Transactions of the Illinois State Academy of Science
(2009), Volume 102, #1&2, pp. 95-106

received 5/5/08
accepted 9/28/08

Records of Nine-Banded Armadillos, *Dasypus novemcinctus*, in Illinois

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ABSTRACT

The nine-banded armadillo, *Dasypus novemcinctus*, has been expanding its range in the United State since the mid-1800s. There had been sporadic reports of this species in Illinois prior to 1990. I conducted a mail survey in 2003 of individuals knowledgeable about the fauna of southern Illinois to investigate the possible expansion of the armadillo into the state. I also sent questionnaires to animal control agencies of 22 southern Illinois counties and municipalities. The questionnaire asked about armadillo sightings in Illinois since 1990. I mailed 158 questionnaires and received 101 responses. Twenty-three respondents knew of recent armadillo sightings and ten had observed armadillos personally. I collected additional records from a variety of sources, including biologists, members of the public, and scientific collections. From 1990 through March 2008 at least 166 armadillos were documented or reported from 42 Illinois counties. Some live animals were observed, but most reports were of apparent roadkills. Ninety-one percent of the sightings occurred after 2000. Eighty-eight percent of armadillo locations that could be mapped were south of a line through central Calhoun and southern Greene counties (approximately 39°N latitude).

INTRODUCTION

The nine-banded armadillo, *Dasypus novemcinctus*, is the only species in the Neotropical family Dasypodidae (order Cingulata) that occurs in the United States (Layne 2003). The species was first documented in the United States in southern Texas in the mid-1800s (Audubon and Bachman 1854). Since then its range has expanded dramatically, through natural dispersal and human intervention (Buchanan and Talmage 1954, Humphrey 1974, McBee and Baker 1982, Taulman and Robbins 1996, Freeman and Genoways 1998, Layne 2003). The species' northward expansion is limited by severity of winter weather because it is unable to hibernate (Humphrey 1974, Jones et al. 1983, Taulman and Robbins 1996), but its potential range might include the southern part of Illinois (Taulman and Robbins 1996). There have been occasional reports of armadillos in the state (e.g. Schwegman 1992, Taulman and Robbins 1996) and two specimens collected in Illinois as of 2000 are in mammal collections. The Illinois State University collection includes a roadkilled armadillo found in Empire Township, McLean County in 1999 (ISU 1215). The Illinois Natural History Survey (INHS) has part of the carapace of a roadkilled armadillo collected near Boody, Macon County in 2000 (INHS 818; Van Deelen et al. 2002).

Recent sightings known to Illinois Department of Natural Resources biologists prompted an investigation of the possible expansion of the range of the nine-banded armadillo into Illinois. I conducted a mail survey of people knowledgeable about the fauna of southern Illinois in 2003. Subsequently I collected additional records from a variety of sources. This paper presents information on armadillo records in Illinois as of 31 March 2008.

RANGE EXPANSION OF THE NINE-BANDED ARMADILLO

Dasypus novemcinctus has the most extensive geographical range of any armadillo species, extending from Argentina and Uruguay through Central America and most of Mexico (McBee and Baker 1982). Audubon and Bachman (1854) first documented the species in the United States in 1849, noting its presence in the lower Rio Grande Valley of southern Texas. It was largely restricted to the Rio Grande Valley until the early 1870s (Strecker 1926). In 1905 armadillos were common in southern Texas (Bailey 1905) and occasional individuals may have occurred in extreme southeastern New Mexico (Bailey 1931). By 1925 the armadillo was common in central Texas and had appeared in northwestern Louisiana (Strecker 1926). It soon spread into northeastern Louisiana (Strecker 1928) and was recorded east of the Mississippi River in Louisiana in 1935 (Lowery 1936). Armadillos were reported in Arkansas in 1921 (Dellinger and Black 1940) and first recorded in northeastern Oklahoma in 1932 (Blair 1936).

In the early 20th century the nine-banded armadillo was introduced into Florida at two locations (Bailey 1924, Sherman 1936). The species spread rapidly along the central east coast during the late 1930s and 1940s (Fitch et al. 1952). An isolated population that had become established in southern Alabama by 1949 presumably represented descendents of introduced animals (Fitch et al. 1952, Buchanan and Talmage 1954). The armadillo's range in 1954 (Figure 1a) included all or parts of Texas, Oklahoma, Arkansas, Louisiana, and peninsular Florida (Buchanan and Talmage 1954). Buchanan (1958) confirmed that the species also was established in southwestern Mississippi. By 1950 there were extralimital records (pioneers or introduced individuals) in Kansas (Hibbard 1943), Missouri (Anonymous 1947), and Georgia (Fitch et al. 1952).

