Evaluation of mechanical mid-story removal as a tool to restore endangered species habitat

Abstract

Although fire is recognized as an important disturbance in longleaf pine uplands of the southeastern US, less is known about the importance of fire or other disturbances in the wetlands embedded within this ecosystem. The reticulated flatwoods salamander (*Ambystoma bishopi*), a federally endangered species, and other rare and declining amphibians, are less likely to breed in low-quality wetlands with high canopy cover and low herbaceous groundcover that typically occur from fire exclusion. Fire rarely carries through these wetlands during winter because of the presence of standing water at this time of year. Our objective was to evaluate whether mechanical removal of the woody midstory could serve as a surrogate for fire, and create high-quality wetlands with moderate canopy cover and high herbaceous groundcover. We chose a series of high-quality (n = 4) and low-quality (n = 21) ephemeral wetlands for study. In 2010, a subset of the low-quality wetlands were then treated mechanically and with herbicide (n = 10). From 2010-2013, four of these treated sites were burned and 7 of the remaining untreated sites were burned. Four sites received no treatment and no fire (remained in a low-quality state). From 2009-2013, sites that received mechanical treatments (n=6) and mechanical treatments that also received a burn (n=4) both continued to have reduced canopy cover. Herbaceous groundcover did not recover over this period, but this effect was seen across treatments. It is likely that prolonged drought has delayed the response of herbaceous groundcover or that other methods may be required to assess the response of herbaceous groundcover. Further, the prolonged drought impacted amphibian populations including an observed decline in the adult breeding population of Reticulated Flatwoods Salamanders at two drift fenced sites and reduced occupancy for other winter-breeding amphibians. Future years of monitoring post-drought may reveal a rebound in both the herbaceous vegetation and amphibian populations.

Project Specifics

Description of geographic setting:

Our study area was located on Eglin Air Force Base (Eglin) in the counties of Okaloosa, Santa Rosa, and Walton in northwestern Florida. Eglin is a large military installation that spans 187,774 ha. The topography of the study area is level to rolling with the highest elevation at ~ 75 m and slopes that generally range from 0-30 %. Most of the upland habitat on Eglin is a longleaf pine (*Pinus palustris* Mill.) and turkey oak (*Quercus laevis* Walter) sandhill community. However, our sites were 25 ephemeral wetlands (ranging in size from 0.3 – 5.9 ha) located in the western portion of Eglin, usually surrounded by wet or mesic flatwoods. These wetlands had overstories of longleaf pine, slash pine (*Pinus elliottii* Engelm.), pond cypress (*Taxodium ascendens* Brongn.), and black gum (*Nyssa sylvatica* Marshall) and had open to dense midstories dominated by myrtle-leaved holly (*Ilex myrtifolia* Walter), buckwheat tree (*Cliftonia monophylla* [Lam.] Britton ex sarg.), and Apalachicola St. Johnswort (*Hypericum chapmanii* P. Adams).

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- Harold Mitchell, U.S. Fish and Wildlife Service
- John Palis, Palis Environmental Consulting

Service branch: Air Force

Project location: Eglin Air Force Base, Florida

Installation size: 464,000 ac (187,774 ha)

Installation primary mission: Testing and Training

Project dates: October 2009 – present

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Figure 1. Breeding habitat of Reticulated Flatwoods Salamanders with same tree at left, pre- (left) and 4 years post-treatment (right) showing the continued lack of midstory regrowth. (Photographed by K. Jones)

Purpose/Need

The southeastern United States, historically dominated by longleaf pine savannas, was a landscape shaped by frequent fire (Frost 1995, Stout and Marion 1993). After over a century of fire suppression, land managers currently recognize the importance of fire to longleaf pine uplands (e.g., Provencher *et al*. 2001), but there are still problems with implementing fires in wetlands within this ecosystem (Bishop and Haas 2005). Our

research focuses on restoration of wetlands within longleaf pine savannas for rare and declining amphibians in the Gulf Coastal Plain of the Florida Panhandle. In particular, our goal is to evaluate and identify management practices that will improve breeding habitat for the reticulated flatwoods salamander (*Ambystoma bishopi*), a federally endangered species that breeds in ephemeral wetlands within the longleaf pine ecosystem (USDI Fish and Wildlife Service 2009, Palis 1996). Specifically, we wanted to develop techniques to restore ephemeral wetlands to enhance reproductive success of flatwoods salamanders and other winter-breeding amphibians in a longleaf pine ecosystem. Because of the challenges of implementing growing-season fire (see Knapp *et al*. 2009), we are particularly interested in evaluating whether and how quickly alternatives to growing-season fire can produce suitable conditions for amphibian breeding.

