Biology of a Spawning Population of *Cycleptus meridionalis* in the Alabama River

Maurice F. Mettee, *Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999*

Thomas E. Shepard, *Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999*

Patrick E. O'Neil, *Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999*

Stuart W. McGregor, *Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999*

Wiley P. Henderson, Jr., *Geological Survey of Alabama, P.O. Box 869999, Tuscaloosa, AL 35486-6999*

Abstract: A spawning population of *Cycleptus meridionalis* was sampled 71 times in the generator outflow area below Millers Ferry Lock and Dam from 1995–2003. Sampling success ranged from 32 fish in 2001 to 247 fish in 2003. Sixty-seven percent of 1059 fish captured were males; 30% were females, and 3% were gender unknown. Females attained a greater total length and total weight than males. Regression slopes for standard length versus total length and total weight versus standard length were significantly different ($P<0.01$) between males and females. Collections of >100 fish indicated peak spawning activity occurred in late March when water temperatures ranged from 15 to 17 C. Most fish left the spawning area when water temperatures reached 20 to 21 C. Twenty percent of 702 *Cycleptus meridionalis* anchor tagged from 1995–2002 were recaptured from 1996–2003. Multiple recaptures confirm many *Cycleptus meridionalis* inhabiting the Alabama River spawn annually below the Millers Ferry Lock and Dam for at least nine years and possibly longer. Lower than expected Jolly and Jolly-Seber population estimates were probably influenced by the timing and number of samples collected annually, water level in the Millers Ferry tailwater and its effect on netting efficiency, the ability of the U.S. Army Corps of Engineers to discontinue hydroelectric discharge during the prime spawning season, and the effect of an extended drought on the ability of fish to move upstream past Claiborne Lock and Dam.

Key words: Cycleptus meridionalis, spawning, length-weight, population estimate.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 57:59–67

The genus *Cycleptus* contains two described and one undescribed species. *Cycleptus elongatus* (Lesueur 1817) occurs throughout the Mississippi River basin (Gilbert 1978, Page and Burr 1991). *Cycleptus meridionalis* (Burr and Mayden 1999) occurs in Gulf Coast drainages from the Pearl River east to the Mobile River

basin. Burr and Mayden (1999) recognized a third form from the Rio Grande still included in *Cycleptus elongatus*.

Cycleptus elongatus was widespread and seasonally abundant in the Mississippi (Coker 1929) and Ohio (Jordan 1882) Rivers until the early 1900s. Recent reports suggest populations have been adversely affected by reservoir construction (Robison and Buchanan 1988, Boschung 1992, Etnier and Starnes 1993), habitat alteration (Pflieger 1975, Etnier 1997, Williams et al. 1989), and increased sedimentation and pollution (Moss et al. 1983, Elstad and Werdon 1993).

Peterson et al. (1999, 2000) reported *Cycleptus meridionalis* populations were stable and self sustaining in the Pearl and Pascagoula Rivers in Mississippi. Ross (2001) predicted Mississippi populations could be harmed by future reservoir construction and sedimentation. Semmens (1985) reported spawning activity in the Alabama River at water temperatures >12 C. Mettee et. al. (1996) mapped *Cycleptus meridionalis* distribution in Alabama including new records from the lower Tombigbee River and Mobile-Tensaw River delta. This paper presents information collected on a spawning population of *Cycleptus meridionalis* sampled in the generator outflow area below Millers Ferry Lock and Dam in the Alabama River, Alabama.

Study Area

The Alabama River is formed by the confluence of the Coosa and Tallapoosa rivers and drains about 58,733 km^2 in central Alabama, western Georgia, and southern Tennessee. It is impounded by three U.S. Army Corps of Engineers locks and dams constructed in the 1970s. Robert F. Henry Lock and Dam at km 380 and Millers Ferry Lock and Dam at km 216 each have a lock chamber, gated spillway, and hydroelectric generation facilities. Claiborne Lock and Dam at km 118 has a lock chamber and an adjoining crested and gated spillway but no generating capabilities. Gated spillways at Henry and Millers Ferry locks and dams effectively block upstream fish movements except when extreme flooding equalizes upper and lower pool levels at these facilities. Fish species can move upstream past Claiborne Lock and Dam when discharge in the Alabama River reaches around 2266 cubic meters per second.

