Altering Hydrology in Breeding Ponds to Benefit Imperiled Amphibians During Drought

Coastal Plains Institute Report to Florida Fish and Wildlife Conservation Commission for work completed 1 Oct 2016 – June 30 2017

Order No: 16209

By

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ABSTRACT

Ephemeral wetlands are essential breeding habitat for Species of Greatest Conservation Need, including the gopher frog (*Lithobates capito*; state-threatened at the time this grant was approved but now no longer state-listed), the striped newt (*Notophthalmus perstriatus*; a candidate species for Federal listing), and the ornate chorus frog (*Pseudacris ornata*). This project builds on a pre-existing project to repatriate the striped newt into Apalachicola National Forest ephemeral wetlands. Pond liners were installed in three striped newt repatriation recipient wetlands to increase the hydroperiod and increase likelihood of success of repatriation efforts. By comparing wetland hydroperiod and amphibian community composition in paired unlined and lined wetlands, this project will determine the effectiveness of this management tool for the relocation, repatriation, and translocation of imperiled amphibian species expected to be negatively impacted by climate change-induced drought. The timing of this report corresponds to the end of the first year of data collection. Early, preliminary results of our study indicate that liners extend wetland hydroperiod, provide increased opportunities for amphibian breeding, and allow resident larval amphibians to complete metamorphosis. Early results also show that liners, if installed properly, do not detrimentally alter ephemeral pond ecosystems, but rather “enhance” habitat to benefit targeted species.

INTRODUCTION

The purpose of this project is to build on a pre-existing effort to repatriate the striped newt back into Apalachicola National Forest (ANF) ephemeral wetlands. This particular aspect of the project focuses on using synthetic pond liners in wetlands to increase the hydroperiod to benefit repatriated striped newt larval development. Pond liners were installed in three striped newt recipient wetlands to increase the hydroperiod and improve success of repatriation efforts. By comparing wetland hydroperiod and amphibian community composition in paired unlined and lined wetlands, this project will determine the effectiveness of this management tool for the relocation, repatriation, and translocation of imperiled amphibian species expected to be negatively impacted by climate change-induced drought. Ephemeral wetlands are essential breeding habitat for the gopher frog (*Lithobates capito*; state-threatened at the time this grant was approved but now no longer state-listed), and Species of Greatest Conservation Need species including the striped newt (*Notophthalmus perstriatus*), a candidate species for Federal listing, and the ornate chorus frog (*Pseudacris ornata*).

The ANF is the former western stronghold of the striped newt (Means et al. 2013). Coastal Plains Institute (CPI) sampling data show that up until 1999, individuals of the western striped newt in the ANF were relatively abundant. However, since that time, the striped newt in the ANF has undergone a mysterious decline. CPI’s sampling data from the ANF through 2007, coupled with data from other researchers, was the impetus for the petitioning to federally list the striped newt as “threatened” under guidelines of the Endangered Species Act (Means et al. 2008). In March 2010, the U.S. Fish and Wildlife Service issued a 90-day notice of listing for the striped newt in the Federal Register in response to the petition (USFWS 2011).

One possible cause of the striped newt decline in the ANF is drought. Drought has been linked to some amphibian declines and extirpations of populations (Lips et al. 2005). Since 1998, North

Florida experienced two prolonged, excessive droughts during the 10-year period from 1998-2008 (M. Griffin, Florida Climate Center, pers. comm.). Severe droughts lasted from 1998-2001 and 2006-2008. Hydroperiods were much shorter in ephemeral wetlands across the Munson Sandhills during the droughts (R. C. Means and D.B. Means, unpublished data). Rarely were there prime opportunities for striped newts to breed, and when there were opportunities, CPI biologists did not detect larval newts despite considerable sampling effort (Means 2007, Means et al., 2008, Means et al. 2015). With the onset of climate change, hydroperiods are expected to shorten in ephemeral wetlands (Bates et al. 2008). In the sandhills habitat, climate-induced drought likely will have negative impacts on ephemeral pond-breeding amphibians. These habitat specialists cannot breed unless the breeding pond fills during the appropriate season and stays hydrated long enough for aquatic larvae to reach metamorphosis into their terrestrial phase.

