



# *Proceedings* of the **Indiana Academy of Science**

## **A REVIEW OF THE STATUS AND DISTRIBUTION OF CRAWFISH FROGS (*LITHOBATES AREOLATUS*) IN INDIANA**

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**ABSTRACT.** The conservation status of Crawfish Frogs (*Lithobates areolatus*) in Indiana has changed over the past several decades. Once described as being locally plentiful, declines led to the listing of Crawfish Frogs as a State Endangered Species in 1988. The status of Crawfish Frogs is difficult to assess because of their fossorial nature and abbreviated calling season. Several records for this species in Indiana are > 50 yrs old and have gone unconfirmed for several decades. The status of most populations along the northern and eastern periphery of their range is undetermined, and many are suspected to be extirpated. However, recent surveys performed by the Indiana Department of Natural Resources have confirmed the continued presence of Crawfish Frogs in parts of southwest Indiana. The discovery of populations in southeast (Big Oaks National Wildlife Refuge) and extreme south-central (Spencer County) Indiana over the past several years has redefined the perceived range of this species in Indiana.

**Keywords:** Distribution, status, Crawfish Frog, *Lithobates areolatus*

Crawfish Frogs (*Lithobates* [*Rana areolata*] *areolatus*) are a cryptic and comparatively understudied species distributed in portions of the Midwest, eastern Great Plains, and south-central United States (Lannoo 2005). Parris and Redmer (2005) described their distribution as “disjunct” with populations being “localized in areas of suitable habitat.” Crawfish Frogs have experienced declines in Illinois, Indiana, and Iowa (Christiansen & Bailey 1991; Phillips et al. 1999; Minton 2001). In Indiana, Crawfish Frogs are listed as State Endangered. In Iowa, Crawfish Frogs are also listed as State Endangered, but they have not been documented in the state for several decades and may now be extirpated (Christiansen & Bailey 1991).

In their summary of the distributions of amphibians and reptiles of Illinois and Indiana, Smith & Minton (1957) identified Crawfish Frogs as a “western species,” noting that most of their range occurs to the southwest of the two states. In Indiana, the majority of historic Crawfish Frog records are located in the western half of the state, extending from Benton County southward to the Ohio River (Minton 2001). An apparently isolated population occurs at Big Oaks National Wildlife Refuge in southeast Indiana (Haswell 2004).

Crawfish Frogs are known to occur in a variety of habitats including open damp areas, wooded mountain valleys, woodlands, and brushy fields (Bragg 1953; Phillips et al. 1999; Minton 2001; Parris & Redmer 2005). However, the northern subspecies *circulosus*, which occurs in Indiana, appears to favor grassland and has been found almost exclusively in this habitat in Oklahoma and Missouri (Bragg 1953; Johnson 2000). While Crawfish Frogs use grassland habitats in Indiana, much of their range appears to occur in areas that were largely forested during pre-settlement times (Jackson 1997; Minton 2001).

Crawfish Frogs are part of a four-species clade contained within the *Nenirana* group of Hillis & Wilcox (2005) that includes Gopher Frogs (*Lithobates* [*Rana*] *capito*) and Federally Endangered Dusky Gopher Frogs (*Lithobates* [*Rana sevososa*] *sevosus*). Both gopher frog species have a southern distribution along the Coastal Plains except for two isolated *L. capito* populations: one in central Alabama and one in Tennessee (Jensen & Richter 2005; Richter & Jensen 2005). Dusky Gopher Frogs have become extremely rare and are currently known from a single site in Harrison County, Mississippi (Richter & Jensen 2005). Gopher Frogs are a protected species in North Carolina,

Florida, and Alabama (Jensen & Richter 2005). All three species are ecologically similar, occupying natural and artificial holes, or burrows made by other species (Richter et al. 2001; Parris & Redmer 2005; Bilhovde 2006).

While listed as Endangered in Indiana, the status of Crawfish Frogs in this state is poorly known. As a component of a larger study to understand the conservation biology of Crawfish Frogs in the northern extreme of their range, we provide an overview of the historic distribution of this species in Indiana, building upon the summary of Minton (2001) by incorporating more recent survey data.

