# Appendix B

## A Survey of Fish, Mussels, and Other Benthic Invertebrates in Parts of the Nolichucky River in East Tennessee

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## INTRODUCTION

Surveys of fish, benthic macroinvertebrates, and native freshwater mussels were conducted in the lower Nolichucky River (River Miles 8.5-60.6) during May and June, 2000. These surveys were designed and conducted to provide aquatic biological information for use in the Nolichucky Flood Remediation Environmental Impact Statement (EIS). The detailed results of these efforts are reported here and are used in the EIS to evaluate the effects of various alternatives on aquatic life. In this report, details in the results also are compared to similar information from earlier surveys in this east Tennessee river.

## PHYSICAL CHARACTERISTICS

The Nolichucky River arises in the Blue Ridge Physiographic Province of the North Carolina highlands at the confluence of the North Toe and Cane rivers. It then flows westward into Tennessee, entering the Central Appalachian Ridge and Valley Province, where the lower 40 percent of its drainage lies. With a total drainage area of 1,756 square miles, the Nolichucky River is a major tributary of the French Broad River system. It enters the French Broad River (Douglas Reservoir) at French Broad River Mile 69.1 near White Pine, Tennessee, at the junction of Hamblen, Cocke, and Jefferson counties. The upper portion of the drainage is primarily forested, while the dominant land use in the lower portion is agricultural. High concentrations of solids, especially sand, from past mica and feldspar mining in the North Toe watershed have caused severe impacts to aquatic life downstream (TVA 1994), which are still apparent throughout most of the river's length.

Basic water quality information from the lower Nolichucky River is available from relatively recent data collected at the TVA gauging station (River Mile 10.7) near Lowland, Tennessee (Ibid). Water is moderately hard (average hardness of 79 milligrams per liter [mg/L]) and moderately alkaline (average total alkalinity of 67 mg/L). The median pH is 7.8, and dissolved oxygen levels ranged from 87 to 100 percent of saturation. Average organic nitrogen (0.223 mg/L), nitrate+nitrite-nitrogen (0.56 mg/L), total phosphorus (0.075 mg/L), and dissolved orthophosphate (0.024 mg/L) are slightly above median concentrations found at 12 other stream monitoring sites across the Tennessee Valley. The total phosphorus concentration is slightly higher than what is considered healthy, although not excessively so.

## SITE DESCRIPTIONS

All biological samples were taken in the lower portion of the main river channel in the Central Appalachian Ridge and Valley Ecoregion. Five sites were selected to characterize benthic macroinvertebrate and fish communities between River Miles 8.5 and 60.5 (Table B1). Sites 1-3 roughly correspond to the lower, middle, and upper thirds of the river segment below Nolichucky Dam. Site 4 is in the impounded portion of Nolichucky Reservoir (also called Davy Crockett Lake), and Site 5 is in the free-flowing portion of the Nolichucky River just upstream of the impoundment. Mussel surveys were conducted at 10 locations: the 5 sites where the fish and benthic samples were

taken and 5 other sites along the length of the river downstream of Nolichucky Dam (Table B1).

All sites except Site 4 had good physical habitat diversity (i.e., riffles, runs, and pools) with good riparian canopy, gravel/cobble substrates, large woody debris, and undercut banks. Other than Site 4, sedimentation is most apparent at Site 1, attributable to low gradient, the proximity to Enka Dam downstream, and inputs from several turbid tributaries, notably Lick Creek, Bent Creek, and Little Chucky Creek. In addition to physical habitat features mentioned above, Site 1 had large areas of waterwillow (*Justicia americana*) and slow, silty pools.

Large *Justicia* beds were also present at Site 2, along with some bedrock outcroppings, but the pool areas were less silted than those of Site 1. Gradient was noticeably higher at Site 3, and the riffles and runs had larger substrate (i.e., rubble and boulders), more exposed bedrock, and smaller expanses of *Justicia* than the lower stations.

The substrate at Site 4 was virtually all sand except for patches of woody debris along the shorelines. Riffles and runs at Site 4 were sampled in flowing waters of the main river channel where water depths ranged from less than 1 foot to about 2 feet. Pool areas in the reservoir were perhaps 4 feet or less in depth, and the mostly wooded shorelines provided good overhanging and undercut bank cover for certain fish species.

Above the reservoir at Site 5, gradient was the steepest. Substrate was mostly bedrock ledges and large cobbles. Riffles and runs were swept clean of sediment by high water velocities, while backwaters, pools and other areas of low velocity had accumulations of silt and sand. Pool areas were bordered by bedrock outcroppings and trees on the outside of the river bend and sandy shorelines on the inside of the bend.

Stream gradient is the most obvious physical habitat feature differing between the sampling sites. The two lowermost sites are in relatively low-gradient regions, whereas Sites 3 and 5 are high. The reservoir site, Site 4, has virtually no gradient, as the streambed is almost entirely sand from bank to bank.

## METHODS

### Benthics

Samples were collected according to TVA's Level III, Benthic Index of Biotic Integrity (IBI) protocols, which include both quantitative and qualitative samples. Quantitative samples were collected with Hess and Surber samplers. Three Hess samples were taken from shallow run habitats and three Surber samples were taken from shallow riffle habitats at each site. A composite qualitative sample was taken from multiple habitats present at each site. The prescribed habitats for qualitative sampling are: riffles, surface of large rocks and large woody debris, leaf packs and/or accumulated organic debris, submerged root wads, sand and sediment, and aquatic macrophytes.

The TVA Level III benthic sampling protocols yield two types of data. The first is simply a list of the total taxa and number of individuals collected at each site. The second is a multimetric benthic IBI score for each site. The benthic IBI uses data from the quantitative and qualitative samples to calculate scores between 1 and 5 for 12 benthic community characteristics or metrics. These individual metric scores are summed to produce an overall site index score. Scores of 45 to 60 are rated good, 31 to 44 are rated fair, and 30 or below are rated poor. TVA's version of benthic IBI metrics and metric scoring criteria are modified from Kearns and Karr (1994).

**Mussels**

Snorkel-equipped divers performed timed qualitative searches for native mussels at each of the 10 sites. Additionally, one collector utilized a clam rake to sample near-shore habitats at each site, and one SCUBA-equipped diver searched deep pool habitats at the uppermost site (River Mile 60.6).

Mussels were removed from the substrate and held in mesh bags until they were identified and counted by species. Species identification was primarily made using external shell morphology. Some individuals were gently pried open enough to see the color of soft tissues and/or interior of the shell (the nacre). A few specimens were preserved in 95 percent ethanol for more detailed examination. Identifications were verified by Dr. Paul W. Parmalee, McClung Museum, University of Tennessee, Knoxville.

**Fish**

Fish communities were sampled at the five Nolichucky River sites in May and June, 2000 using standard IBI protocols (Karr 1981). A backpack-electrofishing unit, a 20-foot seine, and dip nets were used to collect fish in wadeable habitats, while a boat-mounted electrofishing unit was used to sample deep runs and pool areas. Under IBI protocols, all discernible habitats at a given site are sampled until no previously uncollected species are found, thus assuring a permissible sample. IBI metrics address 12 community characteristics, which are summed to produce an overall site score. Scores of 58-60 are rated excellent, 48-52 are considered good, 40-44 are rated fair, 28-34 are poor, and 12-22 are considered very poor.