Methods

Samples were collected in March and April from 1995–2003. Hydroelectric generation was discontinued at 0900 on each sample day. Five 61.5 m-long×2.5 m-high multi-filament nylon gill nets having a 5.7- to 6.4-cm bar mesh, foamcore float, and leadcore bottom lines were deployed in the immediate generator outflow area, fished for approximately 60 minutes, and retrieved. All *Cycleptus meridionalis* collected were placed in a large aerated tank for later processing. Other species were identified, tallied, and released.

Processing and tagging operations were completed downstream of the netting area. Total length (TL) and standard length (SL) were measured in millimeters (mm) and total weight (TW) was measured in grams (g). Gender was determined by ex-

Table 1. Number of net hours and summary data for *Cycleptus meridionalis* collected in the Alabama River below Millers Ferry Lock and Dam, 1995–2003.

		Cycleptus meridionalis statistics			
Study year	Net hours	Males	Females	Gender unknown	Catch per hour
1995	40	56	61	16	3.3
1996	50	88	27	3	2.4
1997	40	93	56	—	3.7
1998	65	23	23	3	0.8
1999	45	156	39	2	4.4
2000	35	30	7	2	1.1
2001	25	22	4	6	1.3
2002	30	101	29	1	4.4
2003	25	163	84	—	9.9

truding gametes with light abdominal pressure. If gametes were lacking, the fish was recorded as gender unknown. A numbered anchor tag was inserted into the abdominal cavity through a small vertical incision made ventral and posterior to the distal end of the flattened left pectoral fin. Tags were pre-soaked in Betadine and the incision area was treated with Betadine after tagging.

Gender-based relationships of TL and SL and SL and TW were examined using least squares regression. Male and female slopes for each relationship were compared using ANCOVA. Spawning population size was estimated using Jolly (Jolly 1965) and Jolly-Seber (Seber 1982) population estimate models. Jolly estimates were calculated by hand for 1997–2000 recapture data. The Jolly-Seber estimate and 95% confidence intervals were calculated on all eight years of capture-recapture data using Mark computer software.

Results

Population Data

Sixty-seven percent of 1059 *Cycleptus meridionalis* collected from 1995–2003 were males, 30% were females, and 3% were gender unknown (Table 1). Males outnumbered females in every year except in 1995 when females outnumbered males (Fig. 1); numbers were equal in 1998. Differences in the 2:1 male to female sex ratio obtained during our study and the 1:1 ratio in Mississippi (Peterson et al. 1999) were probably influenced to a large degree by variations in sampling design between the studies. We sampled a spawning population with gill nets for only two months while Peterson et al. (1999, 2000) collected in 15-minute boat electrofishing samples at randomly selected sections of the Pearl and Pascacgoula rivers throughout the year.

Lowest sampling success (fish per net hour and total fish) occurred in 2000 and 2001 (Table 1) when a two-year drought produced record low water levels in the Alabama River and prevented Claiborne Lock and Dam from being submerged by win-

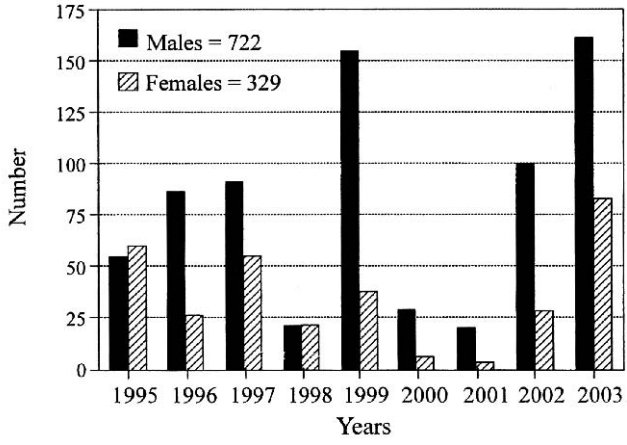

Figure 1. Numbers of male and female *Cycleptus meridionalis* collected in the Alabama River below Millers Ferry Lock and Dam, 1995–2003.

