

## Googling Crawfish Frogs: Using Satellite Imagery and Auditory Surveys to Locate Breeding Sites of a Near-threatened Species in Southernmost Illinois

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### Abstract

Crawfish frogs, *Lithobates areolatus* (formerly *Rana areolata*), are cryptic anurans that produce a loud, distinctive call that can be exploited to detect their presence during their breeding period. Crawfish frogs have declined over their entire geographic range and are classified as Near Threatened by the International Union for Conservation of Nature. Efficient methods for determining presence or absence of crawfish frogs during their brief, early-spring breeding season are needed. By modeling calling activity in relation to survey and weather variables, recent studies in Indiana have provided valuable guidance for surveying crawfish frogs. After pre-selecting survey sites using satellite imagery, I conducted an 8-night auditory survey for crawfish frogs from mid-March to early April 2014 across much of southernmost Illinois. Although visiting each site for shorter-than-recommended periods of time and often during cooler-than-recommended conditions, I heard crawfish frogs at 80 previously undetected sites. My results support the conclusions of the Indiana studies that crawfish frogs are best detected when surveys are conducted during the peak of the breeding season. My results also suggest that single, brief visits to pre-selected potential breeding sites, even at cool air temperatures, can be productive. These results potentially expand the conditions under which crawfish frog surveys can be successfully performed, thereby providing greater opportunity for crawfish frog detection during their brief breeding period.

### Introduction

Crawfish frogs, *Lithobates areolatus* (formerly *Rana areolata*), are relatively large but secretive and seldom-seen frogs (Dodd, 2013). Except during the brief, early-spring breeding season, crawfish frogs are inconspicuous, inhabiting subterranean crawfish burrows in grasslands (Heemeyer et al., 2012; Hoffman et al., 2010). Crawfish frogs breed in farm ponds and similar wetlands, particularly those that are free of predatory fishes (Palis, 2009; Phillips et al., 1999). As a result of terrestrial habitat loss due to housing and business development, modern agricultural practices, and strip mining; destruction of breeding sites; and the introduction of predatory fishes into breeding sites, crawfish frogs have declined over their entire geographic range and are classified as Near Threatened by the International Union for Conservation of Nature (Stuart et al., 2008).

In a recent status review of crawfish frogs in Indiana, Engbrecht et al. (2012) describe a considerable range contraction of the species in Indiana and suggest that, in addition to two government-owned tracts in southern Indiana and the coal spoil prairies of western Kentucky, the healthiest crawfish frog populations east of the Mississippi River are “perhaps in southern Illinois.” There are no recent published occurrence data with which to refute or confirm this statement by Engbrecht et al. (2012). Based on my own informal vocalization surveys of crawfish frogs conducted intermittently since the late 1970s, it appears that crawfish frogs may be widely scattered and locally abundant in southern Illinois.

Crawfish frogs have a brief breeding period lasting  $\leq 1.5$  months, one which waxes and wanes depending upon variations

in weather (Busby and Brecheisen, 1997; Williams et al., 2013). In southern Illinois, the crawfish frog breeding season typically encompasses the month of March, but may begin in late February and extend through early April (personal observations). Because large choruses typically occur on only a few nights (Busby and Brecheisen, 1997; Williams et al., 2013), an efficient means of surveying for vocalizing crawfish frogs during their abbreviated breeding season is necessary to survey large geographic areas.

Vocalization surveys are widely used to monitor and survey frog and toad populations (e.g., Dorcas et al., 2010; Weir and Mossman, 2005) including crawfish frogs (Busby and Brecheisen, 1997; Engbrecht et al., 2012; Williams et al., 2013).



Crawfish frog, *Lithobates areolatus*, from Johnson County, Illinois. Photograph by John G. Palis.

During their brief breeding season in early spring, crawfish frogs are readily detected by their loud, distinctive snore-like call (Smith, 1961). However, because the crawfish frog breeding season is so fleeting, pre-selection of potential breeding sites may help make the best use of limited time the species is readily detected. Here, I describe the use of a widely-available online resource—Google Earth—combined with auditory surveys to detect crawfish frog presence during the spring 2014 breeding season in portions of southernmost Illinois. I define southernmost Illinois as the area encompassed by the following counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson.

