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Martin T. O'Connell

Anne M. Usee O'Connell

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Post-Hurricane Katrina Survey for the Blackmouth Shiner (*Notropis melanostomus*) at Historical Localities in Mississippi

Post-Hurricane Katrina Survey for the Blackmouth Shiner (*Notropis melanostomus*) at Historical Localities in Mississippi

MARTIN T. O'CONNELL^{1*} AND ANN M. UZEE O'CONNELL²

¹Nekton Research Laboratory
Pontchartrain Institute for Environmental Sciences
University of New Orleans
New Orleans, LA 70148

²Pontchartrain Institute for Environmental Sciences
University of New Orleans
New Orleans, LA 70148

*Corresponding author: moconnel@uno.edu

ABSTRACT

The Blackmouth Shiner (*Notropis melanostomus* Bortone) has a limited range, occurring only in select drainages of southern Mississippi, southern Alabama, and western Florida (AFS status = threatened; NatureServe rank = G2, "At high risk"). In southern Mississippi it is found in ephemeral ponds, oxbow lakes, backwaters, and other floodplain habitats. We surveyed 35 sites in 1995 and found eight new populations of *N. melanostomus* in the Pascagoula River floodplain. To assess possible impacts of Hurricane Katrina on these *N. melanostomus* populations and habitats, we re-surveyed the area in 2007-2008. Of the eight localities discovered in 1995, only two yielded *N. melanostomus*. Three 1995 oxbow lake sites were repeatedly sampled in 2007-2008 but no *N. melanostomus* were collected. The remaining three 1995 sites were either partially or wholly dry. Expanding our sampling efforts south in 2007, we discovered a new population of *N. melanostomus* in Luther Lake. While we are encouraged that the species is still present and that more undiscovered populations likely exist, there is concern about the decrease in *N. melanostomus* localities over the last twelve years. For example, recent clear-cutting activities adjacent to one historic site threaten the largest and most consistent population of the species in Mississippi.

INTRODUCTION

The Blackmouth Shiner (*Notropis melanostomus* Bortone) is considered imperiled globally because of its rarity (Litt et al., 2000). It is currently known only from four separate drainages: Pascagoula River Drainage, Mississippi; Blackwater River Drainage, Florida; Yellow River Drainage, Florida; and the Mobile Drainage, Alabama. A recent analysis of museum holdings and collections data suggested that there has not been enough sampling to accurately determine the distribution of *N. melanostomus* across its entire known range (O'Connell et al., 2005). Without this information the conservation status of *N. melanostomus* cannot be properly assessed.

In Mississippi, the last survey work to find populations of *N. melanostomus* was conducted in 1995 (O'Connell et al., 1998). This survey work yielded eight new localities for *N. melanostomus*, increasing the known localities for the species in the state from three to eleven. Once the habitat affinities of *N. melanostomus* were determined during this survey, sampling for the presence of the species in other localities became more effective (O'Connell et al., 1998). Unfortunately, no *N. melanostomus* were collected at these localities during subsequent, less exhaustive surveys in 1998, 1999, 2001, and 2002

(O'Connell et al., 2005). It is unknown if this failure to collect *N. melanostomus* is a result of extirpation or a reflection of the life history and habitat of the species. Many of the habitats used by *N. melanostomus* are ephemeral, including floodplain ponds and backwaters of rivers (Bortone, 1993; O'Connell et al., 1998). Of the eight new localities discovered in 1995, four were ephemeral floodplain ponds. Other historical localities for the species in Mississippi have also been documented as being temporary (Suttkus and Bailey, 1990; O'Connell et al., 1998). The use of ephemeral habitats by this short-lived species makes accurate assessment of its distribution and conservation status problematic. Further complicating the continued existence of this species in Mississippi is the possible negative impact of Hurricane Katrina which may have destroyed some of the habitats at these historical sites.

Therefore, to determine if *N. melanostomus* are extirpated from historical localities in Mississippi either through long-term habitat loss or loss due to Hurricane Katrina, we re-surveyed the area in 2007-2008 using the exact sampling methods developed for the 1995 survey. We wanted to determine if *N. melanostomus* were still present at any of the historical localities or whether there was evidence that Hurricane Katrina impacted these populations. A failure to find any populations of *N. melanostomus* would suggest it has become extirpated from historical localities in Mississippi. Finally, we also conducted some basic geographical analyses to determine if the pattern of *N. melanostomus* occurrence revealed anything about the preferred macrohabitat of this species.

