Southeastern Fishes Council Proceedings

Volume 1
Number 37 *Number 37 (July 1998)*

Article 3

7-1-1998

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ABSTRACT

Notropis chalybaeus in Mississippi is known from only 20 collections taken from 15 different localities. Prior to the onset of this study, *N. chalybaeus* had not been collected in the state since 1984. During 1995-1996, we sampled 11 of the 14 historic sites and an additional 13 localities in close proximity to historic sites. Overall, we collected 5503 fishes comprising 62 taxa and 14 families. *Notropis chalybaeus* was not taken at any of these sites. However, three specimens of *N. chalybaeus* were collected from a new locality in the Escatawpa River in June 1996 (Ross and Rauch, 1996). A variety of factors may account for the rarity of *N. chalybaeus* in Mississippi. This species may be naturally uncommon in Mississippi and habitat degradation may be driving these small populations to extinction. We recommend a more thorough survey of *N. chalybaeus* be undertaken. Conservation efforts should target the Wolf and Escatawpa River systems because of the potential for multiple extant populations and relatively high habitat quality.

INTRODUCTION

The ironcolor shiner, *Notropis chalybaeus,* occurs in low gradient coastal streams along the Atlantic Coast from the Hudson Drainage, New York, to tributaries of Lake Okeechobee, Florida; and along the Gulf Coast from the Chipola River, Florida, to the Sabine River Drainage, Texas. In addition, it occurs in Mississippi River tributaries in Texas, Oklahoma, Louisiana, Arkansas, Iowa and Indiana. Disjunct populations are reported from the San Marcos River, Texas and in Great Lakes drainages of Indiana, Michigan and Wisconsin (Fig. 1; Lee et al., 1980). *Notropis chalybaeus* has been taken from a wide variety of habitats, but most studies cite typical habitat as being small to moderate sized, sluggish, tea-stained streams with aquatic vegetation and heavily wooded riparian areas (Marshall, 1947; Robison, 1977; Jenkins and Burkhead, 1993). Considering its broad distribution, the biology of this species is poorly understood. The most detailed study found that *N. chalybaeus* in central Florida usually occupied pools, probably bred from April to September, and fed on aquatic insects, algae and detritus (Marshall, 1947). *Notropis chalybaeus* lives approximately two years (Jenkins and Burkhead, 1993; Becker, 1983).

The status of *N. chalybaeus* varies widely across its range. While common in certain parts of New York (Smith, 1985), it is apparently extirpated from Pennsylvania (Cooper, 1983). Jenkins and Burkhead (1993) described *N. chalybaeus* as generally rare and uncommon in Virginia. In North Carolina, *N. chalybaeus* is uncommon (pers. comm., F. Rhode, North Carolina Department of Environment, Health, and Natural Resources; W. Palmer, North Carolina Museum of Natural Sciences) and has been recognized by the North Carolina Department of Environmental Management as intolerant to stream degradation (Eagelson, 1995). However, this species appears to be relatively common in South Carolina, Georgia and Florida (pers. comm., J. Crane, South Carolina Department of Natural Resources; L. Hartle, University of Georgia Museum of Natural History; C. Gilbert, Florida Museum of Natural History). Robison (1977) regarded *N. chalybaeus* as uncommon in Arkansas and endangered in Oklahoma (Robison, 1974). *Notropis chalybaeus* was locally abundant, but geographically restricted in Missouri (Pflieger, 1975). Becker (1983) described *N. chalybaeus* as rare in Michigan and probably extirpated from Iowa and Wisconsin. Smith (1979) placed Illinois populations of *N. chalybaeus* in a category of "rare" or "extremely restricted" species. Ironcolor shiners are very rare in Alabama and Louisiana (pers. comm., S. Mettee, Alabama Geological Survey; N. Douglas, Northeast Louisiana University Museum of Ichthyology). Of the 296 specimens documented from Alabama, only one has been collected within this decade and the majority of collections predate 1980. Neil Douglas (pers. comm.) reports that *N. chalybaeus* is infrequently collected and never taken in great numbers within Louisiana.

In Mississippi, *N. chalybaeus* is known from only 20 collections taken from 15 different localities (Ross and Brenneman, 1991; Ross, in press.). Prior to the onset of this study, ironcolor shiners had not been collected in the state since 1984. Despite its apparent rarity in Mississippi, it is not listed as a threatened or endangered taxon (Mississippi Department of Wildlife, Fisheries, and Parks, 1994), nor has it been targeted as a species meriting distributional research. To better understand the conservation status of this species, we conducted a survey of historic localities in Mississippi. Herein we present information on the status of *N. chalybaeus* and make recommendations for future management.

