

Population Characteristics of the Lesser Siren (*Siren intermedia*) in Central Illinois

Baylee Thornton

University of Illinois Springfield

*Correspondence: bnmclaughlin11@gmail.com

ABSTRACT

The Lesser Siren (*Siren intermedia*) is a fully aquatic salamander found throughout the central and south-central United States. The Illinois Department of Natural Resources identifies the Lesser Siren as a Species in Greatest Conservation Need, but there is minimal published information available on Illinois populations. Knowledge gaps about a species create misconceptions about population viability, resulting in insufficient conservation efforts or efforts that do not reflect the current population status. Over a 7-month trapping period in 2020, mark-recapture data were gathered on characteristics of a single population of Lesser Siren occupying a ditch network in Central Illinois to help fill information gaps on this species and to compare with other population studies throughout its range. The estimated population size was 132 Siren (95% CI of 49 – 485) at a density of 0.26 Siren per linear meter. Individuals ranged from 281-360 mm in total length, with mean total length of 322.3 mm and mean snout-vent length of 216.61 mm. Adult males were significantly larger than adult females in total length, snout-vent length, and wet mass. While individual sizes and estimated population size were similar to those observed in other studies conducted in Arkansas and Missouri, density was lower than reported in these studies, as well as studies conducted in Texas. This is the first study on population characteristics of Lesser Siren in Illinois and provides meaningful data for filling information gaps and understanding the species' viability in the state.

INTRODUCTION

The Lesser Siren (*Siren intermedia*) is a fully aquatic, relatively large (up to 600 mm total length) salamander species typically found in shallow, slow-moving waters throughout the central Mississippi Valley and southern Gulf states (Martof, 1973). The Lesser Siren is considered a highly fecund salamander, as it matures quickly, typically within the first two years, and produces an average of 200 offspring annually (Gehlbach & Kennedy, 1978). They are opportunistic carnivores that feed on a variety of small crustaceans, insects, mollusks, amphibians, and amphibian eggs (Altig, 1967; Hampton, 2009). As such, Siren are known to have key influences within their ecosystems (Fauth & Resetarits, 1991; Fauth, 1999). However, relative to other salamander species in the U.S., the ecology and demographic information of this cryptic species is underexplored. In Illinois, one study exists on the diet of Lesser Siren (Altig, 1967), but no other published data exist on Lesser Siren population characteristics in the state.

Despite the relatively high abundance of the Lesser Siren observed elsewhere throughout its range (Gehlbach and

Kennedy, 1978; Frese et al., 2003; Sawyer and Trauth, 2011), the species was listed in 2015 as a Species in Greatest Conservation Need in Illinois, as it is thought to have declining populations in the state due to loss of habitat (Illinois Department of Natural Resources [IDNR], 2015). These population declines are concerning in light of the lack of information on the Lesser Siren in Illinois. Knowledge gaps about a species can create misconceptions about population viability, resulting in conservation efforts that are insufficient or mismatched for the actual population status. A demographic evaluation of the Lesser Siren in Illinois is therefore necessary to develop a more accurate conservation status assessment of the species in the state.

The distribution of the Lesser Siren in Illinois is presumed to be throughout the southern portion of the state. Occurrence records document populations primarily inhabiting the southern half of Illinois. Few occurrence records exist throughout the central portion, and only two of these records were documented since 2010. Many of these populations have not been recently surveyed. To date, the Illinois Natural

History Survey (INHS) has documented 181 occurrence records of the Lesser Siren in Illinois, just 35 of which have been observed since 2010 (INHS, 2020). No occurrence records during the last 10 years have observed more than 10 individuals at a single location, suggesting potentially low population size. Furthermore, Lesser Siren are generally poor dispersers due to their fully aquatic lifestyle, paedomorphic characteristics, and reduced forelimbs (Schalk and Luhring, 2010), hindering their ability to disperse to other areas of the state. Distributions may also be limited due to the energetic demands of aestivation (dormancy during drought), as smaller individuals are not likely to survive recurring droughts (Luhring and Holdo, 2015).

