Distribution, Habitat, and Calling Season of the Illinois Chorus Frog (*Pseudacris streckeri illinoensis*) along the Lower Illinois River

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The cover photograph of a male Illinois chorus frog (*Pseudacris streckeri illinoensis*) was taken about 24.1 km (15 mi) east of Havana, Mason County, Illinois, by John C. Murphy.

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Two aspects of the biology of the Illinois chorus frog *Pseudacris streckeri illinoensis* Smith 1951 are of current interest. The first concerns its highly unusual forward burrowing behavior which involves exclusive use of the forelimbs for digging (Brown et al. 1972). Movements of the forelimbs of the frog are synchronized like the arms of a human swimmer doing the breaststroke. The vast majority of other fossorial species of salientians dig backwards with their hind feet (Emerson 1976). *Pseudacris streckeri illinoensis* has evolved a unique set of morphological adaptations that facilitate forward burrowing: thick forelimbs, enlarged tubercles on the palms of the hands, stout fingers, reduction of the intercalary cartilage of the fingers to a wafer-shaped structure, elimination of vertical offsetting of the terminal phalanx from the subterminal phalanx of the fingers by the intercalary cartilage, and absence of digital pads (Brown et al. 1972; Brown and Means 1984; Paukstis and Brown 1987). Brown (1978) demonstrated that this frog can feed while underground, and that ability helps explain the evolution of the forward burrowing. Underground feeding is not known to occur among other species of salientians. As a member of the family Hylidae, the highly fossorial *P. streckeri illinoensis* is also quite unusual because of the predominance of arborealism in the family.

The second major interest in *Pseudacris streckeri illinoensis* is its rarity. The subspecies has been reported only in isolated populations in northeastern Arkansas (Smith 1966), southeastern Missouri (Smith 1955, 1966; Johnson 1987), extreme southern Illinois in Alexander County (Holman et al. 1964; Brown and Brown 1973), southwestern Illinois in Madison and Monroe counties (Axtell and Haskell 1977; Gilbert 1986), and along the east side of the Illinois River in west-central Illinois in (prior to the initiation of this study) Morgan, Cass, Menard, Mason, and Tazewell counties (Smith 1951, 1961, 1966; Moll 1962). Paucity of specimens and extensive disturbance of habitat led to the listing of the frog as a state threatened species by the Illinois Endangered Species Protection Board (Illinois Department of Conservation 1978; Morris and Smith 1981). In addition, the U.S. Fish and Wildlife Service (Bury et al. 1980) recommended a status survey. More recently, a Notice of Review from the U.S. Fish and Wildlife Service (Dodd et al. 1985) indicated that *P. streckeri illinoensis* is a Category 2 taxon (it may qualify for listing as a federally endangered or threatened species, but further information is needed to ascertain the status and vulnerability of the taxon).

In the early 1980s the Illinois Department of Transportation became concerned that *Pseudacris streckeri illinoensis* might occur in the proposed corridors for several potential Illinois River bridge sites of the Central Illinois Expressway (FAP 408) where the corridors cross the Illinois River floodplain in Scott and Pike counties. Consequently, we conducted a field survey along the lower Illinois River, primarily in the spring of 1984. Presented here are data on the distribution, habitat, and calling season of *P. streckeri illinoensis* collected during that survey.

Methods

Because *Pseudacris streckeri illinoensis* is highly fossorial (Brown 1978), the best time to search for the frogs is when they come to the surface to breed in the spring. Males can begin calling in the spring soon after daytime temperatures are above freezing, and they sometimes call even when patches of snow remain on the ground (L.E. Brown, personal observations). In this study, field trips were initiated when weather conditions seemed favorable in the third week of February and continued until after the breeding season terminated in May. During the main part of the breeding season, field trips were usually taken every 2–4 days. Fieldwork was carried out on 25 nights in the spring of 1984: 17, 23, 25 February; 2, 5, 16, 18, 20, 22, 24, 26, 28, 30 March; 1, 3, 5, 7, 10, 12, 15, 17, 19, 23, 30 April; and 9 May. Thus the complete breeding season of the frog was covered and all choruses in the study area were presumably found. Two field trips had previously been taken to the area in 1983 (9 and 11 May), and two were subsequently taken in 1985 (14 and 19 March).

Listening for the easily detected, species-specific mating call of the male (Blair 1958a; Blair and Littlejohn 1960; Littlejohn and Michaud 1959) provided

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the means for locating *Pseudacris streckeri illinoensis*. The mating call is a short whistle that is repeated relatively rapidly (Figure 1), and it could be detected from a distance of at least 2.1 km (1.3 mi) when the wind was not blowing strongly (Brown 1984). We established listening stations at or within hearing range of bodies of water that could serve as potential chorusing sites on the floodplain of the Illinois River in Scott, Morgan, Greene, eastern Pike, and southern Cass counties. Over the course of the study, 748 stops (not including stops for triangulation) were made at 109 listening stations. A mean of 25.8 stations was visited per evening in the field (range = 9–51 stations). Because of time constraints, not all stations were visited in a given evening. After the locations of choruses were pinpointed, the sites were revisited during daylight hours to examine the habitat.

Results

Distribution

Historical background. Alfred C. Weed, former Curator of Ichthyology at the Field Museum of Natural History in Chicago, collected the first *Pseudacris streckeri illinoensis* in Illinois in September 1922 from the bottom of the hatchery well at the Meredosia Fish Hatchery in Morgan County in the northern part of our study area (Weed 1923). As no hatchery is shown on the 1928 Meredosia quadrangle map (U.S. Geological Survey), we tried to determine its location by contacting fisheries personnel. Maurice A. Whitacre, former State Fish Culturist with the Illinois Department of Conservation, collected information on the history of the state hatchery system shortly before his retirement, and in his opinion no official state-owned hatchery ever existed at Meredosia. He explained the misnomer as follows.