As of 1972 the permanent range of the nine-banded armadillo (Figure 1b) covered all or parts of Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Florida, and Georgia (Humphrey 1974). There were extralimital records for Tennessee (Humphrey 1974), Colorado (Hahn 1966), and South Carolina (Humphrey 1974) as well as more records in Kansas (e.g. Getz 1961, Smith and Lawlor 1964). By 1995 (Figure 1c) the armadillo had increased its range in Texas, Oklahoma, Arkansas, Alabama, Mississippi, Georgia, and Florida and also had become established in parts of Kansas, Missouri, Tennessee, and South Carolina (Taulman and Robbins 1996). Extralimital records existed as far north as Nebraska (Taulman and Robbins 1996, Freeman and Genoways 1998).

Thus, the nine-banded armadillo's expansion northward and eastward from Texas (and in all possible directions from Florida and Alabama) has been well documented. Humphrey (1974) determined that average invasion rates for the species were 4-10 km/yr; these rates are considered rapid for mammals (Taulman and Robbins 1996). Over the period 1972-1995, expansion of the Texas population to the northeast occurred at a rate of 11.2 km/yr,

expansion through Oklahoma into Kansas at about 11 km/yr, and expansion north from the Gulf Coast at 17.2 km/yr (Taulman and Robbins 1996).

METHODS

In 2003 I mailed a questionnaire to 136 individuals considered knowledgeable about the fauna of southern Illinois. The recipients were Illinois Department of Natural Resources (IDNR) District Wildlife Biologists (14), District Foresters (9), and Natural Heritage Biologists (7); Illinois Nature Preserves Commission field staff (4); IDNR biologists at Prairie Ridge and Cache River state natural areas (2); Conservation Police Officers in IDNR Regions IV and V (48); superintendents of state parks, fish and wildlife areas, conservation areas, and other state properties (37); Shawnee National Forest biologists (2); National Wildlife Refuge (NWR) managers (3); The Nature Conservancy biologist at Cypress Creek NWR (1); the U.S. Army Corps of Engineers superintendent at Carlyle Lake (1); and academics (8). I also mailed questionnaires addressed to the person responsible for animal control in 22 southern Illinois counties and municipalities.

The questionnaire asked if the recipient had personally observed nine-banded armadillos in Illinois since 1990 and, if so, when and where the animals had been seen and whether they were dead or alive. It also asked for details of other recent armadillo sightings that the recipient considered reliable. In a cover letter I requested that information on future sightings be sent to me.

I also posted a request for armadillo sightings on IBET, an internet listserve for Illinois birders in 2003. I notified the Bureau of Design and Environment (BDE) of the Illinois Department of Transportation that I was interested in observations of armadillo roadkills. Although unable to collect such information systematically, BDE staff forwarded some sightings by highway workers in southern Illinois. In addition, I contacted Dr. Russell Graham who, while at the Illinois State Museum in 1993, asked Illinois and Missouri residents to report armadillo sightings (Graham 1993).

In 2005 and again in 2008 I checked the mammal collections of the Field Museum of Natural History, Illinois State Museum, University of Illinois Museum of Natural History, Western Illinois University, Eastern Illinois University, Southern Illinois University, Cooperative Wildlife Research Laboratory (Southern Illinois University), and Southern Illinois University-Edwardsville for nine-banded armadillo specimens collected in Illinois. I searched MaNIS (http://manisnet.org) in 2008 for specimens in mammal collections outside Illinois.

Publicity about the armadillo survey (e.g. Hofmann and Esker 2005, Hofmann 2007, newspaper articles) subsequently led to communications from biologists and members of the public about additional armadillo sightings.

RESULTS

I received 101 responses from the 158 questionnaires that were mailed (63.9%). Twenty-three of the respondents (22.8%) knew of at least one armadillo sighting in Illinois since 1990. Two of these respondents did not describe specific sightings, but referred me to

other IDNR personnel who had already received questionnaires. Ten respondents (9.9%) had observed armadillos personally. Seven of these reported a single armadillo, two had seen two animals, and one (Lloyd Nelson, animal control officer for Jackson County) reported multiple records for 2000, 2001, and 2002.

