

## **TADPOLE MADTOM (*NOTURUS GYRINUS*) BIOLOGY IN AN UPPER MISSOURI RIVER BACKWATER**

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### **ABSTRACT**

A tadpole madtom (*Noturus gyrinus*) population was found in Erickson Island Slough, an upper Missouri River backwater in western North Dakota. We assessed basic tadpole madtom biology to obtain baseline data that may be useful when evaluating its interactions in this backwater community. Tadpole madtoms were collected in May, July, and September of 1997 and 1998. Catch per unit effort was <5/trap net night on all sample dates, but increased by more than 4,000% from 1997 to 1998. The population was dominated by age-2 and younger tadpole madtoms. Growth rates were higher than other populations during the first two growing seasons, but decreased sharply after age 2. Food habits were similar to those reported for other populations, with tadpole madtoms primarily consuming chironomids and crustaceans. High reproductive potential, a reputation of existing at high densities, and food habits similar to other native species indicate that tadpole madtoms have the potential to become a common backwater community member and exert influence on the local aquatic system.

### **Keywords**

tadpole madtom, *Noturus gyrinus*, backwaters, Missouri River

### **INTRODUCTION**

The tadpole madtom *Noturus gyrinus* is widespread in eastern North America (Page and Burr 1991) and has been documented in the James, Red, and Big Sioux river systems of the Dakotas. Lee et al. (1980) reported that the tadpole madtom did not occur upstream of Gavins Point Dam in the Missouri River basin; however, North Dakota Game and Fish Department biologists collected this species from Lake Sakakawea in western North Dakota during sampling in 11 of the years between 1956 and 1994 (Hendrickson et al. 1995). We found a population of tadpole madtoms in a Missouri River backwater in northwestern North Dakota (Fig. 1), upstream of Lake Sakakawea.

Since closure of mainstem dams, the reservoir system likely inhibited additional movement of tadpole madtoms up the Missouri River. Therefore, the species may have been either present in low numbers, existing in unsampled

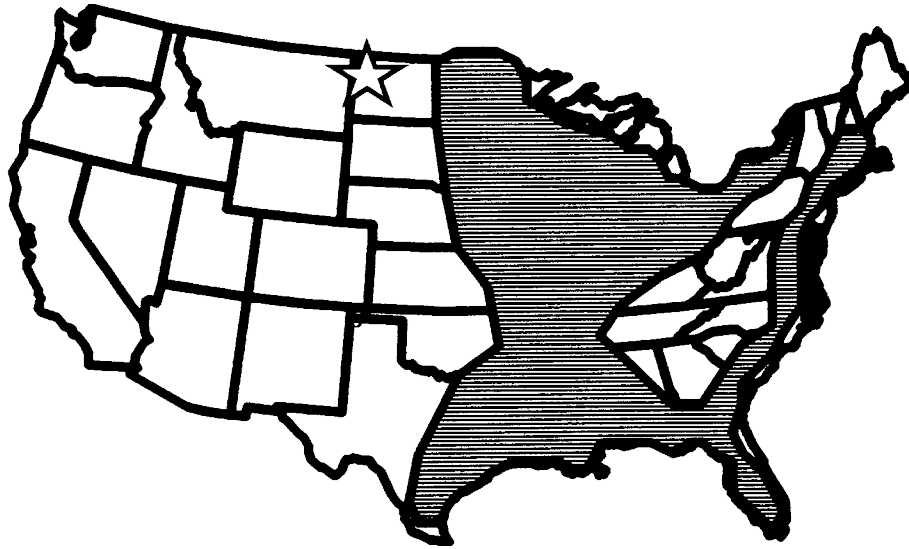


Figure 1. Historical range (shaded area) of tadpole madtoms in the United States. The Erickson Island Slough population is outside of this range (star).

habitats since a time prior to dam closures, or accidentally introduced by anglers who utilize this species as bait in many northern rivers (Eddy and Underhill 1974). Regardless of how tadpole madtoms became established in western North Dakota, the species tends to be abundant where it is found and can affect other species (Hooper 1949). Understanding the structure and function of tadpole madtom populations in regions of potentially critical habitats for native fishes of concern, such as pallid sturgeon *Scaphirhynchus albus*, blue sucker *Cycleptus elongatus*, and sicklefin chubs *Macrhybopsis meeki*, is important. Therefore, the objective for this study was to assess the biology of the species, including evaluations of relative abundance, age and size structure, growth, mortality, and food habits.

#### STUDY SITE

Erickson Island Slough (EIS) is a Missouri River backwater located in Williams and McKenzie counties in northwestern North Dakota. This oxbow wetland has a surface area of approximately 1,100 ha; however, surface area and mean depth vary with changes in seasonal inflow resulting from the dynamic hydrograph of the Missouri River. Due to the strong lotic influence exerted by the unregulated Yellowstone River, EIS and other backwaters in the region have maintained a reasonably historic structure and function.