During the late 1800s and early 1900s, the levee system along the Illinois River was apparently incomplete, and periodic flooding carried fishes far out onto the floodplain. When the water level receded, these fishes were stranded in smaller bodies of water. Through a state rescue program these fishes were collected and relocated to various lakes or ponds for temporary holding. Later these fishes were returned to the Illinois River or distributed to cities, owners of private ponds, sportsmen's clubs, or other organizations throughout the state. After a number of years, the ponds and lakes used for temporary holding were referred to locally as "fish hatcheries."

The Meredosia area was mentioned as a site of fish rescue operations in several adminstrative reports of the state (e.g., Fairbank et al. 1891; Roe and Schmidt 1897; Stratton and Roach 1925; Stratton and Abbey 1928). The 1926–1927 administrative report of the Illinois Department of Conservation (Stratton and Abbey 1928, p. 140) referred to a fish rescue station at Meredosia Bay (Meredosia Lake) north of Meredosia. These references and Whitacre's information suggest that this site may have been where Weed collected

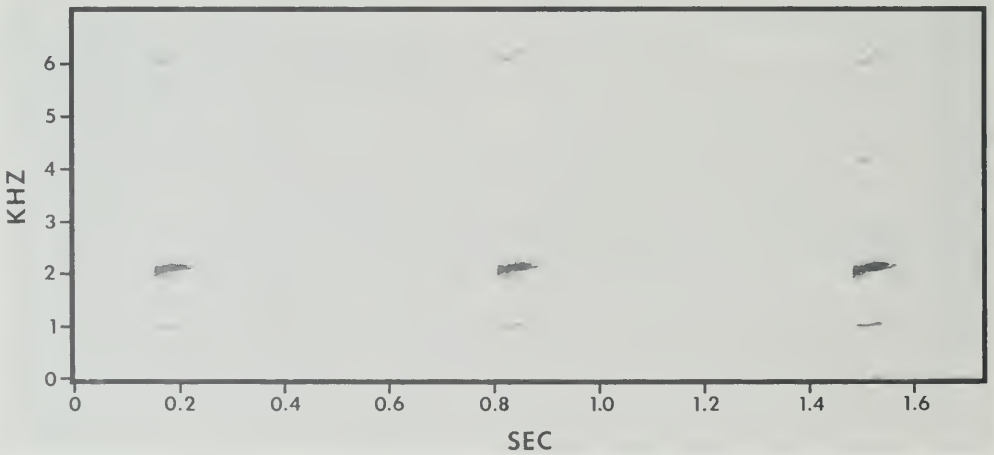

FIGURE 1. Audiospectrogram (narrow band) of three mating calls of a male Illinois chorus frog (*Pseudacris streckeri illinoensis*) recorded by L.E. Brown on 7 April 1970 in a ditch on the north side of the Saidora–Snicarte Road 2.9 km (1.8 mi) west of its junction with Illinois State Route 78, Section 11, Lynchburg Township, Mason County, Illinois. Frequency (in kilohertz) is along the vertical axis; time (in seconds) is along the horizontal axis. Cloacal temperature = 11.6°C; air temperature = 11.6°C; water temperature = 11.8°C (the male was calling in the water). Snout-vent length = 41 mm (measured alive). Photograph by Gerald B. Liebenstein.

Pseudacris streckeri illinoensis. We suspect that the center of operations for the rescue station was located on the southern end of the lake on the east side because the 1928 Meredosia quadrangle map shows a number of buildings in that area.

Weed (1923) noted that the specimen he collected (Figure 2) had a "short, thick body," and he referred it to the species *Pseudacris feriarum* (upland chorus frog). He also stated that it corresponded well with Cope's (1889) first color description for *Chorophilus feriarum brachyphonus* from near the Kiskiminitas River in western Pennsylvania. Walker (1932) examined Weed's specimen during the course of research in Ohio that recognized the mountain chorus frog *Pseudacris brachyphona* as a valid species. Walker stated that the specimen was not *brachyphona*, but he did not identify Weed's specimen to species, possibly because no name was available for the specimen at that time. The following year (1933), Wright and Wright described *Pseudacris streckeri* (Strecker's chorus frog) as a new species from the southern United States. Walker then recognized that Weed's specimen was *P. streckeri*, and he later encouraged Philip W. Smith (late former Head of the Section of Faunistic Surveys and Insect Identification at the Illinois Natural History Survey) to investigate the Meredosia area (Smith 1951).

Weed's specimen (FMNH 3266) was examined by Smith (and later by L.E. Brown in the early 1970s and again in 1985). The specimen is a small (snout-vent length = 28 mm, measured by L.E. Brown in 1985), sexually immature subadult that was emaciated when originally preserved (Figure 2). Because of its size and condition, it is superficially more similar in appearance to *Pseudacris brachyphona* and *P. triseriata feriarum*

FIGURE 2. Preserved specimens of Illinois chorus frogs (*Pseudacris streckeri illinoensis*) representing the older distributional records from Morgan County in the northern part of the study area. On the left, the first specimen collected in Illinois, FMNH 3266 (paratype; sexually immature; snout-vent length = 28 mm, measured in 1985). This specimen was collected in 1922 at the Meredosia Fish Hatchery, Meredosia, Illinois, by A.C. Weed. On the right, INHS 5982 (holotype; male; snout-vent length = 39 mm, measured in 1985), collected "three miles north of Meredosia" in 1950 by students in a herpetology class from the University of Illinois. Photograph by Gerald B. Liebenstein.

than are more normal appearing *Pseudacris streckeri illinoensis*. However, Weed's specimen is definitely *P. streckeri illinoensis*.

