THE UNEXPECTED PRESENCE OF THE SLENDER MADTOM IN ROCK LAKE, WISCONSIN



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"I've been in the wrong place, but it must have been the right time" Lyrics by Dr. John, aka Malcolm John Rebennack Jr. (1973)

We still don't know quite what to make of our discovery. Finding a new population of a rare fish species is always exciting. But finding the population in a completely atypical and unexpected spot can be a bit disconcerting. It calls into question what you think you know about the biology and habitat preferences of the species and, in a larger sense, your competence as a naturalist. Such was the case when we found Slender Madtom *Noturus exilis* in Rock Lake, Wisconsin (Figure 1), to our knowledge the first and only population of this normally flowing-water fish species from a natural lake.

Our tale begins on July 23, 2013, when three of us—Patricia Cicero, Dave Marshall, and Laura Stremick-Thompson—were conducting a survey of the small nearshore fishes of Rock Lake, a 569-hectare (1,365-acre), 18 meter-deep (60 feet), clear-water, natural lake in the Rock River drainage of the Mississippi River basin in south-central Wisconsin. This lake has several regionally uncommon species including Pugnose Shiner *Notropis anogenus* and Least Darter *Etheostoma microperca*, and the survey was to check on their status. As its name suggests, Rock Lake has extensive areas of rocky shoreline that are difficult to sample effectively for bottom-dwelling fishes with

Photos by John Lyons.

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seines and other types of nets. Specifically to cover these rocky areas, Dave had brought a small tow-barge electroshocker with a hand-held anode. Near the Town of Lake Mills boat landing at the north end of the lake (Figure 2) the team electrofished three madtoms. Tadpole Madtoms N. gyrinus are known from the lake, but these fish didn't look right. The crew tentatively identified them as Stonecats N. flavus, a surprising find given that Stonecats are normally stream dwellers, but the species is common in southern Wisconsin, and the proximity to the boat ramp suggested a possible bait-bucket release by an angler who had caught his or her bait locally. Dave mentioned the find to John Lyons, then non-game fish specialist for the Wisconsin Department of Natural Resources (WDNR) as well as Curator of Fishes at the University of Wisconsin Zoological Museum (UWZM). John was intrigued, and he berated Dave good-naturedly for not preserving a specimen or taking a photo. Dave promised to look for more specimens when they completed the lake survey later that field season.

On September 23, 2013, Patricia, Dave, and Laura conducted another shoreline fish survey, and they again caught three madtoms near the boat landing. This time they photographed all three fish and preserved one. When John saw the photos and the specimen (catalogued as UWZM 16286), he was dumbfounded. These weren't



Figure 1: Slender Madtom from Rock Lake, Wisconsin, June 25, 2019.



Figure 2: Rock Lake, Wisconsin, as viewed from the Town of Lake Mills boat landing, the location where Slender Madtom were first captured. Photo date: August 5, 2015.

Stonecats, which would have been unusual enough, but rather they were the locally rare Slender Madtom—completely unexpected.

After the surprise faded a bit, excitement in this new find took over. Laura, the most poetic of the sampling team, was so inspired that she composed an ode:

Slender madtom of the genus Noturus, so much cooler than the gamefish that bore us.

So elongate and smooth with no overbite. Secretive in nature, you hold to the substrate so tight.

Your relative abundance is rare, a lotic system you prefer. So your presence in Rock Lake creates quite a stir.

To those who adore you, you need not explain. Your increase in occurrence is certainly our gain.

We had the following questions. First and foremost, what was the Slender Madtom doing in Rock Lake? Was it native or the result of an introduction or recent invasion? The Slender Madtom has long been thought of as essentially an obligate stream or river dweller. There are a few reports of occasional specimens from riverine impoundments in Kentucky and Iowa (Burr and Warren 1986; Harlan et al. 1987) but none from natural lakes. (Note: the record for Slender Madtom in an Iowa impoundment was rejected by Taylor [1969:67] and is thus considered doubtful by some fish biologists in Iowa.) Although our initial assumption was that these fish were from a bait bucket release, as we thought about it more, we decided that an angler release of a Slender Madtom into Rock Lake seemed unlikely. The Slender Madtom is extremely rare in Wisconsin, in decline, and on the state endangered list (Lyons 1996). It is difficult to collect even in targeted electrofishing surveys of known stream habitats, and the odds of an angler catching one specimen locally for bait with a seine or dip net, much less three, were extremely low. The species is more common (but still difficult to catch) in parts of central Iowa, southern Illinois, central Kentucky, central Tennessee, Missouri, Arkansas, northeastern Oklahoma, and eastern Kansas, but then an angler would have had to bring multiple fish hundreds of miles before releasing them. Rock Lake does draw out-of-state visitors, particularly from northern Illinois, but relatively few from areas where the Slender Madtom is more numerous. Consequently, the possibility of an angler transporting Slender Madtoms as bait from areas further south could not be completely ruled out, but again this seemed to be a very low-probability scenario. Recent natural colonization also seemed unlikely. The nearest records of the Slender Madtom were at least 50 river miles away (Figure 3). And any fish trying to reach Rock Lake would have had to traverse several dams, including one about 10 feet high on the outlet of Rock Lake, Rock Creek, that dates back to 1865. The lake has no inlets with habitat suitable for Slender Madtom. Genetic analyses could help clarify the