### HISTORIC OVERVIEW

Early reports of Crawfish Frogs in Indiana date to the latter half of the 19<sup>th</sup> century. Crawfish Frogs were first reported in Indiana in 1878 by F.L. Rice and N.S. Davis from Benton County (Rice & Davis 1878). This specimen was collected by E.F. Shipman and is deposited in the Chicago Academy of Sciences collection (CA 160; Rice & Davis 1878; Table 1). Willis Blatchley reported two additional specimens collected by C. Stewart and H. McIlroy from Vigo County in 1893 and 1894, respectively (Blatchley 1900).

Others contributing early records of this species in Indiana include R. Mumford, A.P. Blair, H.P. Wright and G.S. Myers of Indiana University (Wright & Myers 1927), and David and Paul Swanson, foresters for the Emergency Conservation Works and the Resettlement Administration (Swanson 1939; Table 1). Sherman Minton secured a number of specimens from 1949 to 1954, documenting the presence of Crawfish Frogs in at least seven additional counties. David Rubin reported Crawfish Frogs from a site now known as “Dave’s Pond” in northern Vigo County (Rubin 1965). The majority of specimens collected from this site are deposited in the Indiana State University Vertebrate Collection.

Minton (1972, 2001) has provided the most thorough descriptions of the biology of Crawfish Frogs in Indiana. According to Minton, Crawfish Frogs were considered “locally plentiful” in western Indiana until about 1970 when populations began to experience unexplained declines. He noted the disappearance of this species at many localities in Indiana, including sites appearing to have experienced little change in habitat. Evansville resident M.J.

Lodato witnessed the extirpation of Crawfish Frogs from three sites near Evansville, Vanderburgh County, all of which were likely extirpated by 1990 (Lodato, pers. comm.). One of these sites, located at Angel Mounds State Historic Site, apparently supported a population of > 100 breeding adults before its numbers diminished during the mid-1980s. Due to their increased rarity in Indiana, Crawfish Frogs were designated a Species of Special Concern in 1984 and elevated to State Endangered status in 1988 (S. Klueh, Indiana Department of Natural Resources, pers. comm.).

In March 2003, Daryl Karns, Joseph Robb, Erin Haswell, and others confirmed the presence of a large population of Crawfish Frogs located within Big Oaks National Wildlife Refuge (Haswell 2004). This discovery added Jefferson, Jennings, and Ripley counties to the Indiana distribution and extended the known range of Crawfish Frogs approximately 90 km eastward. The source of this apparently isolated population is not known, and its status as a natural or introduced population has not yet been determined. Despite intensive surveys, no populations have been located outside the refuge.

### METHODS

To assess the historic status of Crawfish Frogs in Indiana, we compiled a complete list of all known Crawfish Frog records in the state. The historic records of Crawfish Frogs in Indiana are based on locality data from museum and university specimens, literature accounts, Indiana Department of Natural Resources (IDNR) Division of Fish and Wildlife records, IDNR Division of Nature Preserves Heritage Database Center, and other reliable reports. We confirmed these records where possible by examining all known post-metamorphic museum specimens (Table 1). Many of the recent records contained in this report come from an Indiana Department of Natural Resources (IDNR) survey for Crawfish Frogs performed from 2004–2008 (Z. Walker, pers. comm.).

We contacted the following colleges and universities to inquire about possible specimens being stored in their collections: Indiana University-Bloomington, University of Notre Dame, Purdue University, Indiana University-Purdue University Fort Wayne, University of

Table 1.—Museum specimens of *Lithobates areolatus* from Indiana. Specimens CAS-SU 13390–93 were found to be misidentified and are not included in the table. Specimen OUZ A1126 could not be located and may be lost.

County	Year	Collection number
Benton	pre-1879	CA 160
Clay	1950	UMMZ 101623
	1958	UMMZ 118078
	1966	ISUVC 1492
Daviess	1953	UMMZ 108125
Fountain	1951	FMNH 64663
Greene	1949	UMMZ 100304
Jefferson	2003	FMNH 262589
Monroe	1926	CAS-SU 2174–80, 13343–64
	1940	OUZ A1126; UMMZ 95312
Morgan	1978	INSM 71.7.170–71
Owen	1954	UMMZ 110638
Pike	1936	CM 13371–75
	1963	ISUVC 2473
Ripley	2003	FMNH 262588, DRK 381
Sullivan	1952	UMMZ 105544
	1969	ISUVC 2255
Vanderburgh	1936	CM 13378
Vigo	1903	HUMCZ A-7043, A-7044
	1964	ISUVC 395–97, 399– 403; TCWC 66467
	1965	ISUVC 937
	1966	PU 8482–83
	1967	ISUVC 1820
	1969	ISUVC 2822
	1972	ISUVC 2738, 2793, 3204–07
1974	ISUVC 3177	

Indianapolis, University of Evansville, Ball State University, University of Southern Indiana, Oakland City University, Hanover College, St. Joseph's College, and Indiana State University.