Smith's fieldwork with colleagues and students led to his subspecies description of *Pseudacris streckeri illinoensis* in 1951. The holotype (INHS 5982, Figure 2) was collected in 1950 on a highway "three miles north of Meredosia, Morgan County," by students in a herpetology class from the University of Illinois (Smith 1951). That mileage designation would place the type locality north of Morgan County in Meredosia Lake or on Meredosia Island in southwestern Cass County. However, only an unimproved roadway on Meredosia Island, mostly in Cass County, is present in that remote area. Further details on the type locality were not provided by the students (P. Smith, personal communication). The only road in the general area of the type locality that can be considered a highway is U.S. Route 67/Illinois State Route 100, which runs through the area in a north–south direction and is 3.7 km (2.3 mi) by quadrangle map east of Meredosia. Thus, the holotype may well have been collected on that highway northeast of Meredosia. (Several choruses were found near that area during our study.)

New records. We found 36 new locations of choruses of *Pseudacris streckeri illinoensis* on the floodplain on the east side of the Illinois River in Scott, Morgan, and extreme southern Cass counties (Figure 3). Locations 1 and 2 are in Cass County, 3–9 in Morgan County, and 10–36 in Scott County. Specific locations are as follows:

1. SW ¼, SW ¼, Sec. 36, T17N, R13W
2. SW ¼, SE ¼, Sec. 36, T17N, R13W
3. NW ¼, NW ¼, Sec. 6, T16N, R12W
4. S ½, NE ¼, Sec. 11, & SE ¼, Sec. 11, T16N, R13W
5. NW ¼, SW ¼, Sec. 27, T16N, R13W
6. NW ¼, SW ¼, Sec. 26, T16N, R13W
7. SW ¼, SE ¼, Sec. 25, T16N, R13W
8. NE ¼, SW ¼, Sec. 36, T16N, R13W
9. SW ¼, & SE ¼, SE ¼, Sec. 34, T16N, R13W
10. NW ¼, Sec. 6 (1,890 m [6,200 ft] north of south line of Sec. 6, and 838 m [2,750 ft] west of east line of Sec. 6; this is an irregular section), T15N, R13W
11. SW ¼, NW ¼, Sec. 4 (914 and 1,181 m [3,000 and 3,875 ft] north of south line of Sec. 4, and 30 m [100 ft] east of west line of Sec. 4; this is an irregular section), T15N, R13W
12. SE ¼, NW ¼, Sec. 6, & NW ¼, SE ¼, Sec. 6 (869 m [2,850 ft] north of south line of Sec. 6 and 823 m [2,700 ft] west of east line of Sec. 6; and 762 m [2,500 ft] north of south line of Sec. 6 and 686 m [2,250 ft] west of east line of Sec. 6; this is an irregular section), T15N, R13W
13. SW ¼, NW ¼, Sec. 7, T15N, R13W
14. SW ¼, NW ¼, Sec. 8, T15N, R13W
15. NE ¼, NW ¼, Sec. 13, T15N, R14W
16. SW ¼, NE ¼, Sec. 24, T15N, R14W
17. SE ¼, SE ¼, Sec. 24, & SW ¼, SE ¼, Sec. 24, T15N, R14W
18. SE ¼, SE ¼, Sec. 24, T15N, R14W
19. SE ¼, NW ¼, Sec. 30, T15N, R13W
20. SE ¼, SE ¼, Sec. 25, T15N, R14W
21. SW ¼, NW ¼, Sec. 31, T15N, R13W
22. SE ¼, NE ¼, Sec. 31, T15N, R13W
23. NE ¼, SW ¼, Sec. 31, & SE ¼, NW ¼, Sec. 31, T15N, R13W
24. SE ¼, NE ¼, Sec. 1, & NE ¼, SE ¼, Sec. 1, T14N, R14W
25. SE ¼, SE ¼, Sec. 1, T14N, R14W
26. E ½, SW ¼, Sec. 8, & W ½, SE ¼, Sec. 8, T14N, R13W
27. SW ¼, NE ¼, Sec. 19, T14N, R13W
28. SE ¼, NW ¼, Sec. 21, T14N, R13W
29. NW ¼, NW ¼, Sec. 27, T14N, R13W
30. NW ¼, SW ¼, Sec. 29, T14N, R13W
31. NE ¼, SW ¼, Sec. 27, T14N, R13W
32. SW ¼, SW ¼, Sec. 26, T15N, R14W
33. NE ¼, NE ¼, Sec. 3, T13N, R13W
34. NW ¼, SE ¼, Sec. 15, T13N, R13W
35. SE ¼, SE ¼, Sec. 15, T13N, R13W
36. NW ¼, NW ¼, Sec. 7, T14N, R13W

We did not find *Pseudacris streckeri illinoensis* in the Pike County portion of our study area (on the floodplain west of the Illinois River from Valley City to Florence) even though we surveyed that area frequently. The limited habitat available there is quite disturbed (see **Environmental disruption**).

We made several field trips to the southern part of our study area (southern Scott County and Greene County) where sand is much less common. On 10 and 12 April 1984, we surveyed the floodplain, stopping to listen every 0.8 km (0.5 mi) along the Hillview Blacktop between the southernmost locality record in southern Scott County (Figure 3) and Bucks Branch in northern Greene County, but we heard no *Pseudacris streckeri illinoensis*. On 17 April 1984, we visited three locations further south in Greene County on the floodplain in Section 32, T11N, R13W, in Section 17, T10N, R13W, and in sections 29 and 32, T10N, R13W, all in Bluffdale Township. These areas are designated as having sandpits on the 1980 Kampsville quadrangle map (U.S. Geological Survey). No *P. streckeri illinoensis* were heard, but the peak of the calling season had passed. In the following year on 14 and 19 March 1985, we returned to our study area in Scott and Greene counties. *Pseudacris streckeri illinoensis* were calling vigorously at several localities in Scott County. When we went south of Scott County on 19 March 1985, however, and visited an area in Section 31, T12N, R13W, in Patterson Township, Greene County (a pond and flooded ditch in an area desig-

nated as a low-level sand terrace on Plate 7 of Willman 1973), we heard no *P. streckeri illinoensis*.