Figure 3: The distribution of Slender Madtom in southern Wisconsin. All occurrences are in the Rock River drainage of the Mississippi River basin. Open-red circles indicate records from prior to 2000; these populations are presumed extirpated. Blue-filled circles indicate records since 2000; these populations are presumed extant.

	Town of Lake Mills Boat Landing			Tyranena County Park (Jefferson			Fremont Street (City of Lake Mills)		
				County) Lake Public Access			Lake Public Access		
Survey Date	Catch	Meters	Catch/100 m	Catch	Meters	Catch/100 m	Catch	Meters	Catch/100 m
July 23, 2013	3	100	3.0	NS	—	_	NS	_	_
Sept. 23, 2013	3	100	3.0	NS	—	_	NS	_	_
July 19, 2014	2	100	2.0	NS	_	_	NS	_	_
Aug 6, 2015	2	100	2.0	1	100	1.0	4	120	3.3
May 31, 2017	4	100	4.0	NS	—	_	NS	—	_
June 8, 2017	NS	_	—	3	100	3.0	2	70	2.9
June 25, 2019	5	160	3.1	6	120	5.0	0	70	0

 Table 1: Sites sampled for Slender Madtom on Rock Lake, Wisconsin. NS = Not Sampled



Figure 4: Map of Rock Lake, showing sampling areas and potential Slender Madtom habitat.



Figure 5: Sampling Rock Lake at the Tyranena County Park site on June 25, 2019, with a tow-barge electroshocker. From left to right, Dave Marshall, Will Wawrzyn, Patricia Cicero, Laura Stremick-Thompson, and an unidentified person behind Dave.

origin of the Rock Lake population, but lacking that, we concluded that the Slender Madtom population in Rock Lake was natural and had always been present but had been missed in earlier nearshore surveys that had employed only seines, coarse-mesh fyke nets, or boatmounted electrofishers.

What was the status of the Slender Madtom population in Rock Lake? That would require more sampling. Dave, now retired from WDNR, visited the boat-landing site again on July 19, 2014, and caught two more Slender Madtoms. Resources for non-game fish surveys within the WDNR were limited, and John wasn't able to get to Rock Lake to do a more extensive survey until 2015. On August 5, he visited the three public-access sites (Table 1; Figure 4)-including the boat landing-along the rocky northern and eastern shorelines of the lake. With the exception of a few localized rocky areas, the rest of the lake has sand and marl (calcareous silt) nearshore substrates, unsuitable for the rock-loving Slender Madtom. All three sites yielded Slender Madtoms. Catches were low, ranging from 1-3.3 per 100 meters of shoreline shocked. John repeated these surveys on May 31 and June 8, 2017, and again caught madtoms at each site (one of which was preserved as UWZM 17801) with catch rates ranging from 4-5 per 100 m. Finally, on July 25, 2019, Patricia, Dave, John, Laura, and Will Wawrzyn sampled the three sites again (Figure 5), catching Slender Madtoms at two of the sites at a rate of 3.1–4.2 per 100 m.

The habitat where Slender Madtoms occurred in Rock Lake was consistent across all surveys. Madtoms were found only immediately adjacent to shore (within 0.3 m) in water less than 0.3 m deep and under large (> 0.2 m) cobbles and small (< 0.5 m) irregularly shaped boulders (Figure 6). They did not occur in deeper water or further offshore, even though similar rocky habitat extended out to about 1.2 m depth and up to 10 m from shore. They were not found under larger rounded boulders placed as riprap nor under woody debris. Each fish was found separately, and none shared a rock. The areas they occupied had almost constant water movement from waves lapping the shore, even on calm days. This water movement is perhaps functionally equivalent to the currents the Slender Madtom experiences in streams.

