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A Range-wide Assessment of the Status and Distribution of the Striped Newt (*Notophthalmus perstriatus*)

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***Abstract.*—The Striped Newt (*Notophthalmus perstriatus*) is endemic to the xeric uplands of southern Georgia and northern Florida, USA. The U.S. Fish and Wildlife Service designated the species as a candidate for federal protection under the Endangered Species Act in 2011 but determined its listing priority to be low relative to that of other candidate species. To assess the current status and distribution of the species, we conducted surveys of known and suitable breeding ponds, solicited sightings from qualified individuals, and obtained records by searching databases, the literature, and U.S. museum collections. In Florida, 13 counties had recent records (2000–2016) from 106 breeding ponds. However, recent unexplained extirpations in the panhandle suggest that the species faces imminent threats even on protected lands. In Georgia, six counties had recent records from nine breeding ponds. In the last five years, Striped Newts from the western evolutionarily significant unit (ESU) have been found in only two ponds in Georgia and three ponds in Florida. Remaining Georgia populations are widely separated by predominantly unsuitable habitat, which may jeopardize their long-term viability. Our status assessment supports the determination by the U.S. Fish and Wildlife Service that this species warrants federal protection as a threatened species and suggests that Striped Newt populations are not necessarily secure on public lands. Further research is needed to determine the cause of recent declines of populations in the Florida panhandle and southwestern Georgia. Additional conservation measures may be necessary to ensure the long-term viability of western populations.**

Key Words.—amphibian; conservation; Florida; Georgia; salamander

Introduction

The Striped Newt (*Notophthalmus perstriatus*) is a pond-breeding salamander endemic to the xeric uplands of southern Georgia and northern Florida, USA (Dodd and LaClaire 1995; Johnson 2005). The U.S. Fish and Wildlife Service (USFWS) designated the Striped Newt as a candidate for federal protection under the U.S Endangered Species Act in 2011 (USFWS 2011). The original designation and subsequent reviews of its candidate status determined that the listing priority for the Striped Newt was lower (listing priority number eight out of 12) than that of other candidate species (USFWS 2011, 2016). This lower prioritization was primarily based on an assessment that three of the major threats facing the Striped Newt (habitat loss, disease, and inadequacy of existing regulations) were of only moderate magnitude because most remaining populations are on protected lands and no disease outbreaks have been detected in the species (USFWS 2011, 2016). The Striped Newt is not protected in Florida, where most of its known populations occur. It is listed as a state-threatened species in Georgia, although on private lands its protection is limited only to prohibition of direct take (Georgia Department of Natural Resources 2015; Georgia Administrative Code 391-4-10-.06). Indirect or incidental take, such as habitat alteration, is prohibited only on public lands.

Striped Newts have a complex life cycle that requires both upland and wetland habitats, making them vulnerable to threats in both habitats (Johnson 2005). Striped Newts spend most of their lives in the uplands and migrate to wetlands only to reproduce (Dodd et al. 2005), although a paedomorphic (gilled adult) life stage persists in the natal wetland until first reproduction in some populations (Johnson 2005). Habitat destruction and fragmentation were historically the primary threats to the Striped Newt (Dodd et al. 2005; USFWS 2011). Since European settlement, more than 50% of wetlands and 98% of Longleaf Pine (*Pinus palustris*) habitats, including upland pine and sandhill habitats preferred by the Striped Newt, have been lost in the United States (Dahl 1990; Ware et al. 1993; Frost 2006). These numbers likely underestimate the loss of small, isolated

wetlands, which provide breeding habitat for the Striped Newt and are often too small to be detected using aerial or satellite imagery. In Florida, more than 3.8 million ha of wetlands were destroyed from 1780 to 1980, and 90% of remaining Longleaf Pine habitats and 51% of the remaining herbaceous wetlands were lost between 1936 and 1995 (Dahl 1990; Kautz 1998). In Georgia, extensive historical wetland drainage and forest conversion have severely reduced and fragmented Striped Newt habitat, leaving only a few, isolated populations (Dodd and LaClaire 1995). In contrast, a land conservation system in Florida, consisting of public conservation lands and privately owned preserves, protects a large proportion of the remaining xeric uplands and embedded isolated wetlands. A recent GIS analysis estimated that half of the 244,576 ha of remaining suitable habitat for Striped Newts in Florida was on public lands (Endries et al. 2009).

Current threats to Striped Newts include fire suppression in both wetland and upland habitats, prolonged droughts, off-road vehicle impacts at breeding ponds, direct mortality of animals on roads, and habitat loss and degradation on private lands (USFWS 2011, 2016). Johnson and Owen (unpubl. report cited in USFWS 2011) ranked 22 of 51 historical Striped Newt breeding sites in peninsular Florida as having moderate to no potential to support the species. The decline in habitat quality at these sites was primarily associated with fire suppression and habitat conversion to urban, agricultural, or silvicultural uses. A survey of ephemeral ponds on commercial forest lands in northern Florida (207 ponds) and southern Georgia (196 ponds) from 1996 through 1998 found Striped Newts in only four ponds in two counties in Florida and none in Georgia (Wigley et al. 1999), suggesting that some aspect of commercial forestry is incompatible with Striped Newt survival. A prolonged drought may have contributed to the disappearance of Striped Newts from most breeding ponds in the Munson Sandhills in the Apalachicola National Forest, although large declines were not observed in other pond-breeding amphibian species (USFWS 2011; Bruce Means, unpubl. report). No Striped Newts have been found in the privately owned eastern portion of the Munson Sandhills since the native second-growth Longleaf Pine forest was clear cut, roller chopped, and planted in off-site Sand Pine (*Pinus clausa*; Means and Means 2005). Off-road vehicles have destroyed the littoral zone of some Striped Newt breeding ponds in Apalachicola National Forest (USFWS 2011; Bruce Means, unpubl. report). Recent unexplained declines have been documented on some protected lands, particularly in the western part of the range of the species (Dodd et al. 2007; USFWS 2011). These declines have particular significance in light of recent studies that suggest the western populations are ecologically distinct. May et al. (2011) found genetic and ecological niche differences between eastern and western Striped Newt populations, suggesting the presence of two ESUs separated by a lack of contemporary gene flow. Herein, we compare current and historical distributions of the Striped Newt and examine the status of the species throughout its range.