As of 31 March 2008 I had received approximately 90 telephone calls or e-mails about armadillo sightings in Illinois. There was documentation of several of these armadillos; 18 were photographed (I took two photos and have seen eight others) and 13 specimens were collected by or given to IDNR personnel. Physical vouchers are being retained for the INHS mammal collection and five carcasses have been necropsied at the University of Illinois School of Veterinary Medicine Diagnostic Laboratory. I considered nearly all reports valid because the uniqueness of the armadillo makes it unlikely to be confused with any other Illinois mammal. It is possible, though unlikely, that an armadillo was a different species than *Dasypus novemcinctus*.

Sometimes it was clear that more than one person had reported the same armadillo. In a few cases it was not possible to ascertain if separate reports referred to the same animal. The exact number of individual armadillos reported is thus uncertain. From all sources, I collected observations of 161-167 individuals in Illinois from 1990 through March 2008. According to survey respondents, additional armadillos reportedly had been seen in Alexander and Pope counties and there may have been other armadillo sightings of which I am unaware. I found no specimens of free-living armadillos from Illinois that had been added to scientific collections since 2000 (other than vouchers retained at the INHS). Single specimens from McLean (ISU 1215) and Macon (INHS 818) counties were collected (in 1999 and 2000, respectively) and three additional armadillos were documented after 1990 (Schwegman 1992, Taulman and Robbins 1996). Thus, at least 166 armadillos have been reported in Illinois since 1990.

Most of the armadillos reported in Illinois were dead; these were typically found along roads and presumably killed by vehicles. Thirty-one live animals were reported, although at least four of these were known to have been killed subsequently (by vehicles, a gunshot, or a dog). Observations of live armadillos were reported for each year from 2001 through 2008 and some were seen during winter months. People were uncertain about the year of some early armadillo observations, but very few sightings from the 1990s were reported. The vast majority (91%) of sightings occurred from 2001 through March 2008.

I collected records of armadillos from 40 counties for 1990 through March 2008 (Figure 2). Two armadillos were observed near the White/Edwards and Moultrie/Shelby county lines, but only one county for each sighting was included in Figure 2. The specimens from McLean and Macon counties were collected during this period, bringing the total number of Illinois counties with armadillo reports since 1990 to 42. The largest number of armadillo reports (44-48) was from Jackson County, partly because the county animal control officer had kept records of armadillo sightings. Other counties with relatively large numbers of reported observations were Randolph (16-17), St. Clair (10), Clinton (8), and Monroe (7-9). I received only one or two specific armadillo reports for 22 counties (Alexander, Christian, Clay, Cook, DuPage, Edgar, Effingham, Fayette, Fulton, Hardin, Henry, Marion, Montgomery, Moultrie, Perry, Pike, Pope, Pulaski, Scott, Tazewell, Washington, and White).

Figure 3 shows locations of 114 armadillos reported during this survey. Other reports, including many provided by Jackson County Animal Control, were not specific enough to map the animal's location. Also included in Figure 3 are localities for the specimens from McLean and Macon County and an armadillo found in Pope County in 1991 (Schwegman 1992). Although a few armadillos were observed or collected in northern and central Illinois, most have been reported in the southern half of the state. Eighty-eight percent of the armadillos whose locations are shown in Figure 3 (as well as almost all animals that could not be mapped) occurred south of a line through central Calhoun and southern Greene counties. Calhoun County locations were clustered near Hardin, which is at 39˚09'N latitude. Ninety percent of the southern Illinois armadillo locations in Figure 3 were along or west of the I-24/I-57 highway corridor (i.e. in the western portion of southern Illinois).

Climatological Data

The nine-banded armadillo has become established on the Great Plains in areas where mean temperatures for January (typically the coldest month) are between 0ºC and -2.0˚C (Taulman and Robbins 1995). For comparison, I examined winter temperatures along a latitudinal gradient in southern Illinois. Climatological data from five weather stations (Cairo, Carbondale, Belleville, Alton, and Jerseyville) for January 1995-March 2008 were obtained from the Illinois State Water Survey (www.sws.uiuc.edu/data/climatedb). Table 1 shows January temperature information for these stations. Mean January temperature at Cairo in the southern tip of Illinois (Alexander County; 37°00'N latitude) averaged 2.0°C for 1995 through 2008. The January mean was below 0°C twice, but never below -2.0°C (the lowest January mean being -1.7°C in 2003). For the winter of 2000-2001 December was the coldest month at Cairo; it was the only month during 14 winters with a mean temperature less than -2.0°C (-3.4°C). Mean January temperatures at Carbondale (Jackson County; 37˚43'N) averaged 0.9˚C for 1995-2008. The lowest January mean during this period was -2.5˚C in 2003. December 2000 was the only other month during 14 winters with a mean temperature below -2.0°C (-4.8°C) in Carbondale. In Belleville (St. Clair County; 38˚31'N) mean January temperatures for 1995-2008 averaged 1.4˚C and never were below -2.0˚C. As with Cairo, December 2000 was the only month that had a mean temperature less than -2.0°C.