Crawfish Frog records were obtained from the following sources: Wildlife Diversity Section, Division of Fish and Wildlife, Indiana Department of Natural Resources, (IDNR WDS), Indiana Natural Heritage Data Center, Division of Nature Preserves, Indiana Department of Natural Resources, (INHDC), Indiana State University Vertebrate Collection (ISUVC), Purdue Vertebrate Teaching Collection (PU), University of Michigan Museum of Zoology (UMMZ), Field Museum of Natural History

(FMNH), Chicago Academy of Sciences (CA), Harvard University Museum of Comparative Zoology (HUMCZ), Carnegie Museum of Natural History (CM), Texas Cooperative Wildlife Collection (TCWC), California Academy of Sciences (CAS-SU), Hanover College Herpetology Collection (DRK), and the Indiana State Museum (INSM). Data were obtained from records held in the following institutions and accessed through HerpNET data portal (<http://www.herpnet.org>): TCWC, 16 September 2009; CAS-SU, 16 September 2009; and CM, 20 August 2009.

## RESULTS

Minton (2001) included 23 counties in the range of Crawfish Frogs in Indiana. Sixteen of these counties are represented by point localities signifying reliable records and include Benton, Fountain, Vermillion, Vigo, Clay, Owen, Morgan, Sullivan, Greene, Monroe, Daviess, Martin, Pike, Dubois, Vanderburgh, and Warrick. Seven counties not represented by point localities include Warren, Parke, Putnam, Knox, Gibson, Posey, and Spencer. While not necessarily exhaustive (multiple records in a given county may be represented by a single point), Minton's account provides the most thorough compilation of Indiana distributional records for this species in the literature.

Indiana Department of Natural Resources surveys performed from 2004–2008 took place over a large portion of western and south-central Indiana, reaching 17 counties (in part or in whole) including Greene, Owen, Clay, Vigo, Sullivan, Knox, Daviess, Martin, Vermillion, Parke, Fountain, Orange, Lawrence, Pike, Dubois, Morgan, and Monroe (Z. Walker, pers. comm.). Crawfish Frogs were identified in seven of these counties including Vigo, Clay, Owen, Daviess, Sullivan, Parke, and Greene (IDNR, unpub. data). The IDNR surveys, however, did not detect Crawfish Frogs in several previously documented counties including Morgan, Monroe, Fountain, Vermillion, Pike, Martin, and Dubois.

## DISTRIBUTION RECORDS BY COUNTY

The following is a historic (pre-2009) overview of Crawfish Frog records in Indiana based on museum specimens, literature accounts, and several other sources (see Methods). Accounts are arranged by county and are followed by a discussion and summary.

**Benton County.**—Crawfish Frogs were first reported in Indiana from Benton County in 1878 (CA 160; Rice & Davis 1878; Minton 1998; Minton 2001). This record represents the type locality for the subspecies “*circulosus*” and the northernmost locality for the species in the state. The specific location of this site is unknown and the species has not been recorded in Benton County since (Minton 2001). Minton (2001) saw no reason to doubt the authenticity of this record and stated that he had taken Crawfish Frogs “within 30 miles” of the Benton County border. The specimen is currently deposited in the holdings of the Museum of the Chicago Academy of Sciences.

**Clay County.**—Minton (2001) included two point localities for Crawfish Frogs in Clay County, and noted hearing a “spectacular chorus” on 2 April 1950. A Clay County specimen collected on 2 April 1950 (UMMZ 101623) by Minton likely corresponds to the location of the large chorus heard that night. Russell Mumford collected a Crawfish Frog from northern Clay County on 7 April 1958 (UMMZ 118078). David Rubin and P. Allen collected a specimen near Bowling Green on 18 April 1966 (ISUVC 1492). Indiana Department of Natural Resources personnel reported hearing Crawfish Frogs near Brazil on 26 March 2007.