Materials and Methods

To obtain records of Striped Newts from Georgia and Florida, we searched databases of the Georgia Department of Natural Resources (GADNR), the Florida Natural Areas Inventory, and the Florida Fish and Wildlife Conservation Commission; peer-reviewed and gray literature; and U.S. museum collections. We also solicited records from herpetologists and other credible persons with experience in the identification of this species. For each historical record, we tried to obtain precise location data, but this was not always possible. Since 2006, we have conducted intensive dipnet surveys for Striped Newts in 957 historical and suitable breeding ponds throughout Florida (861 in the peninsula and 96 in the panhandle). In Georgia, we conducted dipnet surveys in 128 known or potentially suitable breeding ponds from 2000 through 2015.

We combined records from the same location or breeding pond to create a list of unique locations and identified the first and last years in which Striped Newts were observed at each location. To look for changes in distributions over time, we divided the Striped Newt records for each location into different time periods: pre-1980, 1980–1999, 2000 to July 2016, and 2012 to July 2016. We considered 2000–2016 records to be recent, although we also included a subset of this category (2012–2016) to identify areas with records from the last five years because of concerns about recent declines. For both states, we determined and mapped the date of the last observation for each county using the categories above (Fig. 1, Appendix 1). We examined all records from breeding ponds to assign the current status of Striped Newts into one of three categories (extant, possibly extirpated, or extirpated) for each pond based on the presence of suitable habitat in recent aerial photos, the year of last detection, and the number of surveys since last detection (Fig. 2). We limited this analysis to breeding ponds because Striped Newts are rarely observed in the uplands and our recent sampling efforts at historical and potential sites were limited to breeding pond surveys. We considered Striped Newts to be extant at a breeding pond if the pond and surrounding uplands remained suitable based on known habitat preferences and recent records (since 2000) and if the most recent surveys found Striped Newts. We also considered Striped Newts to be extant at historical

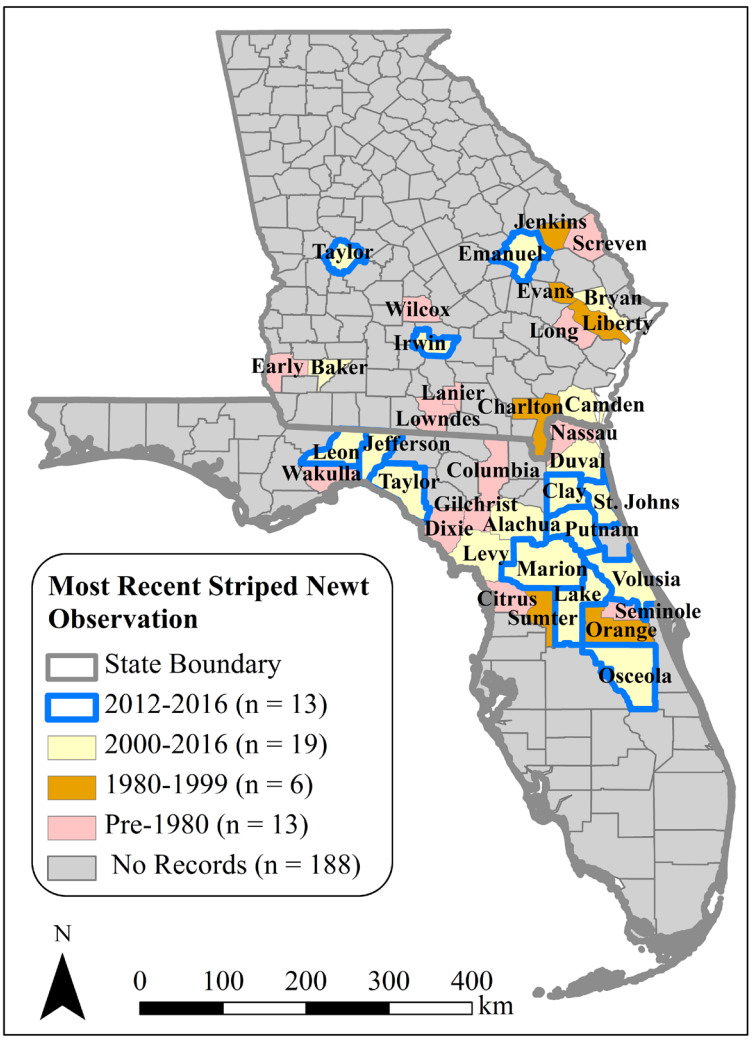

Figure 1. Map of Florida and Georgia, USA, showing the most recent record of the Striped Newt (*Notophthalmus perstriatus*) for each county by time period: pre-1980, 1980–1999, and 2000–2016. Counties with records in the last five years are outlined in blue. Based on recent surveys and information from Bishop (1941), Williamson and Moulis (1994), Dodd and LaClaire (1995), Franz and Smith (1999), and Krysko et al. (2011).

breeding ponds within 1 km of extant localities because they were within the dispersal distance of the species (Johnson 2005). We classified Striped Newts as possibly extirpated from a breeding pond if there were no recent observations (since 2000) at a pond or if multiple recent surveys had failed to detect the species. We presumed Striped Newts were extirpated from a pond if the pond or majority of immediately adjacent uplands were no longer suitable because of prolonged fire suppression, hydrological alteration (duration of pond inundation incompatible with species reproduction), or conversion to urban development, intensive agriculture, or intensive silviculture. We mapped records lacking precise locality information using the best available information as an Exact Location Unknown category because we could not return to the historical location to determine its status.