Approach

The 25 wetlands, including 21 wetlands with overgrown midstories, were part of previous monitoring efforts (Gorman et al. 2013). Occupied and "potential" breeding wetlands for flatwoods salamanders had been identified by Florida Natural Areas Inventory based on soil surveys and some ground-based surveys in the early 1990s. This list had been supplemented over the years by our previous work and by other biologists (e.g., Gorman et al. 2009). We selected a subset of these occupied and potential wetlands for study based on the condition of woody vegetation and their locations in areas that could allow prescribed fire (for example, not on boundary with a public road or neighborhood). We assigned the 21 overgrown-midstory wetlands to four different treatment categories using a stratified random approach based on wetland size. The remaining four sites were considered high-quality sites (representing the desired condition) and were not treated. Because fire treatments were not under our control, some sites originally assigned as untreated low-quality sites were burned in a wildfire, while other sites assigned to a prescribed-burn treatment or a combined mechanical and prescribed-burn treatment were not burned as scheduled. This resulted in the following treatment categories as of fall 2013:

1) *high-quality* (n = 4) – sites were occupied by reticulated flatwoods salamanders at least once between 2006-2008 and had characteristics typical of reproductive habitat for this species (i.e., high amounts of herbaceous groundcover and moderate canopy cover; Gorman *et al*. 2009).
2) *mechanical/herbicide* (n = 6) – sites with an overgrown midstory that received a mechanical treatment and herbicide application.
3) *mechanical/herbicide + burn* (n = 4) – sites with an overgrown midstory that received a mechanical treatment and herbicide application and received a burn after the mechanical/herbicide work was completed.
4) *burn only* (n = 7) – sites with an overgrown midstory and where only fire was applied.
5) *low-quality* (n = 4) – sites with an overgrown midstory that received no treatment and were not recently occupied by flatwoods salamanders.

Mechanical treatments were conducted on the midstory vegetation (i.e., woody vegetation with a diameter at breast height (dbh) < 12.7 cm, excluding only pines and cedars) of the wetlands using hand-held saws (i.e., chainsaws and brush saws). Additionally, we treated the ecotone (i.e., the transition zone between the surrounding uplands and the wetlands) and in some cases cut smaller vegetation with machetes. We followed cutting with a cut-stump application of herbicide. We used only herbicides that

were approved for use within aquatic environments. We treated the mechanical/herbicide wetlands (*n* = 10) in August – September 2010.

Vegetation and Amphibian Sampling

To evaluate if habitat management practices improve conditions for flatwoods salamanders and other wetland-breeding amphibians, we collected pre- (Fall 2009) and post-treatment (Fall 2013) vegetation data at all sites (*n* = 25). We established multiple vegetation plots per wetland to acquire wetland-scale habitat characteristics. Within each vegetation plot, we examined percent canopy cover (including woody midstory and overstory in a single measure), herbaceous groundcover, woody debris, and basal area (m^2/ha), as potential descriptors of amphibian habitat. We measured percent canopy cover using a spherical densiometer, and basal area of woody vegetation using a Jim-Gem Cruz-All® (Forestry Suppliers Inc., Jackson, MS). We used the Daubenmire (1959) cover class scale to estimate the percent herbaceous groundcover.

Pre- and post-treatment amphibian sampling included surveying for larval amphibians, including flatwoods salamanders and ornate chorus frog (*Pseudacris ornata*), a Florida Species of Greatest Conservation Need that breeds in similar wetland types as flatwoods salamanders across the southeastern United States. We conducted timed, systematic, dip-net surveys for larval amphibians twice per month from December–April 2009-2010 and 2013-2014 in each of the 25 wetlands (Bishop *et al*. 2006, Gorman *et al*. 2009), when water levels were sufficient to allow sampling. Also, we conducted nighttime call-surveys to assess the use of these wetlands by calling anurans (i.e., frogs and toads). We listened for amphibians at two calling stations per wetland, one at each end of the vegetation transect. Each survey was five minutes long, and surveys were conducted at each calling station twice per month (when water was present) from December–April 2009-2010 and 2013-2014.

Additionally, we completely encircled three ephemeral wetlands with drift fences and placed funnel traps on the inside and outside, following Palis (1997). On rainy nights, we checked drift fences on a continuous basis, alternating between ponds, with each trap checked approximately every two to three hours. On dry nights, when soil temperatures were at or below 15° C (reducing fire ant activity; Porter and Tschinkel 1987), we checked traps near dusk and just after dawn. On warmer dry nights or on humid nights, we attempted to attend traps every 5-7 hours through the night, but when there was little to no amphibian activity and staff availability was limited, we occasionally left traps unattended for 8-9 hours. Upon capture of adult flatwoods salamanders, we uniquely marked individuals using visual implant elastomer (VIE) or passive integrated transponder (PIT) tags. Yearlings or small adults and gravid females were not PIT tagged. All marked animals received a batch toe-clip indicating the pond of capture. We ran the drift fences during four breeding seasons for flatwoods salamanders. Unfortunately, drought conditions prevented any successful reproduction during all but the 2013-2014 breeding season.