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METHODS

We identified historic localities of *N. chalybaeus* in Mississippi by searching the Fishes of Mississippi database (> 90,000 records). This database contains records from numerous regional ichthyological collections dating back to the mid 1800's (Ross and Brenneman, 1991; Ross, in press), but contains relatively few records from these institutions made beyond the late 1980's. We contacted the following museum curators and regional ichthyologists to make sure there were no recent records of *N. chalybaeus* from Mississippi: H. Bart (Tulane), S. Mettee, C. Knight (Mississippi Museum of Natural Sciences), L. Hartle and N. Douglas.

Surveying of historic sites began in March, 1995 and continued until August, 1996. In some cases, we made collections up and downstream of historic sites and in nearby streams that might have contained unknown populations of *N. chalybaeus*. Several sites were sampled more than once, usually when we felt that seasonal influences may have biased our initial efforts. Collections were typically made with a 1.8 x 3.1 m x 3.2 mm Ace mesh seine, but we also used a 1.8 x 6.2 m x 3.2 mm Ace mesh bag seine and a dipnet where appropriate. Our goal at each site was to collect as many species as possible. Accordingly, we sampled all available microhabitats until no new taxa were collected with additional effort. The active time spent seining was recorded for each site. We also documented any noticeable signs of habitat degradation. All specimens were anesthetized in MS-222, fixed in 10% formalin, identified, preserved in 45% isopropyl, and curated into the USM Museum.