Because dams are often barriers to upstream fish migration, concentrations of prespawning fish species often occur below them. Additional boat electrofishing samples were taken to document the presence of migratory spawning fish species in two key river stretches downstream of Nolichucky Dam. A 4-mile section from Nolichucky Dam to Allen Bridge (River Miles 42-46) was sampled on April 21, 2000. The area immediately below Enka Dam was sampled on March 28 and again on April 20, along with selected shoals in the entire stretch between Enka Dam to the backwaters of Douglas Reservoir. Turbid water was a factor on both sampling trips below Enka Dam.

## RESULTS AND DISCUSSION

### Benthics

One hundred and sixty four benthic taxa were collected from all sites combined (Table B2). Benthic IBI scores ranged from 18.67 at Site 4 (River Mile 50.6) to 41 at Site 1 (River Mile 8.5) (Table B3). Site 4 rated poor, while all other sites rated fair. Overall number of benthic taxa collected at each site ranged from 49 at Site 4 to 97 at Site 3 (River Mile 42.1). Numbers of predators, stoneflies, and collector/filterers were consistently low across all sites. Low densities of intolerant native mollusks at Sites 3-5 also contributed to lowered benthic IBI scores.

Not surprisingly, Site 4, within the impounded reach upstream of Nolichucky Dam, yielded the lowest overall benthic taxa richness and lowest benthic IBI scores (Table B3). Shifting sand dominates the substrate in riffle and run habitats within this reach. Few benthic organisms are adapted to this unstable environment. Sand and silt deposition was not as severe at Site 5 (River Mile 60.5); however, it was more evident there than at sites downstream of Nolichucky Dam. Nutrient enrichment, implied from observations of excessive periphyton growth, is also a likely factor in depressed benthic communities at Site 5.

At sites below Nolichucky Dam, benthic IBI scores improved slightly with distance downstream. While not as heavy as at Site 5, sediment deposition was more evident at Site 3 (River Mile 42.1) than at Site 2 (River Mile 27.7); however, sediment deposition increased again at Site 1. Signs of nutrient enrichment (especially aquatic macrophytes) appear to increase with distance downstream from Nolichucky Dam. Continued improvement in the benthic community is probably abated by increasing agricultural land use within the river floodplain and the inflow from tributaries impacted by erosion and nutrient enrichment (e.g., Lick and Bent creeks).

### Mussels

No live native mussels were found at Sites 9 and 10, upstream of the Nolichucky Dam. The Asian clam (*Corbicula fluminea*) was the only bivalve found at Sites 9 and 10 during the mussel survey. Prior to the mussel survey, one fresh dead shell of the giant floater (*Pyganodon grandis*) was found near Site 9 by TVA personnel surveying for terrestrial animals.

Live native mussels were found at the remaining eight sites surveyed below Nolichucky Dam. A total of 20 native mussel species was identified from 803 live specimens collected (Table B4). Species richness, total individuals collected, and relative abundance (as catch per unit effort) increased with distance downstream from Site 8 (River Mile 42.1) to Site 3 (River Mile 16). Greatest species richness was 10 species (at Sites 3, 4, and 5). The greatest number of individuals collected and highest catch per unit effort occurred at Site 3 (263 and 52.6, respectively).

Three species (purple wartyback, spike, and pocketbook) comprised 75.8 percent of all mussels collected. Ten species were represented by single specimens. One federally listed species—a single specimen of the federally listed as endangered oyster mussel

(*Epioblasma capsaeformis*)—was collected at Site 2 (River Mile 11.4). Additionally, the rare spiny riversnail (*Io fluvialis*) was abundant at Site 4 (River Mile 27.9) and is known from there downstream to Steele Island (River Mile 20.5) (S. A. Ahlstedt, United States Geological Survey [USGS], personal communication).

**Fish**

A total of just over 7,000 fish were collected during the five IBI surveys, including 63 species representing 11 families (Table B5). This corresponds well with the 61 species found in boat electrofishing samples collected by Tennessee Wildlife Resources Agency at 30 sites between Nolichucky River Miles 7.6 and 98 in 1998. Cyprinidae (minnows) was the most numerous family sampled, and accounted for 65 percent of all the fish collected. While 18 minnow species were found, the majority were spotfin shiners (*Cyprinella spiloptera*), rosyface shiners (*Notropis rubellus*), and mimic shiners (*Notropis vollucellus*). The 12 species of perches (Percidae) accounted for 15 percent of the total sample and included 2 species listed as in need of management in Tennessee: sharphead darter (*Etheostoma acuticeps*) and tangerine darter (*Percina aurantiaca*). The third most abundant family was the suckers (Catostomidae), whose 11 species comprised 8 percent of the sample by number. Although weights were not measured in the field, biomass of all the fish collected in the IBI samples was easily dominated by suckers. One blue sucker (*Cycleptus elongatus*), a state-listed as threatened species, was found at Site 3, and seven highfin carpsuckers (*Carpiodes velifer*), listed as in need of management in Tennessee, were found at Site 5. Eleven species of sunfishes (Centrarchidae) accounted for 6 percent of the sample, and included several familiar game fish species: smallmouth bass (*Micropterus dolomiue*), spotted bass (*M. punctulatus*), rock bass (*Ambloplites rupestris*), redbreast sunfish (*Lepomis auritus*) and bluegill (*L. macrochirus).* The remaining seven families comprised only 5 percent of the total number of fish collected.

As indicated by the IBI analysis (Table B6), the healthiest fish community was found at Site 3. With an IBI score of 54, the fish community at Site 3 was rated as good/excellent. More native fish species (44) were found there than at any other site. A high number of spotfin shiners, a tolerant species, were the primary limiting factor that brought the score down. Fish communities at Sites 1, 2, and 5 all rated good with IBI scores of 48, 50, and 48, respectively. Native fish diversity at these sites was 39, 38, and 40 species, respectively, or slightly below the diversity found at Site 3. The fish community at the reservoir site, Site 4, was considerably less healthy, as shown by an IBI score of 38 and a rating of poor/fair. Only 26 native species were collected at Site 4. Most of those species came from boat electrofishing samples along the shorelines where the habitats were more diverse. As stated earlier, the substrate in the reservoir is virtually all shifting sand, which offers little habitat for aquatic invertebrates or fish.

Fish communities in the Nolichucky River have been surprisingly stable over the last several years, according to IBI results collected since 1990 (Table B7). While two early samples at the lowermost station (River Mile 8.5) rated fair, all samples there since 1993 have rated good. Other main stem river samples generally have rated good. Consistent good ratings of fish communities typically indicate an aquatic ecosystem

recovering from serious pollution problems. Consistent good ratings also may indicate that other, less serious, problems remain that prevent the communities from making a more complete recovery.

Overall species diversity is one of the metrics that consistently serves to depress the IBI scores from the Nolichucky River. Historic information indicates that approximately 65 native species would be expected to occur in the Ridge and Valley segment of the Nolichucky River. At all sites except Site 3, less than two-thirds of that number of species were collected. Even the sample taken at Site 3 included only slightly more than two-thirds of the expected species diversity.

Another weakness in these fish communities also tends to drive down the IBI ratings. Species that were noticeably absent or uncommon in this study included blotched chub (*Erimystax insignis*), stargazing minnow (*Phenacobius uranops*), fatlips minnow (*P. crassilbrum*), gilt darter (*Percina evides*), and even logperch (*P. caprodes*) (Table B5). These specialist insectivore species are typically found in runs of moderate streamflow over expanses of small, gravel substrates. The absence or very low occurrence of these small, benthic, run-dwelling fish species suggests that their specific habitat is particularly impacted by pollutants in the Nolichucky River.

