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# Growth and Reproduction in the Ouachita Madtom (Noturus lachneri) at the Periphery of its Distribution

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# Growth and Reproduction in the Ouachita Madtom (*Noturus lachneri*) at the Periphery of its Distribution

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## Abstract

The Ouachita madtom (*Noturus lachneri*) occurs primarily in drainages of the upper Saline River and in a few small tributaries to the Ouachita River in Arkansas, USA. We collected specimens by hand and by use of aquarium dipnets on 29 occasions from 20 October 1999 through 25 July 2000 in Cooper Creek, presently a feeder creek into Lake Catherine on the Ouachita River. Total length was measured, reproductive attributes were noted, and individuals were released at the capture site (with exception of 3 gravid females retained to assess fecundity). We recognized 2 age (size) classes during most of the year based on a plot of length-frequency distributions. Regression of total length against time indicated a mean growth rate of 0.14 mm/day for the population, and 0.20 mm/day for juveniles during warmer months. Hatchlings were found from 27 June through 4 November.

## Introduction

The Ouachita madtom (*Noturus lachneri*) is a small catfish endemic to the upper Saline and Ouachita River drainages in central Arkansas (Taylor 1969, Robison and Buchanan 1988). It has a uniform dorsal coloration ranging from brown to gray to pinkish, and prefers small to medium-sized, high-gradient streams with cobble, gravel, or softer-substrate bottoms (Robison and Buchanan 1988). Most of the historic records for *N. lachneri* are from the Saline River drainage, with 1 record previously known from the Ouachita River drainage (Robison and Buchanan 1988).

Distribution, habitat, and foods of *Noturus lachneri* were described by Robison and Harp (1985), metapopulation dynamics by Gagen et al., (1998), food habits by Patton and Zornes (1991), helminth parasites by Fiorillo et al., (1999), and reproduction by Stoeckel and Gagen (2011).

The most southwestern record, and the second for the Ouachita drainage, is located in Cooper Creek – a small tributary to Lake Catherine on the Ouachita River (Tumlison and Tumlison 1996). It is a shallow, high-gradient creek with a largely non-embedded substrate that includes gravel, cobble, and boulders. Ouachita madtoms are common in Cooper Creek, which provided an opportunity to study this species considered by Buchanan (1974) to be endangered and by Robison and Harp (1985) to be threatened due to its small population size and vulnerability to environmental degradation caused by gravelling and road construction. Presently, the Arkansas Game and Fish Commission designates this species as being one of special concern.

Growth rates based on periodical collection for this madtom are not known. Herein we report growth rates, longevity, and reproduction of *N. lachneri* at the periphery of its range in the Ouachita drainage system.

## Methods

Four sites were selected along Cooper Creek in Garland County, Arkansas based on accessibility and presence of madtoms (for a map of sites see Tumlison and Tumlison 1996). A total of 29 sampling trips was made between October and July, 1999-2000. During each visit to each site, we spent about 2 hrs to thoroughly search all microhabitats in stream sections of about 40 m length, turning stones to reveal madtoms. Pools, riffles, and runs were represented in each sample site, and all of these were searched from bank to bank during each sampling period. Depth of the pools reached 75 cm, although most successful sampling was done at depths < 30 cm and especially in riffle areas where stones protruded above the surface of the water. Also, we established a fixed $1m^2$ plot at each site and lifted all stones within a $1m^2$ wooden quadrat frame to estimate density, per visit.

During each trip, individuals located by lifting stones were caught by use of aquarium dipnets, then transferred to a holding bucket. Seining had proven to be a less efficient sampling technique and electroshockers were not available. Madtoms placed in plastic bags for measurement were in motion constantly, so we decanted water to a minimum prior to measuring specimens. To reduce stress on individuals prior to release, we then measured total length (TL) rather than standard length (SL) on most live specimens. However, to allow comparisons with other studies, we measured both TL and SL on a subset of specimens (those collected 17 May and 25 July: N = 73). Reproductive data were noted when evident (females with eggs, breeding males identified by enlarged cephalic muscles). Subsequently, specimens were released at the site of capture, with the exception of three gravid females retained to obtain eggs counts (vouchered HSU 3589).

