Report for TPWD

Title: Status and breeding biology of the crawfish frog (*Lithobates areolatus*)

Toby Hibbitts[1] and Daniel Saenz[2]

[1]Biodiversity Research and Teaching Collection, Texas A&M University, thibbitts@tamu.edu, 979-845-5783, [2]Southern Research Station, USDA Forest Service, dsaenz@fs.fed.us, 936-569-7981

Objective 1

Introduction—The Crawfish Frog (*Lithobates areolatus*) is identified as a species of greatest conservation need (Texas Conservation Action Plan*2012 SWG and HLLP Grants), and is listed as a near threatened species on the IUCN Redlist and listed as endangered in five of the 12 states in which it occurs (Hammerson & Parris 2004; Parris & Redmer 2005). The crawfish frog has declined in areas where prairie has been converted to agriculture (Platt et al 1974) and most of the extant populations of crawfish frogs from the Midwest are located in remnant prairie habitats (Bragg 1953; Busby & Brecheisen 1997). This same trend holds true for Texas with the two largest populations that are known to occur in Texas being centered on areas with large natural prairies.

Outside of these apparent strongholds few recent records have been found, and many of the records are more than 50 years old.

The main objective of this study was to address the lack of knowledge about crawfish frogs in Texas. In particular, we hope to better understand the current distribution of the crawfish frog in Texas.

Methods—We developed a map of the distribution of crawfish frogs in Texas based on museum records of all of the major collections in the US as well as some smaller collections within Texas. We also solicited information from herpetological enthusiasts that have had experience finding the species in the state. This information was compiled onto a map (Fig. 1) to determine survey regions. Survey regions were identified (Fig. 2) and each region will be surveyed on at least two different nights with the aid of regional volunteers. These survey nights will be when rain has fallen within a 24 hour period and the air temperature exceeds 10ºC between February 1 and May 1. We used satellite imagery to identify roads to be surveyed within each survey region, avoiding areas that are likely to have high traffic and areas that go through unsuitable habitat. The surveyor stopped every mile and listen for calling frogs along their route. Each stop was for at least 30 seconds with the car engine turned off. When a crawfish frog was heard the following was recorded: GPS coordinates (decimal degrees), temperature, time, date, estimate of number of calling frogs, and short audio recordings. We also selected three sites to install automated recorders. These were used to identify the presence of crawfish frogs in hard to survey areas.

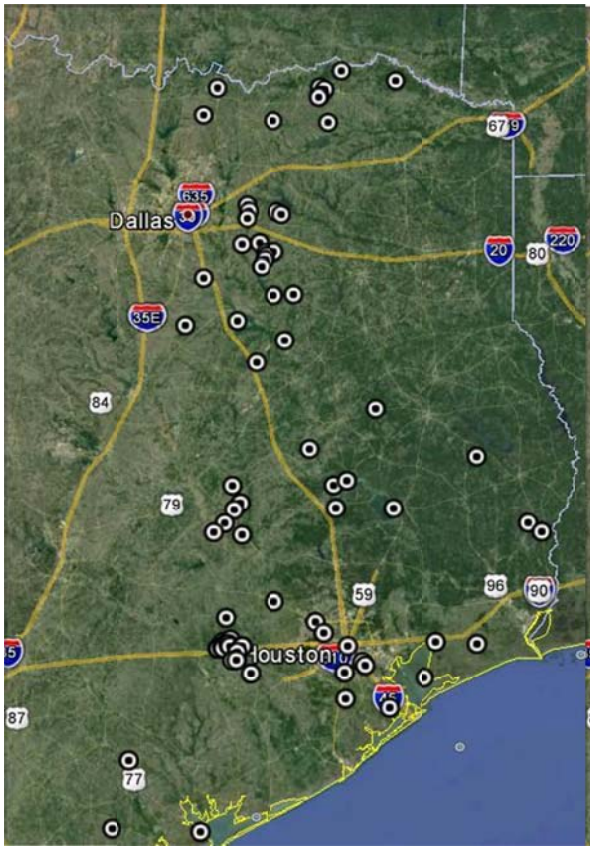


Fig 1. Historical records.

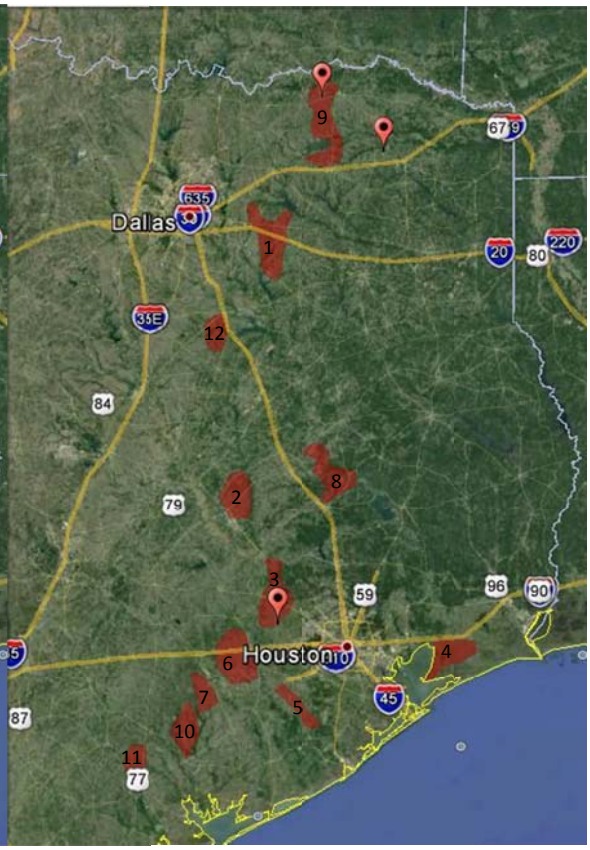


Fig 2. Areas surveyed, red points indicate locations of frog loggers. Numbers correspond to route numbers in table 1.