The occurrence pattern of most of these run-dwelling species over the last 10 years at Thomas Island (River Mile 8.5) has shown similar patterns of perturbation (Table B8). The blotched chub may be an exception to this pattern because it was fairly common each year until 2000, when it was absent. Habitat assessments at Thomas Island and Highway 107 Bridge (River Mile 60.5) in August 1997 indicated excessive sediment deposition and embeddedness at both sites. According to those field observations, sediment deposition affected between 30 and 50 percent of the riverbed, while gravel, cobble, and boulder particles were 25-50 percent surrounded by fine sediment (TVA, unpublished information). While high current velocities may flush sediments from riffles, currents are not sufficient to prevent deposition in other areas of the streambed, including the gravel run habitats used by these insectivore specialists.

Recent IBI analyses of fish communities in tributaries to the Nolichucky River in Tennessee indicate those streams are less healthy than most of the main river (Table B9, TVA, unpublished information). Most of the tributary streams rated poor, especially in the lower reaches. Poor land use practices in those watersheds appear to add excessive amounts of sediment, nutrients, and various agriculture contaminants to the streams.

With regard to migratory fishes, the river stretch below Nolichucky Dam yielded representatives of 12 sucker species when it was sampled on April 21 (Table B10). These species included all five redhorse species (*Moxostoma*), all three carpsuckers (*Carpiodes*), two buffaloes (*Ictiobus*), the northern hogsucker (*Hypentelium nigricans*), and the blue sucker (*Cycleptus elongates*). A school of black redhorse (*Moxostoma duquesnei*) was caught in the act of spawning a short distance downstream from the dam. In addition, two large, mature blue suckers (*Cycleptus elongatus*) were collected,

and it is presumed they also spawn within this 4-mile stretch. Other species found in large numbers below Nolichucky Dam included longnose gar (*Lepisosteus osseus*), gizzard shad (*Dorosoma cepedianum*), and common carp (*Cyprinus carpio*). While some of these species also may spawn elsewhere in the Nolichucky River between Nolichucky and Enka dams, the upper section of this river reach appears to be an important spawning area. No information was collected to confirm or deny a statement that muskellunge (*Esox masquinongy*) spawn in the pool immediately below Nolichucky Dam because many fishermen were there that day and no electrofishing sample was taken.

The area below Enka Dam also yielded large numbers of suckers on both sampling dates (Table B10). Again, all five redhorse species were found, along with carpsuckers, buffaloes, hogsuckers, gizzard shad, and common carp. On March 28, a large muskellunge, estimated at 25-30 pounds, was collected just below Enka Dam, and on April 20, suckers were especially concentrated below Enka Dam. Sampling downstream from the dam to the backwaters of Douglas Reservoir yielded fewer suckers; however, white bass (*Morone chrysops*) were concentrated on the shoals nearest the backwaters of Douglas Reservoir. Two large striped bass (*Morone saxatilis*) were found approximately 2 miles above backwater. Only two sauger were collected in this river reach, suggesting that this area was not an important sauger spawning area in 2000, although turbid water conditions may have hindered the ability to observe them.

As a group, migratory-spawning fish species are more sensitive to sedimentation than other species because they broadcast their eggs on gravel/rubble substrates, do not build nests, and do not provide any parental care for the eggs or young. The eggs of these species are more vulnerable to scouring and/or suffocation under silt and sedimentation. The occurrence of migratory-spawning species in a fish community provides evidence of a reasonably healthy environment. Many of the migratory-spawning species are important game fish species, while others are commercially harvested for human consumption.

## LONG-TERM TRENDS, 1950-2000

The aquatic communities found in the Nolichucky River during the spring and summer of 2000 are dramatically improved over the communities found in this river during past years. Information presented 40 years ago by Mullican et al. (1960) indicates that, benthic fauna was mostly restricted to riffle areas because the streambed in pool areas was blanketed by a layer of particulate matter. Riffle habitats were less impacted by turbidity and siltation because of shallow water, increased light penetration, less particulate matter, growth of riverweed (*Podostemum*), and higher current velocities. Live mussels were only found at one of seven sampling sites in the main river between River Miles 6 and 96, and only two mussel species, black sandshell (*Ligumia recta*) and "*Lampsilis leptodon*" [probably = *Leptodea fragilis*] were found at that site (River Mile 11.4) (Ibid).

Fish communities in the Nolichucky River also were depauperate during the 1950s. Rotenone samples collected by Tennessee Game and Fish Commission in 1959 found no more than 19 species at any of six sampling sites (Ibid). The poorest diversity, nine species, was found at Kinser Bridge, River Mile 60.5, which is within the segment impounded by Nolichucky Dam. At that time it was said, "Conditions in the Nolichucky River are not generally suitable for a population of desirable game fishes. Reproduction of sunfishes was unsuccessful at all mainstream stations" (Ward 1960). The sport fishery was so depressed in 1959 that only 20 individuals of black bass (largemouth bass, smallmouth bass, and spotted bass) were collected in the six rotenone surveys, and the total weight was only about 5 pounds. Siltation was believed to be limiting reproduction of nest building species, such as sunfish (Mullican et al. 1960).

A site at Jones Bridge (River Mile 11.4) had the best biological condition of all sites sampled in 1954, 1956, and 1958, probably indicating a recovery zone from the turbidity, siltation, and sewage discharges further upstream. But the recovery zone was again polluted not far below Jones Bridge. Industrial pollution from the American Enka Plant at Lowlands was polluting the lower 7 miles of river via discharges into Flat Creek, and the streambed below was plagued with noxious growths of *Sphaerotilus*, a filamentous bacterium commonly known as sewage fungus (Ibid).

Favorable biological conditions continued in the recovery zone of the lower Nolichucky River above the American Enka Plant into the 1970s. In September 1976, benthic invertebrate communities at River Mile 9 were indicative of a "clean water situation" (Tennessee Department of Public Health 1977). Beginning in 1976, American Enka began an aggressive effort to reduce pollution of the lower 7 miles of the Nolichucky River by the plant's effluents. By mid-1977, growths of *Sphaerotilus* had remarkably declined, and although it was succeeded by moderate growths of blue-green algae, portions of the streambed were emerging from the blanket of pollution that had suffocated normal aquatic biota, the "first vital step toward…biological recovery…" (Ibid).

In 1980, TVA personnel surveyed mussel communities at 41 sites on the Nolichucky River downstream from Nolichucky Dam (Ahlstedt 1986). Mussel communities then were more similar to conditions found in 2000 than they apparently had been in 1960. Twenty-one species were collected in 1980, while 20 species were collected in the same reach in 2000. Four species collected in 1980 were not found in 2000, and three species were encountered in 2000 that were not found in 1980. At least three of the four species last collected during the 1980 survey are still likely to exist in the Nolichucky River. SCUBA equipment was used at many of the sites surveyed in 1980 (S. A. Ahlstedt, USGS, personal communication), providing better coverage of the deep run and pool habitats where these species are more often found.

While the collection methods used during these two surveys do not allow direct comparison of mussel densities, careful review of the information reported from 1980 and communication with the lead investigator of that study suggests that mussel densities probably have increased substantially in some parts of the river (S.A. Ahlstedt,

USGS, personal communication). Specifically, the reach between Hale Bridge (River Mile 27.9) and the mouth of Lick Creek (River Mile 16) appears to have experienced some of the most improvement in mussel abundance.