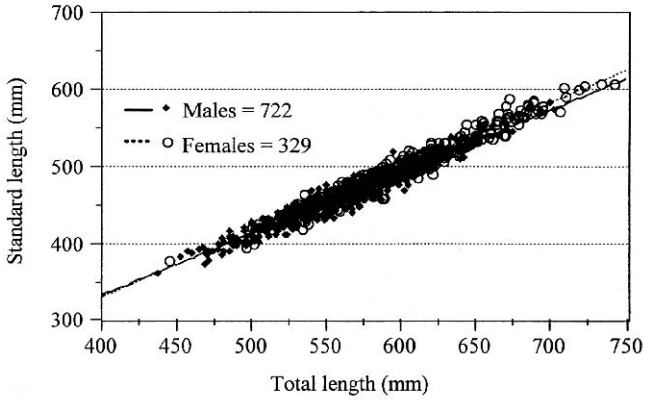

Figure 2. Total length vs. standard length for male and female *Cycleptus meridionalis* collected in the Alabama River below Millers Ferry Lock and Dam, 1995–2003.

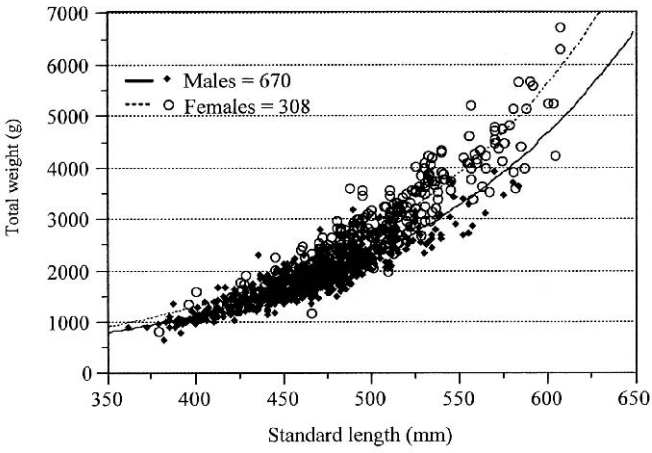

Figure 3. Standard length vs. total weight for male and female *Cycleptus meridionalis* collected in the Alabama River below Millers Ferry Lock and Dam, 1995–2003.

Table 2. Number of days Claiborne Lock and Dam spillway was inundated by spring floods, December 1994–March 2003.

	Month		
Years	December	January	February
1994	4	—	—
1995	7	0	12
1996	2	4	16
1997	6	7	10
1998	0	23	22
1999	0	1	8
2000	0	0	0
2001	0	0	2
2002	13	6	2
2003	—	4	6

ter flooding (Table 2). Greatest spawning activity and sampling success occurred in 1995–1997, 1999, and 2003 when winter floods inundated Claiborne Lock and Dam from 8 to 27 days. *Cycleptus meridionalis* had ample opportunity to move upstream when winter flooding submerged Claiborne Lock and Dam for 51 days from late 1997 through early 1998. However, extended flooding postponed netting operations until most spawning activity had ceased, resulting in the collection of only 45 fish in 1998.

Female *Cycleptus meridionalis* collected in the Alabama River attained a greater length and a heavier weight (742 mm TL and 6810 g TW) than males (700 mm TL and 3915 g TW). Total lengths were similar for females collected in the Alabama River (446 to 742 mm) and in Mississippi (452 to 702 mm), but the TL of Alabama River males were slightly longer (438 to 700 mm) than those collected in Mississippi (327 to 593 mm)(Peterson et al. 1999). Total weights are not compared because Peterson et al.(1999) failed to report weight ranges.