When our study was nearing completion, Moehn (1984) reported the first locality for *Pseudacris streckeri illinoensis* from Scott County: "2.8 km S intersection of US Hwy 54 and Hillview Blacktop." Loren D. Moehn (personal communication) clarified this location; it occurs near one of the choruses we found 2.5 km (by map) south of the intersection of U.S. Route 36 and the Hillview Blacktop (Figure 3). (The highway perpendicular to the Hillview Blacktop in Scott County was formerly known as U.S. routes 54 and 36 but is now designated only as U.S. Route 36.)

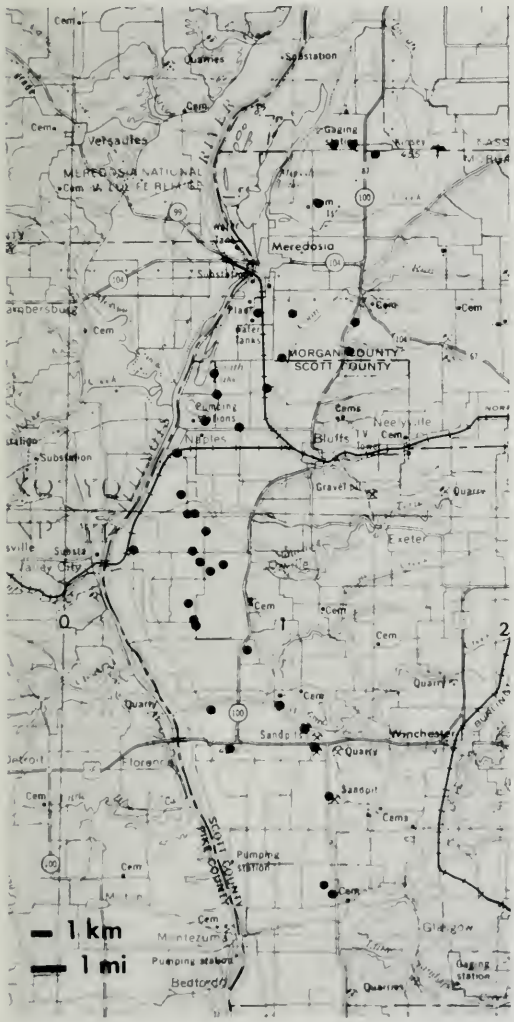

FIGURE 3. New distributional records (larger closed circles) for the Illinois chorus frog (*Pseudacris streckeri illinoensis*) on the floodplain of the Illinois River in Cass, Morgan, and Scott counties, Illinois. Prepared from a portion of a U.S. Geological Survey map (Quincy NJ 15–3; 1956, revised 1980). Photograph by Gerald B. Liebenstein.

Habitat

Availability of sand as a substrate. Brown et al. (1972) demonstrated through discrimination experiments that *Pseudacris streckeri illinoensis* had a highly significant choice of sand for burrowing rather than black prairie sod. Sod was chosen in only 3 of 50 trials, and in those three instances the frogs were unable to burrow because of their unusual method of digging; consequently, they remained on the surface. Smith (1966), Brown and Brown (1973), and Axtell and Haskell (1977) also found that *P. streckeri illinoensis* is restricted to areas in the Midwest that have sand substrates. In Mason County to the north of our study area, sand and sandy soils predominate. Our study area, however, is a mosaic of sand and sandy soils along with soils that have a higher content of clay, silt, and/or organic material.

Origin of sand areas in the study area. The areas of sand in our study area are Pleistocene alluvial sands deposited by glacial meltwater about 14,000 years ago (Cote et al. 1970). The sand ridges are a series of remnants of eroded sandbars of the Bath Terrace (Cote et al. 1970; Willman and Frye 1970). The Illinois Valley was a major meltwater channel during the Pleistocene. When the Wisconsinan glacier was standing behind the Valparaiso Moraine about 14,000 years ago, large quantities of ponded meltwater poured down the Illinois Valley in a great flood. In the vicinity of the study area, the valley filled to the level of the Bath Terrace with eroded sand and gravel from upstream. Subsequently the river deepened its channel, cut away part of the fill, and formed the Bath Terrace. Later overflow (about 10,000 years ago) further eroded the valley to as much as 15.2 m (50 ft) below the present level. During the past 7,000 years the river has deposited sediment, thereby filling the valley to its present level (Cote et al. 1970).

Calling sites in relation to Pleistocene deposits. Thirty-three of the 36 calling sites identified in this study were on or near (within 800 m, usually much less) terrace deposits of the Mackinaw Member (A. Goodfield, personal communication) of the Henry Formation (Willman 1973). Four of these 33 sites were clearly located on Henry Formation deposits; the remaining 29 were either on Henry Formation deposits or on nearby Cahokia Alluvium. Only 3 calling sites that were located on Cahokia Alluvium were more than 800 m from Henry Formation deposits. The Henry Formation is composed mostly of sand and gravel, and "south of Peoria the low-terrace rem-

nants are largely pebbly sand" (Willman 1973). Cahokia Alluvium, on the other hand, is predominantly "poorly sorted sandy or clayey silt," although it occasionally "contains lenses of silty sand" (Willman 1973). The use of sand lenses by *Pseudacris streckeri illinoensis* has been documented by Axtell and Haskell (1977), who reported finding three *P. streckeri illinoensis* in "lenticular sand deposits (ca. three meters wide by 20 m long)."