#### METHODS

Fishes, including tadpole madtoms, were collected with trap nets in May, July, and September of 1997 and 1998 from EIS. We conducted a standard sam-

ple of 18 net nights per sample period (nine nights with nets having 0.9- x 1.8-m frames, 9.5-mm bar mesh, and 16- x 0.9-m leads, and nine nights with nets having 0.6- x 0.9-m frames, 9.5-mm bar mesh on the frames, 3-mm bar mesh on the hoops, and 7- x 0.6-m leads). When tadpole madtom catches were insufficient for food habits and aging analyses, we used additional trap net nights to increase sample size.

Tadpole madtom population density was indexed using catch per unit effort (CPUE) in 1998 and 1997. We defined CPUE as the number of tadpole madtoms per trap net night. We also wanted to compare the relative abundance of tadpole madtoms in EIS with those of other populations; however, no comparison trap net CPUE data were located.

Tadpole madtoms collected during all 1998 trap net sampling were measured to the nearest millimeter total length (TL). Ten fish per centimeter length group from the September sample were placed on ice and returned to the laboratory at South Dakota State University for age analysis. Length data were summarized into seasonal length-frequency histograms and tadpole madtoms retained in September were aged by reading annuli on cross-sections of the pectoral spine.

Left pectoral spines were grasped with a forceps and removed by pressing the spine flat against the body and rotating clockwise (Sneed 1951). Spines were stored in scale envelopes, allowed to dry, cleaned of extraneous tissue, and mounted in a wooden mold (Margenau 1982). We used clear epoxy and lined the trough (6.5 x 6.5 x 230 mm) with wax paper. Mounted spines were allowed to harden for 24-36 h. Cross sections were removed from the spine at the distal end of the basal groove using a jewelers saw (Sneed 1951) and polished with 220-grain sandpaper. Cross sections were placed in a shallow concave glass plate, covered in water (to clarify view), and viewed with a dissecting microscope. Tadpole madtoms were assigned ages based on criteria suggested by Clugston and Cooper (1960), who found that the presence of thin, clear zones under transmitted light indicated slower winter growth and wider dark zones represented faster summer growth. Spines were aged by two independent readers, discrepancies were discussed, and an age was assigned. Percent agreement between readers was calculated and an age-frequency histogram was developed.

We calculated mean TL at age for tadpole madtoms collected in September of 1998. Growth, as represented by the mean TL values, was compared with the mean TL at age for tadpole madtoms collected at other geographic locations during late August or September. Growth data from Hooper (1949) and Mahon (1977) were reported in standard length, which we converted to total length based on Becker (1983).

An annual mortality rate for tadpole madtoms from EIS was estimated using age-structure data collected in September of 1998. We used the Chapman-Robson method because Everhart et al. (1975) suggested that this method would provide a reasonable annual mortality estimate from age-structure data. Stomachs (N=30) were eviscerated from tadpole madtoms collected during each sample period in 1998. Stomach contents were assessed and seasonally quantified into percent by number (number of food items in that category/to-

tal number of items) and frequency of occurrence (number of fish containing that food category/total number of fish). Sample sizes were insufficient to assess food habits by size groups; thus, all lengths were pooled.

## RESULTS AND DISCUSSION

### Relative abundance

CPUE during May, July, and September of 1998 was 0.6 (SE=0.2), 0.1 (SE=0.8) and 4.6 (SE=1.4), respectively (Table 1). A high proportion of the sub-

Table 1. Mean catch per unit effort (CPUE; number per trap net night) for tadpole madtoms collected from Erickson Island Slough, North Dakota in 1997 and 1998. The standard error of each mean is listed in parentheses.

<b>Sample period</b>	<b>1997 CPUE</b>	<b>1998 CPUE</b>
May	0.0 (0.0)	0.6 (0.2)
July	0.2 (0.1)	0.1 (0.1)
September	0.1 (0.1)	4.6 (1.4)

stantial increase in the 1998 September CPUE reflects highly abundant age-0 tadpole madtoms entering the sampled population. Tadpole madtom CPUE was considerably lower in 1997 than in 1998. Two possible explanations for the higher CPUE values in 1998 are capture efficiency differences between years and increasing tadpole madtom density.

Lee et al. (1980) suggested that where tadpole madtoms are found, they often attain high densities. Although the September CPUE increased by more than 4,000% from 1997 to 1998, the relative abundance is still low in the EIS population. However, Hooper (1949) reported that tadpole madtoms composed 35% of the total fish biomass in Demming Lake, again supporting the contention that the species is capable of becoming abundant. The differences in CPUE between 1997 and 1998 may also be attributed capture efficiency. Peak 1997 flow exceeded 2,400 m<sup>3</sup>/s, whereas peak flow in 1998 was approximately 850 m<sup>3</sup>/s. The higher water levels in 1997 created habitats difficult to sample and preferred by tadpole madtoms; thus, we believe that capture efficiency was likely lower.