Fish community samples collected at Hale Bridge (River Mile 27.9) by TVA during the summer of 1981 yielded 37 species (Barr et. al. 1986). While this species total compares favorably with the 40 species collected at that site in 2000, there were some notable differences. Five species present in 1981—blotched chub (*Erimystax insignis*), silver shiner (*Notropis photogenis*), fatlips minnow (*Phenacobius crassilabrum*), blueside darter (*Etheostoma jessiae*), and redline darter (*E. rufilineatum*)—were absent in the 2000 sample. As mentioned in the section entitled "Results and Discussion," blotched chub and fatlips minnow have been conspicuously uncommon in recent Nolichucky River samples. The absence of redline darters at this site in 2000 is puzzling because it is a very common, riffle-dwelling species and was the most abundant darter found at Thomas Island (River Mile 8.5) in 2000 (Table B5). The absence of redline darters and the other four species at Hale Bridge is contrary to the impression of improving fish communities in recent years. Differences in the occurrences of these species imply instability of the fish community in the Hale Bridge vicinity between 1981 and 2000 and suggest that biological recovery is incomplete. It also may be further evidence that small, benthic specialist insectivores are suffering the most from excess sediment in the streambed.

Conversely, seven species not found during the 1981 survey were collected in the river during the 2000 survey. The most notable additions in 2000 were rock bass (*Ambloplites rupestris*), whitetail shiner (*Cyprinella galactura*), and mountain madtom (*Noturus eleutherus*), all of which are considered evidence of community improvement. The records for the other four species—gizzard shad (*Dorosoma cepedianum*), common carp (*Cyprinus carpio*), silver redhorse (*Moxostoma anusurum*) and river redhorse (*M. carinatum*)—may be explained by the use of a boat shocker in 2000, a sampling technique which was not used in 1981.

During the past decade, IBI methods have been used to evaluate fish communities at several sites in both the Nolichucky River and its tributaries (Table B7). Seven of the nine IBI scores for the site at River Mile 8.5 (Site 1) fell in the good category (48-52), including all scores calculated since 1993. Both the 1997 and 2000 scores for the site at River Mile 60.5 (Site 5) also fell in the good category, while the two scores for River Mile 89 showed improvement from fair in 1997 to good/excellent in 2000. Scores for several sites on the streams in North Carolina that flow into the Nolichucky River have shown similar improvements, generally from the fair category in earlier years to the good category in more recent years.

These observations are in stark contrast to the remarks made of aquatic life in the upper portion of the Nolichucky drainage in 1969, when 30 miles of the North Toe River from Spruce Pine to Kona, North Carolina, were referred to as a "biological desert" due to pollution from feldspar, mica, and kaolin mining (TVA 1971). Also at that time, the Nolichucky River entered Tennessee "in a biologically degraded condition," and the

streambed from the state line to Nolichucky Reservoir was “blanketed with feldspar, mica, and sand” which “greatly reduced the abundance of fish and fish food organisms in the river” (TVA 1971).

Significantly improved water quality conditions, based on 1987 TWRA fish surveys, were subsequently documented (Schacher 1990). Improvements noted were increased species diversity, increased sport fish abundance, and the presence of several endangered or threatened aquatic species downstream from Nolichucky Dam. A total of 51 fish species were collected from two sites (River Miles 15.5 and 77, combined), which was more than double the diversity noted in 1959 surveys (Mullican et al. 1960). Smallmouth bass fisheries were reported both below Nolichucky Dam and in the river upstream from Nolichucky Reservoir (Schacher 1990).

A 1999 TWRA investigation reports much improved water quality in the Nolichucky River, supporting one of east Tennessee’s better warm water sport fisheries. All three black bass species (*Micropterus*), rock bass (*Ambloplites rupestris)*, and muskellunge (*Esox masquinongy*) provide fishermen excellent angling opportunities throughout the flowing portion of the river. Spotted bass (*M. punctulatus*) was the most abundant of the black basses. Smallmouth bass (*M. dolomieu*) was collected at 28 of 31 sampling locations between the state line (River Mile 99.1) and just below Enka Dam (River Mile 7.6). Two of the three sites without smallmouth bass were within Nolichucky Reservoir. Rock bass was found at 25 sites but was missing from all four sampling sites within Nolichucky Reservoir. Largemouth bass (*M. salmoides*) was more common in the lower, more sluggish portion of the river. TWRA reports increased recognition of the river’s sport fishery in recent years.

## SUMMARY

The results of this survey and available older information suggest that aquatic life in the Nolichucky River is recovering from past abuses. As the industrial and domestic wastes and the historical sources of the sand and sediment have been brought under control, aquatic communities have rebounded to reasonably good conditions at the present time. These communities, however, apparently have not been able to recover to their full potential because of residual sediment in the riverbed and continuing local sedimentation and other nonpoint source problems, primarily of agricultural origin, entering the main river from certain tributaries.

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Table B1. Listing of fish, benthic macroinvertebrate, and mussel sampling sites on the Nolichucky River sampled in 2000, including sampling dates and locality information.

| Site Name | NRM | County | USGS Quad. | Latitude | Longitude | Mussel Sites | | Fish and Benthic Sites | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Site No. | Date Sampled | Site No. | Date Sampled | |
| | | | | | | | | | Fish | Benthics |
| Thomas Island | 8.5 | Hamblen/ Cocke | Springvale | 36.134288 | -83.201196 | 1 | 14-Jun-00 | 1 | 19-Jun-00 | 19-Jun-00 |
| Beech Bottoms Island | 11.4 | Hamblen/ Cocke | Springvale | 36.143485 | -83.177975 | 2 | 14-Jun-00 | - | - | - |
| Lick Creek Island | 16.0 | Hamblen/ Cocke | Springvale | 36.170611 | -83.168244 | 3 | 14-Jun-00 | - | - | - |
| Hale Bridge | 27.9 | Greene | Parrotsville | 36.098432 | -83.052498 | 4 | 13-Jun-00 | 2 | 15-Jun-00 | 16-May-00 |
| Linebaugh Bend | 35.4 | Greene | Cedar Creek | 36.067922 | -82.976526 | 5 | 12-Jun-00 | - | - | - |
| Island at Old 411 Crossing | 36.9 | Greene | Cedar Creek | 36.068585 | -82.961740 | 6 | 12-Jun-00 | - | - | - |
| Upstream of Jones Is. | 39.5 | Greene | Cedar Creek | 36.071471 | -82.920764 | 7 | 12-Jun-00 | - | - | - |
| Allen Bridge | 42.1 | Greene | Cedar Creek | 36.060167 | -82.907918 | 8 | 12-Jun-00 | 3 | 8-Jun-00 | 16-May-00 |
| Bird Bridge | 50.6 | Greene | Davy Crockett Lake | 36.088640 | -82.821221 | 9 | 13-Jun-00 | 4 | 9-Jun-00 | 15-May-00 |
| TN 107 Bridge | 60.6 | Greene | Chuckey | 36.156546 | -82.725494 | 10 | 13-Jun-00 | 5 | 12-May-00 | 15-May-00 |