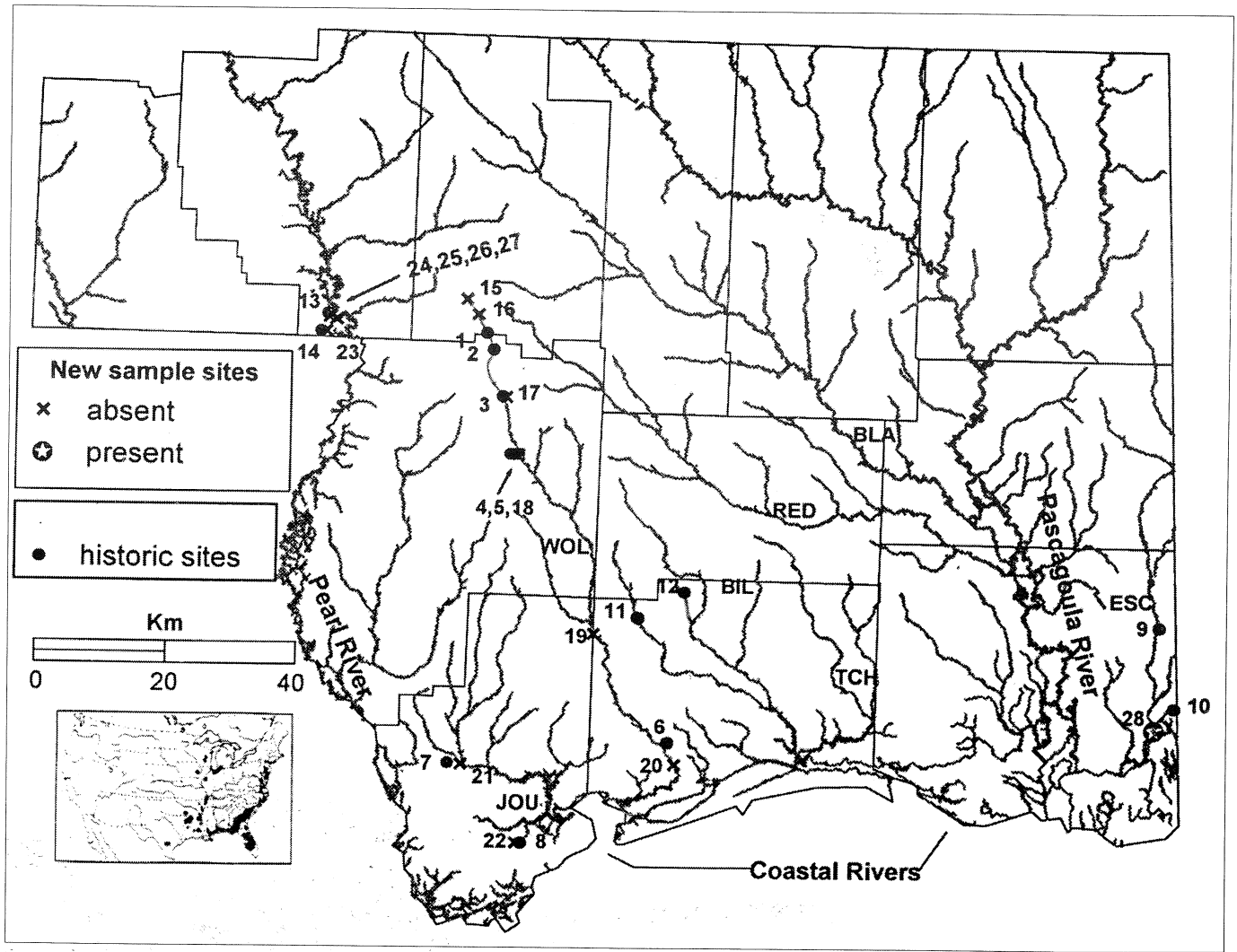

Figure 1. Historic (Sites 1-14) and new (Sites 15-28) collection sites for *Notropis chalybaeus* in Mississippi and the overall distribution of this species in North America (inset). Historic sites were identified by searching the Fishes of Mississippi database (Ross and Brenneman, 1991; Ross, in press) and represent collections made between 1950 and 1984. Most historic and all new sites were sampled during 1995-1996. Major drainages are labeled. Systems are abbreviated as follows: JOU = Jourdan River, WOL = Wolf River, BIL = Biloxi River, TCH = Tchoutacabouffa River, ESC = Escatawpa River, RED = Red Creek, and BLA = Black Creek. Inset adopted from Jenkins and Burkhead (1993).

Table 1. Historic collection records for *Notropis chalybaeus* in Mississippi. Data are from the Fishes of Mississippi database (Ross and Brenneman, 1991; Ross, in press.). Localities marked with an asterisk are uncertain and have been approximated from field notes. Abbreviations are as follows: TU=Tulane, UAIC=University of Alabama Ichthyology Collection, MMNS=Mississippi Museum of Natural Sciences and UFSU=Florida State University. See text for details.

Site	System	Waterbody	Exact Locality	Date	Number Collected	Museum Number
1	Wolf River	Wolf Creek	at Olive Branch Rd.	7/1/1984	7	TU 136637
2	Wolf River	Wolf Creek	at Bass Rd.	7/1/1984	7	TU 136623
3	Wolf River	Wolf Creek	at Hillsdale Rd.	7/1/1984	1	TU 136598
4	Wolf River	Wolf River	at Hwy. 59	4/18/1970	2	TU 65644
4	Wolf River	Wolf River	at Hwy. 59	7/3/1980	9	TU 129713
5	Wolf River	Wolf River	at Hwy 26 Crossing*	10/24/1969	1	TU 59469
6	Wolf River	Big Creek	at Wolf River Rd.	7/1/1965	4	UAIC 1722.02
7	Jourdan River	Wolf Branch	4.5 mi. E. of Santa Rosa*	5/31/1952	45	TU 4852
8	Jourdan River	Bayou Philip	at Hwy. 90	2/22/1952	41	TU 8007
8	Jourdan River	Bayou Philip	at Hwy. 90	3/9/1953	15	TU 7660
8	Jourdan River	Bayou Philip	at Hwy. 90	11/8/1951	64	TU 4760
8	Jourdan River	Bayou Philip	at Hwy. 90	5/18/1952	90	TU 4524
9	Escatawpa River	Escatawpa River	at Hwy. 614.	5/11/1983	8	MMNS 11902
10	Escatawpa River	Jackson Creek	at Forts Lake Rd.	4/28/1966	3	UFSU 13356
11	Biloxi River	Little Biloxi River	at McHenry Rd.	7/1/1965	8	UAIC 1720.01
11	Biloxi River	Little Biloxi River	at McHenry Rd.	10/26/1984	5	TU 138336
12	Biloxi River	Hickory Creek	at McHenry Rd.	7/21/1965	2	UAIC 1736.01
13	Pearl River	Harts Swamp, unnamed tributary	at Hart's Rd *	5/14/1962	48	TU 25786
14	Pearl River	Rankin Creek, unnamed tributary	at Hwy. 35	10/28/1950	1	TU 70
				TOTAL:	361	

Table 2. Summary of *Notropis chalybaeus* collections and recent sampling effort by river system. The number of recent sites sampled exceeds the number of historical sites because we sampled additional localities near historical sites. Several sites were sampled more than once. Effort represents the amount of time spent seining with a 1.8m x 3.1m x 3.2mm Ace mesh seine.