To address gaps in species knowledge related to occurrence, population size, and individual morphometric data, I implemented a mark-recapture study to examine a historically observed Lesser Siren population in Central Illinois. Specifically, my objectives were to locate an extant Siren population based on historic records; collect data on Siren length and mass; collect data on habitat parameters (i.e. water depth

and temperature, air temperature) at each capture site; and use this data to analyze population size, density, and correlations to habitat characteristics of the population. Understanding population information for the understudied Lesser Siren will be useful in developing and implementing conservation actions and management practices for this vulnerable species in Illinois.

MATERIALS & METHODS

Initial Presence/Absence Survey. I conducted a presence/absence survey during February-April of 2019 to survey six locations throughout Mason and Macoupin Counties, four of which were based on historical occurrences of the Lesser Siren (INHS, 2020). The results of these presence/absence surveys determined the mark-recapture study area. However, only one extant population was discovered during these surveys. Each of the six sites was trapped for three consecutive days using 15 unbaited minnow traps (23 x 44.5 cm, two 2.5 cm funnels, 0.5 cm mesh diameter) at each site, with traps placed approximately three meters apart. Traps were checked daily, and all species were counted and documented before being released at the site of capture.

Mark-recapture Study Area. A mark-recapture study was conducted at the only location of the six surveyed where an extant population was detected (see Results). This location was in a ditch network located along Illinois Route 78, north of Chandlerville, Illinois (Fig. 1). The length of the study area totals approximately 500 linear meters. The ditch network is adjacent to a large agricultural field and is also part of a levee system for the Sangamon River. The ditches are thickly vegetated and contain several fish and amphibian species, including Grass Pickerel (*Esox americanus*), Sunfish (*Lepomis* spp.), Madtom (*Noturus* spp.), and Southern Leopard Frog (*Lithobates sphenoccephalus*) (pers. obs.). Historical records from the 1950s indicated Lesser Siren presence near the study site, but no other records have been documented for the species in that area.



Figure 1. Location of the 2020 mark-recapture study site.

Mark-recapture Study. The mark-recapture study occurred during January-May of 2020 for a total of 13 weeks. Two sampling events occurred each week using 45 minnow traps for a total of 1,170 trap nights. Because the Lesser Siren captured during the 2019 presence/absence survey were not marked for recapture, only the individuals captured during 2020 were used in the mark-recapture analyses. Water depth fluctuated from 18-77 cm during the study period, although on three separate occasions, water levels were

too low to allow trapping. Every fifth trap was baited with canned sardines to separately evaluate if baiting traps influences the successful capture of the Lesser Siren (results not shown). Traps were set approximately three meters apart. Any Siren captured was removed from the trap and placed into a 5-gallon bucket filled with water from the site. Each individual was anesthetized in a solution of MS-222 (0.5g:1L) until it could no longer right itself (3-6 mins; Fish et al., 2008). Once anesthetized, wet mass (g), total length (TL;

mm), snout-vent length (SVL; mm), sex, and life stage (juvenile or adult) were recorded. Individuals were sexed based on the presence or absence of enlarged masseter muscles (Gehlbach and Kennedy, 1978; Hampton, 2009). Based upon the smallest individual successfully sexed (165 mm; Hampton, 2009), juveniles were defined as individuals less than 165mm SVL and were not sexed. Once marked, individuals were placed into a bucket of fresh water until normal activity resumed, after which they were released at the point of capture.

Initially, I attempted to use visual implant alpha (VIA) tags, but these were deemed unsuitable for the study due to their small size, low fluorescence, and the dark skin pigmentation of the study organism. Therefore, I switched to passive integrated transponder (PIT) tags during the fourth week of the study, as this method proved successful for other siren studies (Sorenson, 2003; Luhring, 2009; Hampton, 2009). Due to limitations from the size of the needle gauge, individuals less than 130 mm SVL could not be marked. Only individuals marked with PIT tags were considered during analyses.