Table B2. Taxonomic List of Benthic Macroinvertebrates Found in Quantitative and Qualitative Samples Collected in the Nolichucky River, 2000

| CLASS / ORDER / FAMILY / GENUS | SPECIES | Site 1 Thomas Island RM 8.5 QUAN | QUAL | Site 2 Hale Bridge RM 27.7 QUAN | QUAL | Site 3 Allen Bridge RM 42.1 QUAN | QUAL | Site 4 Bird Bridge RM 50.6 QUAN | QUAL | Site 5 SR 107 Bridge RM 60.5 QUAN | QUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NEMATODA | | 5 | | | | 2 | | | | 2 | |
| HYDROZOA | | | | | | | | | | | |
| HYDROIDA | | | | | | | | | | | |
| HYDRIDAE | | | | | | | | | | | |
| HYDRA | AMERICANA | | | | | | 1 | | | | |
| TURBELLARIA | | | | | | | | | | | |
| TRICLADIDA | | | | | | | | | | | |
| PLANARIIDAE | | | | | | | | | | | |
| DUGESIA | TIGRINA | 53 | 1 | | | | 4 | | | | 1 |
| OLIGOCHAETA | | | | | | | | | | | |
| HAPLOTAXIDA | | | | | | | | | | | |
| ENCHYTRAEIDAE | | 1 | | | 1 | | | | | | |
| TUBIFICIDAE | | | | | | | | | | | |
| BRANCHIURA | SOWERBYI | 3 | | | | 5 | | | | | |
| LIMNODRILUS | HOFFMEISTERI | | | | | | | | 1 | | |
| TUBIFICIDAE | | 25 | | | 1 | 20 | 2 | | 1 | | |
| LUMBRICIDAE | | 10 | 6 | 45 | 4 | 48 | 4 | | | 35 | 1 |
| NAIDIDAE | | 1 | | 1 | | | 2 | | | 23 | |
| NAIS | BEHNINGI | | | | | | 2 | | | 41 | |
| NAIS | BRETSCHERI | | | 9 | | 11 | 8 | | | 98 | |
| NAIS | COMMUNIS | | | 10 | | 21 | 23 | | 3 | 50 | |
| NAIS | SP. | 1 | | 17 | 6 | | | | | 10 | |
| SLAVINA | APPENDICULATA | 1 | | 7 | 2 | | | | 2 | | |
| STYLARIA | LACUSTRIS | | | | | | | | 8 | 1 | 2 |
| LUMBRICULIDA | | | | | | | | | | | |
| LUMBRICULIDAE | | | 3 | | 1 | | | | | | |
| BRANCHIOBDELLIDA | | | | | 13 | | 1 | | | | |
| HIRUDINEA | | | | | | | 13 | | | | |
| RHYNCHOBDELLIDA | | | | | | | | | | | |
| GLOSSIPHONIIDAE | | | 1 | | | | | | | | |
| CRUSTACEA | | | | | | | | | | | |
| ISOPODA | | | | | | | | | | | |
| ASELLIDAE | | | | | | | | | | | |
| LIRCEUS | SP. | 1 | 1 | | 1 | | 7 | | | | |
| AMPHIPODA | | 5 | | | | | | | | | |
| CRANGONYCTIDAE | | | | | | | | | | | |
| CRANGONYX | SP. | | | | | | 4 | | | | |
| DECAPODA | | | | | | | | | | | |
| CAMBARIDAE | | | | 1 | | 12 | 1 | | | | 2 |
| ORCONECTES | SP. | 2 | 1 | | 1 | | 1 | | | | |
| BRANCHIURA | | | | | | | | | | | |
| ARGULIDAE | | | | | | | | | | | |
| ARGULUS | SP. | | 1 | | | | | | | | |
| OSTRACODA | | | | | | | | | | 1 | |
| INSECTA | | | | | | | | | | | |
| PLECOPTERA | | | | | | | | | | | |
| PERLIDAE | | | | | | | | | | | |
| AGNETINA | CAPITATA | | | 4 | 3 | | | | | | |
| LEUCTRIDAE | | | | | | | | | | | |
| LEUCTRA | SP. | | | | | | | | | 1 | |
| PERLIDAE | | | | | | | | | | | |
| PERLESTA | PLACIDA | | | | | | 1 | | | | |
| PTERONARCYIDAE | | | | | | | | | | | |
| PTERONARCYS | DORSATA | | 1 | | 1 | | | | | | |

Table B2. Continued.

| CLASS / ORDER / FAMILY / GENUS | SPECIES | Site 1 Thomas Island RM 8.5 QUAN | QUAL | Site 2 Hale Bridge RM 27.7 QUAN | QUAL | Site 3 Allen Bridge RM 42.1 QUAN | QUAL | Site 4 Bird Bridge RM 50.6 QUAN | QUAL | Site 5 SR 107 Bridge RM 60.5 QUAN | QUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ODONATA | | | | | | | | | | | |
| AESHNIDAE | | | | | | | | | | | |
| BOYERIA | VINOSA | | 1 | | 1 | | 2 | | 1 | | 1 |
| CALOPTERYGIDAE | | | | | | | | | | | |
| CALOPTERYX | SP. | | | | | | 2 | | 2 | | |
| HETAERINA | SP. | 4 | 1 | | 1 | | | | | | 1 |
| COENAGRIONIDAE | | | | | 3 | | 3 | | | | |
| ARGIA | SP. | 1 | 2 | | 1 | | 3 | | 6 | | 2 |
| ENALLAGMA | SP. | | | | | | | | 4 | | 2 |
| GOMPHIDAE | | 1 | | 11 | 2 | 1 | | | 1 | | |
| DROMOGOMPHUS | SP. | | | | | | 2 | | | | |
| GOMPHUS | SP. | 3 | 2 | | | 3 | 3 | | 1 | | 1 |
| HAGENIUS | BREVISTYLUS | | | | 1 | | | | 1 | | 1 |
| PROGOMPHUS | OBSCURUS | | | | | | | | 2 | | |
| CORDULIIDAE | | | | | | | | | | | |
| MACROMIA | SP. | | 1 | | 1 | | 4 | | 5 | | 2 |
| NEUROCORDULIA | MOLESTA | | | | 1 | | | | 3 | | |
| EPHEMEROPTERA | | | | | | | | | | | |
| BAETIDAE | | | | | | | | | | | |
| ACENTRELLA | AMPLA | 98 | 3 | 61 | 24 | 60 | 34 | | 1 | 227 | 30 |
| BAETIDAE | | 23 | | | | | | | 6 | 1 | |
| BAETIS | FLAVISTRIGA | | | | | | | | | 1 | |
| BAETIS | INTERCALARIS | 10 | | 6 | | 1 | | | | | |
| BAETIS | SP. | 12 | 4 | 7 | 2 | 3 | 5 | | 7 | 27 | 5 |
| CALLIBAETIS | SP. | | | | | | 1 | | | | |
| CENTROPTILUM | SP. | | 1 | | 1 | | | | | | |
| LABIOBAETIS | SP. | | | | 1 | | 3 | | | | |
| CAENIDAE | | | | | | | | | | | |
| CAENIS | SP. | 72 | 1 | 1 | | | 1 | | | | |
| EPHEMERELLIDAE | | | | | | | | | | | |
| DRUNELLA | SP. | | | | | | 2 | | | | 1 |
| EPHEMERELLA | SP. | | | | | | | | | | 2 |
| SERRATELLA | SP. | 57 | 3 | 44 | 10 | | | | | 10 | |
| EPHEMERIDAE | | | 1 | | | | | | | | |
| HEXAGENIA | SP. | | | | | | 1 | | | | |
| POLYMITARCYIDAE | | | | | | | | | | | |
| EPHORON | LEUKON | | 1 | | | | | | | | |
| ISONYCHIIDAE | | | | | | | | | | | |
| ISONYCHIA | SP. | 47 | 2 | 9 | 4 | 13 | 5 | | 1 | 1 | 1 |
| HEPTAGENIIDAE | | 26 | | 6 | | | | 1 | | | |
| LEUCROCUTA | SP. | 1 | | | | | | | | | |
| STENACRON | INTERPUNCTATUM | 6 | 4 | | | | 2 | | | | |
| STENACRON | SP. | | | | | | 3 | | | | |
| STENONEMA | MEDIOPUNCTATUM | 197 | 8 | 123 | 17 | 162 | 20 | | 2 | 3 | 11 |
| STENONEMA | MODESTUM | 4 | 3 | 67 | 13 | 12 | 2 | | | | |
| STENONEMA | SP. | 81 | 3 | 41 | | 1 | 2 | | 2 | | 1 |
| TRICORYTHIDAE | | | | | | | | | | | |
| TRICORYTHODES | SP. | 25 | 5 | | | | | | | | |
| HEMIPTERA | | | | | | | | | | | |
| NEPIDAE | | | | | | | | | | | |
| RANATRA | SP. | | | | | | 1 | | | | |
| VELIIDAE | | | | | | | | | | | 1 |
| RHAGOVELIA | OBESA | | | | 1 | | 1 | | | | |
| TRICHOPTERA | | | | | | | | | | | |
| GLOSSOSOMATIDAE | | | | | | | | | | | |
| AGAPETUS | SP. | 1 | | | | | | | | | |
| BRACHYCENTRIDAE | | | | | | | | | | | |