Temperature data for January for Alton (Madison County; 38°53'N) only were available for 11 years between 1995 and 2008. Mean January temperatures averaged -0.4°C and were below -2.0°C for three of 11 winters. December 2000 again was the coldest month, with a mean temperature of -5.4°C. At Jerseyville (Jersey County; 39˚07'N) mean January temperatures were available for 12 years between 1995 and 2008 and averaged -1.7˚C. The January mean was below -2.0˚C during six of 12 winters; the lowest January mean was -5.4°C in 1997. Three additional months had mean temperatures less than -2.0°C. For the period 2000-2008, when most of the armadillos were reported in Illinois, averages of mean January temperatures for these five weather stations were 0.1 to 1.1°C higher.

Table 1. January temperature information for five weather stations in southern Illinois, 1995-2008 (Illinois State Water Survey, www.sws.uiuc.edu/data/climatedb). Data were not available for all 14 years at Alton and Jerseyville. Because sample sizes were small, only averages of mean January temperatures are shown. The numbers of years during which the mean January temperature was lower than 0ºC and -2ºC also are presented.

station	average Jan. mean (°C)	# years < 0°C	# years < -2°C
Cairo	2.0	2/14	0/14
Carbondale	0.9	5/14	1/14
Belleville	1.4	4/14	0/14
Alton	-0.4	6/11	3/11
Jerseyville	-1.7	9/12	6/12

DISCUSSION

Only sporadic occurrences of nine-banded armadillos had been reported in Illinois prior to 1990. Schwegman (1992) recalled a newspaper account of an armadillo seen in Union County in the late 1970s and provided a report of a roadkilled animal in Hardin County in the 1980s. The Cooperative Wildlife Research Laboratory performed a necropsy on a moribund armadillo (CW84-7) found in Alexander County in December 1983 (A. Woolf, personal communication, 20 October 2003). A Conservation Police Officer reported a roadkilled animal in southern Illinois around 1990 (R. Graham, personal communication, 26 July 2004) and Schwegman (1992) described an armadillo in Pope County in 1991. Taulman and Robbins (1996) mapped two Illinois armadillos; these were 1994 roadkills from Union County (J. Taulman, personal communication, 27 May 2005). The first Illinois specimens were collected in 1999 (ISU 1215; A. Capparella, Illinois State University, personal communication, 28 January 2005) and 2000 (INHS 818; Van Deelen et al. 2002).

I collected reports of six additional armadillo sightings in Illinois that definitely occurred during the 1990s, but there have been reports of at least 147 sightings since 2000. These findings raise two basic questions. First, how did these animals get to Illinois? Second, has the species become established in Illinois, i.e. is a breeding population present or is there a continual influx of animals from elsewhere?

Natural range expansion involves movement of individuals outward from the edge of a species' range. There is no doubt, however, that human translocation has played a major role in the armadillo's spread (e.g. Fitch et al. 1952, Buchanan and Talmage 1954, Jones et al. 1983, Taulman and Robbins 1996). Armadillos captured as pets or curiosities can later be released or escape long distances from their original locations. Release or escape of individuals led to the establishment of armadillo populations in Florida and Alabama (Fitch et al. 1952, Buchanan and Talmage 1954). In addition, there can be translocation of armadillos into new areas as "hitchhikers" in trucks, railroad cars, and barges. Fitch et

al. (1952), for example, recounted that live armadillos frequently escaped from boxcars when cattle trains from Texas arrived in Rankin County, Mississippi during the 1930s.