Ages of madtoms have been estimated by use of various bony structures (Clugston and Cooper 1960), which may require the sacrifice of specimens. To estimate age distributions without the need to sacrifice specimens, a plot of the frequency distribution of lengths was made for the collection dates of 17 May through 25 July, when sample sizes were larger and young-of-the-year (YOY) were appearing in the population. A linear regression analysis was performed on the data collected over the entire 284-day sampling period to determine the slope of the regression equation, which reflects the mean rate of growth in the population in mm/day. A second regression analysis concerning only hatchlings was made using data from 17 May – 25 July, when sample size permitted distinction of hatchling specimens based on bimodal distribution of sizes. This analysis was used to evaluate the expected higher growth rate for hatchlings during the warmer months (Mayden and Burr 1981, Mayden and Walsh 1984). For the regression analyses, dates were converted to days from day 1 (14 October) to day 284 (27 July).

## Results and Discussion

We made 609 captures over the 29 sampling dates between October and July. Hatchlings appeared in July, and 3 age (size) classes could be discerned at that time.

Densities of *N. lachneri* have been reported to be low (Robison and Harp 1985). Gagen et al., (1998) indicated higher than expected densities obtained by electrofishing, averaging 95/100 $m^2$ (range 17.2-204/100 $m^2$). We found usually 0-2, but a maximum of 8, *N. lachneri* per $m^2$ at the 4 plots over 15 dates (60 samples - mean 80/100 $m^2$). Densities differed at the 2 most productive sites, from May-July averaging 28.1/100 $m^2$ and 84.8/100 $m^2$.

At the latter site, a separate density estimate of 106/100 $m^2$ was calculated based on the largest sample of 33 individuals at the site of 31 $m^2$ area on 27 June. This should be a low estimate of density because it is unlikely that we caught all individuals at the site. However, these figures support the contention of Gagen et al., (1998) that densities of *N. lachneri* can be much higher at some locations than previously thought.

The mean ratio of SL/TL was 0.854 (85.4%, miminum 81.2%, maximum 90.0%, SE 0.26%). Similarly, a regression of SL against TL for *Noturus insignis* revealed a slope of 0.851 (Clugston and Cooper 1960). On average, the caudal fin comprises 14.6% of the total length.

The maximum length we found was 88 mm TL (73 mm SL), from a male collected 25 July. Previously reported maximum lengths were 69.5 mm SL (Robison 1980), a male 83.1 mm SL collected 1 August (Robison and Harp 1985), and 94 mm TL (we estimate 80.3 mm SL) (Gagen et al.1998). Adults usually range from 23-66 mm SL (Robison 1980), and the largest specimens collected in February by Fiorillo et al., (1999) were 69-70 mm (SL). Our largest specimens were male and were collected in July-August, thus it is likely that the maximum length is attained by males that die before the next spring (because none of that size was found entering the breeding season, and larger males appeared to be senescent).

The frequency distribution of lengths prior to the new hatch indicated 2 size (age) classes (Figure 1). With the hatch beginning in July, 3 age classes exist. However, older (larger) specimens were disappearing, and none were present in the previous October samples, suggesting longevity appears to be just over 2 years in the Cooper Creek population. Fiorillo et al., (1999) reported 3 size classes in a February sample from the Saline River, based on a plot of standard length versus body mass. Their larger specimens were 69-70 mm SL in the third size class. Specimens of this size did not appear in the Cooper Creek samples until May. If the sudden appearance (Figure 2) of these sizes does not indicate movement from other locations to the sample areas for breeding, it appears that longevity and adult sizes for *N. lachneri* may differ among localities, with maximum longevity just entering a third year. Based on our findings, very few individuals survived long into a third age class.