Table B2. Continued.

| CLASS / ORDER / FAMILY / GENUS | SPECIES | Site 1 Thomas Island RM 8.5 QUAN | QUAL | Site 2 Hale Bridge RM 27.7 QUAN | QUAL | Site 3 Allen Bridge RM 42.1 QUAN | QUAL | Site 4 Bird Bridge RM 50.6 QUAN | QUAL | Site 5 SR 107 Bridge RM 60.5 QUAN | QUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BRACHYCENTRUS | SP. | 21 | 4 | | 3 | 2 | 1 | | 3 | | |
| LEPTOCERIDAE | | | | | | | | | | | |
| CERACLEA | | | | | 1 | | 2 | | 1 | | |
| HYDROPSYCHIDAE | | 636 | | 58 | 1 | 25 | 2 | 4 | 3 | 60 | |
| CERATOPSYCHE | MOROSA | | | | | 6 | | | | | |
| CERATOPSYCHE | SP. | | | 105 | 10 | 105 | 5 | 1 | | 16 | 4 |
| CHEUMATOPSYCHE | SP. | 1817 | 7 | 414 | 16 | 380 | 19 | | 9 | 390 | 21 |
| HYDROPSYCHE | PHALERATA | 257 | 5 | | | | | | | | |
| HYDROPSYCHE | SP. | 299 | | 7 | 2 | 2 | 6 | | | 11 | |
| HYDROPSYCHE | VENULARIS | | | | | | | | | | 1 |
| HYDROPTILIDAE | | | | 2 | | 3 | 4 | | | | |
| HYDROPTILA | SP. | 2 | | 16 | | | 5 | | | | |
| LEUCOTRICHIA | SP. | | | | | | | | | | 2 |
| LEPTOCERIDAE | | | | | | | | | | | |
| OECETIS | SP. | | | | | | 1 | | | | 4 |
| TRIAENODES | SP. | | | | | | 2 | | | | 2 |
| PSYCHOMYIIDAE | | | | | | | | | | | |
| LYPE | DIVERSA | | 3 | | | | | | | | |
| PSYCHOMYIA | SP. | | | | | 1 | | | | | |
| POLYCENTROPODIDAE | | | | | | | | | | | |
| NEURECLIPSIS | SP. | | | | | | | | | | 1 |
| UENOIDAE | | | | | | | | | | | |
| NEOPHYLAX | SP. | | | | | | 1 | | | | |
| MEGALOPTERA | | | | | | | | | | | |
| CORYDALIDAE | | | | | | | | | | | |
| CORYDALUS | CORNUTUS | 8 | 1 | 32 | 6 | 8 | 2 | | | 2 | 2 |
| SIALIDAE | | | | | | | | | | | |
| SIALIS | SP. | 2 | 1 | | | | | | | | |
| LEPIDOPTERA | | | | | | | | | | | |
| PYRALIDAE | | | | | | | | | | | |
| PETROPHILA | SP. | | 1 | | | 3 | 3 | | | 21 | 2 |
| DIPTERA | | | | | | | | | | | |
| CERATOPOGONIDAE | | | | | | | | | | | |
| BEZZIA | SP. | | 1 | | | | | | | | |
| BLEPHARICERIDAE | | | | | | | | | | | |
| BLEPHARICERA | SP. | | | 2 | | | | | | | 1 |
| CHIRONOMIDAE | | 67 | 2 | 158 | 11 | 269 | 5 | | 3 | 360 | 3 |
| CARDIOCLADIUS | OBSCURUS | 6 | 5 | 651 | 7 | 107 | 5 | | | 73 | 3 |
| BRILLIA | FLAVIFRONS | | | | | | | 1 | 1 | | 1 |
| CHIRONOMUS | SP. | | 1 | | | | 1 | | | | 2 |
| CLADOTANYTARSUS | SP. | | | | | 8 | | | | 25 | |
| CONCHAPELOPIA | SP. | | | | | | | | 1 | | |
| CRICOTOPUS | BICINCTUS | 2 | 1 | 61 | 11 | 45 | 3 | | 4 | 57 | 1 |
| CRICOTOPUS | TREMULUS GR. | 19 | | 149 | 11 | 728 | 16 | 2 | 1 | 628 | 7 |
| CRICOTOPUS | SP. | 19 | 1 | 314 | | 362 | 10 | | | 444 | |
| CRICOTOPUS | TRIFASCIA | | | 293 | 2 | 129 | 6 | 2 | 3 | 309 | 13 |
| CRYPTOCHIRONOMUS | FULVUS | 1 | 2 | | 1 | | | | | | |
| DICROTENDIPES | NEOMODESTUS | | | 10 | | 23 | 1 | | | | |
| DICROTENDIPES | SP. | 2 | | | | | 2 | | | 3 | |
| EUKIEFFERIELLA | DEVONICA | 32 | 1 | 230 | | 270 | | | | 1 | |
| MICROTENDIPES | SP. | 3 | | 14 | 1 | 31 | | | | 1 | |
| NANOCLADIUS | SP. | | | | | 5 | | | | | |
| ORTHOCLADIUS | LIGNICOLA | | | 12 | | | | | | | |
| ORTHOCLADIUS | SP. | | | 80 | 2 | 19 | | 3 | | 48 | |
| PARAKIEFFERIELLA | SP. | | | 5 | 1 | 2 | | | | 4 | 1 |
| PARAMETRIOCNEMUS | LUNDBECKI | | | | | 1 | | | 1 | 1 | |
| PHAENOPSECTRA | SP. | | 3 | 94 | | 13 | 3 | 3 | | 19 | 1 |

Table B2. Continued.