Results—Over the course of two springs we did 19 surveys on 12 different survey routes (Table 1). We found or heard crawfish frogs on 8 of those surveys for a success rate of 42%; however, 2014 had more favorable weather conditions and therefore surveys were much more successful (55% vs 25% in 2013). One crawfish frog was discovered in Fannin County in 2014 by a citizen scientist and brought to our attention via the iNaturalist Herps of Texas project. Additionally we received a recording of a crawfish frog chorus in central Waller County which was also picked up by one of our frog loggers. We only had one frog logger with recordings of crawfish frogs (mentioned above).

Table 1. Presence/absence and date of surveys for crawfish frogs in 2013 and 2014.			
Route	**Date**	**Crawfish Frog (y/n)**	**Comments**
1 Kaufman/Van Zandt	9 Feb 2013	N	
2 Brazos	22 Feb 2013	N	
3 Waller	9 Feb 2013	N	
4 Chambers	31 Mar 2013	N	
5 Fort Bend	18 Feb 2013	Y	Calling at one spot
6 Colorado	20 Feb 2013	N	
7 Colorado	2 Apr 2013	N	
6 Colorado	13 Oct 2013	Y	Many on roads
6 Colorado	11 Jan 2014	Y	Calling at multiple locations
5 Fort Bend	28 Feb 2014	N	
3 Waller	14 Mar 2014	Y	Calling at multiple locations and active on roads
8 Walker/Trinity/Houston	15 Mar 2014	N	
1 Kaufman/Van Zandt	21 Mar 2014	Y	Calling at multiple locations and active on roads
9 Lamar/Hopkins	22 Mar 2014	Y	Calling in few spots
10 Jackson	26 Mar 2014	N	
11 Victoria	26 Mar 2014	N	
12 Navarro	27 Mar 2014	N	
9 Lamar/Hopkins	12 May 2014	Y	One on road
3 Waller	28 May 2014	Y	Few calling many on roads

Discussion—We verified the presence of crawfish frogs from two broad areas in Texas: one in the prairies of northeast Texas from southern Van Zandt and Kaufman Counties north to the Red River, and the other in the northern edge of the gulf coast prairie from Colorado County to northwestern Harris County (Fig. 3). Our surveys indicate that some populations may have become extirpated; however, many more surveys are needed to verify this. The populations that extended along the prairies of the Trinity River valley and in Brazos County have not been observed in over 30 years. Also we would expect that those populations in the forests of east Texas have been extirpated due to the conversion of those remnant prairies to forests with the suppression of fire.

Our survey methods, especially the driving surveys seemed to be sound although we feel the likelihood of missing crawfish frogs at an area is still high due to their need for very specific conditions for activity. We believe that it is risky to attempt to use only call

loggers to verify presence. One of our loggers at a known extant locality failed to verify the presence of crawfish frogs between March and May of 2014 although an egg mass was observed at the breeding site during this time. Due to the difficulty of hitting the "right night" we feel that when crawfish frogs are active that it is imperative to cover as much ground as possible to determine the geographic extent of the population being surveyed.

Fig 3. *Lithobates areolatus* observations from this study. All Calling and sight records have been entered into the Herps Of Texas iNaturalist project.

Literature Cited

Bragg, A. N. 1953. A study of *Rana areolata* in Oklahoma. The Wasmann Journal of Biology 11:273-319.

Busby, H. W. and W. R. Brecheisen. 1997. Chorusing phenology and habitat associations of the crawfish frog, *Rana areolata* (Anura: Ranidae), in Kansas. The Southwestern Naturalist 42:210-217.

Hammerson, G., and M. Parris. 2004. *Lithobates aeolatus*. IUCN 2010: ICUN Red List of Threatened Species. Version 2010.4 http://www.iucnredlist.org. Accessed 2 December 2012.

Parris, M. J. and M. Redmer. 2005. *Rana areolata*. Pages 526-528 in M. J. Lannoo, editor. Amphibian Declines: the conservation and status of United States species. University of California Press, Berkeley, California.

Platt, D. R., J. T. Collins, and R. E. Ashton. 1974. Rare, endangered and extirpated species in Kansas. II. Amphibians and reptiles. Transactions of the Kansas Academy of Science 76:185-192.

This section of the report includes data collected for objectives 2-4, the breeding biology portion of the study.

Site selection and study initiation:

This report includes data collected from 29 January through 31 May 2014.

We used satellite imagery to locate all wetlands on the APCNWR that could be potential crawfish frog breeding sites. The initial survey produced 77 possible sampling sites. We selected a subsample of 12 sites based on size and location of the wetlands. We chose a variety of wetlands to encompass a range of sizes and water permanency from small ephemeral sites to more permanent sites. Also, we attempted to select wetlands that were somewhat evenly distributed across the refuge (Figure 1.)