Results

The results of our study suggest that mechanical treatments of ephemeral wetlands can successfully reduce canopy cover to levels that are similar to those of high-quality sites (e.g., Figure 1, Gorman et al. 2013). However, herbaceous groundcover, a critical component of larval flatwoods salamander habitat, may not always respond in the short-term. The delay of herbaceous plants to respond positively to the treatments may be a result of several factors and we are continuing to investigate while monitoring the results of these treatments.

The number of occupied sites by most winter breeding declined from the pre-treatment year to the post-treatment year (Table 2). This is likely an artifact of three unsuccessful breeding seasons as a result of unusually dry winter breeding seasons. In the seasons of 2010-2011, 2011-2012, and 2012-2013 water-levels in these sites were low and despite better conditions in 2013-2014 it is likely that amphibian populations were suppressed. Before the 2009-2010 pretreatment season, water-levels in many of these sites were not intensively monitored, but our amphibian sampling suggests that the years prior to 2009-2010 were more suitable for amphibian reproduction than in the 3 years after 2009-2010.

Table 2. Frequency of amphibian species encounters (number of sites occupied/number of sites sampled) during dipnet and call surveys at 25 wetlands on Eglin Air Force Base, Florida from December - April 2009-2010 (Pre) and 2013-2014 (Post y4). All sites were sampled in pre-treatment year and post-treatment year 4.

	Proportion of sites occupied	
Species	Pre	Post y4
Barking Treefrog (*Hyla gratiosa*)	0.36	0.04
Bronze Frog (*Lithobates clamitans*)	0.36	0.32
Central Newt (*Notophthalmus viridescens*)	0.16	0.08
Dwarf Salamander (*Eurycea quadridigitata*)	0.40	0.16
Eastern Narrow-mouthed Toad (*Gastrophryne carolinensis*)	0.00	0.00
Florida Bog Frog (*Lithobates okaloosae*)	0.00	0.04
Gray Treefrog (*Hyla chrysoscelis*)	0.00	0.00
Green Treefrog (*Hyla cinerea*)	0.04	0.00
Greenhouse Frog (*Eleutherodactylus planirostris*)	0.00	0.00
Oak Toad (*Anaxyrus quercicus*)	0.00	0.12
Ornate Chorus Frog (*Pseudacris ornata*)	0.52	0.28
Pig frog (*Lithobates grylio*)	0.36	0.16
Pine Woods Treefrog (*Hyla femoralis*)	0.08	0.36
Reticulated Flatwoods Salamander (*Ambystoma bishopi*)	0.32	0.24
Southern Chorus Frog (*Pseudacris nigrita*)	0.64	0.24
Southern Cricket Frog (*Acris gryllus*)	1.00	1.00
Southern Leopard Frog (*Lithobates sphenocephalus*)	1.00	1.00
Southern Toad (*Anaxyrus terrestris*)	0.60	0.28
Squirrel Treefrog (*Hyla squirella*)	0.00	0.00

We documented a larger than expected breeding population of Reticulated Flatwoods Salamanders at two adjacent breeding wetlands, capturing over 100 adults in the first year. (In the preceding decade, no more than a half-dozen adult flatwoods salamanders had been observed in any year.) These two wetlands are used by apparently separate groups of breeding adults (Figure 2). Following complete reproductive failure at these sites during 3 of the last 4 years the number of adults captured at pond 4 declined from a high of 115 in 2010-2011 to a low of 38 in 2013-2014. Pond 5 was trapped for only the later part of the 2010-2011 season, but this breeding site followed a similar trend. Starting in 2011-2012, the population declined from 54 to 21 adults in 2013-2014 (Figure 2). Despite the low numbers, 2013-2014 was a successful breeding year and metamorphs were documented leaving the two breeding wetlands. Documenting the return of these juvenile animals and the response of the population for

at least two years following this successful year will be critical to determining the population viability of this species. It has been postulated that females do not enter the breeding population until at least age 2 (Palis 1997). Given this delayed reproduction, combined with the apparent short life-span of flatwoods salamanders (Palis et al. 2006), we expect that the population declines could continue more rapidly if weather patterns stay erratic as climate models predict. Despite the low numbers, 2013-2014 was a successful breeding year and metamorphs were documented leaving the two breeding wetlands.