Calling sites in relation to soil type. Table 1 lists the soils present (based on preliminary soil maps from the U.S. Soil Conservation Service) at each of the 36 calling sites. Ten of the sites were located on soils described by the U.S. Soil Conservation Service as "sand" (which includes "loamy sand"), and another 9 were on soils described as "sandy loam." The remaining 17 were on nonsandy soils described as loam, silt loam, silty clay loam, clay loam, or silty clay. All but 7 of the 36 calling sites, however, were within 200 m of sand, but only 3 of these 7 were more than 200 m from sandy soil.

Aquatic characterization of calling sites. *Pseudacris streckeri illinoensis* called at several types of aquatic sites. The most common (27 of 36 choruses, 75.0%) were flooded depressions in fields. These sites varied and were further characterized by one or more of the following: small marshlike area, cattle or hog pasture, tilled field, waterway (lentic), flooded drainage ditch (lentic) in a field, roadside ditch (lentic) flooded into a field, and pond flooded into a field. Other aquatic calling habitats included: ditches (lentic) beside or near roads (4 choruses, 11.1%); pits resulting from sand mining (2 choruses, 5.6%); permanent pond (1 chorus, 2.8%); pool created by excavations to build a levee (1 chorus, 2.8%); and retaining basin for a chemical or water storage tank (1 chorus, 2.8%). All sites except for the two ponds were probably ephemeral, and all sites were lentic. These types of calling sites were not unique for *P. streckeri illinoensis* as other local species of salientians also used these habitats. Flooded depressions in fields were probably the most prevalent type of suitable calling habitat present, and their greater use by *P. streckeri illinoensis* probably reflected availability rather than preference over other types of calling habitats utilized.

No mating calls were heard at sites with lotic environments such as ditches with moving water, creeks, and larger rivers including the Illinois River. Nor did we hear *Pseudacris streckeri illinoensis* at larger floodplain lakes.

Environmental disruption. A number of habitat disruptions were found in our study area, and these may have a negative effect on populations of *Pseudacris streckeri illinoensis*. The most conspicuous environmental modification is intensive agriculture. Tilling the soil, moving heavy equipment over the land, compaction of soil, and applying agricultural chemicals (insecticides, herbicides, and anhydrous ammonia and other fertilizers) could be detrimental. However, *P. streckeri illinoensis* is probably fossorial throughout much of the year, and its breeding period frequently occurs before many agricultural activities are initiated in the spring. The presence of many choruses in fields also suggests that *P. streckeri illinoensis* tolerates agriculture or that agricultural practices do not conflict temporally with its activities. The commonly used herbicide Atrazine has been shown to be lethal to frog eggs in England (Hazelwood 1970). Runoff of herbicides into aquatic breeding sites may thus represent a potential threat to *P. streckeri illinoensis*.

Thousands of hogs are raised on the sandy areas in our study area. Their manure pollutes both soil and water, and their activities denude the soil of vegetation (Figure 4). It is also likely that *Pseudacris streckeri illinoensis* are eaten when uncovered by rooting hogs.

The construction of levees along the Illinois River and associated factors (fast movement of water, prolonged inundation in the spring, extensive wave production by the many barges, floating debris, water pollution) provide an environment along the base of the bluffs in Pike County that does not seem conducive to breeding or habitation by *Pseudacris streckeri illinoensis*. The floodplain of the Illinois River has also been considerably altered in other ways by the presence of many levees and drainage ditches (Bellrose et al. 1983; Brown and Moll 1979; Parmalee and Loomis 1969). Wetlands have been drained for agricultural purposes and other areas that were probably only seasonally inundated are now permanently flooded lakes. The consequence of these habitat modifications for *P. streckeri illinoensis* is unclear, but they may not have had a long-term detrimental effect.

Pseudacris streckeri illinoensis could be killed by vehicles on the roads in our study area. However, except for major highways, vehicular traffic is rather light. We never encountered specimens on roads in the many hours we spent in the field during this study. However, the holotype was collected on a highway (Smith 1951), and other specimens have been seen on a road in Missouri (Smith 1955). Furthermore, G. Paukstis (personal communication) encountered road-killed *P. streckeri illinoensis* in Illinois. The construction of highways often results in ditches and depressions that accumulate water and these can serve as breeding sites. In 1972 a vigorous chorus of *P. streckeri illinoensis* was encountered in a water-filled depression within the cloverleaf of the intersection of U.S. Highway 62 and Interstate Highway 55 just east of Sikeston, Missouri (L.E. Brown, personal observation). On the other side of I-55, choruses were found in three years in a marshy depression not far from the highway. Both breeding sites may have been created by the construction of the bridge and access roads at the intersection. On the negative side, however, vehicular

traffic releases heavy metals and other toxins into the environment, and these could contaminate breeding sites adjacent to highways.

The physical process of mining sand (Figures 5 and 6) could kill *Pseudacris streckeri illinoensis* and alter breeding sites. Three choruses in our study occurred on or adjacent to sand ridges where sand had been mined in the past. One chorus was located on top of a sand ridge and the site was quite disturbed (Figure 5). Considerable rubbish had been dumped in the area and gravel had been hauled in to stabilize the sand for the movement of heavy vehicles. Extensive sand mining produced numerous pits that partially filled with water and were used as calling sites. It might be pre-

TABLE 1. Distance from each chorus location of Illinois chorus frogs (*Pseudacris streckeri illinoensis*) to nearest sand and nearest other sandy soil. Soil types are given for the location of each chorus, for nearest sand, and for nearest other sandy soil. Data extracted from preliminary soil maps of the U.S. Soil Conservation Service.