Habitat Characteristics. Water temperature and depth were collected at each point of capture and air temperature was recorded daily, regardless of capture rate. Water temperature was measured with a mercury thermometer; water depth was measured using a ruler; and current air temperature was recorded using The Weather Channel's (2020) weather application, which collects meteorological data from the U.S. National Weather Service.

Population Size & Density Estimates. Population estimates were calculated using the Schnabel method, due to the multiple markings and recaptures on what was thought to be a closed population (Krebs, 1998). This method estimates both the overall population size as well as population estimates for each sample taken (Freese et al., 2003). The Schnabel method is suggested to be conservative in its estimations (Gehlbach & Kennedy, 1978) because this

method assumes that the population is closed, there is equal catchability, marking does not affect catchability, no marks are lost, and all marks are reported in subsequent samples (Krebs, 1998). The equation is as follows:

$$\hat{N} = \frac{\sum_t (C_t M_t)}{\sum_t R_t}$$

The variable C_t is the total number of individuals caught in sample t ; M_t is the number of marked individuals in the population just before the t -th sample is taken; R_t is the number of individuals already marked when caught in sample t ; and \hat{N} is the population size estimate.

Differences in mass and length for males and females were tested with the two-tailed Mann-Whitney U -test. Pearson correlations were used to determine if baited traps, ambient temperature, water temperature, or water depth influenced weekly captures, SVL, TL, or weight. The alpha level of significance was 0.05. Population density was estimated by dividing the estimated population size by the total study length.

RESULTS

Study Area. During the 2019 presence/absence survey from February to April, 15 Siren were captured at one site in Mason County – the only site of the six surveyed where an extant population was observed (Fig. 1). Therefore, this site was determined to be the study area for the mark-recapture study. Most of the captures during the presence/absence survey were juveniles (93%), the majority of which (80%) were captured in the northernmost portion of the study area.

During the 2020 mark-recapture study 33 individuals were captured and marked with PIT tags over 1,170 trap nights, for a 3% trap capture rate during the trapping period. Of the 33 individuals, three Siren were recaptured once for a 9% recapture rate. In addition to capturing Lesser Siren, two other amphibian species were captured – Small-mouthed Salamander (*Ambystoma texanum*) and Southern Leopard

Frog (*Lithobates sphenoccephalus*). Several families of fish were observed during trapping efforts, including Esocidae, Centrarchidae, and Ictaluridae.

Habitat Characteristics. The weekly number of Siren captured was positively correlated to mean weekly water temperature ($t = 2.57$, $p < 0.05$, Fig. 2). The highest capture rates occurred when water temperature was between 10°C and 19°C. Weekly captures were not significantly correlated to either ambient temperature ($p > 0.05$; Fig. 3) or water depth ($p > 0.05$); however, many of the captured Lesser Siren were found in depths between 30-40 cm (Fig. 4). None of the measured habitat characteristics (ambient temperature, water temperature, or water depth) was significantly correlated to Siren SVL, TL, or weight ($p > 0.05$).

Population Characteristics. As calculated by the Schnabel method, the population size estimate for Lesser Siren within the Mason County study area is 132 individuals (95% CI of 49 – 485). Density for my population is

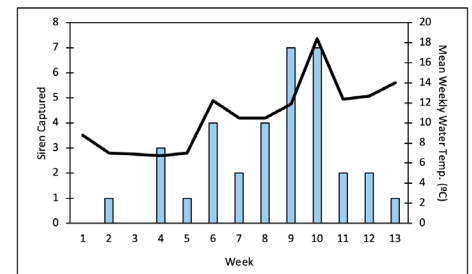


Figure 2. Weekly captures of Lesser Siren in Mason County, IL during Jan-May 2020 (bar) and mean weekly water temperature (°C, line, $p < 0.05$).