METHODS

To determine if *N. melanostomus* are extirpated from historical localities in Mississippi, in 2007-2008 we sampled the prime habitats discovered in the 1995 survey. We focused on these habitats to increase the chances of determining if populations still exist. Based on our field notes from the 1995 survey, we sampled sites with prime *N. melanostomus* habitat during the following periods: 22 – 25 May 2007, 5 – 7 June 2007, 20 – 22 June 2007, 9 – 11 June 2008, 23 – 25 July 2008, and 10 – 11

October 2008.

All but two of the eleven historical sites were sampled along with other nearby sites where *N. melanostomus* had never been collected but where potentially prime habitat exists (O'Connell et al., 1995). Sampling involved either a crew of two observers in one boat or a crew of five to six observers in two boats with polarized sunglasses scanning the shoreline for schools of *N. melanostomus*. This method has proved effective for locating *N. melanostomus* in both Florida (Bortone, 1993) and Mississippi (O'Connell et al., 1998). At each historical locality, surveying continued until all suitable habitats were scanned. If a school of *N. melanostomus* was observed, we estimated school size and then attempted to capture voucher specimens using fine-mesh dipnets (as described in O'Connell et al., 1998). Fish were anesthetized in the field with sodium bicarbonate (Booke et al., 1978), fixed in 5% formalin, and preserved in 70% ethanol. Voucher specimens were archived in the Mississippi Museum of Natural Sciences (MMNS) and the University of New Orleans Vertebrate Collection (UNOVC).

In late 2007, we contacted Becky Stowe of the Mississippi Chapter of the Nature Conservancy (TNC). She granted us access to TNC property which had never been surveyed for *N. melanostomus*. We took advantage of this opportunity and surveyed oxbow lakes and ponds on TNC property in 2008. Later in 2008 we also made two trips to the locality of the first known collection of *N. melanostomus* in Mississippi: Doctor Lake. This small, isolated oxbow pond is located in the floodplain of Black Creek, a tributary of the Pascagoula River. While previous attempts post-1995 to locate Doctor Lake were unsuccessful because the lake had completely dried up, on both occasions in 2008 water was present.

We have determined that *N. melanostomus* occur in microhabitats that have submersed aquatic vegetation, sand, and some detritus (O'Connell et al., 1998). These microhabitats are also less turbid than those areas without Blackmouth Shiners (O'Connell et al., 1998). On a macrohabitat scale, lakes where *N. melanostomus* have been found do not have a specific geographic orientation and additionally this species can be found in other types of habitats (i.e., backwaters, ponds, and sloughs). For this study we

attempted to determine if any of these habitats were more important than others for this species. We characterized all sites sampled either in 1995 or 2007-08 into one of four categories: oxbow lake, pond, slough, or backwater. Sites were divided into those where *N. melanostomus* occur (i.e., presence confirmed at least once) or where *N. melanostomus* do not occur (multiple attempts have yielded none). We then conducted a chi square test followed by residual analyses (with residual values >1.96 or <-1.96 indicating significant deviations from expected) to determine which waterbody categories had significant numbers of occurrences of *N. melanostomus*.

Occurrence of *N. melanostomus* in any of these macrohabitats is likely the result of dispersion of individuals during inundation of the floodplain. If so, we expected that the proximity of a macrohabitat to the Pascagoula River could determine the likelihood of occurrence. That is, macrohabitats closer to the river would be more likely to contain *N. melanostomus*. Local topography could also determine whether *N. melanostomus* occurs in a given macrohabitat. Waterbodies at higher elevations are less likely to be inundated during flooding, precluding colonization by *N. melanostomus*. Topography can also determine whether a macrohabitat retains water during drier periods. Using Earthtools (Stott, 2011), we measured the shortest distance from the Pascagoula River for all sites surveyed, including both known *N. melanostomus* sites and non-occurrence sites. We also determined the elevation above sea level for each site. We then characterized each site based on the level of measured *N. melanostomus* occurrence:

- 1) *N. melanostomus* collected both in 1995 and 2007-2008 (highest level of occurrence);
- 2) site sampled both in 1995 and 2007-2008 but *N. melanostomus* collected only during one period OR site sampled during only one of these periods and *N. melanostomus* collected;
- 3) site sampled only in 2007-08 and no *N. melanostomus* collected;
- 4) site sampled only in 1995 and no *N. melanostomus* collected; and
- 5) site sampled both in 1995 and 2007-2008 and no *N. melanostomus* collected.