Chorus identification number	Soil type(s) at location of chorus[b]	Nearest sand (S) or nearest other sandy soil (SS)		Nearest sand[a]	
		Distance (m)	Soil type(s)[b]	Distance (m)	Soil type(s)[b]
1	7302	75(S)	54B	–	–
2	206	50(S)	54B	–	–
3	200	0(SS)	200	100	49, 88B
4	302	50(S)	88B	–	–
5	54B	0(S)	54B	–	–
6	682A	150(SS)	172A	450	⁙
7	81	25(S)	54B, 54D	–	–
8	81	25(S)	54D	–	–
9	70, 302	50(S)	88B	–	–
10	682A	25(SS)	87	125	54B
11	180, 302	25, 100(S)[c]	88B	–	–
12	87	0(SS)	87	100, 150[c]	588
13	49, 302	0(S)	49	–	–
14	172A, 200	0(SS)	172A, 200	75, 125[c]	49
15	87, 302	0(SS)	87	500	88B
16	200	0(SS)	200	50	54D
17	54B	0(S)	54B	–	–
18	54B	0(S)	54B	–	–
19	26	25(S)	54D	–	–
20	26, 682A	50(SS)	172A	100	88B
21	49	0(S)	49	–	–
22	200	0(SS)	200	150	54B
23	49, 682A	0(S)	49	–	–
24	7070	425(SS)	200	1600	54B
25	26	100(SS)	200	800	54B
26	26, 71, 180, 200	0(S)	54B, 88B, 200	–	–
27	71	250(S)	588	–	–
28	54D	0(S)	54D	–	–
29	862	0(S)	862	–	–
30	71, 302	50(SS)	172A	100	49
31	54B	0(S)	54B	–	–
32	150B, 302	0(SS)	150B	100	54B
33	49	0(S)	49	–	–
34	7070	275(S)	54B	–	–
35	26	75(S)	54D	–	–
36	200	0(SS)	200	600	54B

[a]When sandy soil was nearer than sand to a given chorus, the nearest sand is listed in these columns.

[b]Soil types are indicated as follows.

Sands:
49 Watseka loamy sand
54B Plainfield loamy sand, 2–7% slopes
54D Plainfield loamy sand, 7–15% slopes
88B Sparta loamy sand, 1–6% slopes
588 Sparta loamy sand, loamy substratum
862 Sandpit
⁙ Sand spot

Other sandy soils:
87 Dickinson sandy loam
150B Onarga fine sandy loam, 2–5% slopes
172A Hoopeston sandy loam, 0–3% slopes
200 Orio sandy loam

Other soils:
26 Wagner silt loam
70 Beaucoup silty clay loam
71 Darwin silty clay
81 Littleton silt loam
180 Dupo silt loam
206 Thorp silt loam
302 Ambraw clay loam
682A Medway loam, 0–3% slopes
7070 Beaucoup silty clay loam, frequently flooded
7302 Ambraw loam or silty clay loam, rarely flooded

[c]The three choruses for which two distances are given are choruses that were divided into two parts, the centers of the two parts being as much as 280 m apart. Two of these choruses were divided by Coon Run Creek.

FIGURE 4. Habitat modification due to hog raising on a sand ridge in Scott County, Illinois. Note that the hog pen is denuded of vegetation. The dead trees in the area adjacent to the pen were probably killed earlier by hogs. The fertile, level land (with more clay, silt, and/or organic matter) in the foreground is planted in corn. Illinois chorus frogs (*Pseudacris streckeri illinoensis*) were heard calling in the springs of 1984 and 1985 not far from this site. Photograph taken on 30 August 1985 by Kevin J. Tarrant.

FIGURE 5. Habitat modification due to sand mining on a sand ridge in Scott County, Illinois. Mining has apparently been carried out periodically for a number of years at this site. Illinois chorus frogs (*Pseudacris streckeri illinoensis*) were heard calling in ephemeral pools at this site in 1984. Photograph taken on 30 August 1985 (rain had occurred the previous day) by Kevin J. Tarrant.

sumed that because sand mining provided additional breeding sites, it promotes conservation of *P. streckeri illinoensis*. However, a number of the sandpits were dried up in the spring of 1984 before fieldwork in that year was concluded, and any tadpoles of *P. streckeri illinoensis* present may have died before they had a chance to metamorphose. We first heard calling males at this site on 28 March 1984, but a number of the pits had dried up by 19 April 1984. Taubert et al. (not dated) estimated that 35–50 days are required for development of a tadpole from egg to metamorphosed juvenile, and thus the sandpit breeding pools may not retain water long enough for tadpoles to metamorphose. Although the ecological characteristics of an adequate breeding site for *P. streckeri illinoensis* are unclear, aquatic sites over soil with a high content of clay, silt, and/or organic material may be better because surface water would be retained longer.

Another chorus also is of particular interest. The sand ridge associated with it has been mined since at least 1980 (the site is marked by a symbol for a gravel, sand, clay, or borrow pit and the word "sandpit" on the 1980 Bedford quadrangle map), and the recreational use of ATVs has also disturbed the ridge. On 1 May 1983 Loren D. Moehn found a chorus of approximately ten males calling on top of the ridge (Moehn 1984; Moehn, personal communication). Later in 1983 the aquatic site on the sand ridge was destroyed by sand mining (Moehn, personal communication). On 28 March 1984 we stopped at the site. *Pseudacris streckeri illinoensis* were not calling on the sand ridge, but a chorus of approximately 25 males was found in a wide, flooded ditch between the sand ridge and the nearby Hillview Blacktop (third-most southerly locality in Figure 3). The following spring, on 14 and 19 March 1985, we revisited the area and estimated that 25 and 10 males, respectively, were calling in the same ditch. The soil at the new site has considerably more clay, silt, and/or organic matter and hence a greater capacity to retain surface water. The proximity of the site to the road, however, subjects dispersing, newly metamorphosed *P. streckeri illinoensis* to danger from vehicular traffic.