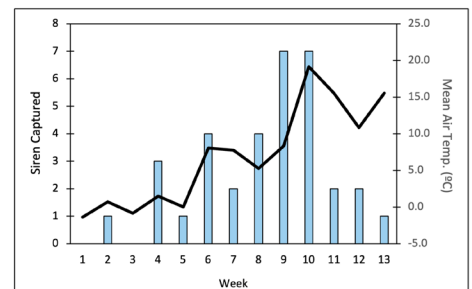


Figure 3. Weekly captures of Lesser Siren in Mason County, IL during Jan-May 2020 (bar) and mean weekly ambient temperature (°C, line, $p < 0.05$).

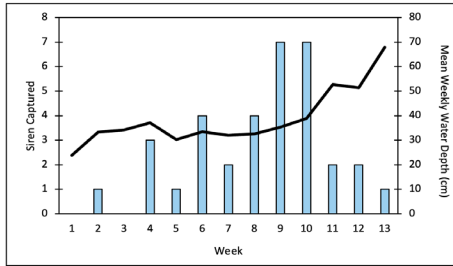


Figure 4. Weekly captures of Lesser Siren in Mason County, IL during Jan-May 2020 (bar) and mean weekly water depth (cm, line, $p < 0.05$).

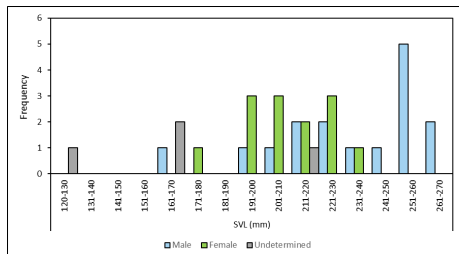


Figure 5. Snout-vent length (SVL) frequency by sex of all captured Siren (juveniles < 165 mm; adults > 165 mm) within the Mason County, IL study area.

best reported by individuals per linear meter due to unpredictable variation in depth and width (Sawyer & Trauth, 2011), and is calculated to be 0.26 Siren/m. No Siren were caught in traps that were baited.

Juveniles comprised 6.7% of the captured individuals. Adult males ($n = 15$) were 167 – 270 mm in SVL ($253.22 \pm SD 28.46$) and 252–400 mm in TL ($350.88 \pm SD 39.48$). Adult females ($n = 12$) were 172 – 232 mm in SVL ($201.19 \pm SD 18.85$) and 252–347 mm in TL ($317.4 \pm SD 30.12$). Male wet masses were 36.29–181.4 g ($112.82 \pm SD 42.76$) and females were 36.28–136.08 g ($66.99 \pm SD 26.78$). Adult males were significantly larger than adult females in TL ($U = 42.5, p < 0.05$), SVL ($U = 43.5, p < 0.05$), and wet mass ($U = 41.5, p < 0.05$).

The majority of captured Siren were between 190-260 mm SVL (Fig. 5). The mean SVL for all captured Siren was 216.61 mm, and the largest Siren collected had a SVL of 270 mm.

DISCUSSION

The Lesser Siren is listed as a Species

in Greatest Conservation Need in Illinois by the state’s Department of Natural Resources due to declining populations (IDNR, 2015). When conducting the presence/absence survey in 2019, six areas throughout Central Illinois were surveyed for extant populations of Lesser Siren, four of which were based on historical occurrences (INHS, 2020). However, only one extant population was discovered during these surveys. Additional surveys are necessary to confirm extirpated populations in the other areas of historical occurrence throughout Mason and Macoupin Counties. If confirmed, extirpations at these sites may contribute evidence that the Lesser Siren is in decline in Illinois.

While my study population is currently considered an isolated, peripheral population, it demonstrates population characteristics similar to populations studied throughout the center of the Lesser Siren’s range. The majority of known Lesser Siren locations in Illinois are within the southern portion of the state (INHS, 2020), and the Lesser Siren is primarily observed in southern states throughout the U.S. (Parra-Olea et al., 2008). My study population in Mason County, Illinois is one of the northernmost known populations of Lesser Siren (INHS, 2020; Martof, 1973; Michigan Herp Atlas, 2019; Parra-Olea et al., 2008), and is thought to be an isolated population (INHS, 2020). Therefore, Lesser Siren observed at my study site (i.e. on the edge of their range) may be expected to have stunted growth and smaller population sizes compared to Lesser Siren within the species’ representative range (Hardie & Hutchings, 2010). On the contrary, individuals observed in my study ex-

hibited sizes similar to those observed in more centralized locations within the species’ range, where habitat conditions are desirable for the species’ biology (e.g. warmer and deeper waters, native vegetation) (Table 1).