We initiated data collection by deploying automated audio recording units, to detect crawfish frog calling activity, at 12 sites on 29 January 2013 and by deploying automated water depth loggers at each wetland on 18 March 2013. A delay in the funding process prohibited us from deploying our equipment synchronously and delayed the initiation of the study; however winter drought conditions (no water in the wetlands) likely delayed any crawfish frog breeding activity that we might have missed. We feel confident that our data represents all crawfish frog breeding activity at our sites in 2013 and 2014.

Objective 2. Determine association between crawfish frog calling activity and exogenous factors (rainfall, ambient temperature, relative humidity, wind speed, barometric pressure, water temperature, and water depth).

Rainfall, air temperature, relative humidity, and wind speed data were taken from the weather station located at the APCNWR (see figures 2 & 3 for daily rainfall and air temperature data from 29 January 2013 – 31 May 2014). Barometric pressure, water temperature, and water depth data were collected via our water depth loggers (see figures 4 & 5 for daily wetland water depth data from 18 March – 20 May 2013, data not available for ponds 3, 4, and 8).

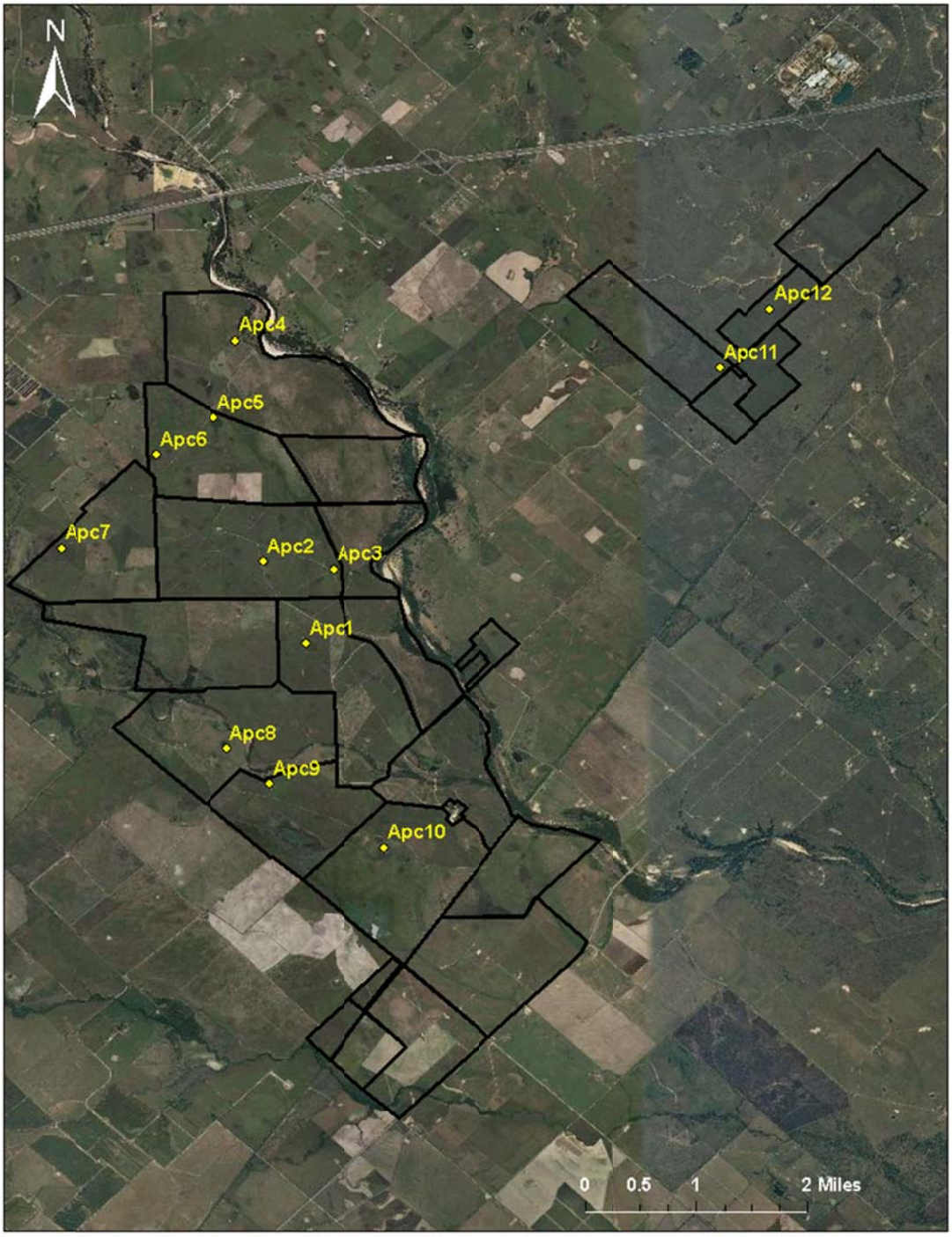


Figure 1. Points on the areal image indicate sampling locations for crawfish frog breeding activity.