Results

Florida.—We compiled records of Striped Newts from 190 unique locations in Florida that included 147 breeding ponds in 22 counties (Fig. 1, Appendices 1–2). We found historical (pre-1980) records from 44 locations, including nine breeding ponds, in 14 counties from the panhandle east of the Apalachicola River to central peninsular Florida. We could not trace most historical records to breeding ponds because specific locality information was lacking. Eight counties had records from 1980 through 1999 at 83 locations that included 77 breeding ponds. We documented recent records (2000–2016) in 13 counties at 106 locations, all of which were records from breeding ponds.

Since 2012, surveys have detected Striped Newts in 56 breeding ponds in 10 counties in Florida (Appendix

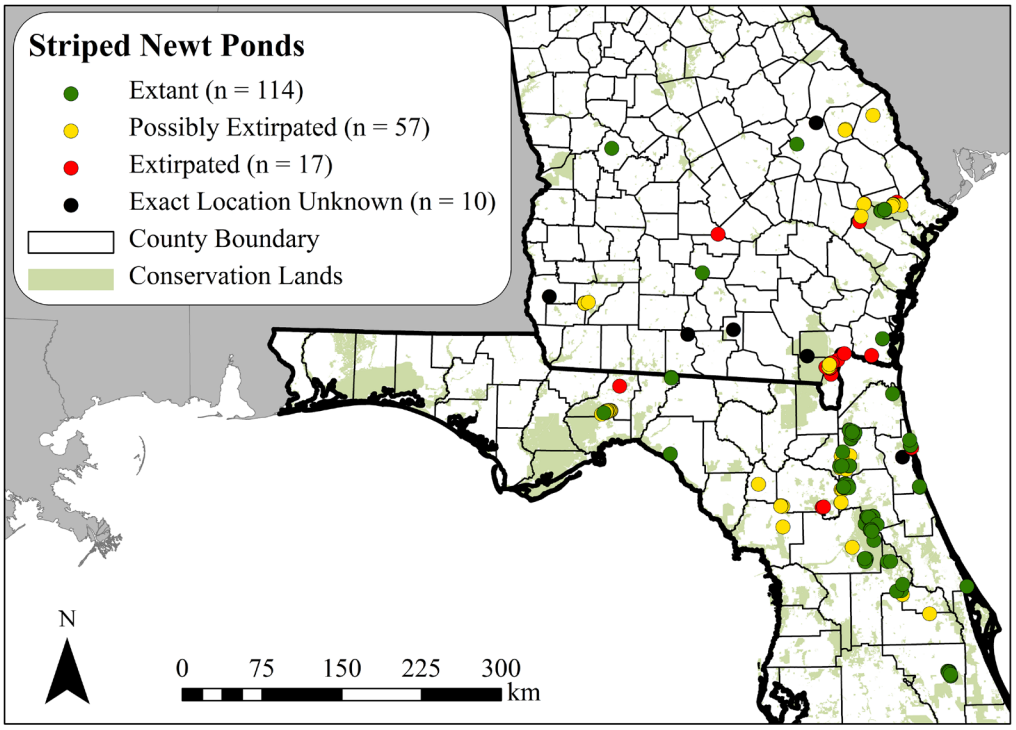

Figure 2. Current status of all known breeding ponds of the Striped Newt (*Notophthalmus perstriatus*) in Georgia and Florida, USA, classified as extant, possibly extirpated, or extirpated. Based on recent surveys and information from Bishop (1941), Williamson and Moulis (1994), Dodd and LaClaire (1995), Franz and Smith (1999), and Krysko et al. (2011).

2). Most of these observations are from five public lands in peninsular Florida: Camp Blanding, Jennings State Forest, Ocala National Forest, Ordway-Swisher Biological Station, and Triple N Ranch Wildlife Management Area (WMA). We detected Striped Newts in only three breeding ponds in the panhandle during this time period, including a single pond on Apalachicola National Forest and two ponds in a newly discovered population on a private plantation in Jefferson County (Hill and Sash 2015). The Apalachicola National Forest observation was the first observation of a native Striped Newt (not from the translocated population) since 2007 and the first evidence of breeding by native animals there since 1998. We also discovered three new populations in the peninsula during this time period. In 2014, we discovered a previously unknown population on Triple N Ranch WMA, Osceola County, which is 57 km south of the previous southernmost record (Enge et al. 2014). Also in 2014, we discovered a previously unknown population (two ponds) on the Spring Creek unit of Big Bend WMA, Taylor County, which fills the purported 125-km-wide distributional gap between panhandle and peninsular populations (Mays and Enge 2014). In 2015, we detected Striped Newts for the first time in a pond on Merritt Island National Wildlife Refuge, Volusia County (Enge et al. 2015).