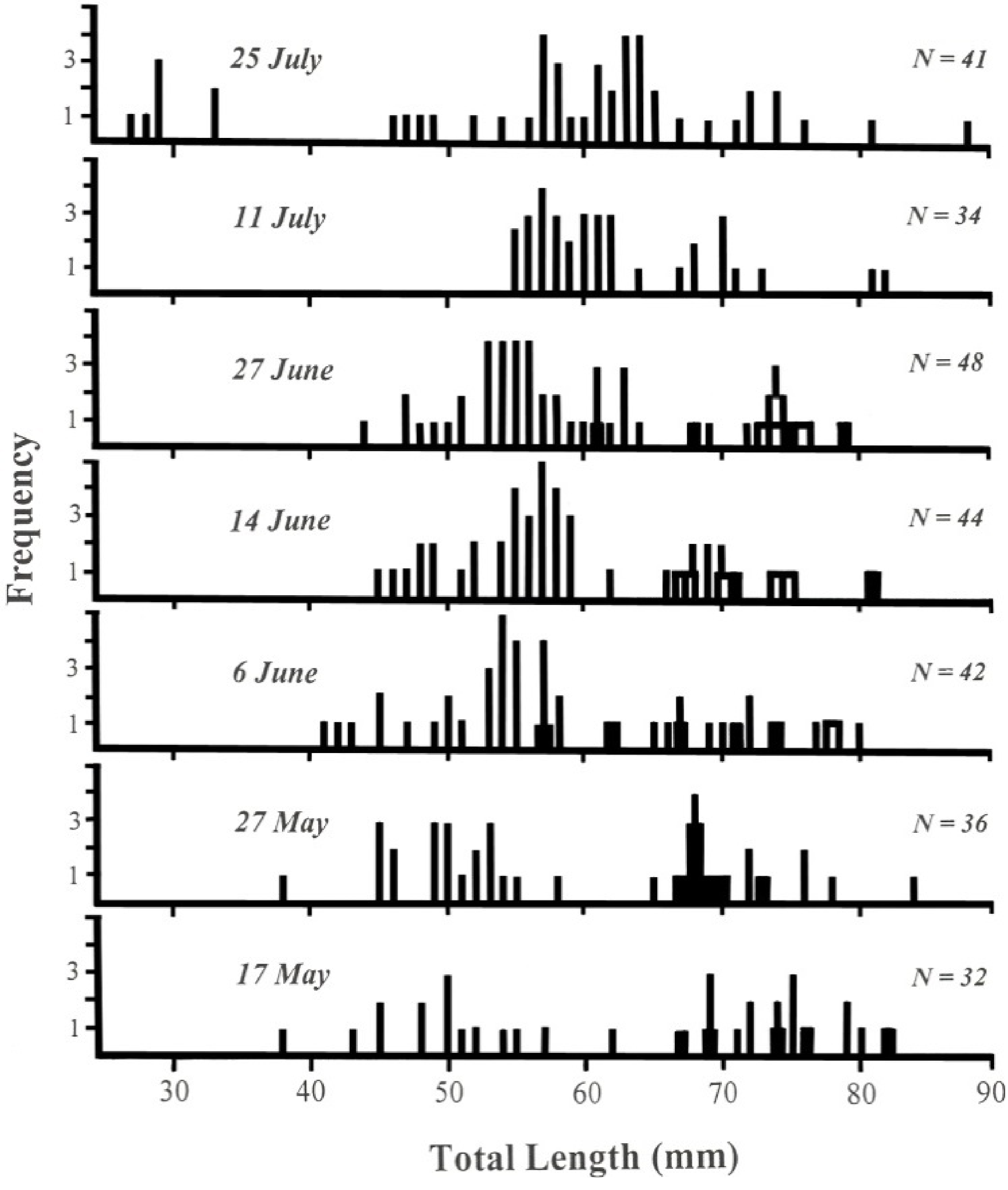


Figure 1. Frequency distribution of total lengths (mm) of *Noturus lachneri* for May-July, 1999-2000, collections in Cooper Creek, Garland Co., AR. Gravid females are indicated by blackened rectangles and breeding males by open rectangles. Earlier hatchlings were beginning to exceed 30 mm TL on 25 July.

Similarly, a study of *N. miurus* (Burr and Mayden, 1982a) found that < 0.5% of the population was $\geq$ 2 years old, and a study of *N. placidus* demonstrated that few individuals survived to age 2 (Bulger & Edds 2001).