The nine-banded armadillo occupies Missouri as far north as the Missouri River (Robbins et al. 1994), but armadillos are found only occasionally in Kentucky (http://fw.ky.gov/kfwis/speciesinfo/speciesinfo.asp). Thus, Illinois is separated from the nearest population from which natural dispersal could occur by the Mississippi River. Armadillos can swim (e.g. Taber 1945), but it is not known if they are able to swim far enough to cross the Mississippi River at southern Illinois. “Island-hopping” may enable armadillos to cross it in stages. It also might be possible that they use highway bridges, but I received no reports of roadkilled armadillos on bridges over the Mississippi River. Armadillos could enter Illinois from other states on trucks, trains, or the barges that travel up the Mississippi, Ohio, and Illinois Rivers. Finally, people could intentionally transport armadillos into Illinois and release them (as pranks or after having second thoughts about keeping them as pets). Although the way in which armadillos arrived in Illinois cannot be determined, it is likely that people translocated animals intentionally or unintentionally. This is especially likely for armadillos observed or collected in the northern half of the state.

There is consensus that climate will limit the distribution of the nine-banded armadillo (e.g. Taber 1939, Humphrey 1974, Jones et al. 1983, Taulman and Robbins 1996). Because armadillos have high thermal conductance (McNab 1980) and cannot hibernate, their northward expansion will be limited by the severity of winter temperatures. Since these temperatures vary from year to year, the northern edge of the armadillo’s distribution will be fluid. For example, there were fewer armadillo sightings in northern Kansas in 2001, following the very cold winter of 2000-2001 (Merriam 2002). Taber (1939) thought that cold would prevent the armadillo's establishment north of 33˚N. By 1954, however, the species was established close to 35˚N (Buchanan and Talmage 1954), while Humphrey (1974) suggested that the "winter barrier" might be moving northward. The armadillo's range in 1995 reached about 38˚N latitude in Kansas (Taulman and Robbins 1996). Taulman and Robbins (1996) found that the species was established in areas on the Great Plains with mean January temperatures between 0ºC and -2.0˚C. These regions tend to have fewer than 24 freeze-days annually, although the number of consecutive freeze-days may be more limiting than the total number (Taulman and Robbins 1996). Taulman and Robbins (1996) produced an isotherm for a mean January temperature of -2.0˚C, based on climate data through 1990, which crossed Illinois at about 39˚N latitude (north of Alton).

Although there was a cluster of armadillo reports in Jersey, Greene, and Calhoun counties (Figure 3), temperature records since 1995 for Jerseyville (where the mean January temperature averaged -1.7°C) suggest that the species might survive that far north only during mild winters. Mean monthly temperatures were only infrequently less than -2.0°C at the Belleville, Carbondale, and Cairo weather stations. Thus, winter temperatures in Illinois south of the East St. Louis metro region should be suitable for the establishment of nine-banded armadillo populations. Depth and duration of snow cover or prolonged periods of below-freezing temperatures, however, also would likely affect armadillo survival. Even in far southern Illinois mortality could increase during harsh winters, reducing armadillo numbers or even eliminating them from the state. Given the potential for inten-

tional and unintentional translocation of armadillos, they should be able to repopulate southern Illinois under favorable climatic conditions.

It has not yet been demonstrated that a breeding population of nine-banded armadillos has become established in Illinois. Necropsies revealed that two females found in the state contained fully formed fetuses. Superdelayed parturition has been documented in this species, with gestation lasting as long as 24 months (Storrs et al. 1988). Therefore, it is possible that these females mated elsewhere and subsequently dispersed or were transported into Illinois. The large number of sightings in recent years and the fact that live animals have been seen during winter, however, suggest the possibility that some armadillos are surviving and breeding in the southern part of the state. Humphrey (1974) felt that range maps should make a distinction between areas with permanent armadillo populations and those where only pioneering individuals occurred. Genoways et al. (2000:93) defined the pioneering zone of a species as "the area where, under favorable conditions, the species is capable of reproducing and conducting its normal activities." At the present time Illinois can be considered, at least, part of the pioneering zone of the nine-banded armadillo.

SUMMARY

At least 166 nine-banded armadillos have been documented or reported in Illinois from 1990 through March 2008. The vast majority of these animals (91%) have been observed since 2001. Armadillos have been reported or collected in 42 counties. Most mapped locations of armadillos (88%) were south of a line through central Calhoun and southern Greene counties (approximately 39°N latitude). It is likely that people intentionally or unintentionally transported these armadillos into the state. The relatively mild winters in the southern third of Illinois should be favorable for armadillos to survive and reproduce, but the establishment of a breeding population in Illinois has not yet been demonstrated.

ACKNOWLEDGMENTS

This project was supported by grant 04-037W from the Illinois Wildlife Preservation Fund (IDNR). Terry Esker (IDNR) was instrumental in its development. Individuals too numerous to list contributed by responding to the mail survey or reporting observations. Carolyn Nixon (INHS) produced Figure 1 and Diane Szafoni (INHS) Figures 2 and 3. Joseph Merritt and Jean Mengelkoch (INHS) reviewed the manuscript.