Slender Madtoms appear to be uncommon in Rock Lake. If we assume that Slender Madtom abundances in rocky habitats throughout the lake are the same as in our three sampling areas, we can make a rough population estimate. Based on our average catch rate across all samples (35 fish in 1,240 m = 2.8/100 m or 0.028/m), the approximate length of suitable shoreline habitat in the lake (~3,000 m; Figure 4), and assuming a capture efficiency of 33% (conservative and probably low given the ideal sampling conditions of shallow clear water with moderate conductivity and high visibility), there may be only about 255 adult Slender Madtoms in the entire lake ($255 = (0.028 \times 3000)/0.33$).

Slender Madtoms in Rock Lake are on the small side compared to some other populations. The 24 fish we measured ranged in total length from 51–88 mm, with a mean of 70 mm, and only 25% of the specimens were greater than or equal to 76 mm (3 inches). Con-



Figure 6: Shoreline habitat where Slender Madtoms were collected from Rock Lake at the Fremont Street Public Access in Lake Mills on August 6, 2015.



Figure 7: Potential Slender Madtom habitat in Lower Nemahbin Lake, July 8, 2019. No Slender Madtoms were collected, but Rainbow and Fantail darters were common.

versely, Slender Madtoms from the Bark and Oconomowoc rivers to the east (Figure 3) were generally larger, with a range of 36-125 mm total length, a mean of 97 mm, and 80% at or above 76 mm (N=41; WDNR unpublished data). Two studies from the scientific literature give quantitative data on Slender Madtom lengths: from Green Creek in southern Illinois (Mayden and Burr 1981) and from Flint Creek in northeastern Oklahoma (Vives 1987). Both studies reported Slender Madtom size as standard length, but Vives (1987) provided an equation [TL=4.4 + 1.09(SL)] that we used to convert their standard lengths to total lengths. Slender Madtom from Green Creek, with a total length range of 29–113 mm, reached a larger maximum size than those from Rock Lake but a smaller maximum than Slender Madtoms from the Bark and Oconomowoc rivers. Slender Madtoms from Flint Creek, with a total length range of 48–84 mm, were similar in size to those from Rock Lake.

The occurrence of Slender Madtoms in Rock Lake naturally led to the question of whether the species occurred in other rocky natural lakes in the Rock River drainage of southern Wisconsin. In particular, the Bark and Oconomowoc river systems, last strongholds for the Slender Madtom in Wisconsin (Figure 3), have several natural lakes that appeared to have potential suitable habitat. In 2019, John, now retired from WDNR, Dave, and Will received a grant from the WDNR to sample the two most-promising lakes, Oconomowoc Lake in the Oconomowoc River system, and Upper and Lower Nemahbin Lake (connected by a short deep channel and functionally the same lake) in the Bark River system. Both lakes have Slender Madtom populations in the rivers upstream of them. On June 26, 2019, aided by Laura, they electroshocked 300 m of shoreline on Oconomowoc Lake, and on July 8 they sampled 270 m on Upper and Lower Nemahbin Lake, focusing on rocky shorelines with habitat similar to Rock Lake (Figure 7). No Slender Madtoms were captured in either lake, although Rainbow *Etheostoma caeruleum* and Fantail darters *E. flabellare*, typically thought of as "stream" species, were common in both.

The results from Oconomowoc and Upper and Lower Nemahbin lakes suggest that Rock Lake may be the only natural lake anywhere with a population of the Slender Madtom. Certainly, it is worth continuing to look for the species in other lakes, but whether or not Rock Lake proves to be unique, special care must be taken to protect its Slender Madtom population. More study is needed on the distribution, abundance, and habitat use by Slender Madtoms in Rock Lake. The population appears to be very small in number and highly specialized in the habitat it occupies and thus especially vulnerable. Of particular concern is modification to the shoreline that would replace the rocks now present with larger rounded riprap, seawalls, or even sand beaches, eliminating Slender Madtom habitat. The areas where we collected Slender Madtoms were all public lands under the control of local governments where inappropriate shoreline modifications could hopefully be prevented, but most of the suitable shoreline habitat in the lake is private property. Although there are some regulatory measures that can limit shoreline modifications on private lands in Wisconsin, their scope is limited. Publicity about the Slender Madtom coupled with public education about appropriate shoreline habitat management may be the best way to help prevent possible habitat loss. With outreach, vigilance, and a little luck, we can hope that the Slender Madtom will continue to grace Rock Lake far into the future.

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