There is conservation benefit to be gained for the future management of the striped newt and other imperiled species through this study. Since the striped newt is not state-listed in Florida, a Species Action Plan (SAP) does not exist. However, this salamander is identified as a Species of Greatest Conservation Need (SGCN) in the Florida's State Wildlife Action Plan (SWAP). The striped newt is a Federal Candidate, and a SGCN species in Florida because of biological vulnerability (FNAI = S2, Millsap = 29). The gopher frog (SGCN) and ornate chorus frog (SGCN) use the same wetlands, and require sufficient hydroperiod. There is a clear need to evaluate the use of pond-liners as a hydroperiod enhancement technique to benefit Florida's imperiled ephemeral-pond breeding amphibians. Hydropepriod enhancement techniques, such as the use of pond liners, are expected to become more and more necessary in conservation projects as we move forward into the climate change era.

To meet the intent of the State Wildlife Grants Program and to foster the SWAP, FWC's Florida's Wildlife Legacy Initiative was created to assist in development and implementation of the SWAP (FWC 2012). This project is relevant to Florida's SWAP and Legacy Initiative Goals because it is an on-the-ground project to limit the effects of drought through hydroperiod alteration in ephemeral wetlands. This project will evaluate how applied techniques (i.e. pond liners) can increase hydroperiod for amphibians in the face of increased drought expected from climate change. While installing liners in ephemeral wetlands on a landscape level is not a practical management tool, this project will provide a template for targeted, specific active management practices in instances where drought may have severe and lasting negative impacts. Those activities could include relocation, repatriation, or translocation, and efforts to increase population sizes of imperiled amphibian species expected to be negatively impacted by climate change-induced drought.

The following three objectives will be met by this project:

1. Utilize, maintain, and repair already-installed liners in three ponds to enhance repatriation sites for sufficient pond hydroperiod throughout critical larval metamorphosis lifestage.
2. Monitor amphibian populations in three lined and three unlined ponds with frog-call surveys, incidental observations, and monthly dipnet surveys to assess influence of increased hydroperiod in lined ponds versus ponds without liners.
3. Evaluate expected hydroperiod changes in lined ponds relative to paired, unlined reference ponds.

METHODS

Study Area

The project is located within the Apalachicola National Forest (ANF) just south of Tallahassee, FL in Leon County (Figure 1). The targeted habitat is longleaf pine sandhill with embedded ephemeral wetlands, located within the Munson Sandhills. While the Munson Sandhills region is approximately 45,000 acres in size, this project is concentrated in an area of less than 600 acres. The six study wetlands range in size from 0.5 acres to 0.6 acres and are pictured in Appendix A.