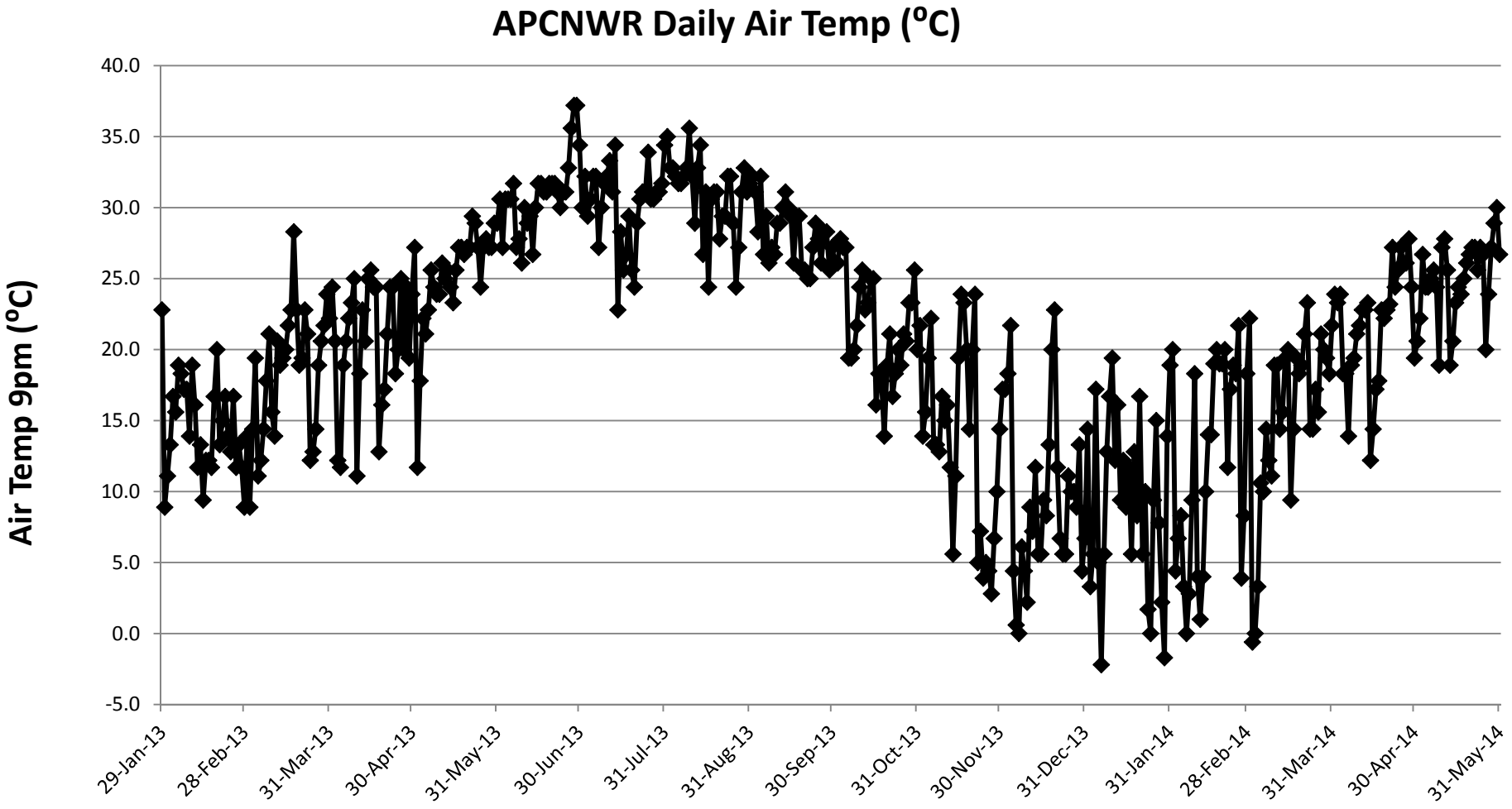


Figure 2. Points indicate daily temperature (C) at 9 pm each day at the Attwater Prairie Chicken National Wildlife Refuge.