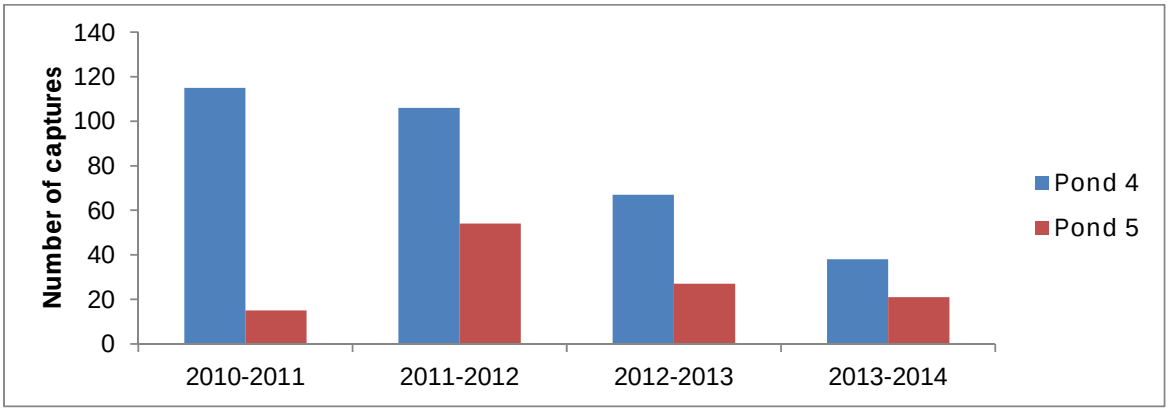

Figure 2. Number of captures of adult Reticulated Flatwoods Salamanders at two wetlands from November 2010 - April 2014 on Eglin Air Force Base, Florida.

Benefit

Ephemeral wetlands occur on installations throughout the southeastern US, and require management to avoid conflicts between military missions and sensitive species (Harper et al. 1998). The reticulated flatwoods salamander (*Ambystoma bishopi*) and the similar frosted flatwoods salamander (*A. cingulatum*) occur on several military installations throughout the Southeastern United States including Eglin Air Force Base, Hurlburt Field, Navy Outlying Landing Field Holley, Fort Stewart Military Installation and Townsend Bombing Range. These species are classified under the Endangered Species Act as endangered and threatened, respectively. Globally, amphibians are declining and are at the forefront of conversation need, therefore other military installations that support diverse suites of amphibians within the longleaf pine matrix will likely benefit from this work. Upon completion of this adaptive management project, we will be able to recommend the most appropriate methods to restore breeding habitat for these two federally protected species that are considered umbrella species for the ecosystem. Restoration of habitat for these species will contribute to their conservation and will increase the likelihood of their recovery. Identifying techniques that could enhance or replace burning would allow greater management flexibility, especially in areas located in close proximity to major highways, neighborhoods, or military infrastructure. A better ability to maintain and improve ephemeral wetland habitats will allow managers to reverse the loss of these unique habitats and help reduce the risk of continued decline in species of concern such as white-topped pitcher plants (*Sarracenia leucophylla*), ornate chorus frogs (*Pseudacris ornata*), and gopher frogs (*Rana capito*). New knowledge about population dynamics of reticulated flatwoods salamanders will be useful for population modeling.

Recommendations/Lessons learned

In this ongoing study, after four years post-treatment we have successfully reduced the midstory of 10 mechanically/herbicide treated wetlands. However, the herbaceous component may take several years to increase following mechanical/herbicide treatments alone (Martin and Kirkman 2009). The slow recovery of herbaceous plants to respond positively to the treatments may be a result of several factors. In upland longleaf pine stands, herbaceous groundcover responded positively both to increased light levels and increased soil moisture levels associated with removal of hardwoods and shrubs (Harrington 2006). Perhaps in our study, herbaceous groundcover grew less in the drought year (post-treatment) than in the year with high precipitation (pre-treatment). This is supported by an overall decline of herbaceous groundcover in the drought year across treatments, including the high-quality sites.

Intensive population monitoring associated with this study has revealed several interesting patterns related to Reticulated Flatwoods Salamander breeding. As with Frosted Flatwoods Salamander, we confirmed that prolonged drought causes declines in the adult population (Palis et al. 2006), but that even with a smaller number of adults populations have the potential to rebound following a successful breeding season.

Communications

The approach and results from this work have been presented at a variety of meetings, including an invited presentation at the 9th INTECOL International Wetlands Conference (2012) in Orlando, FL, an invited presentation at the Florida Fish and Wildlife Conservation Commission Ephemeral Pond Workshop (2012) in Bristol, Florida, a poster presentation at the Annual Conference of The Wildlife Society (2012) in Portland, Oregon, a poster presentation at the Southeast Partners in Amphibian and Reptile Conservation Conference (2013) in McCormick, South Carolina, and Flatwoods Salamander Working Group Meeting (2013) in St. Marks, Florida.

Also, this work has been published in the journal, *Fire Ecology and Herpetological Review*.

Citation:

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

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