### Survey Methodology

My 2014 crawfish frog survey of southernmost Illinois was a three-step process. Step 1: I examined Google Earth satellite imagery—available on the internet—to locate potential crawfish frog breeding sites. I searched for ponds and wetlands that looked similar to known crawfish frog breeding sites and that occurred in agricultural settings (pastures, hayfields, fallow fields and cropfields) and in or near rural communities. I selected water bodies that appeared to be shallow and, therefore, likely fishless. Water in shallow ponds and wetlands tends to be lighter in color than deeper bodies of water. I also gave preference to relatively small ponds as they are more likely to be fishless than relatively large ponds. I searched for potential breeding sites in the vicinity of roads from which I could listen for vocalizing male crawfish frogs. I flagged potential breeding sites using the placemark feature at Google Earth and saved satellite images to my computer. I denoted locations of potential breeding sites on county maps to assist in finding pre-selected sites while afield. Step 2: I conducted nocturnal auditory surveys for calling crawfish frogs. I initiated surveys after determining that crawfish frogs had begun vocalizing. I surveyed on dry nights (i.e., not raining) after days that were relatively warm and sunny or partly cloudy. I conducted surveys by driving from wetland to wetland previously selected using Google Earth. Surveys at individual sites consisted of stopping my vehicle, lowering my windows, turning off the engine, and listening for vocalizing frogs for a minimum of one minute (stops were shortest at sites where no frog species were calling or when extraneous noises, such as the sound of

traffic or nearby barking dogs, significantly interfered with my ability to hear frogs). Oftentimes, I quietly exited my vehicle and cupped my ears forward with my hands to better detect and locate provenance of calling frogs. When crawfish frogs were detected, I noted my location using road mileage from a landmark, such as a crossroad, and on field maps. In some instances I also used a Garmin Etrex Legend GPS unit to obtain geo-coordinates. I recorded a qualitative description of chorus size, identified other species of calling anurans, and recorded air temperature at my vehicle. Step 3: Using my field notes and maps, I located and determined geo-coordinates for each field-confirmed crawfish frog breeding site at Google Earth. These data are being accrued as part of an ongoing study of the current distribution and conservation status of the crawfish frog in southernmost Illinois.

### Results

I selected 600 potential breeding sites to survey across eight southernmost Illinois counties (Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson). I surveyed on eight nights from 15 March through 1 April 2014 (Table 1). Crawfish frogs were not heard calling prior to 15 March (personal observation; Chris Evans, personal communication; Rob Stroh personal communication). My survey was interrupted by periods of cold weather, including nights having low temperatures below freezing and snowfall. Air temperatures recorded while crawfish frogs were calling (including chorusing) ranged from 1.0 to 16.5°C and winds varied from 0 to 27 km/h (Table 1). Surveys were initiated (and crawfish frogs were calling) as early as 1920 CDT and terminated (and crawfish frogs were calling) as late as 0130 CDT. The peak of crawfish frog calling appeared completed by April 1st as frogs were calling intermittently on that date and some were even calling at burrows away from breeding sites. Crawfish frogs sometimes call at burrows following breeding activity (Smith et al., 1948).

I visited approximately 220 of the 600 pre-selected sites and detected crawfish frogs in 90 breeding sites, including 80 newly documented sites. In some cases, frogs may have been calling from more than one of a cluster of ponds or wetlands. I also heard crawfish frogs vocalizing elsewhere during this survey, but was unable to determine provenance of the calls. I detected

**Table 1.** Weather variables observed before and during 2014 crawfish frog surveys. Daily maximum air temperature, and wind speed and direction during surveys are for weather stations closest to survey areas and include Cape Girardeau, Missouri; Carbondale, Illinois; and Paducah, Kentucky (obtained at [www.wunderground.com](http://www.wunderground.com)). Cloud coverage before and during surveys and high and low temperatures during surveys were observed by JGP.

Date 2014	Sky (day / night)	Daily maximum temperature °C	Wind		Survey air temperature	
			Speed (km/h)	Direction	High °C	Low °C
15 March	clear / clear	22.5	6.5–11	SSE	13	5.5
18 March	partly cloudy / clear	14	13–24	SSE	11	8.5
20 March	clear / clear	18	5.5–7	SW	11	1
21 March	partly cloudy / partly cloudy	20.5	5.5–27	SSW	16.5	13
22 March	clear / clear	15.5	9.5–14.5	NNW	8	5.5
28 March	clear / clear	15	11–17	NW	13	8
30 March	clear / clear	15	0–9.5	SSW	7	3.5
1 April	partly cloudy / cloudy	20	0–13	W	14	11

crawfish frogs at 7–19 (mean = 11) breeding sites per survey-night. Number of males detected per breeding site included: 1) one male, 2) several males (non-overlapping or individually distinguishable overlapping calls), 3) a chorus of males (overlapping calls that blend together, individuals are not readily distinguished), or 4) a strong chorus of males (extremely loud chorus of overlapping calls; a “roar”). Because crawfish frog choruses at any given wetland vary considerably in size during the breeding season or even during the same night (personal observations), I do not consider detection of one or a few individuals during one brief visit an accurate indicator of size of the breeding population. I do, however, suspect that strong “roaring” choruses are indicative of large breeding populations. For example, at one such chorus in a small, wooded, roadside pond in Saline County, I observed a minimum of 100 calling males congregated on the north side of the pond. Males continued calling despite the presence of two human observers shining lights on them; no females were present. I heard crawfish frog choruses at 39 sites and strong choruses at five sites. Other frogs heard calling with crawfish frogs include American toads, *Anaxyrus* (formerly *Bufo*) *americanus*, spring peepers, *Pseudacris crucifer*, trilling chorus frogs, *Pseudacris feriarum*–*Pseudacris triseriata* complex, and southern leopard frogs, *Lithobates sphenoccephalus* (formerly *Rana sphenoccephala*).