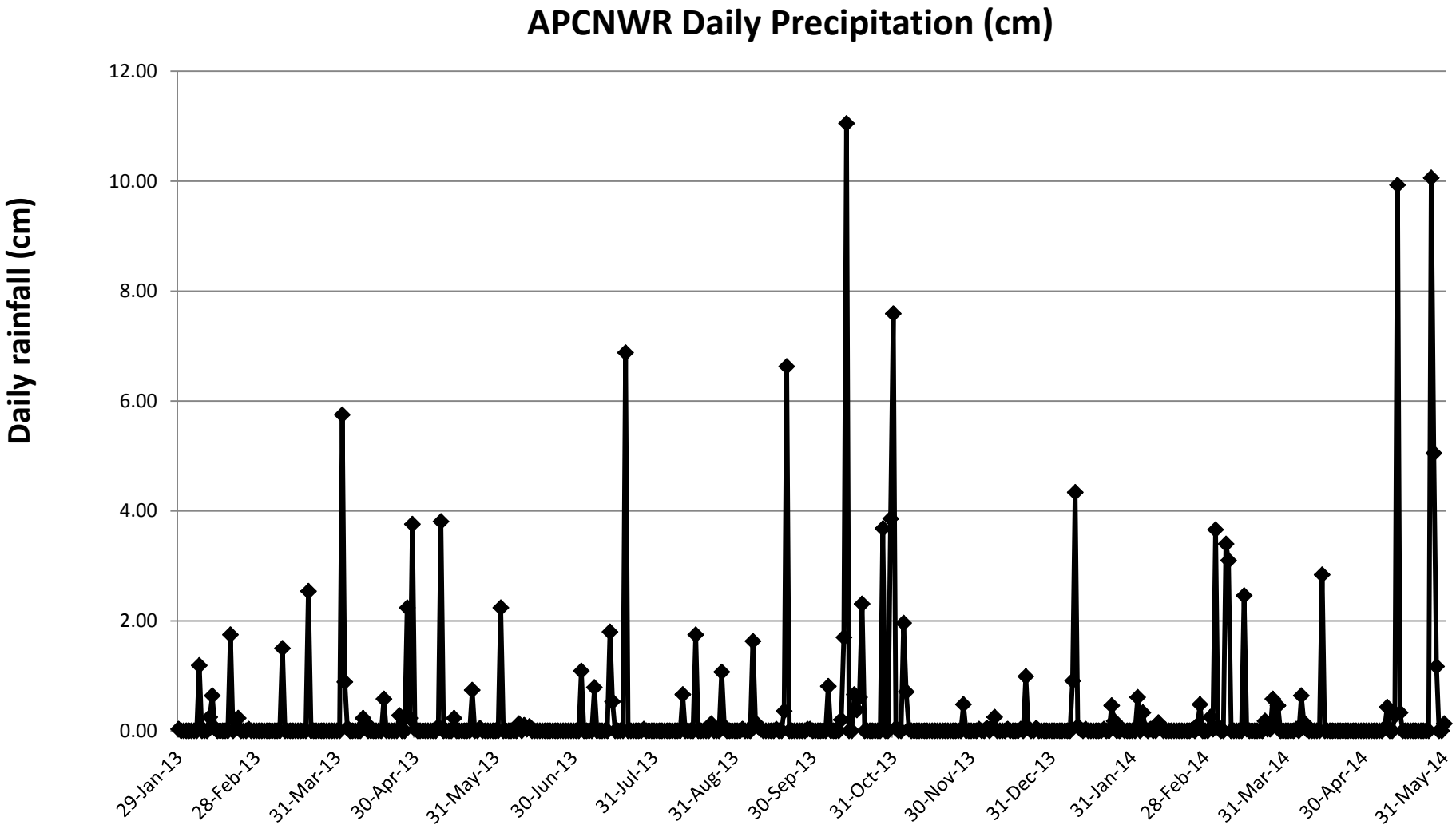
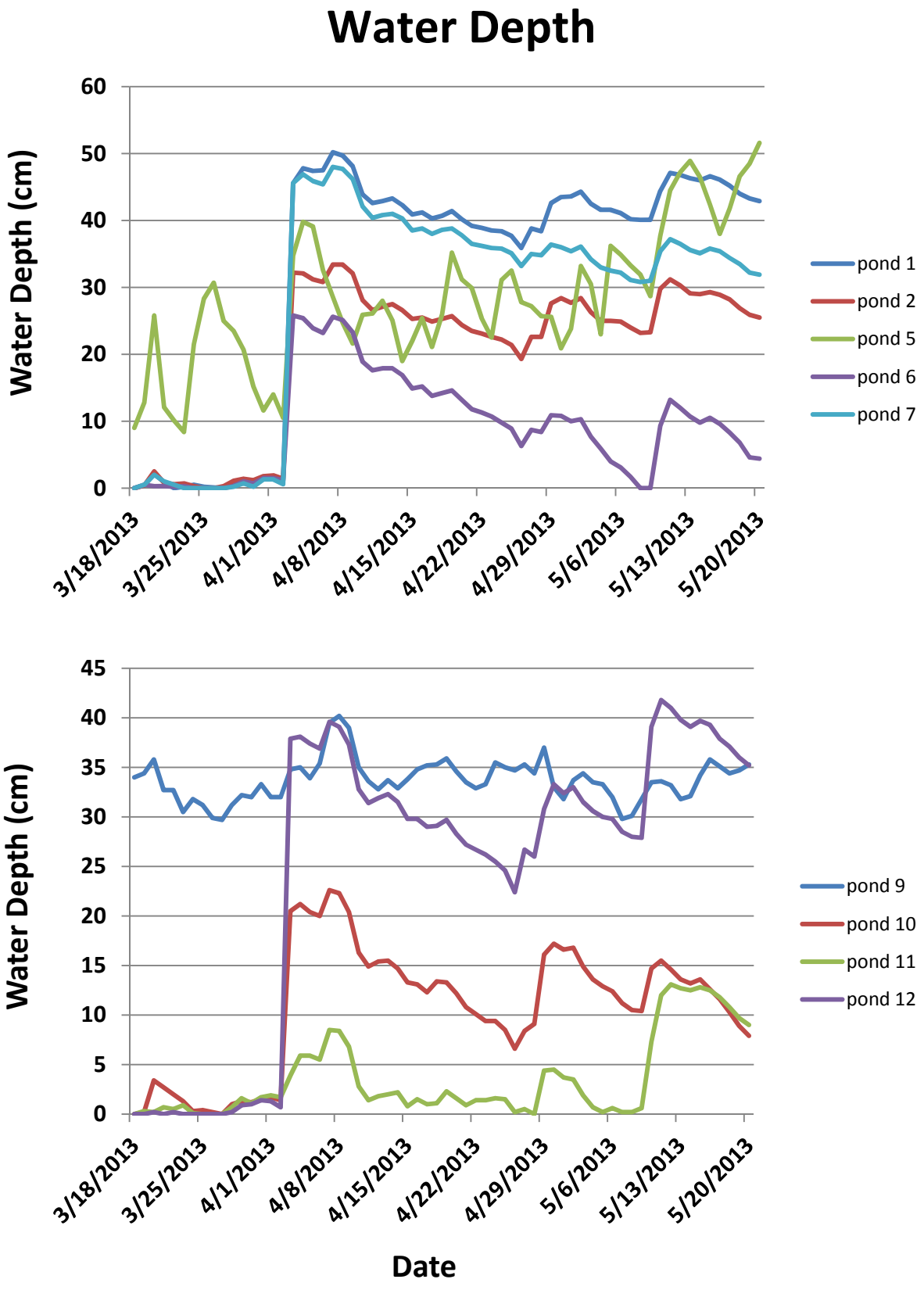


Figure 3. Points indicate daily toal rainfall (cm) each day at the Attwater Prairie Chicken National Wildlife Refuge.