Based on our evaluation of historical and recent records that could be associated with breeding ponds, we concluded that Striped Newts were extirpated from four ponds, possibly extirpated from 40 ponds, and extant at 103 ponds (Fig. 2). We could not determine the status of the species at two breeding ponds with imprecise locality information. Twenty-five ponds in the peninsula were not occupied during recent surveys but were placed in the extant category because of their proximity (< 1 km) to ponds with recent records.

The four ponds in the extirpated category included two ponds on the Lochloosa Wildlife Conservation Area in Alachua County whose uplands were converted to silviculture and a pond on Guana Tolomato Matanzas National Estuarine Research Reserve with fire-suppressed uplands. Another breeding pond on private land in Leon County was deepened and converted to a horse pond. In contrast, ponds on Apalachicola National Forest (with the exception of the one pond with recent records) and the Watermelon Pond tract of Goethe State Forest, which appear to still have suitable habitat, were placed in the possibly extirpated category because of a lack of observations during multiple recent surveys. In addition, we placed other ponds in the possibly extirpated category because of a lack of recent survey data either because the wetlands were dry during all recent survey

attempts (one pond) or because of difficulties in gaining access to ponds on private lands or in active areas of military bases (five ponds).

Georgia.—We compiled records of Striped Newts from 49 unique locations in 16 counties in Georgia, all of which appear to be based on collections made at breeding ponds (Fig. 1, Appendices 1–2). Before 1980, records document the Striped Newt from 23 breeding ponds in 11 counties extending from southeastern and south-central Georgia west to Lowndes and Wilcox counties, with a single record from extreme southwestern Georgia that was based on an Early County museum specimen (FMNH 9309) that was lost and could not be confirmed. Eight counties had records in 1980–1999 from 21 breeding ponds, and records for this period documented the species in southwestern Georgia at Ichauway Reserve (Baker County) and as far north as Taylor County in the Fall Line sandhills region (Jensen and Klaus 2004; C. Kenneth Dodd, Jr., unpubl. report). Recent records (2000–2016) in six counties documented the species in nine breeding ponds. During the last five years, we detected Striped Newts in only three ponds in three counties, all of which are on public conservation lands (Appendix 2).

Of the 49 known Georgia breeding ponds, we determined that Striped Newts were extirpated from 13 ponds, possibly extirpated from 17 ponds, and extant at 11 ponds (Fig. 2). We could not assess the status of eight historical locations with inexact location information. We concluded that Striped Newts were extirpated from eight historical sites from the Trail Ridge on the eastern side of Okefenokee Swamp in Charlton County (Dodd and LaClaire 1995; C. Kenneth Dodd, Jr., unpubl. report). In this area, commercial forestry practices (i.e., fire suppression, ditching, clear cutting, and bedding) have significantly diminished habitat quality on lands outside of Okefenokee National Wildlife Refuge. We also determined that Striped Newts were extirpated from Chesser's Island inside the refuge because of hydrological alterations to ponds on the island from ditching. Striped Newts may still be extant in one breeding pond on the refuge where the habitat is intact and managed with prescribed fire, although multiple recent surveys have failed to detect the species. We considered single breeding ponds in Bryan, Wilcox, and Camden counties as no longer suitable for Striped Newts due to long-term wetland fire suppression, wetland destruction, and urban development, respectively. Similarly, we deemed two ponds in Evans and Long counties on Fort Stewart as no longer suitable for the species because of fire suppression and ditching of one of the ponds.

Based on our criteria, we concluded that Striped Newts are extant in multiple breeding ponds on Fort Stewart and on a private land in Camden County where the species was discovered in 2008 (Appendix 2). Recent (2000−2016) records exist for two Fort Stewart ponds (both in Bryan County), although newts may still occur at four other ponds with suitable habitat that are near ponds with recent records. Additional extant newt localities, based on a single pond each, occur on the Ohoopee Dunes WMA (Emanuel County), Fall Line Sandhills WMA (Taylor County), and Alapaha River WMA (Irwin County). We classified multiple ponds on Fort Stewart and Okefenokee National Wildlife Refuge as possibly extirpated because of a lack of recent records despite multiple recent surveys. We categorized all ponds on Ichauway Reserve in Baker County as possibly extirpated because the species has not been detected there since 2006 despite good habitat and multiple survey efforts. We classified historical localities from private land in Jenkins and Screven counties as possibly extirpated because of a lack of recent survey data.

Discussion

Our data suggest that the Striped Newt has experienced recent precipitous population declines in the western part of its range, and that populations in the Georgia and Florida panhandle are heavily fragmented. Since 2012, the western ESU of the species has been found in only five breeding ponds on four different properties (May et al. 2011; Eric Hoffman, unpubl. data). In Georgia, only a few Striped Newt breeding ponds remain on five properties that span the range of the species in the state. All of these properties are separated from each other by large areas of intensive agriculture and other unsuitable habitats, eliminating any connectivity between these populations. In addition, most of the Georgia occupied properties consist of only one or two known breeding ponds, although Fort Stewart may support multiple populations. Striped Newts and many other pond-breeding amphibians are hypothesized to live in metapopulations in which dispersal of individuals from neighboring breeding ponds allows for the recolonization of populations after local extinctions (Johnson 2005). In this context, properties with few breeding ponds (Ohoopee Dunes WMA, Alapaha River WMA, the private property in Camden County, Fall Line Sandhills WMA) may be vulnerable to extirpation over the long term because of demographic fluctuations and periods of unfavorable habitat or climate conditions (Semlitsch 2000, 2002).