Linear regressions were used to compare the relationship of TL to SL for 722 males and 329 females collected from 1995–2003 (Fig. 2). Equations were: SL = 7.75 + 0.81 (TL)(r = 0.944) for males and SL = –7.97 + 0.845 (TL) (r = 0.954) for females. Slopes were significantly different ($P < 0.01$) as determined using ANCOVA. The relationship of TW to SL for 670 males and 308 females was plotted as an exponential function because long-lived fishes generally grow faster in their first few years of life (Fig. 3). Equations describing these functions were: $\log_{10}$ TW = –5.4433 + 3.2615 ($\log_{10}$ SL)(r = 0.923) for males and $\log_{10}$ TW = –6.6070 + 3.7214 ($\log_{10}$ SL)(r = 0.954) for females. The slopes for this relationship were also significantly different ($P < 0.01$) as determined using ANCOVA.

Spawning Season

Water temperatures ranged from 15 to 21 C during most netting operations. The head and dorsum on males in pre-spawning condition were a pale bluish grey, the

ventrum varied from grey to cream color, and the head, body, and fins were densely covered with prominent white tubercles. The head and dorsum of females were a lighter shade of bluish grey and the ventrum was grey to cream color. Tubercles present on the head, body, and fins were less prominent and more widely spaced. Spawning was in progress on 29 March 1999 and 26–27 March 2003 when we collected >100 fish per sample at 15 to 17 C. All individuals collected were much more intensely colored and they freely extruded large quantities of gametes when removed from the nets and processed. Frayed fins and open wounds on both sexes could have resulted from aggressive spawning behavior and/or moving upstream through turbulent currents near Claiborne Lock and Dam. Most *Cycleptus meridionalis* left the generator outflow area at 20–21 C.

Capture/Recapture and Population Estimates

Twenty percent of 702 *Cycleptus meridionalis* anchor tagged below Millers Ferry from 1995–2002 were recaptured in the same sampling area from 1996–2003 (Table 3). One hundred-two fish were collected only once, from one to eight years after their original release. The remaining 37 fish were recaptured two to six times, some two to three times in a single year. The longest recapture record was a male tagged in 1995, re-tagged in 1997 and 2000, recaptured three times in 2002, and last recaptured in 2003. These data confirm that many *Cycleptus meridionalis* inhabiting the Alabama River spawn annually below the Millers Ferry Lock and Dam for at least nine years and possibly longer.

Recapture data suggest some *Cycleptus meridionalis* move upstream and downstream past Claiborne Lock and Dam. Two males tagged below Millers Ferry in 1997 and 1999, respectively, were recaptured in the Claiborne tailwater in 2000. The 1999 fish subsequently moved back upstream and was recaptured below Millers Ferry in 2002. A male tagged in the Claiborne tailwater in 2000 was recaptured below Millers Ferry in 2002. A female tagged below Millers Ferry in 1996 was recaptured 148 km downstream of Millers Ferry and 52 km downstream of Claiborne in 2000. Although these fish may have moved through the lock chamber rather than past the spillgates or over the spillway at Claiborne, this possibility seems remote since the number of boats locking past the dam has declined substantially over the past 10 years.

Population estimates for the number of *Cycleptus meridionalis* spawning below Millers Ferry ranged from 775 to 1034 fish using the Jolly model and 733 to 1275 fish using the Jolly-Seber model. Both estimates seem very conservative because we have already tagged 913 fish and only 121–362 fish remain to exceed upper population estimates from both models. Lower than expected population estimates probably resulted from a combination of several uncontrollable factors that occurred throughout the study. Sample number and scheduling throughout the study were directly dependent on flow conditions in the Alabama River, water levels in the Millers Ferry tailwater, and the ability of the U.S. Army Corps of Engineers to discontinue hydroelectric generation during the prime spawning season. As stated earlier, extreme flooding postponed netting operations in 1998 until most *Cycleptus meridionalis* had already left the sampling area. Conversely, Claiborne Lock and Dam was never inun-

Table 3. *Cycleptus meridionalis* anchor tagged in the Alabama River below Millers Ferry Lock and Dam from 1995–2002 and recaptured in the same area from 1996–2003. *N* (%) totals exclude multi-year recaptures of the same fish and fish recaptured in their original tag year. Bottom totals include fish recaptured in their original tag year.