Figures 4 & 5. Lines represent water depth at 9 of the 12 wetlands at the APCNWR.

We made the simple observation that crawfish frogs did not call at wetlands when they did not contain water. Logistic regression models generated from our data suggest that relationships exist between crawfish frog calling activity and weather variables. Our best model suggested that a five-day accumulation of rain and daily minimum temperature are the best predictors of crawfish frog calling activity. $P < 0.0001$, QIC 2498.86 (Figure 6). It is evident in Figure (6) that calling activity was closely tied to rainfall but mainly during the time of year when the minimum daily temperatures were low. Crawfish frogs seemed to avoid calling during the warmest months, despite favorable rain conditions.

We feel that more relationships between other exogenous factors and crawfish frog calling exist, such as water depth and daily air temperature, however we have not been able to demonstrate those relationships at this time. Although we are approaching a good understanding of the exogenous stimuli that mediate calling behavior in crawfish frogs from the Coastal Prairies of Texas, more quality data are needed to increase the power of our predictive models.

Objective 3. Determine crawfish frog breeding season.

A good understanding of the timing of crawfish frog breeding activity is critical for developing protocols for surveys. Also, this knowledge could be useful to managers for scheduling activities at times that would avoid conflict with the frog. Prior to this study, our only information to provide any insight into crawfish the frog breeding season in Texas was from collection records. The assumption with these data is that if the frogs that were collected were active away from burrows, they were presumed to be engaged in breeding activity. Our expectations, based on museum records, were that crawfish frog breeding activity would be concentrated in January and February.

Our results from January 2013 through May 2014 indicate that crawfish frog calling activity at the APCNWR is much more prolonged that previously expected. During the our study, so far, we detected calling during 7 different months of the year. While an 18-month study will only give us a partial understanding of the breeding phenology, we did learn that crawfish frogs can call much later in the summer than expected based on collection records and previous research conducted in the northern part of the range and we detected them calling during the fall months which was also unexpected (Figure 6). Clearly, more data are needed to definitely determine the breeding phenology of the crawfish frog in Texas.