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Figure 1. Distribution maps for the nine-banded armadillo in the United States: (a) range in 1954, after Buchanan and Talmage 1954; (b) range in 1972, after Humphrey 1974; (c) range in 1995, after Taulman and Robbins 1996.

Figure 2. Illinois counties with nine-banded armadillos sightings, 1990-March 2008. Solid fill = counties with reports collected during the present study, cross-hatching = counties represented by museum specimens (ISU 1215 and INHS 818).

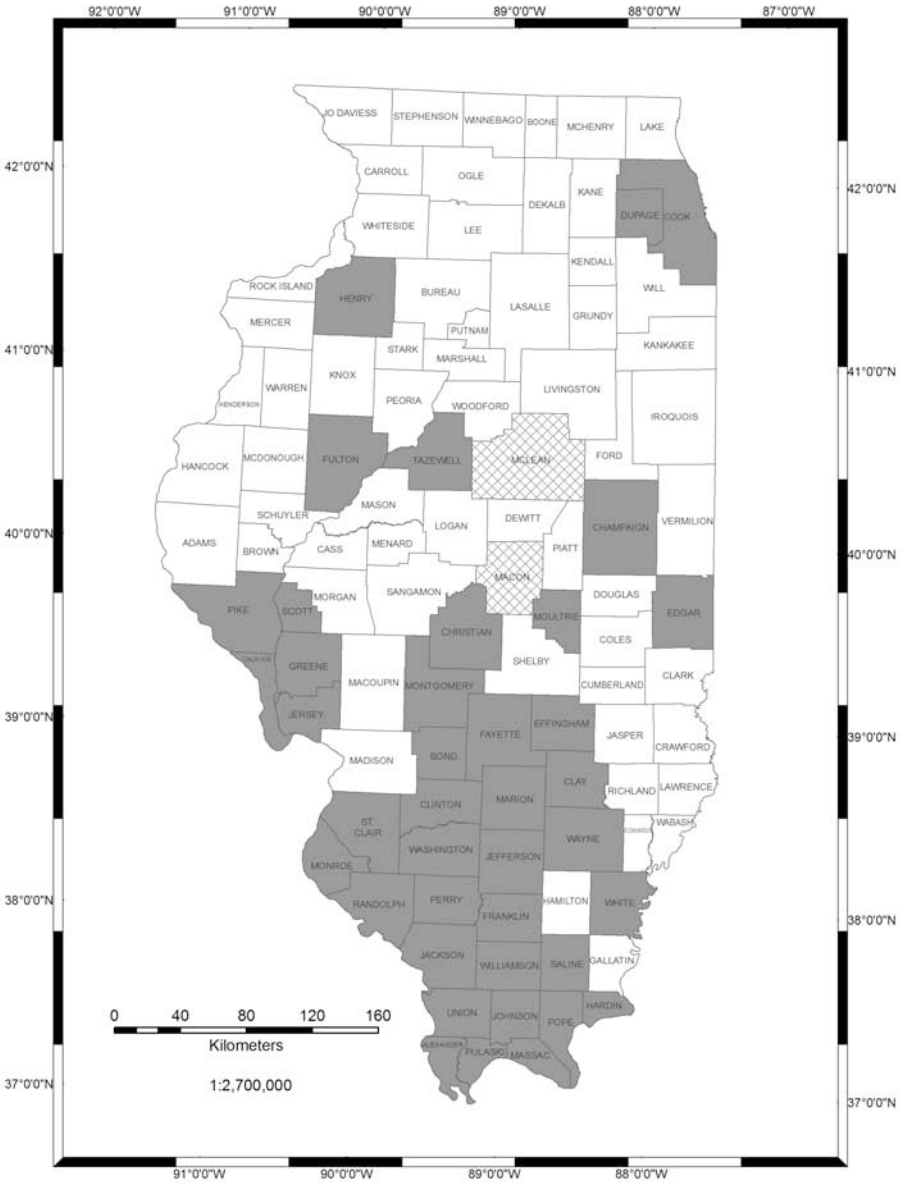

Figure 3. Locations of nine-banded armadillo sightings in Illinois, 1990 – March 2008. Gray dots = sightings collected during the present study, black dots = specimens (ISU 215 and INHS 818) and Pope County location from Schwegman (1992).