Tag year	New fish tagged	Recapture year and total recaptures									*N*(%)
		1995	1996	1997	1998	1999	2000	2001	2002	2003	
1995	133	3	25	7	0	6	0	0	3	1	42 (32)
1996	100		4	16	2	6	0	0	0	2	26 (26)
1997	124			1	2	13	0	0	1	2	18 (15)
1998	45				3	7	5	0	1	0	13 (29)
1999	148					6	8	0	4	9	21 (14)
2000	23						0	0	2	0	2 (9)
2001	31							0	4	0	4 (13)
2002	98								11	13	13 (13)
Totals	702	3	29	24	7	38	13	0	26	27	139 (20)

dated by winter floods from 1999 through early 2001. During this time period, Claiborne effectively blocked upstream fish movement in the Alabama River and contributed to the lowest *Cycleptus meridionalis* collections recorded throughout the study.

Discussion

The tailwater area below Millers Ferry Lock and Dam provides excellent spawning habitat for *Cycleptus meridionalis*, but it is not the only spawning site for this species in the Alabama River nor does it support a large number of year-round residents. We and several colleagues have collected *Cycleptus meridionalis* in prime spawning condition near rock training jetties and along natural shorelines downstream of Claiborne Lock and Dam. This trend is particularly apparent in years when Claiborne was not inundated by winter floods.

Cycleptus meridionalis congregated below Millers Ferry when water temperatures ranged from 15–21 C, but greatest spawning activity occurred in late March when water temperatures ranged from 15–17 C. These dates and temperatures were consistent with the >12 C reported by Semmens (1985) in the Alabama River and 13–14 C reported by Peterson et.al. (1999) in Mississippi. Spawning ceased and most fish left the Millers Ferry spawning area when temperatures reached 20–21 C. Alabama and Mississippi spawning times are somewhat earlier than May spawning in Kansas (Moss et al.1983) and late April to early May spawning in the upper Mississippi River (Rupprecht and Jahn 1980, McInerny and Held 1988).

Peterson et al. (1999) determined male *Cycleptus meridionalis* live 33 years and females lived 31 years. Males had visibly developed gonads by age 4 and females at age 11. We decided to conduct a capture-recapture study rather than sacrifice large numbers of individuals for age and growth studies and in doing so, learned that many

Cycleptus meridionalis spawned annually below Millers Ferry Lock and Dam for at least nine years.

The lower Alabama River is inhabited by a self sustaining *Cycleptus meridionalis* population of unknown size, but the status of this species should be closely monitored if future dredging and other river-based activities such as point- and non-point discharges begin to adversely affect existing habitat and water-quality conditions in the river. The gated spillway at Millers Ferry Lock and Dam has no doubt blocked the upstream movements of anadromous Gulf sturgeon and Alabama shad, paddlefish and other riverine species into the upper Alabama River and the Cahaba River, its major tributary. Several stakeholder government agencies are currently investigating ways to increase fish movements past locks and dams on the Alabama River. We encourage these organizations to continue their efforts to protect this important resource.

Acknowledgments

We thank several agencies and individuals for their individual and collective contributions to this research. Section 6 funding was provided by the Division of Wildlife and Freshwater Fisheries (DWFF) of the Alabama Department of Conservation and Natural Resources (ADCNR), U.S. Fish and Wildlife Service, and Geological Survey of Alabama. Supplemental funding was received from the State Lands Division of the ADCNR. The Mobile District Office of the U.S. Army Corps of Engineers arranged temporary interruptions in the hydroelectric generation schedule at Millers Ferry Lock and Dam to accommodate our netting operations. The DWFF provided personnel, a pontoon boat, and sampling equipment during the early stages of the project. J. Haffner from DWFF and M. Maceina and J. Slipke from Auburn University assisted with the completion of population estimates for the paper.

Literature Cited

Boschung, H.T.1992. Catalog of freshwater and marine fishes of Alabama. Alabama Museum of Natural History Bulletin 14:1–266.