Fiorillo et al., (1999) noted the small number of *N. lachneri* specimens in their third size class and reported that heavily parasitized individuals may experience greater mortality. We noted a battered

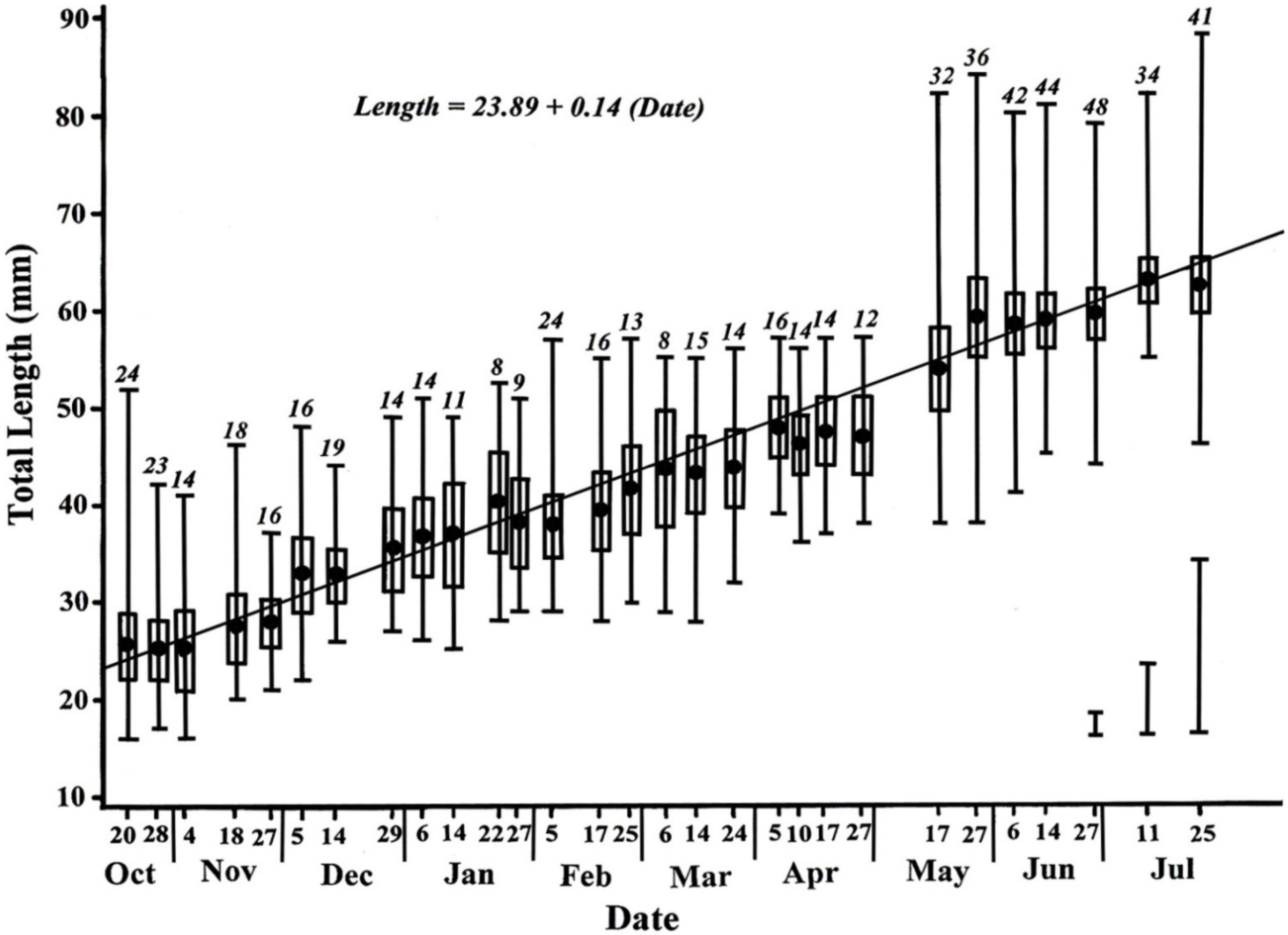


Figure 2. Linear regression of total length (mm) against time for *Noturus lachneri* in Cooper Creek, 1999-2000. Mean (black dot), ±2 SE (open rectangles), and range (bars) for each sample date are shown. Sample sizes appear above the maximum length for each date. Additional range bars in July reflect hatchlings (not used in calculation of the regression). The slope of the regression equation indicates a mean population growth rate of 0.14 mm/day, $R^2 = 0.69$.

appearance on many larger male specimens, which could indicate that costs of reproduction may contribute to mortality of larger (breeding) individuals.