**Daviess County.**—Paul Swanson provided the earliest report of Crawfish Frogs from Daviess County. He reported frequently hearing Crawfish Frogs from “within the city limits of ... Odon” (Swanson 1939). Minton and W.M. Overlease collected a Daviess County specimen on 21 March 1953 (UMMZ 108125). This record likely corresponds to the single point locality Minton (2001) shows on his distribution map and is the only voucher specimen known from the county. Indiana Department of Natural Resources personnel reported a cluster of four call points northeast of Odon between 2004 and 2008 which appear to be distinct from the sites reported by Swanson (1939) and Minton and Overlease. These surveys also revealed a cluster of breeding sites in south-central Daviess County.

**Dubois County.**—Swanson (1939) identified Crawfish Frogs from Dubois County and characterized them as “quite plentiful.” This observation likely corresponds to a point locality given by Minton (2001). Surveys performed by IDNR personnel from 2004–

2008 failed to find this species, and therefore the status of Crawfish Frogs in Dubois County is unknown.

**Fountain County.**—Fountain County is represented by a single voucher specimen (FMNH 64663) collected near Kingman by Minton on 18 April 1951. This animal was reported from a shallow pond in a cultivated field (Alan Resetar, Field Museum of Natural History, unpubl. data). Surveys performed by IDNR between 2004 and 2008 were unable to confirm the presence of Crawfish Frogs at this site and therefore the status of Crawfish Frogs in Fountain County is unknown.

**Greene County.**—At least 17 Crawfish Frog reports come from Greene County, with most arising from the western portion. A number of these records are based on recent IDNR surveys. Minton deposited an animal collected on 25 March 1949 in the University of Michigan Museum of Zoology (UMMZ 100304). This Crawfish Frog represents the only voucher specimen known from Greene County. Minton (2001) includes two points in his distribution map, one of which appears to correspond to the UMMZ specimen.

Crawfish Frogs were reported from the Goose Pond basin, south of Linton in 2002 by Matt Blake and Vicky Meretsky (INHDC). Indiana Department of Natural Resources survey work in the Goose Pond basin from 2004–2008 identified Crawfish Frogs in six areas, including a confirmation of the Blake and Meretsky record. These surveys also identified localities on reclaimed coal mine land in northwestern Greene County.

**Martin County.**—Swanson (1939) included Martin County in a list of counties where Crawfish Frogs were “quite plentiful,” and reported frequently hearing them from within the city limits of Loogootee. No voucher specimens are known. The point locality given by Minton (2001) likely corresponds to Swanson’s Loogootee observation.

**Monroe County.**—Wright & Myers (1927) reported finding a population “two miles west of Bloomington” on 21 March 1926. This record is supported by specimens deposited in the California Academy of Sciences (CAS-SU 2174-80, 13343-64). Mittleman (1947) reported the collection of one juvenile and an unknown number of tadpoles by H.T. Gier from a small pond “four miles north of Bloomington” on 12 April 1940. These specimens were deposited in

the Ohio University collection (OUZ A1126), but appear to have been relocated and may now be lost (S. Moody, Ohio University, pers. comm.). A series of transforming tadpoles (UMMZ 95312) dated 19 July 1940 with the locality description of "Bloomington" were deposited in the University of Michigan Museum of Zoology by A.P. Blair. These specimens may be associated with those collected by Gier that same year (Mittleman 1947). Minton (2001) apparently considered the localities reported by Wright & Myers (1927) and Mittleman (1947) to be the same "colony", even though the collection notes give distinctly different locality descriptions ("two miles west of Bloomington" for Wright and Myers, and "four miles north of Bloomington" for Mittleman). In his 1972 monograph, Minton describes the location as occurring in the "grassy valley of Beanblossom Creek" (Minton 1972). Both populations may be extirpated, as no recent records exist for either of these locations in Monroe County.

A more recent locality for Monroe County was given by Al Parker, who reported sighting two individuals at a wetland near Bloomington along the Beanblossom Creek bottoms on 23 March 1991 (INHDC; Parker, pers. comm.). Indiana Department of Natural Resources personnel were unable to confirm the presence of Crawfish Frogs at this site from 2004–2008, despite numerous visits. Crawfish Frogs are presumed to be extirpated from this location.