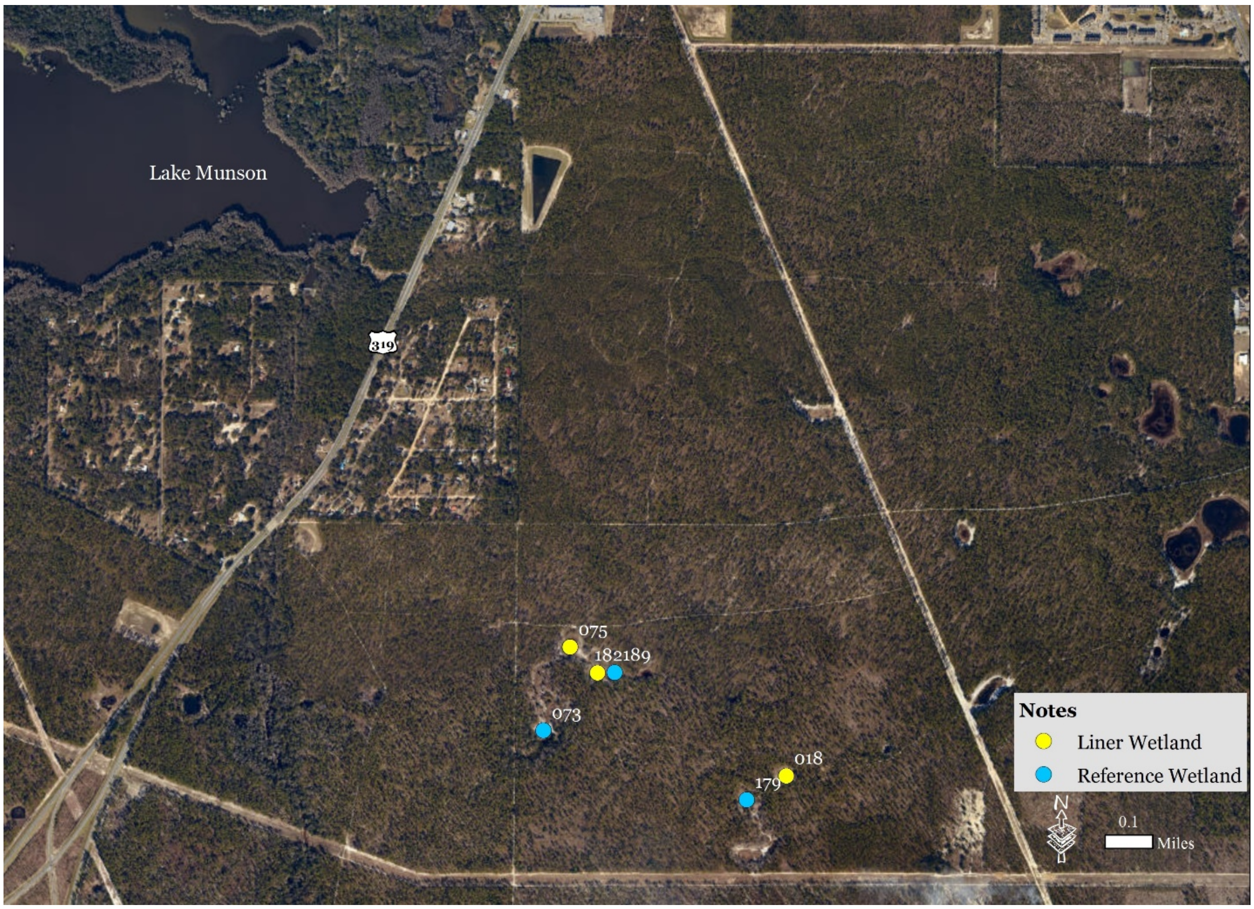

Figure 1: Map of the northeastern ANF showing the location of lined wetlands that serve as striped newt repatriation sites and unlined wetlands that serve as a hydrological control. Pond 18 is paired with Pond 179, Pond 75 is paired with Pond 73, and Pond 182 is paired with Pond 189.

Hydrological Monitoring

Hydrological work conducted by Katherine Milla (Florida A&M University) and Steve Kish (Florida State University) revealed that Munson Sandhills ponds are aquifer-driven, meaning they predominately respond to fluctuations in the groundwater table over time, not to individual rainfall events (pers. comm). With that knowledge, CPI hypothesized that installation of liners would create an artificial water confining layer, currently non-existent in the sandy soiled Munson Sandhills, that would effectively change the way in which lined ponds would hydrate. Lined wetlands would begin responding to individual rain events whereas unlined ponds would still require groundwater to rise in order to become hydrated.

During 2012 and as part of a larger striped newt repatriation study (see Means et al. 2012), CPI selected four wetlands as repatriation (recipient) wetlands based on historic striped newt breeding habitat and suitability for synthetic liner installation. We installed synthetic (EPDM), 40-mil, “fish grade” rubber liners underneath the central portions of three of four selected repatriation wetlands (Ponds 18, 75, and 182) that had been gripped by severe drought at the time of installation. We hypothesized that liners would boost recipient pond hydroperiods, thereby making them more drought resistant for the purpose of providing repatriated newt larvae with enough time to reach metamorphosis. The fourth wetland, Pond 16, also was scheduled to receive a liner, but conditions there have been too wet to complete installation.

In an effort to quantify the hydrological impact of liners, we selected nearby and hydrologically similar wetlands as reference/control wetlands. Pond 18 is paired with Pond 179, Pond 75 is paired with Pond 73 and Pond 182 is paired with Pond 189. On 20 December 2016, we installed one, 0-3.32 foot, WaterMark ® Style “C” Stream Gauges in each of the six wetlands to begin quantitatively monitoring water levels. We attached each gauge to the top three feet of a four-foot section of PVC pipe using pre-drilled holes in the gauges and 2” galvanized screws. Using a mallet, we hammered the PVC pipe/stream gauges into the center of all six wetland basins until the gauge bottom (reading of 0.00”) was flush with the wetland floor. All three reference wetlands were dry during time of installation. The three liner wetlands held small pools of water so we could not gain a visual reference of the wetland floor. Instead, we hammered the PVC pipe down until, using our hands, we could feel the bottom of the staff gauge was flush with the wetland floor. We were able to get an accurate read because the floor of these wetlands was firm. We did not hammer the PVC pipe deep enough to puncture the liners. Liners are covered by approximately 16-18” of organic soil beneath present wetland bottoms.

We also placed 5” Rain Gauges adjacent to wetlands. We checked pond water levels and rain gauges once a week beginning 20 December and at least every other day from January through June. The greater monitoring effort corresponded to the opening of drift fences associated with the striped newt repatriation project. During site visits, we checked that the liners were intact and seemingly functional based on the appearance of pooled water above the liner locations. We also checked for physical damage from off-road vehicle use, which has been an issue in the past.