The mean length of *N. lachneri* increased in a linear pattern (Figure 2). The slope of the regression equation indicated a mean growth rate of 0.14 mm/day ($R^2$ = 0.69, P < 0.0001), but the growth rate of hatchlings during the warmer months was estimated to be 0.20 mm/day ($R^2$ = 0.39, P < 0.0001). The regression likely appeared to be linear, even with 2 age classes present, because most of the juvenile cohort (the hatchlings from the previous year) already had accomplished its most rapid summer growth by the start of the study in October. Burr and Mayden (1982a) reported that one half of annual growth in length of *N. miurus* was attained within 2 months, and evaluated growth rate with a curvilinear regression model. In *N. insignis*, Clugston and Cooper (1960) noted a rapid increase in TL during the first 2 summers and thereafter only in late summer following reproduction.

Variation in the percent of each age class comprising successive samples could alter the calculated growth rate, thus the percent of each sample representing juveniles was calculated to evaluate bias. From October to early May, juveniles comprised an average of 80.1% of the samples (range 56-88%, with 10 of 12 dates ≥79%), meaning that about 80% of the sampled population during that portion of the year was from the most recent hatch. During the part of the reproductive season from mid-May through July, the frequency of the juvenile class (not including new hatchlings) decreased to an average of 67.9% (range 47-80%). At this time, more and larger adults were collected, perhaps because of spawning activity.

Smallest hatchlings were measured at 15 mm TL, and juveniles (N = 32) collected on 25 July (the same date when hatchlings became most common) averaged 61.4 mm TL (estimated 52.4 mm SL). Average size of adults (N = 10) on 27 June (when hatchlings were first observed) was 73.4 mm TL (estimated 62.7 mm SL).

Populations of madtoms can be especially susceptible to environmental damage if individuals are semelparous (Simonson and Neves 1992, Fuselier and Edds 1994). Presently, reproductive data for *N. lachneri* are limited (Robison and Buchanan 1988, Stoeckel et al. 2011). In our study, 5 of 18 adults (identified when TL > 65 mm, see Figure 1) were identifiable as females with developing eggs on 17 May (water temperature 19.0°C). Gravid females were noted on each collection date through 27 June (Figure 2, blackened rectangles). The frequency distribution of sizes indicated that on 6 June and 27 June, 2 females presumably of the juvenile class (based on TL of 57 and 61 mm) were gravid with eggs visible through the abdomen. Stoeckel et al. (2011) also noted oocyte development in some smaller *N. lachneri* and believed that females mature between 58 – 66 mm TL in Saline River drainage populations. Most reproductive females in our study were estimated to be 2 years old (Figure 1). Mature ova in subadults are also known in *N. exilis* (Mayden and Burr 1981) and *N. miurus* (Burr and Mayden 1982a).

Counts of eggs were made on 3 preserved gravid females. Two females collected 17 May (TL = 82 mm) and 27 June (TL = 79 mm) contained 25 and 22 eggs, respectively, of 2-3 mm diameter. A third female collected 17 May (TL = 69 mm) contained 37 eggs of 1.5-2.5 mm diameter. The only nest found, on 6 June, contained 23 eggs. A mean number of 35 oocytes was found in *N. lachneri* during a Saline River drainage study, and the mature size was estimated to be >3 mm (Stoeckel et al. 2011).

Schooling or ‘communal activity’ was not observed by Robison and Harp (1985). No schooling was observed in our study, however on 27 May, 4 individuals were revealed by lifting a single stone of 150 mm diameter. This proximity may be due to the onset of the reproductive season, although these specimens were not caught to determine their sex. Previously, pairs of unsexed madtoms were seen in Cooper Creek by lifting single stones in July (Tumlison and Tumlison 1996).