The most recent record for Monroe County comes from Brodman (2003), who reported a call record at an unnamed locality. Little is known about this observation, and the status of this population is unknown.

**Morgan County.**—Robert Luker collected two individuals from Monrovia in early April 1978 (INSM 71.7.170–171). This record likely corresponds to a point locality given by Minton (2001) and appears to represent the easternmost voucher record in this species' contiguous range in Indiana. Crawfish Frogs may have occurred at more than one site prior to 1980 (IDNR Amphibian and Reptile Technical Advisory Committee 1987), and an INHDC record indicates that the species persisted at Monrovia until at least 1987. Indiana Department of Natural Resources surveys from 2004–2008 failed to detect Crawfish Frogs near Luker's Monrovia site, and populations there may be extirpated.

**Owen County.**—Minton collected Crawfish Frogs from Owen County on 25 March 1954 (UMMZ 110638). Minton (2001) included two records for the southern half of Owen County, one of which is likely the UMMZ specimen. Indiana Department of Natural Resources personnel detected a single population of Crawfish Frogs near the Owen-Clay County line in March 2007. This locality, a cluster of small wetlands on reclaimed coal mine property, represents the only known extant population in Owen County.

**Parke County.**—Indiana Department of Natural Resources surveys identified a single population of Crawfish Frogs in Parke County on 26 March 2007. The locality description associated with this record is somewhat obscure and the exact location of the site is unknown. The status of Crawfish Frogs at this site and throughout the county is undetermined.

**Pike County.**—Swanson and Swanson (Swanson 1939) collected a series of Crawfish Frogs from Winslow that are now deposited in the Carnegie Museum of Natural History (CM 13371-13375). John Tritt collected a single Crawfish Frog "near Spurgeon" on 25 June 1963 (ISUVC 2473). Surveys conducted by IDNR from 2004–2008 did not detect Crawfish Frogs in Pike County, and the status of the species there is unknown.

**Spencer County.**—Crawfish Frogs were discovered near Newtonville in Spencer County in 1998 by D.S. Dugas (M.J. Lodato, pers. comm.). Frogs at this site appear to be using a series of breeding ponds situated over several acres on reclaimed mine land (Lodato, pers. comm.). No voucher specimens have been collected. A second locality, located ca 6.5 km from the original site, was discovered in 2008 by Lodato, who identified and photographed a single adult male crossing a highway during a heavy rainstorm (Lodato, unpubl. data.). The breeding wetland has not been identified. Because of the distance between these localities, they appear to represent separate populations. Brodman (2003) reported detecting Crawfish Frogs from an unnamed locality in Spencer County.

**Sullivan County.**—Sullivan County contains at least 26 Crawfish Frog records, with most occurring in the east-central region. Vouchered records include a specimen collected by Minton on 21 March 1952 near Shelburn (UMMZ 105544) and a single adult collected by John

Whitaker, Jr. near Sullivan during the first week of June 1969 (ISUVC 2255). Timm (2001) identified 14 Crawfish Frog localities in her report on anuran use of reclaimed and unreclaimed mine areas. She reported Crawfish Frogs from a variety of habitats including a ditch, slough, beaver impoundment, and larger “final cut” strip pits. Voucher specimens are not known from this study and the current status of Crawfish Frogs at these sites is unknown. Brodman (2003) reported Crawfish Frogs from an unnamed locality in Sullivan County.

Surveys performed by IDNR from 2004–2008 reported nine Crawfish Frog localities from Sullivan County including sites near Cass, Hymera, and Dugger. Most of these sites represent call points located along roadways.

Indiana Department of Natural Resources property manager Ron Ronk reported hearing Crawfish Frogs calling from a private wetland complex north of Dugger every year from 2004–2008 (Ronk, pers. comm.). Stuart Smith reported finding a Crawfish Frog after a hard rain near Lake Sullivan on 20 May 2002 (INHDC). Voucher specimens are not available for these records.