Amphibian Community Assessment

We used monthly dipnet surveys to detect larval and breeding adult amphibians in lined and unlined, reference wetlands. We sampled using a heavy duty dipnet (Memphis Net and Twine Co. HDD-2 model) with 3/16” mesh. The number of dip net sweeps per paired lined/unlined wetland was held constant but varied between wetland pairs based on wetland size and hydration. We concentrated sweep efforts along pond periphery and herbaceous vegetation patches. Dipnetting did not take place during periods when striped newt breeding activity was occurring or if tiny larvae were present to avoid harming those individuals. We conducted opportunistic searches around the pond perimeters during monthly dipnetting surveys. We documented all amphibians observed by species and quantity, including egg masses, larvae, and adults.

We conducted seasonal, nocturnal call surveys at all six ponds during prime breeding weather conditions to ascertain the presence of all adult anuran species. Frog call surveys were conducted between the hours of 10 pm and 12:30 am and involved recording the species and relative number per species heard calling during a 15-minute period (none, a few, and constant chorus). In order to reduce hour-of-night influence on survey results, time between call surveys at a lined wetland and its unlined pair did not exceed 15 minutes.

PROGRESS

We began hydrological and rainfall monitoring on 20 December, and we have recorded water levels and rainfall amounts simultaneously, almost daily, throughout the study period. We conducted monthly dipnet surveys at hydrated wetlands from January – June and completed three frog call surveys (February, April, and June). We conducted opportunistic searches at all six wetlands during dipnet and frog call surveys. We completed this year’s field season on 29 June. All liners continue to be in good condition. No off-road vehicle damage has occurred in the current study to date, and no repairs have been needed.

RESULTS

Hydrological Monitoring

Early analysis of preliminary hydroperiod data indicate that all lined ponds exhibited significant hydroperiod extensions relative to their unlined, paired wetland counterparts (Appendix B).

Pond 18 held water for the entire period, while its paired, unlined counterpart Pond 179 remained completely dry during the study period. Pond 18 was drying down to low levels in March and received a 4,000-gallon boost from an augmentation event associated with the striped newt repatriation project on 24 March. Pond 18 may have gone dry if not for this augmentation boost, although Pond 75 (another lined wetland) had a lower pond level than Pond 18, did not receive an augmentation boost, and did not go dry until the end of April. Regardless of the augmentation boost, Pond 18 held water for a significant amount of time while it’s paired, unlined wetland remained dry. Pond 75 held water for the entire winter and spring (over 130 days) before drying on 28 April, while its paired, unlined counterpart, Pond 73, held water for a maximum of 83 days during that same time period. After both wetland dried completely again in May, Pond 73 remained dry two weeks longer than Pond 75 and hydrated to lower water levels once it did fill. Pond 182 held water for over 100 days during winter and spring, while its paired, unlined counterpart, Pond 189, remained dry throughout the study period.

In all three pairings, lined ponds held water for significantly longer than unlined ponds. Average hydroperiod of three lined ponds 20 December through 30 June = 99 days. Average hydroperiod of the three unlined ponds during the same time period = 10 days. Our experimental design for the liners is that all lined ponds still go dry periodically, since we did not wish to create "permanent" wetlands out of naturally ephemeral wetlands.

Lined ponds responded to single rain events much more dramatically than unlined counterparts. Single heavy rains on 3 April and 22-24 May significantly increased lined pond water levels instantly, whereas unlined counterparts either hydrated for a short time (Pond 73 held water for 24 days after April rain event) or remained dry after the same rainfall event. This observation is consistent with the hypothesis that no natural confining layers exist between area wetland bottoms and the underlying aquifer, and it supports the additional assertion that area ponds are naturally driven by aquifer fluctuations instead of by given rainfall events.

Amphibian Community Assessment

Data for striped newts are not reported as they are affected by our repatriation efforts, and this species likely is only in the wetlands in which they have been repatriated. Repatriation activities can be variable from pond to pond, and often are dependent on several other uncontrolled variables. We detected no other salamander species at any of our six wetlands in 2017, but preliminary data indicate that several anuran species expected as part of the ephemeral wetland community were present at lined wetlands but were not as abundant at unlined wetlands (Table 1).

