approaches (e.g., control measures and fencing) may be needed to avoid degradation to occupied sites and sites going through restoration.

Invasive plant species such as cogongrass (*Imperata cylindrica*) threaten to further degrade existing habitat. Cogongrass, a perennial grass native to Southeast Asia, is one of the leading threats to the ecological integrity of native herbaceous flora, including that in the longleaf pine ecosystem (Jose et al. 2002). Reticulated flatwoods salamander habitat management plans will need to address threats posed by invasive plants and develop strategies to control them. It has been documented that cogongrass can displace most of the existing vegetation except large trees. Especially threatening to the reticulated flatwoods salamander if the ability of cogongrass to outcompete wiregrass (Scientific name), a key vegetative component of reticulated flatwoods salamander habitat.

Climate change, especially in combination with other stressors, is a daunting challenge for the persistence of amphibians (Walls et al. 2013). Sea level rise is becoming and will likely continue to increase as a threat to the extant populations of the flatwoods salamanders (both species). Most of the remaining relatively resilient populations occur in very low lying areas within a short distance of the coast. These populations are already vulnerable to high tide storm-influenced saltwater intrusion, and these threats will likely increase as sea level rise from global climate change continues. Climate change models predict the occurrence of more variable patterns of precipitation in the future, with longer droughts and larger (but fewer) rainfall events, in addition to increased temperatures (Heisler-White et al. 2008; Lucas et al. 2008). Increases in the occurrence of drought and heavy precipitation events are known to be impacting a variety of amphibians, including those that breed in ephemeral wetlands (Walls et al. 2013). In addition to rainfall amounts, the timing of precipitation events is an important stimulus for reproduction in many pond-breeding amphibians (Walls et al. 2013). Thus, climate change may have an impact on reticulated flatwoods salamanders by altering the timing of fall and winter rains, as well as creating drier winters than historically would have occurred (Chandler 2015).

Small population sizes, especially concentrated in small areas, are more susceptible to stochastic events that could negatively impact the entire population. Examples include salt water intrusion from storm surge (for those areas near enough to the coastline, which is the case for the majority of currently occupied *bishopi* ponds) extended drought, introduced contaminants, fire exclusion, among others.

Pesticides and herbicides may pose a threat to amphibians such as the reticulated flatwoods salamander, because their permeable eggs and skin readily absorb substances from the surrounding aquatic or terrestrial environment (Duellman and Trueb, 1986). Negative effects on amphibians may include delayed metamorphosis, paralysis, reduced growth rates, and mortality (Bishop, 1992). Herbicides used near reticulated Flatwoods salamander breeding ponds may alter the density and species composition of vegetation surrounding a breeding site and reduce the number of potential sites for egg deposition, larval development, or shelter for migrating salamanders. However, the potential for negative effects from pesticide and herbicide use can be reduced by following label directions for application and avoiding aerial spraying over areas adjacent to breeding ponds (Tatum, 2004). Aerial spraying of herbicides over outdoor ponds has been shown to reduce zooplankton diversity, a food source for larval reticulated flatwoods salamanders and cause very high (68-100 percent) mortality in tadpoles and juvenile frogs (Relyes 2005). Additionally, herbicides, if used according to the label and used in specific applications, may aid in restoration of upland and wetland habitat that have been altered by fire suppression and/or exclusion.

Another natural threat in relation to the presence of predatory fish mentioned under Factor C is these fish have a marked effect on invertebrate communities and alters prey availability for larval salamanders with the potential for negative effects on larval fitness and survival (Semlitsch 1987).