Most population studies on the Lesser Siren have been conducted in natural wetland habitats, with the exception of my study and Sawyer and Trauth (2011), who conducted their demographics study in a ditch habitat near factories in Arkansas. Despite the artificial ecosystems provided by these ditch habitats, Lesser Siren observed in both my study and Sawyer and Trauth (2011) are comparable in length and wet mass to Siren observed in more natural settings (Gehlbach & Kennedy, 1978; Sugg et al., 1988; Frese et al., 2003). Given that differences in habitat type may influence prey availability (Hampton & Ford, 2007), the survival of Lesser Siren in artificial habitats that vary in prey abundance and assortment may offer evidence of opportunistic feeding habits (Altig, 1967). Further research regarding specific habitat composition (e.g., vegetation, substrate composition, water quality, prey species and availability) is warranted to better understand potential factors that may influence Lesser Siren population dynamics.

While individual sizes in my study population are comparable with those observed elsewhere, the population density is the lowest reported, despite an equal or greater sampling effort (Hampton, 2009 [0.33 sirens/m²]; Frese et al., 2003 [1.35-2.17 sirens/m²]; Gehlbach & Kennedy, 1978 [0.9-1.3 sirens/m²]; Sawyer & Trauth, 2011 [0.81 sirens/m]). The capture rate of Lesser Si-

Table 1. Comparison of lesser siren (*Siren intermedia*) population characteristics.

Population Size	Mean SVL	SVL Range	SVL SD	Mean TL	TL Range	TL SD	Sex	Source	Location
132	253.2	167-270	28.5	350.9	252-400	39.5	M	This Study	IL
	201.2	172-232	18.9	317.4	252-347	30.1	F		
-	282.4	122-315	45.0	321.9	179-461	60.9	M	Sugg et al. 1988	AR
	216.9	138-282	29.9	189.5	221-439	38.2	F		
5,969	-	-	-	348.2	317-403	23.2	M	Frese et al. 2003	MO
	-	-	-	286.8	215-365	32.9	F		
110	181.1	135-255	49.3	277.3	170-365	47.6	Both	Sawyer and Trauth 2011	AR

ren in my study (3%) is also lower than previously documented elsewhere (Frese et al., 2003; Wilson et al., 2005; Hampton, 2009). However, the estimated size of my study population is comparable to those reported in other areas (Hampton, 2009; Johnson & Blackwell, 2011; Sawyer & Trauth, 2011). It is possible that low density and capture/recapture rates in my study may be due to the bias introduced by the Schnabel method assumptions. Due to the water levels at the site, traps were placed for ease of trap retrieval rather than true random placement, violating the assumption of equal catchability. Additionally, while recaptures were present in the study sample, and these were reported in the analyses, there was no method to evaluate if any marks were lost over the duration of the study. Furthermore, due to the hydrology and geography of the site, it could not be determined if the population was closed. As such, the population density and capture/recapture rates may be influenced by the potential violation of these assumptions of the Schnabel method.

Because the Lesser Siren is a wide-ranging species, population characteristics vary from region to region, so that demographic studies are needed throughout its range (Frese et al., 2003). This is the first documented study on population characteristics of the Lesser Siren in Illinois. The Lesser Siren is thought to be abundant throughout its range (Parra-Olea et al., 2008), but little is known about its natural history and population ecology, leading to possible misconceptions about the species' true population viability. With many amphibian species experiencing global declines, the Lesser Siren may also be experiencing threats to its populations. Therefore, a greater understanding of this species' biology is necessary to accurately understand its status throughout its range, and this study can help fill information gaps and improve understanding of its viability in the state.

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