Table 1. Species detected at lined versus unlined wetlands, January through June 2017. Detection methods included dipnet and frog call surveys and opportunistic searches. All four species reported for unlined wetlands were detected at only one of the three unlined wetlands, Pond 73. The other two wetlands were dry throughout the study period and no amphibians were encountered.

Amphibian Species	**Lined Wetlands**	**Unlined Wetlands**
Lithobates sphenocephalus	X	X
Hyla gratiosa	X	
Lithobates capito	X	X
Lithobates catesbiana	X	
Acris gryllus	X	
Hyla femoralis	X	X
Pseudacris ornata		X
Psuedacris ocularis	X	
Species Richness	7	4

We conducted dipnet surveys in all hydrated wetlands monthly from January through June. We did not dipnet during the month of February due to presumed breeding activity of newly released adult striped newts. Pond 73 was dry during April and May and therefore we only dipnetted this wetland in January, March and June. Ponds 179 and 189 remained dry throughout the study period, we did not dipnet these wetlands. Because Ponds 179 and 189 never hydrated, we found a significant difference in the larval amphibian community between these two lined and unlined wetland pairs (Table 2). Our Pond 75 and Pond 73 pair did not exhibit as dramatic of a difference. Pond 73 hosted a significant gopher frog breeding event (we captured 100s of tadpoles during our 23 March survey), but the wetland went dry at the end of March and those tadpoles did not make it to metamorphosis. Pond 75, the lined wetland paired with Pond 73, dried an entire month later,

Table 2. Larval amphibian species detected at six study wetlands during dipnet sampling events January through June, 2017.

Larval Amphibian Species	Lined Pond 18	Unlined Pond 179	Lined Pond 75	Unlined Pond 73	Lined Pond 182	Unlined Pond 189
Acris gryllus	15	0	0	0	0	0
Hyla femoralis	10	0	50-100	>100	50-100	0
Hyla gratiosa	15	0	>100	0	50-100	0
Lithobates capito	>100	0	10	>100	50-100	0
Lithobates catesbiana	1	0	0	0	0	0
Lithobates sphenocephalus	5	0	50	>100	10	0
Pseudacris ornata	0	0	0	16	0	0
Psuedacris ocularis	0	0	0	0	50-100	0
Species Richness	6	0	4	4	5	0

We conducted three frog call surveys during the 2017 study year. A winter survey was conducted on 7 Feb during a 1.5” rain event. Lined wetlands were hydrated. Ponds 179 and 189 were dry but the other unlined wetland, Pond 73, had been hydrated for at least a month. There was not a significant difference of amphibian calling activity between lined and unlined wetlands during this call survey. No frogs were calling at Pond 18 or its reference wetland, Pond 189. No frogs were calling at Pond 182 or its reference wetland, Pond 189. Only one species was calling at Pond 75 (southern leopard frog) and its paired wetland, Pond 73.

We conducted a spring frog call survey on 3 April during a major rain event that resulted in 3.5” of rainfall. The majority of wetlands were dry at this time, including all unlined wetlands. Ponds 18 and 75 held water but were experiencing a major drawdown. No frog calling activity was detected at any wetland.

We conducted a summer frog call survey on 28 June after a four-day rainy period. We heard no frog calling activity at the two dry wetlands, Ponds 179 and 189. One species of frog, the southern cricket frog, was chorusing at all four hydrated wetlands (the three lined wetlands and Pond 73, an unlined wetland). We also detected pine woods treefrogs chorusing at Pond 73.

Because lined wetlands held water for an average of 99 days and two of the three unlined wetlands remained dry throughout the study period, we attribute the greater amphibian activity (and especially breeding events) to the liners. At no time did we detect any unexpected amphibian species within lined or unlined wetlands.

In conclusion, our preliminary results suggest that liners have increased pond hydroperiods, provided increased opportunities for resident amphibians to breed, including our targeted imperiled management species, and have thus far not had any observed deleterious effects to pond fauna. We conclude that liners, thus far, are operating favorably and desirably, in line with our current conservation and management needs.

FUTURE PLANS

We expect to begin field operations for Year 2 in January 2018, in conjunction with the beginning of the striped newt repatriation project. Because we are in the beginning phases of this project, statistical data interpretation is not appropriate yet. Over time, as we gather sufficient empirical water level and biological data from lined and unlined ponds, we expect to identify potential differences between amphibian communities (species richness and abundance) and hydrology at lined versus unlined wetlands using paired t-Tests.

If we decide to de-activate liners in the future, we can simply auger holes into the liners from above to restore original hydroperiods and allow for aquifer interaction with ponds.