### Size and age structure

Low sample size limited the interpretive value of the length-frequency histograms for tadpole madtoms collected in May and July of 1998. However, of

the tadpole madtoms sampled, we verified that a mode containing age-1 and age-2 madtoms was present and moved from a median of 5-cm TL in May to 8-cm TL in September (Fig. 2). By September, a second mode of madtoms with a median TL of 5 cm was present. We verified that the second mode was dominated by age-0 tadpole madtoms.

The tadpole madtoms collected in September (N=68) ranged in age from 0 to 3 (Figure 3). Hooper (1949) detected tadpole madtoms up to age 2 in Deming Lake, Minnesota and other studies have reported madtoms up to age 3 (Mahon 1977; Paruch 1979) in northern portions of their range.

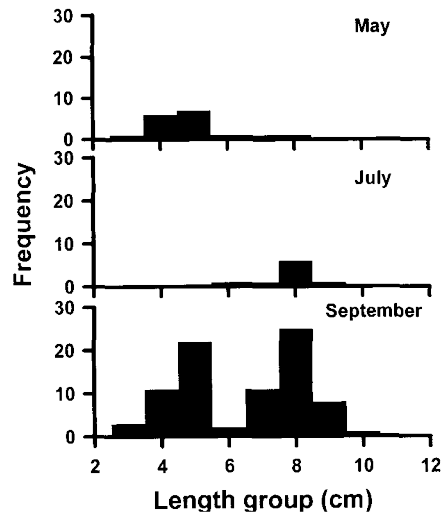


Figure 2. Size structure of tadpole madtom samples collected with trap nets from Erickson Island Slough, North Dakota during May (top), July (middle), and September (bottom) of 1998.

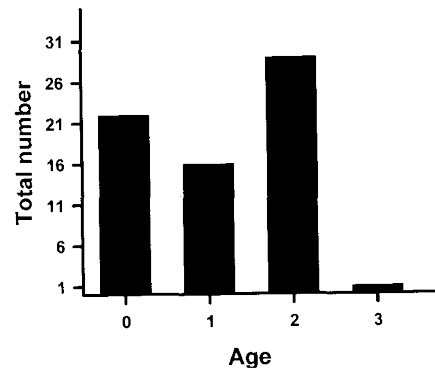


Figure 3. Age structure of tadpole madtoms collected in September of 1998 from Erickson Island Slough, North Dakota.

However, tadpole madtoms may grow older at southern latitudes. Whiteside and Burr (1986) documented age-4 tadpole madtoms from creek populations in southern Illinois.

#### Growth

Growth of tadpole madtoms up to fall age 1 in EIS appeared to exceed growth rates for other reported populations (Fig. 4). Tadpole madtoms typically hatch in June or July (Becker 1983). EIS age-0 tadpole madtoms attained a mean TL of 50 mm by September and added a 30-mm increment during the age-1 growing season. However, after the second growing season, growth of tadpole madtoms in EIS slowed considerably; they added only a 9-mm increment during the third growing season.

The apparent decrease in EIS tadpole madtom growth rates may be attributable to environmental conditions, energy allocation, and/or interspecific

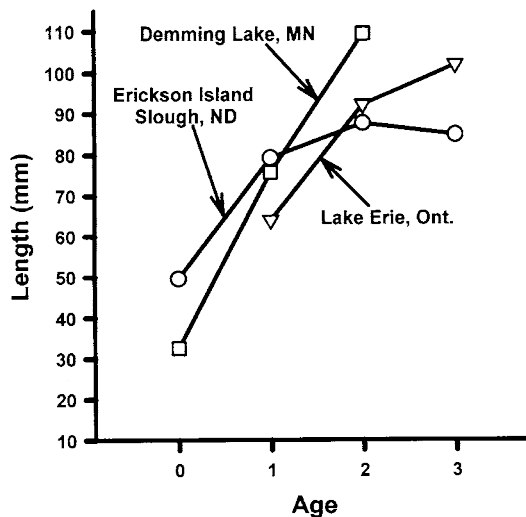


Figure 4. Mean total length at age for tadpole madtoms collected during late August and/or early September in 1998 from Erickson Island Slough, North Dakota, in 1975 from Demming Lake, Minnesota (Hooper 1949), and in 1946 from Lake Erie, Ontario (Mahon 1977).

competition for available food resources. The EIS tadpole madtom population exists on the edge of their range; therefore, environmental conditions, particularly cold, extended winters, may have a negative effect on the species. Pflieger (1975) stated that most tadpole madtoms reproductively mature at age 2. Thus, energy allocations may be moved from somatic to gonadal growth. Also, several native species that frequently utilize EIS, including river carpsucker *Carpionodes carpio*, black bullhead *Ameiurus melas*, age-0 buffaloes *Ictiobus* spp., and age-0 channel catfish *Ictalurus punctatus*, tend to consume similar prey, as will be discussed later. However, deleterious

competition for food resources assumes that food availability is limiting.