System	Number Collected	Historical Sites	Recent Sites	Recent Samples	Effort (min)
Wolf	31	6	11	15	1010
Jourdan	255	2	3	4	375
Escatawpa	11	2	2	4	415
Biloxi	15	2	2	3	300
Pearl	49	2	6	6	500
TOTALS	361	14	24	32	2600

RESULTS

Historic collection records of *N. chalybaeus* in Mississippi are confined to blackwater streams of the southeastern part of the state (Fig. 1). The majority of collections and specimens are from small river systems within the Coastal Rivers Drainage (Table 1). Specific localities are not characterized by one particular habitat type. For example, only three of the localities (Sites 12, 13 and 14) are currently characterized by abundant aquatic vegetation. Some of the sites occur within or are surrounded by open swamp habitat (Sites 3, 8, 9, 13), while others drain densely canopied woodlands. *Notropis chalybaeus* is not specific to a particular stream size, having been collected in first, second, third, fourth and fifth order streams.

Thirteen of the 19 historic collections predate 1980. The Jourdan River System is notable for the great number of *N. chalybaeus* collected there during the 1950's (Table 2). Most of these specimens were collected from one site on Bayou Philip. The greatest number of collection sites occurs within the Wolf River System; however, these collections represent very few specimens. Until the onset of this study, the most recent collection of *N. chalybaeus* was made in the Biloxi River

System.

We sampled 11 of the 14 original historic sites. We could not get permission to sample Site 6 (Big Creek), and could not precisely locate Site 7 (Wolf Branch) or Site 13 (unnamed). An additional 13 sites in close proximity to historic sites were also sampled. A total of 32 collections were made and over 43 hours were spent actively seining (Table 2).

We collected 5503 fishes comprising 62 taxa and 14 families[2]. No *N. chalybaeus* were taken at any of the sites. Considering all sites, *Lythrurus roseipinnis*, *Cyprinella venusta*, *Labidesthes sicculus*, *Pteronotropis signipinnis*, *Percina nigrofasciata* and *Fundulus olivaceus* were numerically dominant. Including only the historic sites, *L. roseipinnis*, *C. venusta*, *F. olivaceus*, *L. sicculus*, *P. nigrofasciata* and *Notropis texanus* were numerically dominant. The most diverse assemblages were taken in the Wolf River System at Sites 4 (26 species), 5 (23 species), and 3 (21 species).

Deteriorating habitat quality was apparent at four of the historic sites. Site 8 (Bayou Philip) appears to have been channelized downstream of the bridge over Hwy 90. Its channel was straight with very little variation in depth and practically no instream habitat structure (i.e., snags). The Army Corps of Engineers has no documentation of a channel modification project within Bayou Philip, so we cannot be certain when this disturbance occurred (pers. comm., Doug Nestor, Mobile District). We also observed the construction of a new drainage ditch that was being linked to the main channel approximately 200 m upstream of the bridge on Hwy 90. Little erosion control had been taken and this may account for the high turbidity we observed (relative to other historic sites). *Notemigonus crysoleucas* was the only cyprinid collected at this site. Site 6 (Big Creek) was also severely degraded. Upstream of the historic locality, many of the headwater tributaries had been ditched and flow was frequently diverted to fill a series of impoundments. Riparian areas both upstream and at the historic site consisted primarily of pasture land. Compared to other low order streams in the Wolf River System, Big Creek was excessively turbid. Unfortunately, we have no recent data on the fish fauna for this site. Sites 1 and 2 on Wolf Creek were dry or drying up two of the three times we observed them. We are uncertain whether this desiccation is related to changes in landuse or part of the natural variation in stream discharge. Considering the highly diverse assemblage of fishes downstream of this site, we feel that drought conditions accounted for the low diversity of fishes collected at these sites.

Notropis chalybaeus was collected from a new locality in Mississippi on June 27, 1996 (Ross and Rauch, 1996). Three specimens were taken in a backwater area off the mainstem of the Escatawpa River. The habitat was characterized by dense aquatic vegetation, low flow and moderate depth (about 1m). This locality represents the first reported collection of *N. chalybaeus* in Mississippi from a sixth order stream.

DISCUSSION

Rarity

Because the apparent decline of *N. chalybaeus* in Mississippi has largely gone undocumented, it is difficult to understand the causes of its rarity. Herein we speculate on what factors may be responsible. This species may be naturally uncommon in Mississippi and habitat degradation may be driving local populations to extinction. Some evidence suggests that interactions with *N. texanus* may be an additional factor.

Rarity is a natural feature of stream fish assemblages (Sheldon, 1987). Most communities are characterized by a few extremely abundant species, many species intermediate in number, and a few rare species (Brower et al., 1989). Meffe and Carroll (1994) delineated types of rarity based upon geographic range, habitat specificity and local population size. Obviously, *N. chalybaeus* is not geographically rare. It may exist as a rare species in Mississippi because of the rarity of some particular habitat type, but this cannot be the only factor given the variety of habitats it has been taken from in the state.