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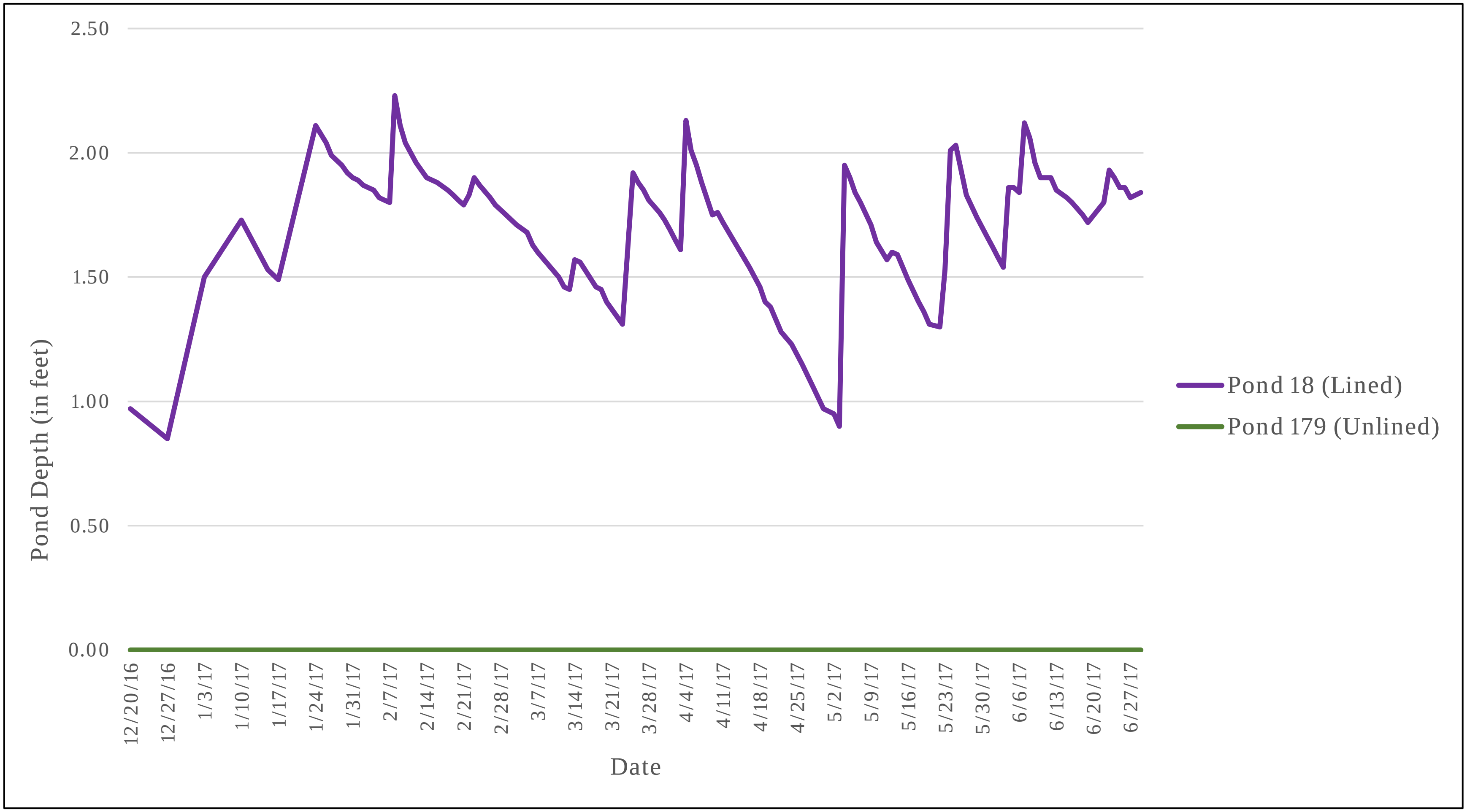
APPENDIX A. Study Wetlands.

(a). Pond 18 (top picture), a lined wetland, and it's paired, unlined wetland Pond 179 (bottom picture). Before installation of the pond liner, these wetlands, which are within 1/10 of a mile from each other, were hydrologically similar.