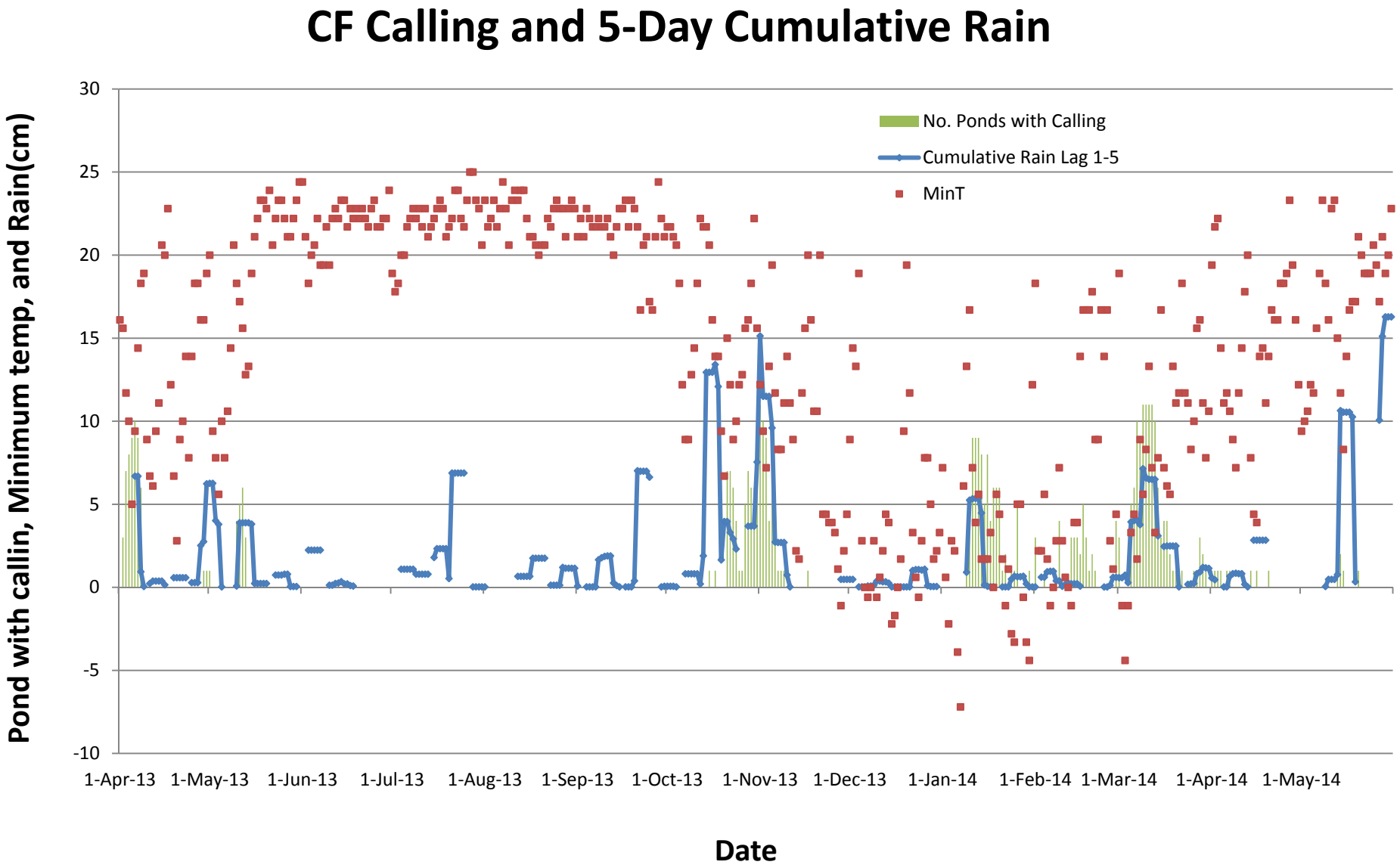


Figure 6. Green bars indicate the number of ponds with calling detected each day, blue lines indicate 5-day accumulation of rain, and red points indicate the daily minimum air temperature.

Objective 4. Determine crawfish frog diel calling activity.

An understanding of hourly calling activity is important because it will provide information about peak calling times during a 24 hour period, which is important for developing protocols for crawfish frog calling surveys.

We analyzed the first three pulses of calling activity from 2013 separately since calling intensity was different for each period (Figure 7). We learned that the pattern of calling activity was similar across the three periods of calling. Calling activity commenced and peaked soon after sunset and maintained relatively constant levels until sunrise. Very little calling activity was detected during daylight hours. Our results clearly indicate that surveys should be conducted after sunset and may be continued until sunrise with no decline in detectability. This is inconsistent with the literature, based on northern populations that suggest that calling activity decreases several hours before sunrise. However, data presented here is of calling that occurred much later in the season in 2013, during a warmer period of time, than what might be observed in other years. Diel calling activity patterns may be differ if calling were to take place early in the season when nighttime temperatures are lower. More data analyses are needed to determine if diel calling patterns during early season breeding are consistent with our observations in April and May.

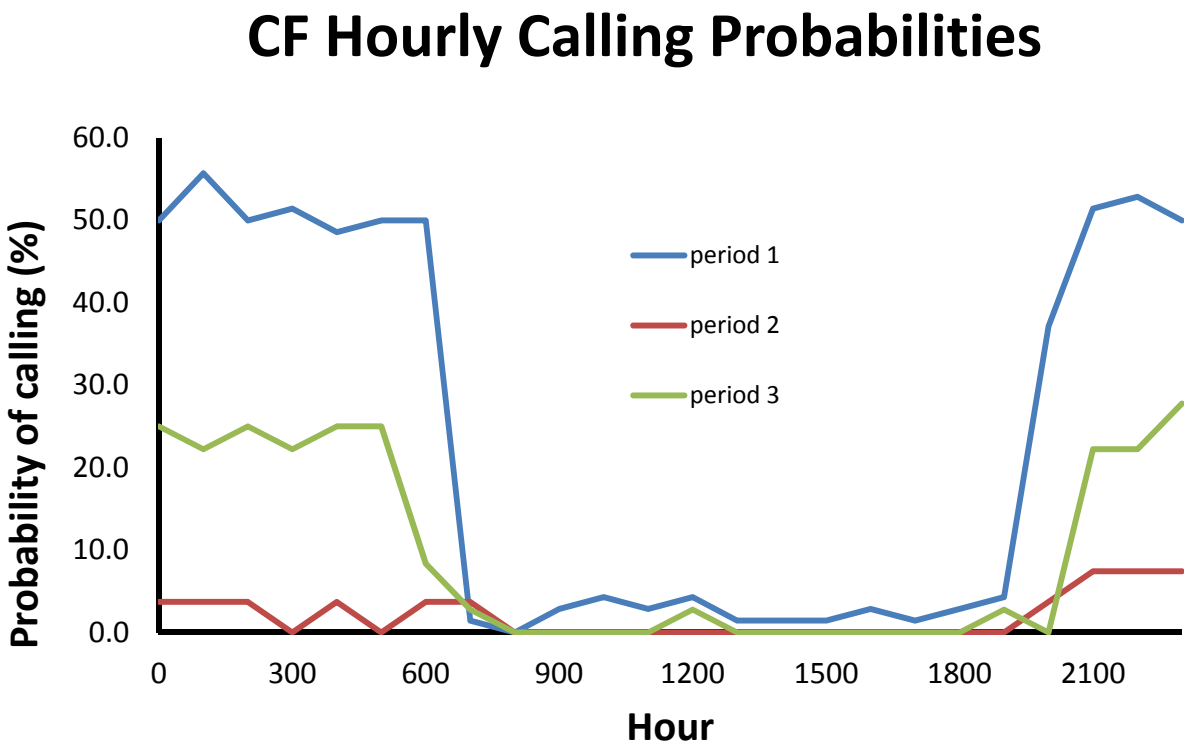


Figure 7. Line indicate probability of calling each hour of the day for each calling period.