Burr, B.M. and Mayden, R.L.1999. A new species of *Cycleptus* (Cypriniformes: Catostomidae) from Gulf slope drainages of Alabama, Mississippi, and Louisiana, with a review of the distribution, biology, and conservation status of the genus. University of Alabama Museum of Natural History Bulletin 20:19–57.

Coker, R.E.1929. Keokuk Dam and the fisheries of the upper Mississippi River: U.S. Department of Commerce, Bureau of Fisheries Document 1063:87–139.

Elstad, S.A. and S.J. Werdon.1993. Status report on blue sucker *(Cycleptus elongatus)*, a candidate endangered or threatened species. U.S. Fish and Wildlife Service, Bismarck, North Dakota.

Etnier, D.A. 1997. Jeopardized southeastern freshwater fishes: a search for causes. Pages 87–104 *in* G.W. Benz and D.E. Collins, editors. Aquatic fauna in peril, a southeastern perspective. Southeastern Aquatic Research Institute Special Publication 1.

_____ and W.C. Starnes.1993. The fishes of Tennessee. The University of Tennessee Press. Knoxville, Tennessee.

Gilbert, C.R.1978. *Cycleptus elongatus* (Lesueur), blue sucker. Page 396 *in* D.S. Lee et al. Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina.

Jolly, G.M. 1965. Explicit estimates of capture-recapture data with death and immigration-stochastic model. Biometrika 52:225–247.

Jordan, D.S. 1882. Report on the fishes of Ohio. Pages 735–1002 *in* Report of the Geological Survey of Ohio. Columbus, Ohio.

Lesueur, C.A.1817. A new genus of fishes, of the Order Abdominales, proposed, under the name Catostomus; and the characters of the genus, with those of its species, indicated. Journal of the Philadelphia Academy of Natural Sciences 1:8–96,102–111.

McInerny, M.C. and J.W. Held.1988.Collections of young-of-the-year blue suckers *(Cycleptus elongatus)* in Navigation Pool 9 of the upper Mississippi River. Wisconsin Academy of Science 76:69–71.

Mettee, M.F., P.E. O'Neil, and J.M. Pierson.1996. Fishes of Alabama and the Mobile Basin: Oxmoor House. Birmingham, Alabama.

Moss, R.E., J.W. Scanlan, and C.S. Anderson.1983. Observations on the natural history of the blue sucker (*Cycleptus elongatus* LeSueur) in the Neosho River. American Midland Naturalist 109:15–22.

Page, L.M. and Burr, B.M.1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin, Boston, Massachusetts.

Peterson, M.S., L.C. Nicholson, D.J. Synder, and G.L. Fulling.1999. Growth, spawning preparedness, and diet of *Cycleptus meridionalis* (Catostomidae). Transactions of the American Fisheries Society 128:900–908.

_____, _____, and G.L. Fulling. 2000. Catch-per-unit-effort, environmental conditions and spawning migration of *Cycleptus meridionalis* Burr and Mayden in two coastal river drainages in the northern Gulf of Mexico. American Midland Naturalist 143:414–421.

Pflieger, W.L.1975. The fishes of Missouri. Missouri Department of Conservation. Jefferson City, Missouri.

Robison, H.W. and T.M. Buchanan.1988. Fishes of Arkansas. University of Arkansas Press, Fayetteville, Arkansas.

Ross, S.T. 2001. The inland fishes in Mississippi. University Press of Mississippi. Jackson, Mississippi.

Rupprecht, R.J. and L.A. Jahn.1980. Biological notes on blue suckers in the Mississippi River Transactions of the American Fisheries Society 109:323–326.

Seber, G.A.F. 1982. The estimation of animal abundance and related parameters. Second edition. Macmillan, New York.

Semmens, K.J.1985. Induced spawning of the blue sucker *(Cycleptus elongatus)*. Progressive Fish-Culturist 47:119–120.

Williams, J.E., J.E. Johnson, D.A. Hendrickson, S. Contreras-Balderas, J.D. Williams, M. Navarro-Mendoza, D.E. McAllister and J.E. Deacon.1989. Fishes of North America Endangered, Threatened, or of Special Concern. Fisheries 14(6):2–20.