**Vanderburgh County.**—A specimen collected by P.L. Swanson and D.C. Swanson on Route 41 in Vanderburgh County on 28 March 1936 is deposited in the Carnegie Museum of Natural History (Swanson 1939; CM 13378). Other sites known to have supported Crawfish Frogs include Angel Mounds State Historic Site near Newburgh. This site, which held a robust population containing an estimated 100 adults in 1980, had shrunk to fewer than 10 breeding individuals in 1987 (IDNR Amphibian and Reptile Technical Advisory Committee 1987). The population was apparently extirpated by 1990 (M.J. Lodato, pers. comm.). Two nearby sites located in Evansville were destroyed by suburban development shortly after the demise of the Angel Mounds site (Lodato, pers. comm.). Extant populations of Crawfish Frogs are not known from any sites in Vanderburgh County.

**Vermillion County.**—Minton collected a specimen on 18 April 1951 from a “shallow pond” near Perrysville in northern Vermillion County (UMMZ 103361); this represents the only known site for Vermillion County. The Vermillion and Benton County records appear to be the two northernmost records in Indiana,

and the only populations known to occur west of the Wabash River. The current status of the Vermillion County population is unknown.

**Vigo County.**—Crawfish Frogs were first reported in Vigo County from two sites by Blatchley, who received two specimens collected by C. Stewart at “the south part of the city of Terre Haute” on 8 and 9 October 1893 and a third specimen collected by H. McIlroy “three miles west from where the others were secured” on 9 May 1894 (Blatchley 1900). Locality data for these sites are vague, but a single point locality given by Minton (2001) may represent these two sites. Two Vigo County specimens collected by Blatchley deposited in the Harvard University Comparative Museum of Zoology (HUMCZ A-7043, A-7044) have a collecting date of 09 October 1903. Though specific locality data are not known, these specimens appear to be distinct from the ones previously reported by Blatchley (1900).

An additional locality was identified by Rubin (1965) in northeast Vigo County on 24 March 1964. This area (Dave’s Pond) contains at least three distinct wetlands and has been visited numerous times over the past several decades by researchers from Indiana State University. A number of voucher specimens have been collected from this site (ISUVC 395–97, 399–400, 401–403 [eggs only], 937, 2738, 2793, 2822, 3177 [eggs only], 3204–07; PU 8482–83). Crawfish Frogs were present at this site in 2008 (M.J. Lannoo, unpub. data). A specimen collected by E.G. Zimmerman on 6 April 1964 (TCWC 66467) contains the locality description “5 mi NE Terre Haute” and may correspond to the Dave’s Pond complex. John Whitaker and Rubin collected a specimen about three miles ENE of Dave’s Pond near Fontanet on 30 March 1967 (ISUVC 1820). An additional frog was observed in the base of a broken metal pole about three miles west of Dave’s Pond around the late 1960’s (J.O. Whitaker, pers. comm.).

Indiana Department of Natural Resources personnel identified a site near the Parke County line in 2007. This location is situated in a low, flat basin near Raccoon Creek. A specific breeding site has not been identified but a series of small wetlands is present and may be used.

**Warrick County.**—Swanson (1939) includes Warrick County in a list of counties in which Crawfish Frogs are described as being “quite

plentiful.” However, Minton et al. (1982) note that “some colonies in Vanderburgh and Warrick counties have been destroyed by surface mining, drainage, and urban expansion.” Lodato reported Crawfish Frogs from three sites near Elberfeld, Millersburg, and Paradise that were apparently destroyed by mining operations and subsequent housing developments (Lodato, pers. comm.). To our knowledge, no Warrick County specimens have been vouchered, and no extant populations are known from the county.

**Jefferson, Jennings, and Ripley counties.**—Records for Jefferson, Jennings, and Ripley counties are all located within Big Oaks National Wildlife Refuge, and thus have been placed together here. The suspected presence of Crawfish Frogs at Big Oaks in the spring of 1999 was confirmed in March 2003 (Hauersperger 2005). Three specimens collected by Daryl Karns, Joseph Robb, Erin Haswell, and Diana Schuler on 18 March 2003 have been deposited in the Field Museum of Natural History and Hanover College Herpetology Collection (Jefferson Co: FMNH 262589; Ripley Co: FMNH 262588, DRK 381). Haswell (2004) identified 23 sites at Big Oaks: 21 breeding call locations, two sight records. At least one of these sites is located in Jennings County, which encompasses the northwestern portion of the refuge. Crawfish frogs have been detected in all three counties within Big Oaks every year since their initial discovery at the refuge (J. Robb, pers. comm.). Breeding choruses at Big Oaks tend to be widely scattered and relatively small (typically < 10 individuals, often < 5).