| CLASS / ORDER / FAMILY / GENUS | SPECIES | Site 1 Thomas Island RM 8.5 QUAN | QUAL | Site 2 Hale Bridge RM 27.7 QUAN | QUAL | Site 3 Allen Bridge RM 42.1 QUAN | QUAL | Site 4 Bird Bridge RM 50.6 QUAN | QUAL | Site 5 SR 107 Bridge RM 60.5 QUAN | QUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POLYPEDILUM | CONVICTUM | 509 | | 52 | | 5 | | | | 28 | 5 |
| POLYPEDILUM | FALLAX | 5 | | | | | | | | | |
| POLYPEDILUM | HALTERALE | 14 | | | 1 | | | 3 | 1 | | |
| POLYPEDILUM | ILLINOENSE | 26 | | 20 | | 11 | 3 | | | 37 | |
| PSECTROCLADIUS | SP. | | | 25 | | | | | | 34 | |
| PSEUDOCHIRONOMUS | SP. | | | 29 | | 14 | | | | | |
| RHEOCRICOTOPUS | ROBACKI | | | | | | | | 2 | | 1 |
| RHEOTANYTARSUS | SP. | 451 | 2 | 1385 | 11 | 280 | 4 | | 6 | 152 | 3 |
| ROBACKIA | CLAVIGER | | | | | | | 28 | 1 | | |
| ROBACKIA | DEMEIJEREI | | | | | | | | | 6 | 1 |
| SMITTIA | SP. | | | | | | | 1 | | | |
| STENOCHIRONOMUS | SP. | 2 | | | | | 1 | | | 1 | |
| SYNORTHOCLADIUS | SEMIVIRENS | | | 52 | 7 | 4 | 2 | | | 2 | 1 |
| TANYTARSUS | SP. | 379 | | 187 | 2 | 120 | 9 | 1 | 2 | 243 | 4 |
| THIENEMANNIELLA | XENA | 15 | 1 | 21 | 6 | | 1 | 1 | | | 1 |
| THIENEMANNIMYIA | SP. | 5 | | | | | | | | | |
| TRIBELOS | SP. | | | 24 | | | | | | | |
| TVETENIA | SP. | 278 | | 9 | | | 1 | | | | |
| XENOCHIRONOMUS | XENOLABIS | | | | | | | | | 2 | |
| EMPIDIDAE | | | | | | 1 | | | | | |
| HEMERODROMIA | SP. | 31 | | 1 | | | | | | 1 | |
| TANYDERIDAE | | | | | | | | | | | |
| PROTOPLASA | FITCHII | | | 11 | | 2 | 2 | | | | |
| SIMULIIDAE | | | | 4 | | 1 | | | | 10 | |
| SIMULIUM | SP. | 186 | | 80 | 13 | 44 | 7 | | 2 | 46 | 3 |
| PLEIDAE | | | | | | | | | | | |
| PARAPLEA | SP. | | | | | | | | | 2 | |
| TIPULIDAE | | | | | | | | | | | |
| ANTOCHA | SP. | | | 137 | 6 | 199 | 10 | 1 | | 200 | 8 |
| TIPULA | SP. | | | | 1 | | 2 | | | | |
| COLEOPTERA | | | | | | | | | | | |
| PTILODACTYLIDAE | | | | | | | | | | | |
| ANCHYTARSUS | BICOLOR | | | | 1 | | | | | | |
| ELMIDAE | | | | | | | | | | | |
| ANCYRONYX | VARIEGATUS | | | | | | | | | | 1 |
| DUBIRAPHIA | SP. | | 1 | | | | | | | | |
| MACRONYCHUS | GLABRATUS | | 1 | | 2 | 22 | 2 | | | | 1 |
| MICROCYLLOEPUS | PUSILLUS | 2 | 1 | | | | | | | | |
| PROMORESIA | SP. | | | | | | 1 | | | | |
| STENELMIS | SP. | 549 | 12 | 299 | 14 | 9 | 1 | | | | 1 |
| HYDROPHILIDAE | | | 1 | | | | | | | | 1 |
| BEROSUS | SP. | | | | | | | | | | 1 |
| GYRINIDAE | | | | | | | | | | | |
| DINEUTUS | SP. | 2 | 1 | | | 3 | 3 | | 2 | | 6 |
| GYRINUS | SP. | | | | | | 1 | | | | |
| DRYOPIDAE | | | | | | | | | | | |
| HELICHUS | BASALIS | | | | | | | | 1 | | |
| HELICHUS | LITHOPHILUS | | | | 1 | | 4 | | | | 1 |
| PSEPHENIDAE | | | | | | | | | | | |
| PSEPHENUS | HERRICKI | 8 | 1 | 2 | 2 | 1 | | | | | |
| GASTROPODA | | | | | | | | | | | |
| MESOGASTROPODA | | | | | | | | | | | |
| VIVIPARIDAE | | | | | | | | | | | |
| CAMPELOMA | DECISUM | | 1 | | 3 | | | | | | |
| PLEUROCERIDAE | | | | | | | | | | | |
| LEPTOXIS | PRAEROSA | 179 | 3 | 31 | 4 | | | | | 1 | |
| LITHASIA | VERRUCOSA | 14 | | | | | | | | | |

Table B2. Continued.

| CLASS<br>ORDER<br>FAMILY<br>GENUS | SPECIES | Site 1<br>Thomas Island<br>RM 8.5<br>QUAN | QUAL | Site 2<br>Hale Bridge<br>RM 27.7<br>QUAN | QUAL | Site 3<br>Allen Bridge<br>RM 42.1<br>QUAN | QUAL | Site 4<br>Bird Bridge<br>RM 50.6<br>QUAN | QUAL | Site 5<br>SR 107 Bridge<br>RM 60.5<br>QUAN | QUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PLEUROCERA | UNCIALIS | 74 | 3 | 3 | 3 | 2 | 8 | | | | |
| BASOMMATOPHORA | | | | | | | | | | | |
| ANCYLIDAE | | | | | | | | | | | |
| FERRISSIA | RIVULARIS | 53 | 1 | 2 | | | | | | | |
| PHYSIDAE | | | | | | | | | | | |
| PHYSELLA | SP. | | 1 | | | 1 | 5 | | 1 | | 3 |
| BIVALVIA | | | | | | | | | | | |
| UNIONOIDA | | | | | | | | | | | |
| UNIONIDAE | | | | | | | | | | | |
| ELLIPTIO | DILATATA | 2 | | | | | | | | | |
| LAMPSILIS | FASCIOLA | | | | 1 | | | | | | |
| VENEROIDA | | | | | | | | | | | |
| CORBICULIDAE | | | | | | | | | | | |
| CORBICULA | FLUMINEA | 206 | 2 | 92 | 1 | 41 | 1 | 145 | 2 | 13 | 1 |
| **TOTAL TAXA PER SITE** | | **89** | | **89** | | **97** | | **49** | | **86** | |
| **TOTAL TAXA (ALL SITES)** | **164** | | | | | | | | | | |

QUAL = Quality
QUAN = Quantity
RM = River Mile
SR = State Route

Table B3. Listing of Benthic Index of Biotic Integrity (BIBI) metrics, scoring criteria, scores, and BIBI values for benthic invertebrate community surveys in the Nolichucky River, 2000.