Other types of habitat modification that may threaten *Pseudacris streckeri illinoensis* in our study area include trash dumps, a junkyard, development adjacent to towns, burning of vegetation around calling sites, development of chemical storage facilities, and bulldozing to remove trees and improve drainage.

In spite of actual and potential environmental threats to *Pseudacris streckeri illinoensis*, considerable habitat for the animal remains in our study area. Much of the land on the sand ridges and other sandy areas is wooded and not too disturbed. These areas probably can provide suitable habitat for the frog.

FIGURE 6. Sand mining initiated in 1985 on a sand ridge in Scott County, Illinois. Note tracks of ATVs on the slope to the right of and in front of the end loader. Illinois chorus frogs (*Pseudacris streckeri illinoensis*) were heard calling adjacent to this site in the springs of 1984 and 1985. Photograph taken on 30 August 1985 by Kevin J. Tarrant.

Calling Season

On 22 March 1984, when patches of snow were still evident on the sides of drainage ditches, we heard the first *Pseudacris streckeri illinoensis* calling in the northern part of the study area just north of the Cass/Morgan county line. Calling was intermittent and only two or three males were vocalizing at this site. *Pseudacris streckeri illinoensis* were heard nowhere else in the study area. Heavy rain fell during the evening of 24 March 1984 and calling was more extensive at several locations in the study area. The last calling was heard on 23 April 1984 at several localities in Scott County. Calling may have continued for a few days after 23 April when we were not in the field, but by 30 April and 9 May 1984 (our next nights in the field) calling had ceased. Thus, the calling season was at least 33 days in length.

Pseudacris streckeri illinoensis were vocalizing on each of the 15 nights we were in the field during the calling season, but the number of males calling in each chorus varied from night to night and not every chorus was active every night. However, males were heard in two of the larger choruses in Scott County almost every night we were in the field during the calling season. The peak period of calling activity seemed to be 1–5 April 1984. During that period, males also vocalized during daylight hours—a phenomenon not noted earlier or later in the calling season. As the end of the calling season approached, fewer calling males seemed to be present and breeding may have diminished.

Discussion

Our study uncovered far more new localities for *Pseudacris streckeri illinoensis* than have been reported in any previous publication. Indeed, the 36 choruses we found represent a greater number of populations than the total number heretofore known to be extant. The most comprehensive previous distributional study (Taubert et al. not dated) found 18 new localities and a total of 25 extant populations.

Taubert et al. (not dated) found the older historical populations reported for Morgan, Cass, and Menard counties to be inactive in 1981. Therefore, no active localities were known to exist in 1981 along the Illinois River south of Mason County. Our new records, however, firmly establish the presence of *Pseudacris streckeri illinoensis* in Scott, Morgan, and Cass counties. Our findings do not necessarily mean that *P. streckeri illinoensis* has undergone a recent population explosion or range expansion. Rather, we feel that the populations we found have been in existence for some time and went undiscovered because the area is remote and was previously little explored for frogs.

The zoogeographic history of *Pseudacris streckeri* has received comment in various papers. Blair (1958b, 1965) presented an argument that southward advances of glaciers during the Pleistocene forced the withdrawal of numerous species into refuges in Mexico and Florida. In various cases the subsequent isolation and differentiation of these disjuncts resulted in speciation (Blair 1965). The species pair *P. streckeri* (of the southwestern United States) and the ornate chorus frog *Pseudacris ornata* (of the southeastern United States) probably originated in that manner (Blair 1958b, 1965). This speciational event was considered to have been initiated prior to the Wisconsinan glaciation (Blair 1965).

The present occurrence of *Pseudacris streckeri* in west-central Illinois was thought by Blair (1965) to be the result of a post-Wisconsinan northeastward dispersal from the main portion of the range of the species in the southwestern United States. Smith (1957) suggested that *P. streckeri* was one of several species adapted to the grasslands of the Great Plains that later dispersed eastward into the Prairie Peninsula of Illinois during the Xerothermic period (6,000 to 4,000 years ago). He envisioned that after the wane of the Xerothermic and the return of a cooler, moister climate, *P. streckeri* was eliminated throughout most of the Prairie Peninsula except for such favorable refugia as sand prairies.

The discovery of the close association of *Pseudacris streckeri illinoensis* with sand substrates and the frequent occurrence of the frog on floodplain-like topography led Axtell and Haskell (1977) to suggest a refinement of Smith's (1957) Xerothermic hypothesis. They favored a more southern dispersal avenue for *P. streckeri* across Arkansas along the Arkansas River floodway and up the Mississippi River floodplain to central Illinois. Isolated distributional records for the species in Arkansas and Louisiana uncovered by Axtell and Haskell (1977), Turnipseed and Shepherd (1985), and Fesperman (1986) support a more southern dispersal route.

The timing of these events is, of course, not known with certainty. However, we feel that the optimal period for the initial dispersal of the frog through our study area along the valley of the lower Illinois River was from 8,000 to 5,000 years ago. Two geological phenomena were favorable for colonization at that time. First, the last overflow of glacial meltwater down the Illinois River valley occurred 10,000 years ago, and the floor of the valley was as much as 15.2 m (50 ft) below the present level of the floodplain (Cote et al. 1970). Second, the deposition of sediments into the valley of the Illinois River began 7,000 years ago (Cote et al. 1970). Consequently, more extensive remnants of the eroded sand terraces would have been evident on the surface of the floodplain. Additionally, nonsandy areas would have been smaller and distances between sand remnants would have been shorter. Thus, *Pseudacris streckeri* could have dispersed

through the valley of the lower Illinois River with less hindrance 8,000 to 5,000 years ago than in earlier or later times.