In recent years, Striped Newts have mysteriously disappeared from most historical localities in the Florida panhandle, despite seemingly suitable habitat. Apalachicola National Forest was once considered a stronghold for the species with 19 known breeding ponds in the Munson Sandhills east of the Apalachicola

River (Johnson 2005; USFWS 2011). However, extensive recent surveys have detected the species in only one wetland in Apalachicola National Forest since 2007, even though upland and wetland habitats appear suitable and still support numerous other amphibian species (USFWS 2011; Ryan Means, pers. comm.). Similarly, Striped Newts were last observed in the Panacea Unit of St. Marks National Wildlife Refuge (NWR) during a drift-fence survey in 1977–1979 (Dodd et al. 2007). Dodd et al. (2007) failed to trap any Striped Newts during a resurvey of the same sites from 2002–2005. Furthermore, since 2001, biologists with the U.S. Geological Survey (USGS) have conducted annual dipnetting and minnow-trapping of multiple ponds in the Panacea Unit but have not found any Striped Newts (William Barichivich, pers. comm.), and our own dipnet surveys for the species have been unsuccessful. The Panacea Unit of St. Marks NWR still has suitable habitat for the species and supports a rich amphibian fauna (Dodd et al. 2007), with Gopher Frogs (*Lithobates capito*) and Striped Newts notably absent.

Drought likely played a role in the recent Florida panhandle declines. The southeastern United States experienced multiple severe droughts during the last three decades that were notable for the period of record covered by weather station instruments (since 1895), although data from tree rings suggest that droughts of similar severity and duration occurred more frequently in previous centuries (Seager et al. 2009; Pederson et al. 2012). These severe droughts are within the time period during which Striped Newts declined on Apalachicola National Forest and other conservation lands. At Fort Stewart, Georgia, Striped Newt breeding ponds monitored from 1992 to 2004 remained dry for seven of the 13 y, and dipnetting and trapping surveys conducted from 2003 to 2005 failed to detect newts at many known sites following an extended drought from 1999 through 2002 (Stevenson and Cash 2008). Bevelhimer et al. (2008) linked this same drought event to local extinctions of Frosted Flatwoods Salamander (*Ambystoma cingulatum*) populations at Fort Stewart. This drought event may also be responsible for the decline of Striped Newt populations on Ichauway Reserve in southwestern Georgia. Striped Newts bred at four ponds at Ichauway prior to the drought and, although surveys identified a fifth breeding pond in 2002, consistent dipnetting efforts at all five ponds have detected the species at only one pond since then. Reticulated Flatwoods Salamanders (*A. bishopi*) also disappeared from Ichauway following this drought, with the last record of this species occurring in 1997. The Striped Newt is relatively long-lived (Wallace et al. 2009) and is presumably adapted to droughts, which occur periodically within its range (Dodd 1993; Dodd et al. 2005; Dodd and Johnson 2007). However, habitat fragmentation has likely increased the threat of drought to Striped Newts because populations are too isolated from each other for colonization to occur after local extirpations (Johnson 2005). Although drought probably contributed to recent Striped Newt population declines, the continued persistence of a diversity of other amphibian species in Apalachicola National Forest, Ichauway, and other lands where Striped Newts have declined or disappeared suggests that drought may not be the only factor in their extirpation. The Striped Newt was the only species that did not successfully breed in the Munson Sandhills of Apalachicola National Forest after the 1999–2000 drought (Bruce Means, unpubl. report).

A die-off from disease could explain why Striped Newts, but not other species, are apparently missing from former strongholds in the Florida panhandle. Diseases often affect individual species and life stages differently, and newts in the genus *Notophthalmus* are susceptible to a number of pathogens, including various ranaviruses, parasites, and fungal and fungus-like infections (Jancovich et al. 2001; Green et al. 2002; Raffel et al. 2006, 2008; Duffus et al. 2008). However, we are not aware of any disease-associated Striped Newt die-offs in wild populations. Efforts are underway to test for a variety of known and novel pathogens in a reintroduced population of Striped Newts and museum specimens from Apalachicola National Forest. Additionally, skin swabs were collected from Striped Newts at breeding ponds in Georgia and Florida 2015–2016 to test for the presence of the chytrid fungi *Batrachochytrium dendrobatidis* and *B. salamandrivorans*, which have caused amphibian die-offs in other parts of the world (Martel et al. 2014).

Historical habitat loss and fragmentation have undoubtedly played a role in the decline of the Striped Newt in Georgia and the western part of its range. The Munson Sandhills of Apalachicola National Forest are isolated from other Striped Newt populations to the north by urban development and to the east by intensive silviculture (Means and Means 2005; USFWS 2011). In Georgia, agricultural and silvicultural land uses now dominate the uplands of the Coastal Plain, and associated soil- and hydrology-disturbing activities have impacted many of the remaining isolated wetlands (GADNR 2015; Stuber et al. 2016). These land-use changes have significantly reduced available habitat for Striped Newts, confining them largely to public lands and private conservation-focused properties, which are often themselves islands surrounded by unsuitable habitat (Fig. 3). Because of these habitat alterations, it is unlikely that connectivity remains between any of the western or Georgia populations (Fig. 4). In contrast, remaining peninsular populations in Florida are on lands predominantly connected by the conservation