Newly-discovered crawfish frog breeding sites—as revealed by Google Earth satellite imagery—include 1) large, shallow, constructed wetlands (surrounded by cropland or land recently retired from crop production); 2) ponds in cropfields, hayfields, pastures, or lawns (including recently-dug ponds and old ponds surrounded, or overtopped, by trees); and 3) flooded low areas in or on the edge of agricultural fields (one of which was confluent with a roadside ditch) or, in one case, in a cleared forest. Breeding sites were in rural agricultural settings; within small, rural communities; or in housing developments on the outskirts of growing communities. Some newly-discovered breeding sites were not pre-selected. These sites, often small and hidden from satellite view by trees, were discovered while traveling between pre-selected sites or after following calls heard in the distance while listening at pre-selected sites.

## Discussion

The goal of this survey was to locate as many previously undetected crawfish frog breeding sites as possible during the peak of one breeding season and across a relatively large geographic area. To accomplish this goal, stops at/near individual potential breeding sites were, by necessity, brief, generally lasting no more than 1–5 minutes. As such, I may have missed crawfish frogs at sites where they were present, but not vocalizing at the time of my visit (crawfish frogs often call intermittently, especially at the beginning and end of the breeding season [personal observations]). In addition, time constraints prevented me from pinpointing the exact location of some breeding sites. Crawfish frog calls can carry up to 2 km under certain circumstances (personal observations) and determining provenance of calls can sometimes be difficult from the roadside, especially when multiple wetlands occur in the direction of the calling frogs or when it is impossible to get closer via, or triangulate from, another road. Surveying a smaller geographic area and/or fewer

sites would potentially provide enough time to return to potential breeding sites where frogs were not detected, and to request permission to enter private property to pinpoint location of breeding sites.

Of the environmental parameters that may affect crawfish frog calling intensity and thus survey success, temperature, particularly air temperature, has received considerable attention. Smith et al. (1948), working in Williamson County, Illinois, wrote, “Air and water temperatures of about 10°C appear to be the critical optimum for *R. areolata*. Breeding activity does not begin until they reach about 8°C, and is not active until about 12°C. When well under way, the breeding activity lessens markedly by reduction of temperatures to 10°C, and virtually ceases at 6°C or less.” Busby and Brecheisen (1997), studying crawfish frogs in Kansas, reported that (air) “Temperatures of  $\geq 13^\circ\text{C}$  appeared necessary for active chorusing, although sporadic calling was noted at temperatures as low as 8.0°C.” Parris and Redmer (2005), summarizing the literature and their own observations, stated that “Ambient air temperatures of 10–12°C (minimum 8°C) are critical to initiate and maintain breeding activity.” Modeling of calling behavior in southern Indiana by Williams et al. (2012; 2013), indicate that crawfish frogs are best detected at air temperatures  $\geq 8^\circ\text{C}$ .

During my survey, I heard crawfish frogs calling (including chorusing) at air temperatures as low as 1°C. Of the 87 air temperature readings I recorded while listening to calling crawfish frogs, 30 (34.5%) were less than 8°C (mean of 5.3°C). Fifteen of these air temperature readings were recorded while crawfish frogs were chorusing. I attribute crawfish frogs calling and chorusing at low air temperatures to surveying on nights that followed relatively warm, sunny days (Table 1). I suspect water in breeding sites, heated by the sun during the day, was warmer than the air temperatures I was recording. This would allow crawfish frogs to be active and continue calling at air temperatures below that which is considered minimal for breeding activity or recommended for surveying.

My observations support the conclusion of Williams et al. (2013), who suggest that timing of sampling may be more important than air temperature. Although the probability of detecting calling crawfish frogs rises with an increase air temperature (Williams et al., 2012; 2013), my results indicate that auditory surveys conducted under cooler-than-recommended air temperatures can be productive. Doing so can increase the window of opportunity to detect this species. However, I recognize that longer and/or repeated visits to potential breeding sites, and surveying at higher air temperatures, may have resulted in the detection of crawfish frogs at a greater number of sites.

Crawfish frogs are of considerable conservation concern throughout their range (Stuart et al., 2008), and discussions to petition crawfish frogs for protection under the Endangered Species Act have begun (Williams et al., 2013). Efficient means of determining presence or absence of crawfish frogs during their abbreviated breeding season are needed. Pre-selection of survey sites directs surveyors to areas having the greatest potential to detect crawfish frogs, thereby saving time and potentially increasing the number of sites that can be visited in a single breeding season. Moreover, auditory surveys conducted under

less-than-ideal conditions can be effective at detecting calling crawfish frogs.

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