#### DISCUSSION

With the exception of a few outlying records, Crawfish Frogs historically were known from the southwest quarter of the state, west of the unglaciated region of south-central Indiana. Their recent discovery at Big Oaks National Wildlife Refuge in southeastern Indiana suggests either that the species has a broader, long-undetected, range in the state, or that animals were introduced into the former Jefferson Proving Grounds (Haswell 2004).

Post-glacially, Crawfish Frogs may have become established in the scattered prairies that arose in the region that would become Vigo, Sullivan, Clay, Greene, Knox, and Daviess counties (Betz 1976). While this does

not provide an explanation for the existence of populations in the southern two tiers of counties where prairie was apparently not as common (Betz 1976), it is possible that grassy river valleys and unforested flood plains may have supported the species there. Populations occurring in unglaciated, forested areas near Bloomington, Indiana may have existed under similar conditions (Minton 1972). Natural disturbances such as wildfires and bison activity may have also contributed to the eastward expansion of this species into predominantly forested areas of Indiana.

Smith and Minton (1957) suggested that Crawfish Frogs are part of a group of prairie dwelling species that were already declining in numbers prior to Euro-American settlement due to natural changes in the environment. They surmise that relic populations of several western species occurring in Illinois and Indiana “provide almost irrefutable evidence of a retreating grassland fauna.” If true, it could explain the occurrence of Crawfish Frog populations in non-grassland habitats in southern Indiana.

In addition to grasslands and seasonal or semipermanent wetlands, Crawfish Frogs also seem to be at least somewhat dependent on the presence of burrowing crayfish. The answer to why Crawfish Frogs were not found in the historic prairie peninsula of northwest Indiana may be that the sandy soils of the “Kankakee Sands Section” (Homoya et al. 1985) do not support burrowing crayfish (Thoma & Armitage 2008). Another possible explanation may be related to the climatic conditions that occur in northwest Indiana. Colder winters in this part of the species’ range could be a limiting factor in restricting the northward extension of Crawfish Frogs into other parts of the Prairie Peninsula. The latitude of Indiana’s northernmost record in Benton County is similar to that of the northernmost distributional records of Crawfish Frogs in Iowa (Christiansen & Bailey 1991; Parris & Redmer 2005).

Several records occurring along the northern and eastern edge of this species’ contiguous range are at least 50 years old and have not been reconfirmed since at least 1955. These records include sites in Benton, Vermillion, Fountain, Martin, and Dubois counties. Though apparently confirmed at a relatively recent date (1987), populations in Morgan County now appear to be extirpated (INHDC;

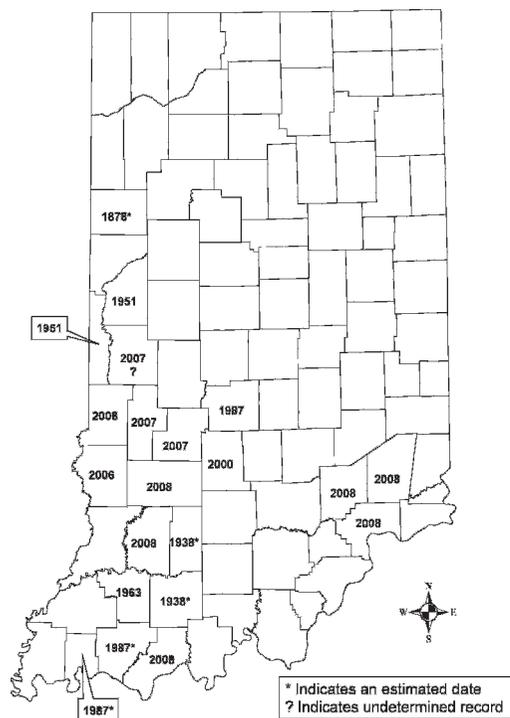


Figure 1.—Most recent records (pre-2009) for *Lithobates areolatus* in Indiana by county.

IDNR Amphibian and Reptile Technical Advisory Committee 1987).