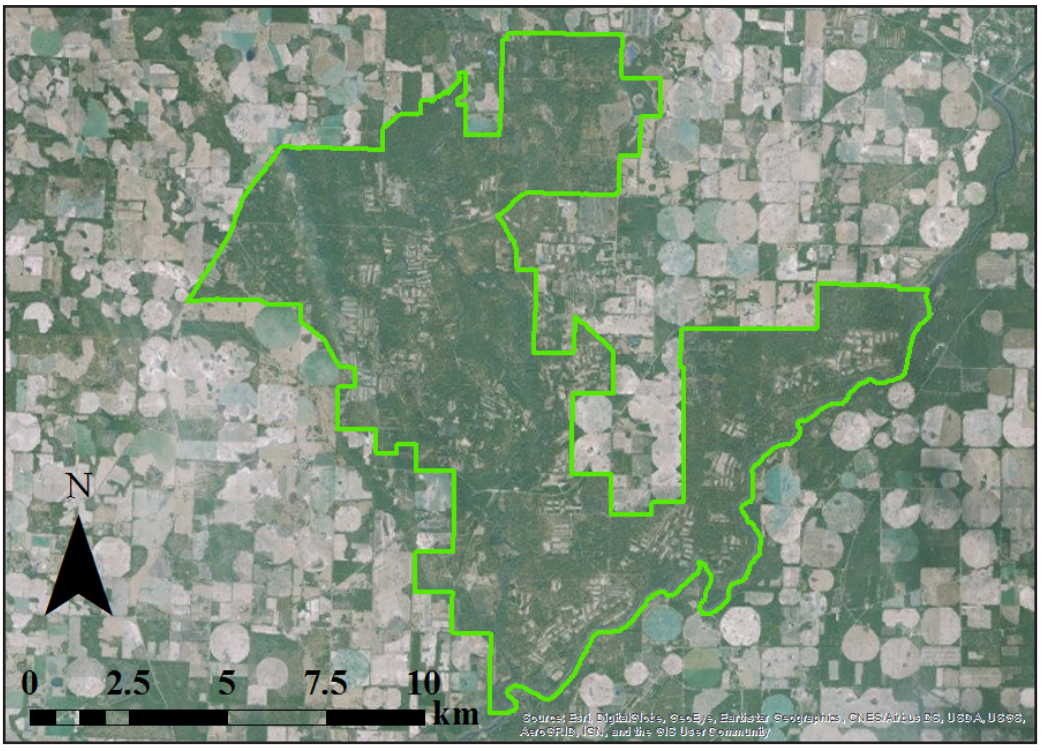

Figure 3. Aerial image of Ichauway Reserve, Baker County, Georgia, USA, and surrounding unsuitable agricultural habitat. (Aerial image: U.S. Department of Agriculture, National Agriculture Imagery Program, 2015).

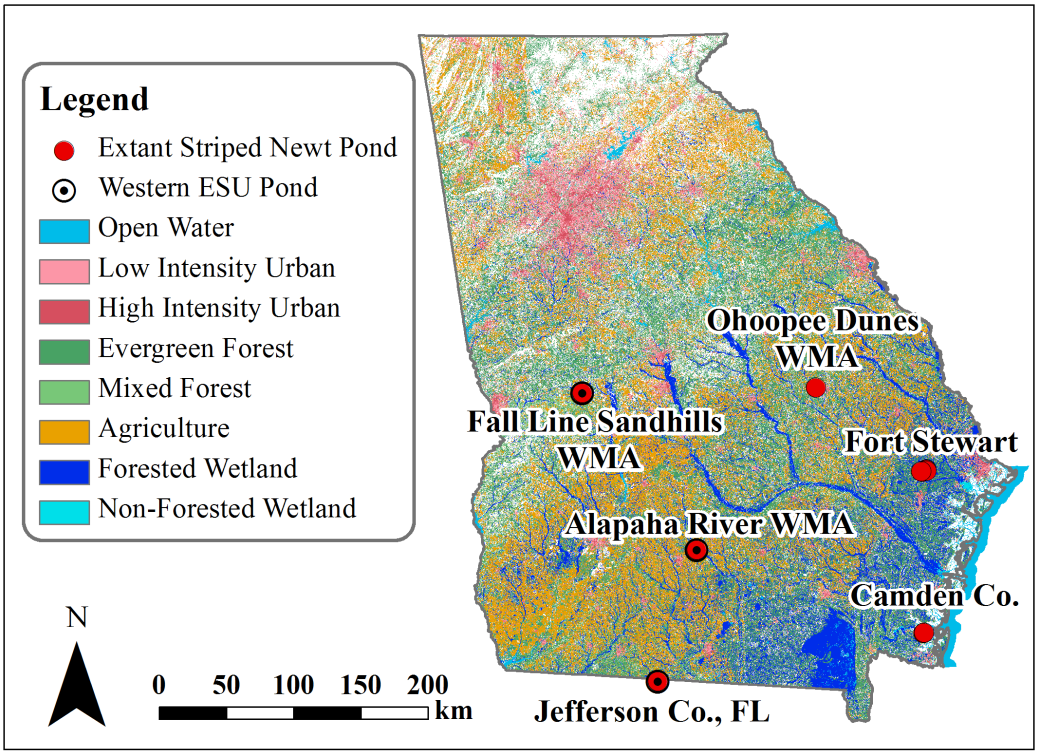

Figure 4. Map of Georgia, USA, and extant breeding ponds of the Striped Newt (*Notophthalmus perstriatus*) showing unsuitable landcover between populations. Extant pond locations based on recent surveys and information from Bishop (1941), Williamson and Moulis (1994), and Dodd and LaClaire (1995). (Landcover Source: Georgia Land Use Trends 2008).