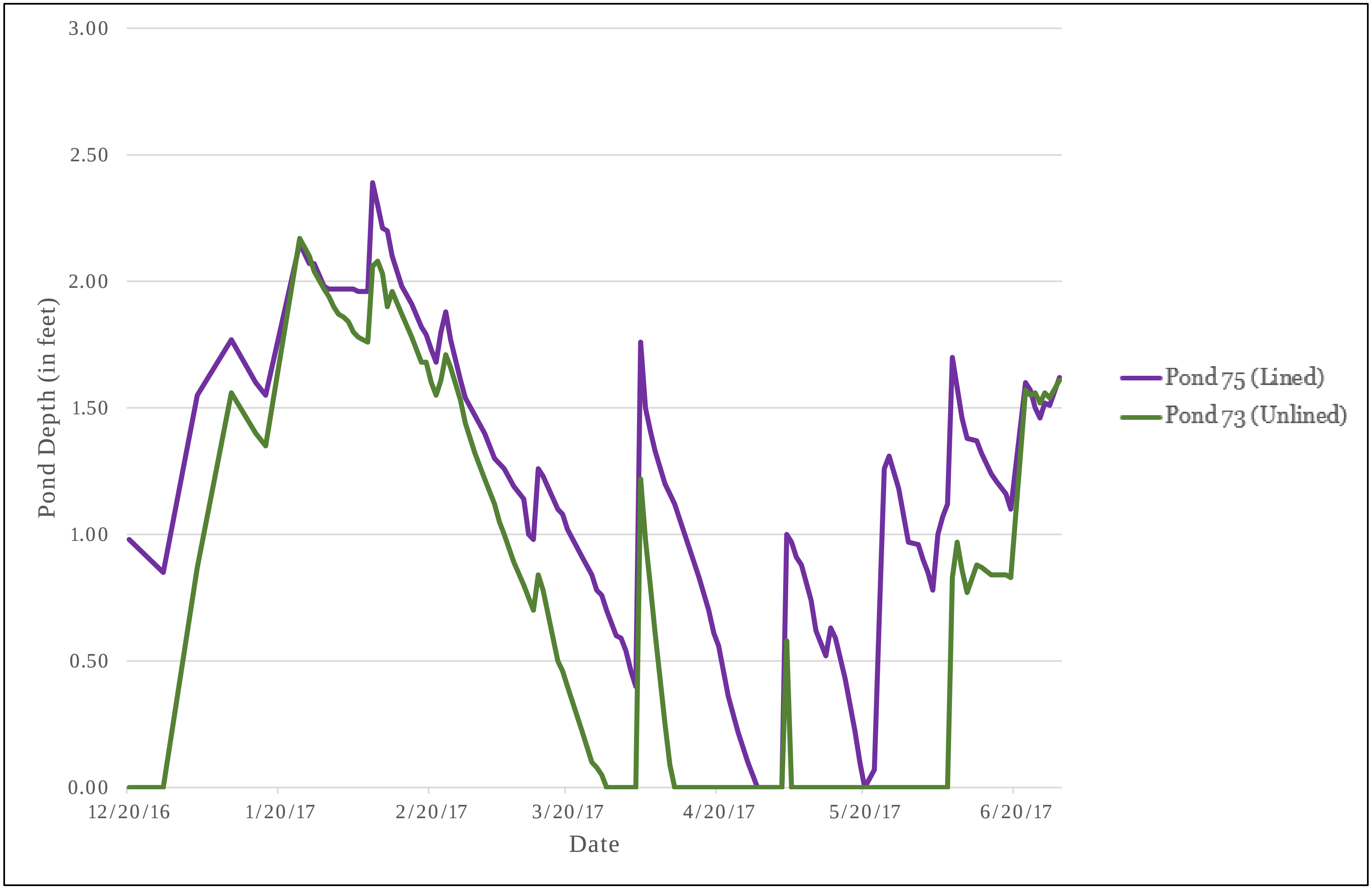
(b). Pond 75 (top picture), a lined wetland, and it's paired, unlined wetland Pond 73 (bottom picture). Before installation of the pond liner, these wetlands, which are less than 2/10 of a mile from each other, were hydrologically similar.

(b). Pond 182 (top picture), a lined wetland, and it's paired, unlined wetland Pond 189 (bottom picture). Before installation of the pond liner, these wetlands, which are less than 200 feet from each other, were hydrologically similar.