Growth of age-2 tadpole madtoms in Demming Lake did not substantially decrease as did growth of EIS madtoms. The Demming Lake fish community consisted of northern pike *Esox lucius*, pumpkinseed *Lepomis gibbosus*, yellow perch *Perca flavescens*, black bullhead, and tadpole madtoms (Hooper 1949). The simple community in Demming Lake may have not experienced interspecific competition, particularly because black bullhead density was low. In EIS, juvenile black bullhead CPUE in 1997 and 1998 from EIS often exceeded 1,000/trap net night; therefore, interspecific competition was possible.

#### Annual mortality

Annual mortality of tadpole madtoms was estimated at 47%. Our annual mortality rate was considerably lower than the rate reported for age-1 and -2 tadpole madtoms in Demming Lake, Minnesota (97.4%; Hooper 1949), Lake Erie (77.8%; Mahon 1977), and Dutchman Creek, Illinois (67.6%; Whiteside and Burr 1986). The lower mortality rate that we report here may be skewed by the inclusion of age-0 fish and the lack of a stair-step age-frequency distribution. The age-structure histogram (Figure 3) indicates that recruitment of tadpole madtoms likely is erratic in EIS. For example, the age-2 cohort (1996 year

class) is more abundant (i.e, strong year class) than would be expected given the abundance of age-1 and age-3 fish.

#### Food habits

All 30 of the tadpole madtom stomachs examined contained food items. Copepoda, Diptera (>95% Chironomidae), and Plecoptera were primary diet items in May (N=11; Table 2). During July (N=7) and September (N=12),

Table 2. Summary of food items found in tadpole madtom stomachs collected from Erickson Island Slough, North Dakota, in May (n=11), July (n=7), and September N=12) of 1998. Percent by number (total number of items in each category/total number of items in all categories), and frequency of occurrence (number of fish containing food item/total number of fish) are reported.

<b>Diet item</b>	<b><u>Percent by number</u></b>			<b><u>Frequency of occurrence</u></b>		
	<b>May</b>	<b>July</b>	<b>September</b>	<b>May</b>	<b>July</b>	<b>September</b>
Plant material	0.0	10.4	16.2	0.0	14.3	33.3
Copepoda	32.5	4.4	20.0	63.6	28.6	50.0
Cladocera	2.0	3.6	1.3	0.0	14.3	16.7
Hydracarina	0.2	0	0.2	9.1	0.0	8.3
Amphipoda	0.4	0	1.0	9.1	0.0	25.0
Corixidae	4.7	6.8	1.7	45.5	57.1	8.3
Diptera	21.3	59.9	56.8	54.5	100.0	100.0
Ephemeroptera	0.7	0	0	9.1	0.0	0.0
Odonata	0.2	0	0.4	9.1	0.0	16.7
Plecoptera	22.4	10.2	1.1	81.8	57.1	16.7
Trichoptera	11.5	4.7	0.5	54.5	28.6	16.7
Fish eggs	4.0	0	0	9.1	0.0	0.0
Fishes	0	0	0.8	0.0	0.0	8.3

Diptera made up more than 55% by number of the tadpole madtom diet and Plecoptera and Trichoptera utilization decreased. Diptera were also utilized by most tadpole madtoms, occurring in 55% of the stomachs in May and 100% of the stomachs in July and September. Corixidae and Copepoda were the most persistent stomach contents among seasons and late summer diets indicated some usage of plant material and other items, such as small fish, Amphipoda, and Odonata. Regardless of sample region, tadpole madtom diets appear to be dominated by insect larvae and zooplankton. Whiteside and Burr (1986) reported that the predominant stomach contents of 267 tadpole madtoms col-

lected in southern Illinois were Diptera larvae (primarily Chironomidae) and Crustacea. Historical reports (e.g., Adams and Hankinson 1928) also indicated that tadpole madtoms primarily feed on Chironomidae and Crustacea.

#### ACKNOWLEDGMENTS

We thank the many individuals who assisted in field collections, logistics, and analysis, including Dan Moon, Randy Sheik, Dray Walter, Gene Galinat, Tim Bister, Steve Krentz, Mike Olson, and Derek Klawitter. Funding for this project was provided by the U. S. Fish and Wildlife Service, Bismarck, North Dakota, and the U.S. Department of Agriculture Multicultural Scholars Program at South Dakota State University. This manuscript was approved for publication by the South Dakota Agricultural Experiment Station as Journal Series No. 3119.

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