The ability of *Pseudacris streckeri illinoensis* to cross nonsandy areas is problematic. In regions with extensive sand deposits (e.g., in Mason County), the dispersal of the frog may be relatively unhindered. However, in some other regions (e.g., Scott County), nonsandy soils occur between many populations of *P. streckeri illinoensis* on sandy areas. Also, in the southern part of our study area (Greene County) only minimal sand is present. Thus, the interesting question arises as to how the frog disperses from one sand area to another when the intervening nonsandy regions are of suboptimal or perhaps even inhospitable habitat. Fossorialism imposes low vagility and thus dictates a further hindrance to dispersal. *Pseudacris streckeri illinoensis* has rarely been found on the surface of the ground outside of the calling season (Smith 1966; Brown 1978). During the spring calling season when adult frogs are on the surface, dispersal is possible. However, mature frogs may be less inclined to leave established home ranges, and the animals may recognize nearby sand more readily. Dispersal is also possible soon after metamorphosis. Young frogs would not yet have established home ranges, and their experience with sand would be limited or nonexistent. Thus, they would be more likely to move randomly from their aquatic habitat to previously unoccupied areas. Brown and Means (1984) found that recently metamorphosed *Pseudacris ornata* (also a forelimb burrower) in southern Georgia dispersed at least as far as 370 m and possibly as far as 480 m from the breeding pond where they originated. The location of many of the breeding sites of *P. streckeri illinoensis* on nonsandy substrates adjacent to sand ridges (as seen in Scott County) may well promote dispersal because random movement of newly metamorphosed frogs away from such sites might enhance the colonization of other more distant isolated sand areas. Thus, even though *P. streckeri illinoensis* is probably fossorial (and of low vagility) throughout much of its life, there are two periods in the year (during the calling season and, especially, after metamorphosis) when dispersal is quite possible.

In the southwestern United States the potential period of breeding for Strecker's chorus frog *Pseudacris streckeri streckeri* is relatively long. Blair (1961) found males calling as early as 22 October and Wright and Wright (1949) reported breeding in late May. Blair (1961) concluded that rain stimulated the activity of this primarily winter breeder and temperature was important in determining calling periods.

In the Midwest, the potential period of breeding of *Pseudacris streckeri illinoensis* occurs in the spring and is considerably shorter than that of its southwestern relative. The typical breeding period in central Illinois along the Illinois River may be during the month of March (Smith 1961). However, the calling season we observed in 1984 took place from 22 March through 23 April. Standing water was available for breeding and some rainfall did occur as early as 17 February 1984. Conditions seemed appropriate for calling, and on 23 February 1984 we heard two small choruses of striped chorus frogs *Pseudacris triseriata* (which at other times frequently called with *P. streckeri illinoensis*). Intermittent snow storms, sleet, and cold weather, however, occurred in late February and in the first half of March. Thus, periodic inhospitable weather probably delayed the calling season in 1984.

Clearly, *Pseudacris streckeri illinoensis* was commonly encountered in our study area. We did not, however, carry out mark and recapture studies to estimate population sizes because the time required (probably at least 2–4 hours each night at each location) would not have permitted adequate sampling of other listening stations. Further, it would have been impossible to satisfy the restrictive conditions of Poole (1974) that must be fulfilled to assure the validity of statistical estimates of population size (see Brown and Moll 1979). We did, however, estimate chorus sizes by listening to the numbers of males calling. In small choruses (fewer than seven males) our estimates were probably quite accurate; in larger choruses our estimates were less precise. In 1984, half of the choruses (n = 18; 50.0%) were estimated to have a maximum of 1–10 calling males. Eleven choruses (30.6%) were estimated to have a maximum of 11–20 males; 3 choruses (8.3%), a maximum of 21–30 males; 2 choruses (5.6%), a maximum of 31–40 males; 1 chorus (2.8%), probably about 50 males; and 1 chorus (2.8%), possibly around 100 males. However, the number of males calling in the choruses varied on different nights. Nonetheless, the numbers of calling males in many choruses were relatively small. Additional field surveys in southeastern Missouri, northeastern Arkansas, along the Mississippi River, and further south along the Illinois River would help for the determination of whether or not *P. streckeri illinoensis* should be listed as a federally threatened or endangered species.

Summary

Thirty-six new distributional records are reported for the Illinois chorus frog *Pseudacris streckeri illinoensis*, a species listed as threatened by the Illinois Endangered Species Protection Board. These records were collected on the floodplain of the Illinois River in Morgan, Scott, and southern Cass counties, Illinois, and represent a greater number of populations than the total number heretofore known to be extant. The choruses were found on or not far from sand or sandy soils. The most typical calling sites were ephemeral, flooded depressions in fields. No choruses were found in lotic environments or at larger floodplain lakes. Substrates at calling sites frequently contained a

considerable amount of clay, silt, and/or organic matter; these soils can hold surface water longer than permeable yellow sand. Considerable environmental disruption occurs in the study area, and agricultural practices (particularly hog raising and the application of agricultural chemicals) probably pose the greatest potential threat to the frog. However, considerable relatively undisturbed habitat remains available for the frog in our study area, particularly on sand ridges. The 1984 calling season extended from 22 March until at least 23 April and peaked from 1–5 April. Inhospitable weather in late February and March probably delayed the calling season. Although the number of choruses found in our study area was relatively large, the numbers of calling males in many choruses were small. Additional field surveys in other areas are desirable before a determination is made as to whether or not the Illinois chorus frog should be listed as a federally threatened or endangered species.

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