Using MANOVA (IBM SPSS Statistics 19; SPSS, Inc., 1989; 2010) we determined if distance from the Pascagoula River and elevation differed among these categories to determine if these factors play a role in determining Blackmouth Shiner occurrence in particular macrohabitats.

RESULTS

Of the eight localities that contained *N. melanostomus* populations in 1995, only two yielded *N. melanostomus* during our 2007-2008 survey (Fig. 1). The first of these two historical sites was a shallow floodplain pond located under the Route 26 bridge east of Benndale. This site is located on the Pascagoula River Wildlife Management Area (PRWMA) and is on the east bank of the Pascagoula River. The second of these two historical sites is an artificial pond located southeast of Boneyard Lake (Site #31, MT95-031 in O'Connell et al., 1995). While it was previously believed that this pond was on PRWMA property, clear-cutting in the forest surrounding the pond during the summer of 2008 indicates it is privately owned.

Of the remaining six localities that contained *N. melanostomus* populations in 1995 but did not yield the species in 2007-2008, three were oxbow lake sites. These were repeatedly sampled in 2007-2008 but no *N. melanostomus* were collected even though the habitat was good to moderate. The remaining three 1995 historical sites were either partially or wholly dry. One of these was an ephemeral pond on PRWMA property that was wholly dry for both 2007 and 2008, though it consistently had water and *N. melanostomus* in 1995. Another site was located just west of the Route 26 bridge site mentioned above. This waterbody was low, muddy, and contained neither *N. melanostomus* nor proper habitat, though both were present in 1995. The third historical site was a backwater area of an oxbow lake. No *N. melanostomus* were collected and the water was low, stagnant, and no appropriate habitat was located.

Our efforts to sample beyond the area covered in the 1995 survey resulted in the discovery of a new population of *N. melanostomus* in Luther Lake. Luther Lake is on the PRWMA and is just south of historical site #31 (Fig. 1). Luther Lake was inaccessible in 1995 and could not be surveyed.

Appropriate *N. melanostomus* habitat exists in Luther Lake at the distal ends of the lake (north and south ends) and one school was observed just across from (west of) the PRWMA ramp. Unfortunately, our other efforts beyond the historical *N. melanostomus* range yielded no more new populations. For example, none of the habitats we sampled on TNC property (e.g., see upper-most six white circles in Fig. 1) contained the species. Most of these lakes were turbid and muddy with little to no appropriate *N. melanostomus* habitat. Some of the smaller lakes and sloughs on TNC property, though, did support small areas of good habitat, but no *N. melanostomus* were collected. We also sampled McCrea Dead River on the west bank of the Pascagoula River which was also not accessible in 1995. While in the area, we briefly surveyed potential backwater habitats along the Pascagoula River itself just to the east of this large oxbow lake. Neither McCrea Dead River nor the backwater habitats had appropriate *N. melanostomus* habitat and none were collected. While both trips to Doctor Lake (not shown in Fig. 1) revealed that it was not dry and contained water, neither trip produced a collection of *N. melanostomus*.

Our geographical analyses revealed no relationships between *N. melanostomus* occurrence and the measured geographical features. According to the chi-square analysis, none of the four waterbody categories had more occurrences of *N. melanostomus* than expected (observed 2 = 2.60; $p = 0.91$). Also, neither distance to the Pascagoula River (MANOVA, $p = 0.941$) nor elevation (MANOVA, $p = 0.568$) differed among the five occurrence categories.