Along the southern edge of their Indiana range, Spencer County alone is known to currently support Crawfish Frogs. All other counties in the lower two tiers of southwest Indiana either lack records, have suffered extirpations, or have not had older records ( $\geq 45$  yrs) reconfirmed. The presence of Crawfish Frogs in six Indiana counties (Benton, Fountain, Vermillion, Martin, Dubois, and Pike) has not been verified for at least 45 years (Fig. 1).

Crawfish Frogs appear to be doing well in two areas where, paradoxically, ecosystems were severely degraded in the recent past. Several records have been identified in the large reclaimed coal mine region in western Greene and eastern Sullivan Counties, many of which fall within 11 km of the Greene-Sullivan County line. A recent record for Spencer County (M.J. Lodato, pers. comm.) also occurs on what appears to be reclaimed mine land. Big Oaks National Wildlife Refuge is located at the former Jefferson Proving Grounds. Approximately twenty five million rounds of artillery were discharged there from 1941–1994, and

recovery impact fields were subject to herbicide applications, soil sterilents, and disking (K. Knouf, pers. comm.). Despite this history, Haswell (2004) identified 23 Crawfish Frog locality records from Big Oaks. At least one Greene County reclaimed coal mine site and parts of Big Oaks National Wildlife Refuge are currently being maintained as grasslands. Habitat restoration in the form of managed grasslands appears to have favored Crawfish Frogs at these sites. It is evident that once Crawfish Frogs reach these vast grassland sites (whether naturally or anthropogenically), they have the capacity to do well.

In summary, our understanding of the status and distribution of Crawfish Frogs in Indiana has changed over the past several decades. Formerly described as being “locally plentiful” (Minton 2001), declines in this species led to its inclusion on the State Endangered Species List. A lack of recent records in several counties along the northern and eastern periphery of the species’ contiguous range and the destruction of several breeding sites further south suggests that Crawfish Frogs may no longer exist in many of the areas they were previously reported to occur.

Habitat destruction resulting from human activities such as mining, suburban development, and farming have likely played a role in the extirpation of localized Crawfish Frog populations. However, the cause of the post-1970 declines noted by Minton (2001) remains unknown. Despite their Endangered status in Indiana, Crawfish Frogs continue to persist in scattered, sometimes clustered, populations in southwestern Indiana. Their discovery at Big Oaks NWR in southeast Indiana extends their range approximately 90 km east of where they were previously known to occur. The presence of this species at sites that have been restored from intense ecological destruction highlights the ability of Crawfish Frogs to colonize/recolonize areas where suitable habitat is present. This stresses the importance of protecting existing populations which can potentially serve as source populations for new colonies, and gives hope for the prospects of successful Crawfish Frog restoration in the future.

#### ACKNOWLEDGMENTS

We thank the many individuals and institutions who shared information, provided specimens, and offered locality data, including Alan

Resetar, Kathleen Kelly, and Sarah Rieboldt (Field Museum of Natural History), Tom Anton (Chicago Academy of Sciences), Greg Schneider (University of Michigan Museum of Zoology), Ricka Stoelting (California Academy of Sciences), Stephen Rogers (Carnegie Museum of Natural History), Jonathan Losos and José Rosado (Harvard University Museum of Comparative Zoology), John Whitaker (Indiana State University), Rod Williams (Purdue University), Toby Hibbits (Texas Cooperative Wildlife Collection), Daryl Karns (Hanover College), Damon Lowe and Michele Greenan (Indiana State Museum), Ron Hellmich, Sarahbeth Klueh, Michael Lodato, Vicky Meretsky, Anne Timm, Zack Walker, Scott Moody, Al Parker, Joseph Robb, Perry Williams, Cary Floyd, and Ken Knouf. Thanks to Susie Lannoo, John Whitaker, Vanessa Kinney, Jennifer Heemeyer, and Alan Resetar for reviewing earlier drafts of this manuscript and to Jim Berry, Daryl Karns, and Andrew Hoffman for reviewing a later draft of this manuscript. Special thanks to Katie Smith and the Indiana Department of Natural Resources, Division of Fish and Wildlife, Wildlife Diversity Section who supplied funding for this project (State Wildlife Grant E2-08-WDS13).

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*Manuscript received 5 January 2010, revised 29 April 2010.*