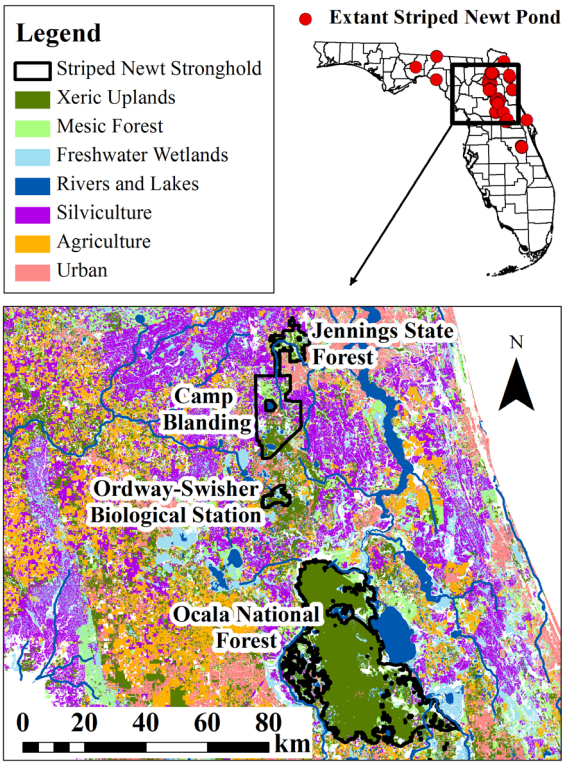

Figure 5. Map of current strongholds the Striped Newt (*Notophthalmus perstriatus*) in Florida, USA, showing suitable habitat (xeric upland habitat and freshwater wetlands), potential movement corridors (mesic forest), and potential barriers/unsuitable habitat (rivers and lakes, silviculture, agriculture, and urban areas). Other landcover types are not mapped. Extant locations/strongholds based on surveys and information from Bishop (1941), Franz and Smith (1999), and Krysko et al. (2011). (Landcover Source: Florida Cooperative Landcover, version 2.3.).

land system and suitable habitat on private lands (Fig. 5), although the Ocklawaha River is likely a barrier between populations in Ocala National Forest and populations farther north.

Although probably not a major factor in the Florida panhandle declines, changes in both the frequency and timing of prescribed burns likely contributed to Striped Newt extirpations on private lands and some public properties. Both upland and wetland habitats used by Striped Newts are fire-dependent communities that, under natural conditions, burned as a result of lightning-ignited fires during the spring and summer (Johnson 2005; USFWS 2011). These natural areas historically burned at intervals and intensities determined by the productivity of the soil, structure and type of vegetation, composition of adjacent natural communities, and frequency of lightning strikes (Myers 1990). Today, roads and other barriers prevent fires from spreading across the landscape; consequently, these natural areas must be intentionally burned by land managers who are increasingly limited by public safety and smoke concerns, shortages of trained personnel or inadequate funding, environmental regulations, and a lack of public support (Myers 1990; Ryan et al. 2013). Only a small fraction of southern forests are currently managed with prescribed fire, particularly on private lands, which are often smaller and lack the resources available to public land managers (Wade et al. 2000; Kobziar et al. 2015). In addition, many land managers are reluctant to conduct prescribed burns during the spring and summer (growing season) for a variety of reasons, including fear of impacting nesting gamebirds, the greater chance of tree scorch and killing mature trees, the high potential for fire volatility and associated liability, and the possibility that fires may smolder for extended periods in accumulated peat layers in the basins of some seasonally inundated wetlands (an artifact of fire suppression; Knapp et al. 2009; Ryan et al. 2013; Watts and Kobziar 2013). However, dormant-season fires are typically less intense than growing-season fires and, therefore, not as effective at reducing hardwood encroachment in uplands (Drewa et al. 2006, Mitchell et al. 2006). In addition, dormant-season fires generally do not burn through isolated wetlands, which are typically inundated in the winter (Kirkman et al. 2012). Periodic burning of dry Striped Newt breeding wetlands is necessary to reduce the accumulation of peat in the wetland basin and to maintain the open, grassy conditions favored by the species (Johnson 2005; USFWS 2011; Kirkman et al. 2012).

In an effort to reverse Striped Newt declines in Apalachicola National Forest, the Coastal Plains Institute initiated a reintroduction program in the Munson Sandhills in 2013. Although too early to judge the program, observations of juvenile efts exiting the translocation ponds 2013–2015, released larvae returning to one pond as mature adults in 2015–2016, and the presence of first-generation larvae in 2016 offer some early signs of success (Ryan Means et al., unpubl. reports). In support of this repatriation program, multiple zoos now maintain captive Striped Newt breeding colonies, which serve as both assurance colonies for the western ESU and as source populations for reintroductions. These efforts may serve as a model for future reintroduction efforts.

Recent federal status reviews of the Striped Newt determined that threats to the species are moderate because most populations are on public lands or private preserves (USFWS 2011, 2016). However, our analysis of all available surveys and records shows that recent unexplained extirpations and declines have occurred on public lands and private preserves that have suitable habitat. This suggests that the species faces significant and ongoing threats, even on protected lands. Additional research is needed to determine and address

the cause(s) of these recent declines. In addition, the remaining Georgia and western populations are now reduced to a few small, isolated populations separated by predominantly unsuitable habitat, putting them in danger of extirpation. Intensive species-management actions that include reducing known threats to remaining populations and expanding current translocation and captive breeding efforts should be considered for both the Georgia and Florida panhandle populations to ensure their long-term viability. We recommend regular monitoring of extant breeding ponds with dipnet surveys and using occupancy modeling (see MacKenzie et al. 2002) to track future changes in occupancy of breeding ponds as an indicator of species abundance. Surveys of suitable breeding ponds in the Florida panhandle, near the newly expanded southern extent of the range, and any suitable habitat in Georgia should also be conducted. Recent discoveries of populations of Striped Newts in Florida (Enge et al. 2014; Mays and Enge 2014; Enge et al. 2015; Hill and Sash 2015) provide hope that additional populations will be found.