Males of many species of madtoms are known to guard the nest (Taylor 1969, Robison and Buchanan 1988). As in many other species of madtoms, breeding males of *N. lachneri* can be identified by the enlarged cephalic epaxial muscles, and such males were found from 6 June through 27 June (open rectangles, Figure 1). On 6 June, at a water temperature of 17.0°C, a male 78 mm TL was found guarding a nest. The clutch consisted of 23 eggs of yellowish color adhering to one another in a mass. The brooding site was a depressed area under a flat stone 190 x 180 mm wide and 30 - 40 mm thick, at a water depth of 200 mm. The site was mid-stream about 3.5 m from each bank, and in a pool area just upstream from the nearest riffle. Stoeckel et al. (2011) reported nests of *N. lachneri* from mid-June through July at water temperatures of 19-27°C and with characteristics consistent with this single observation. These habitat characteristics also are consistent with other descriptions of nests of *Noturus* (Mayden et al. 1980, Mayden and Burr 1981, Burr and Mayden 1982a).

As a behavioral caveat, we noted this male remained on site even when the eggs were dipped into a net, allowing the individual to be captured. Non-brooding madtoms moved to cover under adjacent stones when a stone was lifted exposing them. The male and the egg mass were placed in the same bucket, and the male ingested the eggs. Similarly, Burr and Mayden (1982a) noted that a disturbed guardian male *N. miurus* picked up a clutch of eggs and shook it vigorously. By 27 June, breeding males tended to be thin and battered in appearance, and were less vigorous in attempts to escape capture, presumably as a result of the energy spent guarding the eggs and the concomitant lack of opportunity to forage. We found no evidence of males breeding in their first year.

Robison and Buchanan (1988) reported hatchlings (16-25 mm SL) collected 1 August, and Tumlison and Tumlison (1996) found hatchlings (20 mm SL) as early as 15 July but more commonly on 29 July (15 mm SL). In the present study, hatchlings (2, each 17 mm TL) were first captured on 27 June (water temperature 21.5°C). Eight hatchlings, 20-23 mm TL, were seen on 11 July. By 25 July, hatchlings of different sizes were found: 9 recently hatched at 15 mm TL and 22 older hatchlings at 27-33 mm TL. Although most hatching appears to occur in late July and August, recent hatchlings still were found as late as 20 October (18 mm), 28 October (17 mm), and 4 November (16 mm). From these data, the length of the hatching season appears to be from late June through early November. It is not known whether the long hatching season is extended via multiple spawning as suggested by Mayden and Burr (1981) and Vives (1987) for *N. exilis*.

Finding hatchlings in a stream smaller than was considered to be typical habitat, Robison and Harp (1985) suggested that *N. lachneri* may move to spawn in smaller tributaries. In contrast, Vives (1987) found no significant difference in depths occupied by smaller versus larger *N. exilis*. Some species of *Noturus* move to riffles to spawn (Mayden and Burr 1981), and others move to pools (Burr and Mayden 1982b, Starnes and Starnes 1985). We seldom found hatchlings of *N. lachneri* in mainstream sections of the sample sites, but did discover many of them while searching smaller and shallower reaches of the stream. If most spawning did not occur at these fine-grained sites, at least the young moved there soon after hatching.

Searches for hatchlings of *N. lachneri* revealed them in shallower riffle areas where cobble protruded above the surface of the water and where particle size of most of the substrate was smaller (gravel versus cobble). Tumlison and Tumlison (1996) previously noted that smaller YOY tended to be found in finer-grained microhabitat. Only 1 nest was found during this study, but Stoeckel et al. (2011) also found nests in similar conditions in Saline River populations. If these observations do represent typical spawning habitat, hatchlings soon move into the smaller gravel of the main stream but away from the larger individuals until some growth has occurred.

This madtom is considered to be a species of special concern largely due to its very limited range and lack of life history information. Our results reveal that the species is short-lived and most individuals likely breed only once, therefore it is important that habitats be protected against sedimentation and other degradation to the limited habitat.

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## Literature Cited

**Buchanan TM**. 1974. Threatened native fishes of Arkansas. *In*: Arkansas natural area plan. Arkansas Dept. of Planning, Little Rock, AR. p. 67-92.

**Bulger AG** and **DR Edds**. 2001. Population structure and habitat use in Neosho madtom (*Noturus placidus*). Southwestern Naturalist 46:8-15.