Additional knowledge obtained: We determined how ponds differed with regard to crawfish frog calling activity and anuran community composition.

Crawfish frog calling was detected at all sites sampled on the APCNWR, however activity varied across ponds, from very frequent to just a few a few days at some ponds (Figure 8). In general, permanent ponds (ponds 3, 4, and 9, red bars in Figures 8) tended to have lower crawfish frog calling intensity and frogs called fewer nights at those ponds while the larger ephemeral ponds tended to have the larger choruses and the frogs called on more nights.

Overall, 12 species of anurans were detected at the APCNWR, representing four families of frogs. The families, Ranidae and Hylidae were well represented with 4 and 5 species respectively (Table 1). Although, we did not detect Strecker's chorus frog or Houston toads, two species of concern, by the time of our 2013 report, we later detected the chorus frog at 4 sites (Table 1). Anuran community composition and richness varied greatly across ponds. Anurans were detected at all ponds. Mean species richness was 8.5 species per site. Richness varied from 7 species at several ponds to a high of 10 species at several others.

Some anuran species were very common on the APCNWR. Crawfish frogs, southern leopard frogs, eastern narrowmouth toads, and upland chorus frogs were detected at all ponds during our study. In contrast, the bronze frog and Woodhouse's toad were only detected at one pond each (Table 1). From our results, we were unable to definitively determine patterns of co-occurrence with crawfish frogs and other anuran species, partly because we only surveyed 12 ponds and partly because crawfish frogs were ubiquitous on the APCNWR.

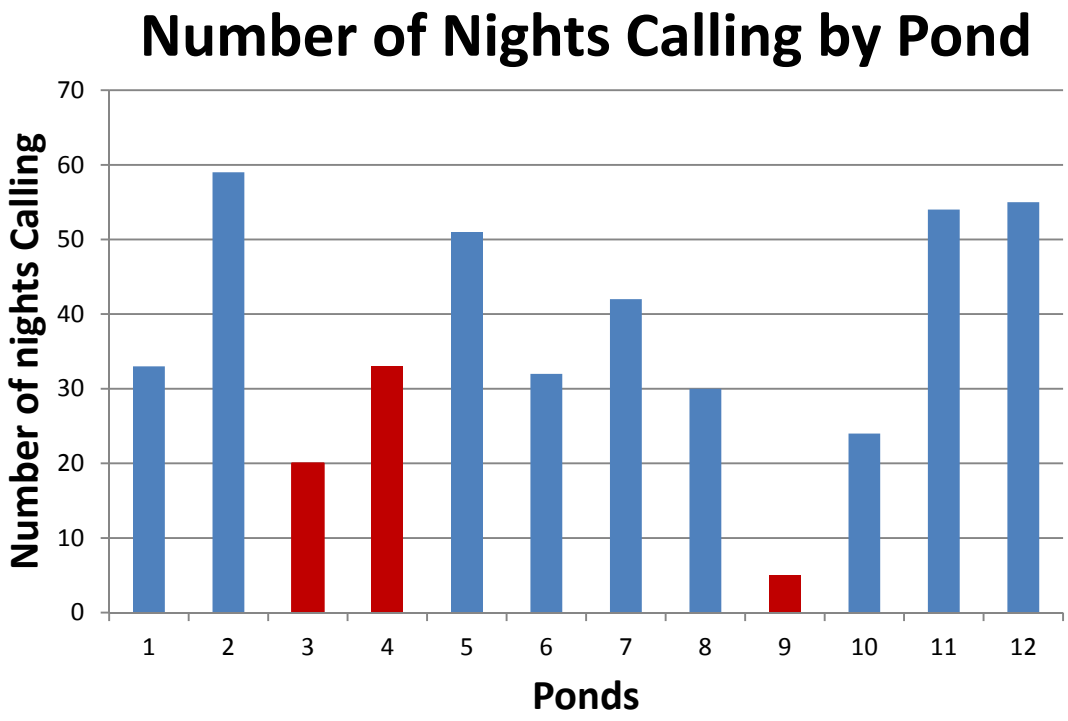


Figure 8. Cumulative *L. areolatus* calling by pond. Red bars indicate permanent ponds and blue bars are ephemeral

Table 1.Species of anurans detected at ponds at the APCNWR from 29 January 2013 through 31 May 2014. An X in the table indicates that the particular species was detected at the pond referenced in the column above. For example, *L. sphenocephalus* was detected in all ponds except ponds while *A. woodhousii* was only detected in pond 3.

	Pond											
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	Ranidae											
L. sphenoceph.	X	X	X	X	X	X	X	X	X	X	X	X
L. areolatus	X	X	X	X	X	X	X	X	X	X	X	X
L. clamitans					X							
L. catesbeiana	X	X	X	X	X	X	X		X	X		
	Hylidae											
H. cinerea	X	X	X	X	X		X	X	X	X	X	X
H. squirrela			X	X				X	X	X		
P. streckeri				X	X	X						
P. triseriata	X	X	X	X	X	X	X	X	X	X	X	X
A crepitans	X		X	X	X	X	X	X	X	X	X	X
	Bufonidae											
A. woodhousii			X									
I. nebulifer	X	X	X	X	X		X	X	X	X	X	X
	Microhylidae											
G. carolinensis	X	X	X	X	X	X	X	X	X	X	X	X