DISCUSSION

While our 2007-2008 survey for *N. melanostomus* in historical localities in Mississippi revealed that this species still exists in the region at two historical sites and at a newly discovered locality, we are concerned about the absence of *N. melanostomus* from other historical localities. Based on our observations of habitat conditions both in 1995 and 2007-2008, the only marked change in aquatic habitat over the last twelve years has been the drying of certain ephemeral ponds which had previously contained *N. melanostomus*. The lack of water in these habitats, though, does not appear to be a long-term condition

because many appeared still damp and muddy. We fully expect that after the dry 2007-2008 period these historical sites will again offer potential habitat to *N. melanostomus*. Even though we found fewer localities with *N. melanostomus* than in 1995, there was no evidence that Hurricane Katrina had been the cause of this decline. Except for the low water and dry conditions, the habitats and the area in general seemed mostly unchanged from 1995. It should also be noted that most of these historical sites remain protected as part of the PRWMA and the level of protection has also not changed in the last twelve years.

Our discovery of a new population of *N. melanostomus* in Luther Lake is encouraging and suggests that other undiscovered populations likely exist along the floodplain habitats of the Pascagoula River. This discovery agrees with our modeling work, which predicted that more *N. melanostomus* populations would be discovered with increased surveying efforts (O'Connell et al., 2005). The survey methods needed to find *N. melanostomus* and the habitats where they occur are atypical. The perceived rarity of this species is likely due, in part, to *N. melanostomus* not being collected during standard surveys with typical collecting gear (e.g., seines, electroshocking). As we have done with the help of TNC in the current survey, we suggest that future conservation efforts in Mississippi focus on attempting to gain access to areas that have yet to be surveyed for *N. melanostomus* (e.g., privately owned property).

These current survey results offer a mixed bag regarding the current conservation status of *N. melanostomus* in Mississippi: while finding a new population is a sign that the populations are more numerous than previously thought, the absence of the species from historical sites warrants an increased level of protection until further expanded survey work can be conducted as outlined above. We still know little about the actual ecology of *N. melanostomus*, though our recent observations during 2007-2008 have given us more insight as to how it uses these floodplain habitats. Our analyses indicate that this species is not limited to certain habitats and can occur both near and far from the Pascagoula River. In Mississippi, because *N. melanostomus* occurs more in floodplain habitats versus backwaters of the Pascagoula River, we suspected that individu-

als reach these isolated habitats during flooding events. Therefore the occurrence of *N. melanostomus* might be based on chance and the vagaries of non-directional dispersion during river inundation of the floodplain. We refer to this phenomenon as a flood-based 'lottery' delivery system where individual *N. melanostomus* are deposited either in good habitat (e.g., ponds or oxbow lakes with submersed aquatic vegetation) or bad habitats (e.g., turbid water bodies with no vegetation). The fact that we found no *N. melanostomus* in habitats that appeared good both in 1995 and 2007-2008, suggests that this type of 'lottery' delivery system is not occurring every year. That is, we would have expected to find *N. melanostomus* in at least a few of those good habitats that were not inhabited in 1995: we did not. We suggest that the dispersion might occur only during large, 'super floods' when most of the floodplain is inundated and fishes have access to all riparian ponds and oxbows. This would explain why after 12 years *N. melanostomus* was still present at the historical site #31 which is upstream of a mostly blocked culvert and likely rarely inundated. Without larger floods dispersing *N. melanostomus* to other habitats, populations such as those that existed in historic localities such as Upper and Lower Rhymes lakes and Hudson Lake in 1995 may have died off as this species is short-lived (1-2 years) and available good habitat can change on a seasonal basis.

While lower elevation could indicate the potential for a shallow area to receive and retain water after a flood (due to its closeness to the water table) and thus providing *N. melanostomus* habitat, this factor was not significant in determining *N. melanostomus* occurrence. Describing topography for a site is difficult with just one elevation value as elevation can vary greatly within a site. Even other methods of topography determination may not adequately describe potential *N. melanostomus* habitat within an area. Again this lack of relationship may indicate the vagaries of floodplain dispersion of Blackmouth Shiners. It may, though, also indicate that extensive, persistent shallow habitat is not necessarily good for this species. While the importance of submersed aquatic vegetation for this species is known, there was a lack of *N. melanostomus* in some sites where there was widespread shallow habitat with submersed aquatic vegetation. Areas with extensive submersed

aquatic vegetation may provide habitat for other species which could potentially out-compete or prey upon *N. melanostomus*. Besides the magnitude of flooding playing as a determinant of where *N. melanostomus* occur, it may be that persistent yet small amounts of clear, shallow areas with submersed aquatic vegetation offer better habitat for this species by protecting them from those species that need and can exploit larger areas with good habitat. It is important to better understand these *N. melanostomus* requirements so that essential habitat can be adequately protected.