Rarity in *N. chalybaeus* may be related to inherent features of its population structure. In other words, this species may be adapted to persist at relatively low population densities. Indirect evidence for this type of rarity comes from the small sample sizes of *N. chalybaeus* taken from Mississippi and other states and the testimonials from many aquatic biologists that *N. chalybaeus* is usually not taken in large numbers (but see Introduction for exceptions). If this is an accurate assessment of the population structure of this species, then there are important implications for conservation. When species exist at low densities, extinction can only be prevented when sufficient recruitment from other areas is possible (Sheldon, 1987). Thus, populations of *N. chalybaeus* may be especially vulnerable in fragmented river networks or systems containing a small number of populations. In accordance with this idea, the Wolf River population (if it still exists) of *N. chalybaeus* should be least vulnerable to extinction because of the relatively large number of collection sites within this system. Individuals at any one site could be an important source of colonists for areas where *N. chalybaeus* has been locally extirpated. If undiscovered populations exist in the Escatawpa River, then this system could also provide a stronghold for *N. chalybaeus* in Mississippi.

In addition to its natural rarity, *N. chalybaeus* is intolerant of habitat degradation (Eagelson, 1995; Cooper, 1983). Small population sizes undoubtedly predispose *N. chalybaeus* to extirpation when habitat is degraded, but other ecological characteristics of this species may also make it vulnerable. Angermeier (1995) compared the characteristics of Virginia's extirpated and non-extirpated species, and predicted that *N. chalybaeus* is especially vulnerable to imperilment because of the characteristics it shares with extirpated species. The

[2]Appendices containing detailed locality information and species abundance at historical and recent sites are available by request from Brett Albanese.

absence of *N. chalybaeus* from Bayou Philip may be related to its intolerance of habitat degradation. Although less extreme, poor land management practices near other localities may have also played a role in declines or extirpations.

Robison and Buchanan (1988) described the distribution of *N. chalybaeus* in Arkansas as complementary to the weed shiner, *N. texanus*. They suggested that competition or differences in tolerance to degradation may account for this peculiar distribution. In Mississippi, *N. texanus* ranked sixth in abundance and was found at 9 of the 11 historic sites sampled. Is it possible that *N. texanus* has replaced *N. chalybaeus* at some of these sites? The fact that *N. texanus* and *N. chalybaeus* are closely related species (Amemiya et al., 1992) raises the plausibility of strong competitive effects. It is also possible that the existence of *N. texanus* at historic localities reflects differences in the tolerances of these two species to stream degradation, further supporting the idea that *N. chalybaeus* is an intolerant species. Unfortunately, we know very little about the interactions between these species, and these ideas remain untested. It is also intriguing that some authors report *N. chalybaeus* and *N. texanus* as commonly co-occurring species (Smith, 1979; Page and Burr, 1991).

Conservation

While the future of *Notropis chalybaeus* in Mississippi appears bleak, there are many things that can be done to improve its chances for persistence. We give the following recommendations:

1. *Notropis chalybaeus* should be listed by the Department of Wildlife, Fisheries, and Parks as an imperiled species (S2). This status should provide the impetus to conduct further research on this species.
2. A more thorough survey of *N. chalybaeus* should be completed. In the interest of limited conservation resources, the next survey should focus on, but not be limited to, the Escatawpa and Wolf River systems. This survey should attempt to identify new localities and prioritize them for further conservation.
3. The only known extant population of *N. chalybaeus* in Mississippi should be protected from habitat degradation in the Escatawpa river, floodplain, and local watershed. Establishing a riparian buffer zone will protect instream habitat and water quality. New development in the local watershed should follow best management practices.
4. The status of *N. chalybaeus* in other states, particularly Alabama and Louisiana, should be investigated.

ACKNOWLEDGMENTS

We appreciate the efforts of all those who assisted with the project. Steve Ross and Martin O'Connell provided meaningful suggestions for improving this manuscript. Steve Ross also assisted with the production of the distribution map and provided access to the Fishes of Mississippi database. Hank Bart verified the *N. chalybaeus* deposited at Tulane. Rick Mayden verified the *N. chalybaeus* deposited at the University of Alabama. John Crane, Neil Douglas, Carter Gilbert, Lee Hartle, Bob Jenkins, Scott Mettee, Bill Palmer, Fred Rhode, Royal Suttkus and Wayne Starnes shared information on the distribution and abundance of *N. chalybaeus* throughout the Southeast.

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