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Appendix 1. The first and last year the Striped Newt (*Notophthalmus perstriatus*) was observed and the number of breeding ponds by county with extant (and possibly exitirpated) populations. Based on recent surveys and information from Bishop (1941), Williamson and Moulis (1994), Dodd and LaClaire (1995), Franz and Smith (1999), and Krysko et al. (2011).

County	State	First Year	Last Year	Breeding Ponds
Alachua	Florida	1929	2006	0 (2)
Citrus	Florida	1933	1933	0 (0)
Clay	Florida	1976	2016	25 (9)
Columbia	Florida	1977	1977	0 (0)
Dixie	Florida	1973	1973	0 (0)
Duval	Florida	1922	2006	1 (0)
Gilchrist	Florida	1973	1979	0 (1)
Jefferson	Florida	2015	2016	2 (0)
Lake	Florida	2003	2016	6 (0)
Leon	Florida	1922	2016	1 (17)
Levy	Florida	2005	2010	0 (3)
Marion	Florida	1948	2016	31 (1)
Nassau	Florida	1950s	1970s	0 (0)
Orange	Florida	1977	1999	0 (2)
Osceola	Florida	2014	2016	9 (0)
Putnam	Florida	1970	2016	19 (5)
Seminole	Florida	1935	1935	0 (0)
St. Johns	Florida	1992	2015	6 (0)
Sumter	Florida	1998	1998	0 (0)
Taylor	Florida	2014	2016	2 (0)
Volusia	Florida	2015	2016	1 (0)
Wakulla	Florida	1976	1979	0 (0)
Baker	Georgia	1994	2006	0 (5)
Bryan	Georgia	1969	2010	6 (5)
Camden	Georgia	1953	2008	2 (0)
Charlton	Georgia	1922	1994	0 (2)
Early	Georgia	1957	1957	0 (0)
Emanuel	Georgia	1998	2016	1 (0)
Evans	Georgia	1978	1998	0 (1)
Irwin	Georgia	1982	2016	1 (0)
Jenkins	Georgia	1987	1993	0 (2)
Lanier	Georgia	1940s	1940s	0 (0)
Liberty	Georgia	1994	1998	0 (1)
Long	Georgia	1978	1978	0 (0)
Lowndes	Georgia	1966	1966	0 (0)
Screven	Georgia	1961	1975	0 (1)
Taylor	Georgia	2004	2015	1 (0)
Wilcox	Georgia	1947	1948	0 (0)
Total				114 (57)

Appendix 2. Striped Newt (*Notophthalmus perstriatus*) breeding ponds for each time period and number of ponds with extant populations by state and property. Based on recent surveys and information from Bishop (1941), Williamson and Moulis (1994), Dodd and LaClaire (1995), Franz and Smith (1999), and Krysko et al. (2011). Asterisks (*) denote western evolutionarily significant unit. Abbreviations are NERR = National Estuarine Research Reserve, NWR = National Wildlife Refuge, SF = State Forest, SP = State Park, WCA = Wildlife Conservation Area, WMA = Wildlife Management Area.

Property (County)	Pre-1980	1980–1999	2000–2016	2012–2016	Extant
Florida					
Apalachicola National Forest (Leon)*	1	18	5	1	1
Big Bend WMA (Taylor)	0	0	2	2	2
Camp Blanding Military Reservation (Clay)	1	11	10	7	8
Faver-Dykes SP (St. Johns)	0	1	3	1	3
Goethe SF (Alachua, Levy)	0	0	5	0	0
Guana River WMA (St. Johns)	0	0	3	3	3
Guana Tolomato Matanzas NERR (St. Johns)	0	1	1	0	0
Jennings SF (Clay)	0	11	13	13	17
Lochloosa WCA (Alachua)	1	2	0	0	0
Merritt Island NWR (Volusia)	0	0	1	1	1
Ocala National Forest (Lake, Marion, Putnam)	3	15	40	12	39
Ordway-Swisher Biological Station (Putnam)	0	12	7	5	13
Private land (Gilchrist)	1	0	0	0	0
Private land (Jefferson)*	0	0	2	2	2
Private land (Leon)	1	0	0	0	0
Private land (Putnam)	0	3	0	0	0
Private land (St. Johns)	0	1	0	0	0
Pumpkin Hill Creek SP (Duval)	0	0	1	0	1
Rock Springs Run SP (Lake, Orange)	0	1	3	0	3
Seminole SF (Lake)	0	0	1	0	1
Triple N Ranch WMA (Osceola)	0	0	9	9	9
University of Central Florida (Orange)	1	1	0	0	0
Florida Total	9	77	106	56	103
Georgia					
Alapaha River WMA (Irwin)*	0	1	1	1	1
Fall Line Sandhills WMA (Taylor)*	0	0	1	1	1
Fort Stewart Military Installation (Bryan, Liberty, Long)	2	12	2	0	6
Ichauway Reserve (Baker)*	0	4	2	0	0
Ohoopee Dunes Natural Area (Emanuel)	0	1	1	1	1
Okeefenokee NWR (Charlton)	2	1	0	0	0
Private land (Bryan)	1	0	0	0	0
Private land (Camden)	1	0	2	0	2
Private land (Charlton)	8	0	0	0	0
Private land (Jenkins)	0	2	0	0	0
Private land (Screven)	1	0	0	0	0
Private land (Wilcox)	1	0	0	0	0
Unknown locations (Charlton, Early, Emanuel, Lanier, Lowndes)	7	0	0	0	NA
Georgia Total	23	21	9	3	11