**Burr BM** and **RL Mayden**. 1982a. Life history of the brindled madtom *Noturus miurus* in Mill Creek, Illinois (Pisces: Ictaluridae). American Midland Naturalist 107:25-41.

**Burr BM** and **RL Mayden**. 1982b. Life history of the freckled madtom *Noturus nocturnus* in Mill Creek, Illinois (Pisces: Ictaluridae). Occasional Papers, Museum of Natural History, University of Kansas 98:1-15.

**Clugston JP** and **EL Cooper**. 1960. Growth of the common eastern madtom, *Noturus insignis* in central Pennsylvania. Copeia 1960:9-16.

**Fiorillo RA**, **RB Thomas**, **ML Waren Jr**. and **CM Taylor**. 1999. Structure of the helminth assemblage of an endemic madtom catfish (*Noturus lachneri*). Southwestern Naturalist 44:522-526.

**Fuselier L** and **D Edds**. 1994. Seasonal variation in habitat use by the Neosho madtom (Teleostei: Ictaluridae: *Noturus placidus*). Southwestern Naturalist 39:217-223.

**Gagen C**, **JRW Standage** and **JN Stoeckel**. 1998. Ouachita madtom (*Noturus lachneri*) metapopulation dynamics in intermittent Ouachita Mountain streams. Copeia 1998:874-882.

**Mayden RL** and **BM Burr**. 1981. Life history of the slender madtom, *Noturus exilis*, in southern Illinois (Pisces: Ictaluridae). Occasional Papers, Museum of Natural History, University of Kansas 93:1-64.

**Mayden RL**, **BM Burr** and **SL Dewey**. 1980. Aspects of the life history of the Ozark madtom *Noturus albater* in southeastern Missouri USA (Pisces: Ictaluridae.) American Midland Naturalist 104:335-340.

**Mayden RL** and **SJ Walsh**. 1984. Life history of the least madtom *Noturus hildebrandi* (Siluriformes Ictaluridae) with comparisons to related species. American Midland Naturalist 112:346-368.

**Patton TM** and **ML Zornes**. 1991. An analysis of stomach contents of the Ouachita madtom (*Noturus lachneri*) in three streams of the upper Saline River drainage, Arkansas. Proceedings of the Arkansas Academy of Science 45:78-80.

**Robison HW**. 1980. *Noturus lachneri* Taylor, Ouachita madtom. *In*: Lee DS, CR Gilbert, CH Hocutt, RE. Jenkins, DE McAllister and JR Stauffer, Jr., editors. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History (Raleigh) p. 462

**Robison HW** and **TM Buchanan**. 1988. Fishes of Arkansas. University of Arkansas Press, Fayetteville (AR). 536p.

**Robison HW** and **GL Harp**. 1985. Distribution, habitat and food of the Ouachita Madtom, *Noturus lachneri*, a Ouachita River drainage endemic. Copeia 1985:216-220.

**Simonson TD** and **RJ Neves**. 1992. Habitat suitability and reproductive traits of the orangefin madtom *Noturus gilberti* (Pisces: Ictaluridae). American Midland Naturalist 27:115-124.

**Starnes LB** and **WC Starnes**. 1985. Ecology and life history of the mountain madtom, *Noturus eleutherus* (Pisces: Ictaluridae). American Midland Naturalist 114:331-341.

**Stoeckel JN**, **CJ Gagen**, and **RW Standage**. 2011. Feeding and reproductive biology of Ouachita Madtom. American Fisheries Society Symposium 77:267-279.

**Taylor WR**. 1969. Revision of the catfish genus *Noturus* Rafinesque, with an analysis of higher groups in the Ictaluridae. Bulletin of the United States National Museum 282:1-315.

**Tumlison R** and **C Tumlison**. 1996. A survey of the fishes in streams draining the Jack Mountain area, Hot Spring and Garland Counties, Arkansas, with notes on the Ouachita Madtom (*Noturus lachneri*). Proceedings of the Arkansas Academy of Science 50:153-158.

**Vives SP**. 1987. Aspects of the life history of the slender madtom *Noturus exilis* in northeastern Oklahoma (Pisces: Ictaluridae). American Midland Naturalist 117:167-176.