We are also concerned about the current conservation status of *N. melanostomus* in Mississippi because historical site #31 is directly threatened by recent clear-cutting activities which extend up to the banks of this pond. Based on all of our research since 1995, we know that this site contains the largest and most consistent population of the species in Mississippi. Though we had assumed in the past that this pond was on the PRWMA, the 2008 logging activity revealed that the pond is located on private in-holdings that are being cleared for development. The loss of this large *N. melanostomus* population will eliminate one of only two populations which survived between 1995 and 2007-2008 (the other is under the Route 26 bridge). We suggest either protection of this pond (if the population has not already been eliminated) or more efforts to confirm that other large populations of *N. melanostomus* exist elsewhere in Mississippi.

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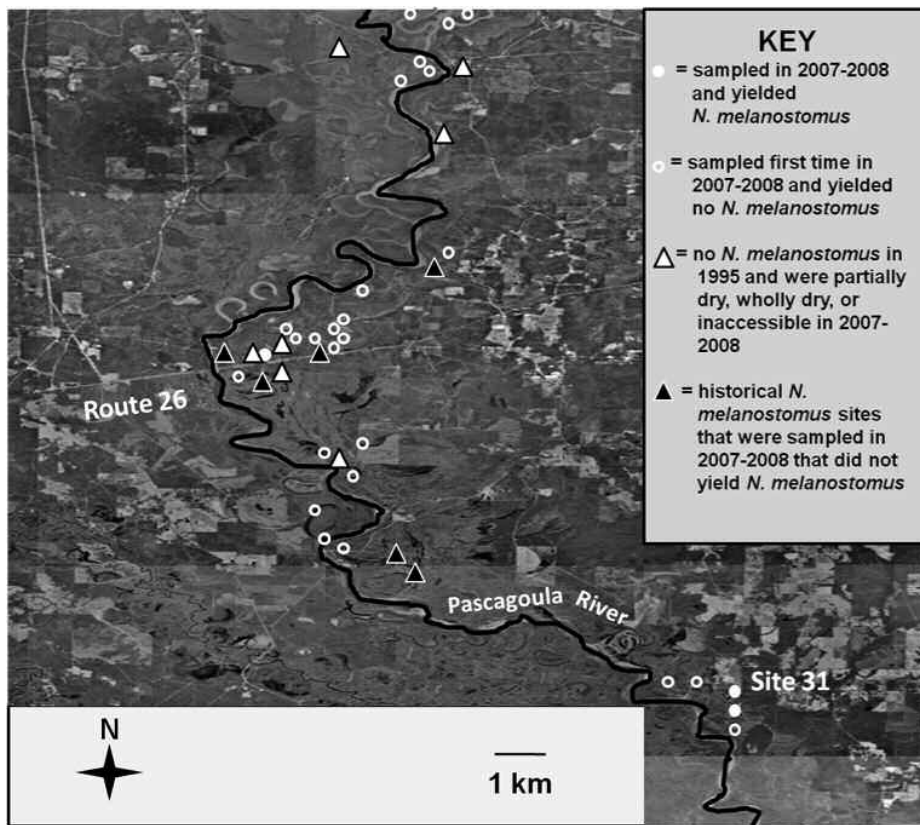


Figure 1. Select sampling sites for 1995 and 2007-2008 survey for *Notropis melanostomus* in historical and nearby localities along the upper Pascagoula River, Mississippi. Symbols represent different results of sampling (see key). Historical site 31 (MT95-031) contained the largest and most consistent population of the species in Mississippi (lower right). This site is currently threatened by riparian vegetation loss due to clear-cutting.