D. Synthesis -

In summary, given the low detectability of this species, intermittent or even sustained multi-year drought, and inconsistent monitoring of breeding wetlands in many areas, it is difficult to make a strong inference of its status. We believe the status of the species could be described as stable to slightly declining over the past 5 years based on the best available data we have been able to gather since our 2009 rule. As mentioned earlier, 11 of the 20 populations described in the 2009 rule (74 FR 6700) occur on private lands. These 11 are not factored into the assessment of status, simply because we have limited data to make such an inference. However, we do know that habitat suitability is poor on some of these private lands and one of the eleven populations that has been sampled has gone locally extinct. An analysis of critical habitat units, that includes mostly private land populations, indicates that the majority of these CHU's are not suitable for breeding (J. Barichivich, USGS, pers comm.). This was also confirmed by site visits to many of these populations (Means 2013). Also, many of the private lands populations are comprised of only a single known breeding wetland, which are more likely to go locally extinct than populations comprised of several breeding wetlands, because the latter can operate as a metapopulation and compensate for environmental stochasticity. On public land, there have been between 5 and 6detected populations documented. The 9 public lands populations have been sampled more intensively than private lands, but even of the 9 populations on public lands a decline of 33-45% has occurred since the 2009 rule.

Until 2014 and 2015, comprehensive surveys were limited (including many private lands). Many of the threats (mentioned above) continue to plague this species and it is quite possible that one or two stochastic events (hurricane and/or drought) could push the remaining populations to extinction, given their current locations, vulnerability, and low numbers. We believe *bishopi* continues to meet the definition of an endangered species.

Everything reasonably possible is being explored and implemented to prevent extinction and promote recovery.

III. RESULTS

A. Recommended Classification:

_X_ No change is needed

B. Recovery Priority Number 2

We recommend that the recovery priority number (RPN) be revised from 5 to 2. An RPN of 2 indicates this is a species with high threat yet high recovery potential. Several threats still face this species, including among others, loss of high-quality habitat, prolonged droughts impacting breeding wetlands, and occurrence in a reduced geographic area. Also, the two largest known populations of *A. bishopi* occur on Eglin AFB and Hurlburt Field, but there is still potential conflict with future development and growth, particularly along US Hwy 98. Occasionally plans to widen the highway, create a bypass, and to create new entrances and exits to the installations are considered. Thus far these projects have not gone beyond the planning stage. However, if a project to the south of these installations becomes likely, there will also likely be very significant negative effects to the habitat that remains for breeding salamanders and may hamper ongoing habitat management efforts (e.g., prescribed burning). These threats have continued to hamper stabilization of this species' status and, since 2009, the species has continued to decline on public lands.

Since 2010, however, habitat management has become more focused on restoring breeding habitat (e.g., Gorman et al. 2013). The process of restoring habitat takes time, but combining habitat restoration with *in-situ* assistance techniques (i.e., cattle-watering tanks to increase survival to metamorphosis) shows strong promise to both restore habitat, stabilize and then increase the number of individuals within a population (O'Donnell et al. 2015). The approach of using cattle-watering tanks as mesocosms is a well-established technique in the field of amphibian ecology which, when salamanders are reared at low densities in the absence of predators with an ample food supply, has repeatedly been demonstrated to increase overall survival of individuals from the egg to the metamorphic life history stage, including for *A. annulatum* a close relative of *A. bishopi* with a similar breeding strategy (Shoop, 1974; Anderson and Semlitsch 2014; Semlitsch et al. 2014; Anderson et al. 2015; Anderson and Whiteman 2015; R. D. Semlitsch, pers. comm. February 2015; T. L. Anderson, pers. comm. 25 March 2015). Moreover, under these circumstances, individuals can metamorphose at a larger body size, which has been demonstrated empirically to be related to correlates of adult fitness in at least two other species of *Ambystoma* (*A. talpoideum* and *A. opacum*; Semlitsch et al., 1988; Scott 1994). Specifically, for both of these species, larger juveniles at metamorphosis were also larger adults at first reproduction, which in turn, produced larger clutches of eggs at a younger age (Semlitsch et al. 1988; Scott 1994). Further, this *in situ* approach has successfully been employed for the conservation and recovery of another federally endangered amphibian, *Rana sevosa* (USFWS 2014). Last, methods to rear this species in captivity are underway (Fenolio et al. 2014) and if this process is successful it may provide a captive source population for future repatriations of formerly occupied sites that have been properly restored (Walls et al. 2015). This new potential, along with the implementation of methods to boost metamorph production (undertaken since the 2009 final rule), will offer a suite of approaches for more rapid population recovery by increasing the survivability of larvae and improving habitat conditions, improves the recovery potential and justifies the upgrade from an RPN of 5 to an RPN of 2.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS -

Collaboration with Public and Private Landowners to better protect this salamander

Clearly, improvement of access and communication with private land owners is needed. Eleven populations were known from private lands, but limited data is available from these populations. Outreach and education are vital to securing the trust of private land owners. Access to these properties is limited, but 1 property in Georgia has been sampled and access is permitted (J. Jensen, pers. comm.). Also, another one of the 11 private lands has been purchased recently and is under the management of the Northwest

Florida Water Management District. However, the acquisition was very recent and to date, no recent salamander surveys are known from this property.

Education and Outreach to private landowners should include a detailed presentation of opportunities such as the Partners for Fish and Wildlife Program, Recovery programs, Safe Harbor agreements, and other instruments that will benefit the landowner as well as provide protection and management to occupied private lands.

Greater expansion of survey efforts to include more areas where habitat is suitable but no known populations exist, including greater documentation of areas we do not believe continue to support populations, and why.

More aggressive prescribed fire programs focused on the restoration of individual ponds. This is a difficult thing to accommodate in that most prescribed fire programs are geared to larger more general fire management. Resources that are deployed for large scale burning are not frequently available for small focused fire specifically to restore suitable breeding pond habitat.

Increase the "assisted metamorphosis" idea as we learn from our experiences and improve the techniques.

Habitat Restoration

Having suitable, available, breeding and upland habitat is of utmost importance in any restoration/recovery work for a species. Every effort should be made to first maintain suitable wetland breeding and upland habitat where the species still occurs and expand/restore such habitat to suitable condition as soon as possible. Keeping habitat from being degraded by lack of fire, changes in hydrology, and potential invasion of exotic and normally fire excluded plants will be a significant challenge. Frequent (1-3 years) prescribed fire during the lightning season and taking advantage of dry dormant season conditions to burn breeding wetlands if reproduction was unsuccessful based on that years monitoring will assist with restoring conditions in breeding wetlands. Prescribed fire during the lightning season may be facilitated by burning uplands around breeding sites during the dormant season to provide a safety-strip around wetlands (Gorman et al. 2009). Additionally, maintenance of hydrological function will be critical for salamander persistence. Additionally, restoration and management for flatwoods salamanders could be more effectively focused on the need for demographic connectivity and recolonization that are essential for metapopulation stability (Semlitsch et al., in review).

Surveys/inventories, and monitoring

The surveys conducted for both species of flatwoods salamander in the Winter/Spring of 2014 and 2015 constitute the most comprehensive survey efforts since at least the 1993-1994 surveys conducted by John Palis (Palis 1995b). Surveys have occurred by various agencies and individuals each year but rarely is there comprehensive information collected in a single season that gives an adequate 'snapshot' of the range –wide status of the species. In short, annual surveys that adequately allow us to evaluate status should be completed in the near term. The precarious situation of both species of flatwoods salamanders is such that even a 1or 2 year gap of data may be critical to preventing extinction.

Monitoring

Monitoring programs need to be refined so that data will be compatible among all participating agencies and to develop a better understanding of the current status of the species with particular emphasis on private lands and other populations that have not been sampled as intensively. Additionally, multiple surveys should be conducted at known/historic sites each year for a minimum of 3-5 years to develop a base-line for the current status. Relying on single year surveys may provide misleading results, because weather conditions and other variables can obscure detectability or prevent sampling altogether (e.g., sampling of aquatic larvae, the most widely recommended sampling technique for range-wide surveys [Bishop et al. 2006], is compromised during drought years with dry winters).