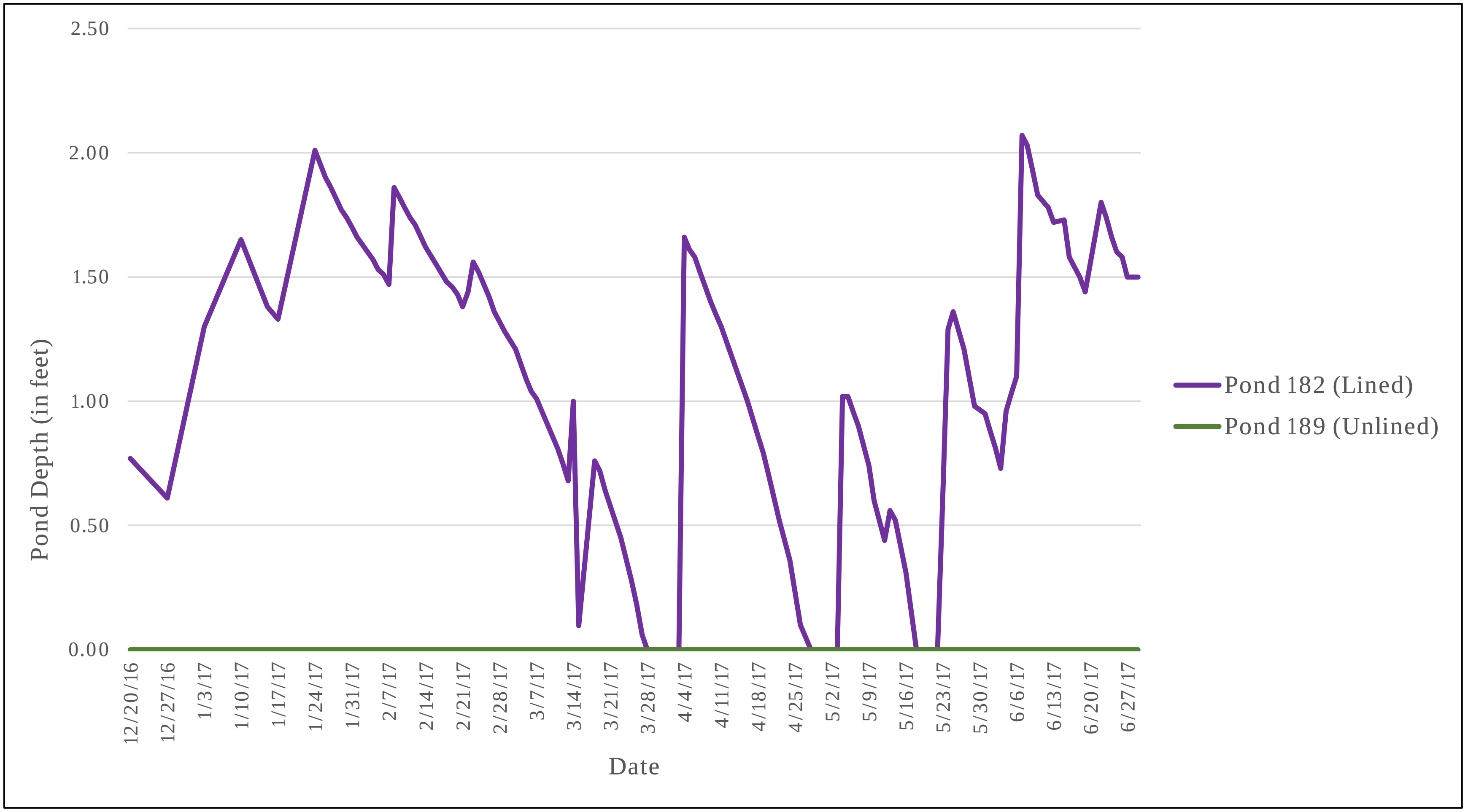
APPENDIX B. Hydrological Graphs of the Three Paired Lined and Unlined Wetlands: (a) Ponds 18 and 179, (b) Ponds 75 and 73, and (c) Ponds 182 and 189.



(a). Pond 18 remained hydrated throughout the study period while Pond 179 was completely dry. Note: The March boost in Pond 18's water level was due to an augmentation event associated with the striped newt repatriation project. It is possible Pond 18 would have dried by early April if this augmentation had not occurred.



(b). While Pond 75 and Pond 73 appear to have exhibited similar hydroperiods there are three major differences that had the potential to impact amphibian communities. Pond 75 dried completely only twice during our study period, while Pond 73 dried three times. Pond 75 maintained a deeper pond level, corresponding to a larger wetland basin and therefore more habitat for larval amphibians. Finally, Pond 75 maintained a longer hydroperiod (an average of 30 days longer) than Pond 73.



(c). Pond 182 hydrated and dried several times during our study period while Pond 179 remained completely dry. During the winter, Pond 182 stayed hydrated for over 100 days, providing an opportunity for winter-breeding amphibians to reproduce.