The continued decline of numbers and populations, as well as continued habitat degradation, will require much more intensive monitoring to remain well informed on the status of the species. Annual status updates are recommended for the coming years until there is some stability or trending increase in numbers and populations. Specific attention and effort to gain access to currently inaccessible private lands that historically are known to have flatwoods salamanders present needs to be initiated. Surveys are also recommended to identify potential habitat. Recovery of this species will require expansion from its currently occupied populations and knowing where these animals still occur, and where they do not will influence areas chosen for potential recovery actions.

Research

Capture-mark-recapture studies that provide information on vital rates (e.g. individual growth and survival) and demographic parameters of populations are needed to develop a Population Viability Analysis (PVA), which is essential for recovery planning. (Walls *et al* 2015) Very little is currently known about the ecology of juveniles and during the portion of the year that they are using habitat in the uplands surrounding breeding ponds.

Population Management

Head starting, “assisted metamorphosis”, and captive populations are recommended to increase larvae survival to the metamorph stage and to help increase numbers of individuals more rapidly than is possible under current natural circumstances. (O’Donnell *et al*. 2015; Walls *et al*. 2015). The primary known populations (80%) for this species occur in two counties in the panhandle of Florida with all the known breeding ponds being in close proximity (range of 1.2-6.5 km) to the Gulf of Mexico. Implementation of these options are particularly essential because one or two stochastic events, such as a prolonged drought or hurricane, could all but extirpate the majority of the extant populations of *A. bishopi*.

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U.S. FISH AND WILDLIFE SERVICE
Reticulated flatwoods salamander/*Ambystoma bishopi*

Current Classification: ____Endangered______
Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change is needed

Review Conducted By: Harold Mitchell, Panama City Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve Catherine D. Phillips Date Aug 5, 2015

APPENDIX A: Summary of peer review for the 5-year review of
Reticulated flatwoods salamander/*Ambystoma bishopi*

A. Peer Review Method:
Upon completion of the draft of this document, the Service chose three peer reviewers (see 1.B) for their close evaluation of this 5-year review document. The reviewers used the markup review feature in Word and returned their corrections, comments and edits to the recovery lead to evaluate and consider making the appropriate changes. Upon receipt, all comments were evaluated and considered and then the document was submitted forward for supervisor approval with final edits.

B. Peer Review Charge:
We provided all reviewers with the draft document via email. We asked them to review all provided materials by the Service; to identify, review, and provide other relevant data that appears to not have been used by us; do not provide recommendations on the ESA classification; and provide comments on the validity of data; adequacy of the data; scientific uncertainties; strengths and weaknesses; and reasonableness of the assessment. We specifically asked for updated scientific data on recent findings of occupancy, numbers of individuals, and habitat information. All reviewers provided comments.

C. Summary of Peer Review Comments/Report –

Drafts were sent and returned by each of the peer reviewers. All reviewers submitted grammatical edits and those corrections were made.

The following are significant comments made by each of the reviewing entities.

Dr. Susan Walls: (with input from Dr Jamie Barichivich, and Dr Katie O'donnell)
Throughout the draft process, we worked closely with USGS Amphibian Research Initiative. During this time, comments were submitted by the USGS team, incorporated accordingly. The vast majority of edits focused on updating the biological information to reflect the most recent data available. The core edits originate from the taxonomic split of flatwoods salamanders in 2009. Populations and survey data had to be teased apart to more accurately reflect the relative situations of each species.

Dr. Brook Talley: Submitted comments about disease in salamanders, and made some usage and grammatical edits.

Dr. Thomas Gorman: Submitted comments in conjunction with Dr Walls, on the same subjects: clarifying and updating recent biological information on *A. bishopi*.

D. Response to Peer Review –

Throughout the review process, communication was frequent. The great majority of comments and edits were accepted, particularly because nearly all were simply updates to our body of biological knowledge about this species. There were no controversial items or comments that were rejected based on disagreement. Virtually all grammatical and style edits were accepted.

There were a few items that required clarification between the reviewers, reflected in comments that were settled and common language agreed upon. Differences mainly centered on characteristic habitat plants occurring prominently in one of the species range, but not prominently in the other. Sawgrass was the primary issue. This was clarified in 5-year review.