| Metric | Gear | Scoring Criteria 1 | Scoring Criteria 3 | Scoring Criteria 5 | Scores Site 1 RM 8.5 | Scores Site 2 RM 27.9 | Scores Site 3 RM 42.1 | Scores Site 4 RM 50.6 | Scores Site 5 RM60.6 |
|---|---|---|---|---|---|---|---|---|---|
| Taxa richness | Surber or Hess* | < 9 | 9-17 | =>18 | 4.67 | 5.00 | 5.00 | 1.33 | 5.00 |
| Occurrence of intolerant mollusk taxa | Combined** | 0 | 1-2 | => 3 | 3.00 | 3.00 | 1.00 | 1.00 | 1.00 |
| Number of mayfly taxa | Surber or Hess | < 3 | 3-5 | => 6 | 4.33 | 3.67 | 2.33 | 1.00 | 1.67 |
| Number of stonefly taxa | Surber or Hess | < 2 | | =>2 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Number of caddisfly taxa | Surber or Hess | < 2 | 2-3 | =>4 | 3.67 | 4.00 | 4.00 | 1.33 | 3.00 |
| Number of EPT taxa | Combined | <14 | 14-24 | =>25 | 5.00 | 3.00 | 5.00 | 1.00 | 3.00 |
| Percent individuals as oligochaetes | Surber or Hess | => 0.05 | 0.01-0.049 | <0.01 | 4.00 | 4.33 | 3.67 | 5.00 | 3.00 |
| Percent individuals of two dominant taxa | Surber or Hess | => 0.75 | 0.5-0.749 | <0.5 | 4.67 | 5.00 | 5.00 | 1.67 | 4.33 |
| Percent individuals as omnivores and scavengers | Surber or Hess | =>0.9 | 0.6-0.89 | <0.6 | 3.67 | 3.67 | 3.00 | 1.33 | 2.67 |
| Percent individuals as collectors/filterers | Surber or Hess | =>0.5<br>=>0.6 | 0.2-0.49<br>0.3-5.9 | <0.2<br><0.3 | 2.33 | 2.67 | 2.33 | 1.33 | 1.67 |
| Percent individuals as predators | Surber or Hess | =<0.04 | - | >0.04 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Total abundance in quantitative samples*** | Surber | =<40 | 40-160 or >600 | 161-600 | 3.67 | 4.00 | 3.67 | 1.67 | 3.67 |
| BIBI Score | | | | | 41.00 | 40.33 | 37.00 | 18.67 | 31.00 |
| Rating | | | | | F | F | F | P | F |

* Metric score is the average of individual Hess and Surber samples
** Includes qualitative sample.
*** Low scores are given for both high and low values.

Rating Abbreviations: F - fair, P - poor

Table B4. Numbers of each native mussel species collected at 10 survey sites in the Nolichucky River, June 12-14, 2000.

| Site | Number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | River Mile Locations | 8.5 | 11.4 | 16 | 27.9 | 35.4 | 36.9 | 39.5 | 42.1 | 50.6 | 60.6 | Totals |
| **Common Name** | **Scientific Name** | | | | | | | | | | | |
| spike | *Elliptio dilatata* | 55 | 26 | 94 | 85 | | | | | | | 260 |
| purple wartyback | *Cyclonaias tuberculata* | 28 | 15 | 127 | 46 | 12 | 4 | 5 | 1 | | | 238 |
| pocketbook | *Lampsilis ovata* | 6 | 1 | 21 | 26 | 36 | 5 | 11 | 5 | | | 111 |
| wavyrayed lampmussel | *Lampsilis fasciola* | 5 | 6 | 8 | 12 | 10 | 8 | 8 | 11 | | | 68 |
| kidneyshell | *Ptychobranchus fasciolaris* | 6 | 1 | 6 | 20 | 2 | 1 | | | | | 36 |
| creeper | *Strophitus undulatus* | 1 | | 3 | 11 | 13 | 2 | | | | | 30 |
| pimpleback | *Quadrula pustulosa* | 3 | 1 | 1 | 6 | 5 | 1 | 2 | 1 | | | 20 |
| pink heelsplitter | *Potamilus alatus* | | | | 4 | 2 | 1 | 6 | | | | 13 |
| elktoe | *Alasmidonta marginata* | | | | 1 | 3 | 1 | 2 | 5 | | | 12 |
| Tennessee pigtoe | *Fusconaia barnesiana* | 3 | | 1 | | 1 | | | | | | 5 |
| black sandshell | *Ligumia recta* | | | 1 | | | | | | | | 1 |
| elephant ear | *Elliptio crassidens* | | | | 1 | | | | | | | 1 |
| fragile papershell | *Leptodea fragilis* | | 1 | | | | | | | | | 1 |
| giant floater | *Pyganodon grandis* | | | | | | | 1 | | | | 1 |
| longsolid | *Fusconaia subrotunda* | | | | | | | 1 | | | | 1 |
| mountain creekshell | *Villosa vanuxemensis* | | | | | | 1 | | | | | 1 |
| mucket | *Actinonaias ligamentina* | | | 1 | | | | | | | | 1 |
| oyster mussel | *Epioblasma capsaeformis* | | 1 | | | | | | | | | 1 |
| spectaclecase | *Cumberlandia monodonta* | | 1 | | | | | | | | | 1 |
| threeridge | *Amblema plicata* | | | | | 1 | | | | | | 1 |
| Number of species | | 8 | 9 | 10 | 10 | 10 | 9 | 8 | 5 | 0 | 0 | 20 |
| Total mussels | | 107 | 53 | 263 | 212 | 85 | 24 | 36 | 23 | 0 | 0 | 803 |
| Effort (person-hours) | | 6 | 6 | 5 | 9 | 6 | 8.25 | 7.8 | 10.1 | 2 | 10 | 70.1 |
| Catch per unit effort | | 17.8 | 8.8 | 52.6 | 23. 6 | 14.2 | 2.9 | 4.6 | 2.3 | 0 | 0 | 11.5 |

Table B5. Number of Each Fish Species Collected in Fish Community Samples in the Nolichucky River, 2000

| Common Name | Scientific Name | Site 1 RM 8.5 | Site 2 RM 27.9 | Site 3 RM 42.1 | Site 4 RM 50.6 | Site 5 RM 60.6 |
|---|---|---|---|---|---|---|
| **Lampreys** | **Petromyzontidae** | | | | | |
| Ohio lamprey | *Ichthyomyzon bdellium* | 3 | 5 | 1 | - | 2 |
| American brook lamprey | *Lampetra appendix* | - | - | 1 | 4 | 3 |
| **Gars** | **Lepisosteidae** | | | | | |
| Longnose gar | *Lepisosteus osseus* | - | 3 | 6 | - | - |
| **Herrings** | **Clupeidae** | | | | | |
| Gizzard shad | *Dorosoma cepedianum* | 1 | 9 | 15 | 5 | 5 |
| **Minnows** | **Cyprinidae** | | | | | |
| Largescale stoneroller | *Campostoma oligolepis* | 16 | 12 | 8 | 1 | 33 |
| Whitetail shiner | *Cyprinella galactura* | - | 20 | 5 | 27 | 21 |
| Spotfin shiner | *C. spiloptera* | 257 | 54 | 346 | 487 | 113 |
| Common carp | *Cyprinus carpio* | - | 4 | 1 | 1 | - |
| Bigeye chub | *Hybopsis amblops* | 1 | 1 | - | 1 | - |
| Striped shiner | *Luxilus chrysocephalus* | 2 | 30 | - | - | - |
| Warpaint shiner | *L. coccogenis* | - | - | - | - | 7 |
| River chub | *Nocomis micropogon* | 6 | 14 | 6 | - | - |
| Tennessee shiner | *N. leuciodus* | - | 3 | - | - | 1 |
| Rosyface shiner | *N. rubellus* | 423 | 219 | 576 | 49 | 61 |
| Sand shiner | *N. stramineus* | - | - | - | - | 28 |
| Mirror shiner | *N. spectrunculus* | - | - | - | - | 2 |
| Telescope shiner | *N. telescopus* | 63 | 21 | 1 | - | 47 |
| Mimic shiner | *N. volucellus* | 255 | 144 | 195 | 486 | 321 |
| Stargazing minnow | *Phenacobius uranops* | - | 1 | 1 | - | - |
| Bluntnose minnow | *Pimephales notatus* | 6 | - | 1 | 87 | 82 |
| Bullhead minnow | *P. vigilax* | 1 | - | - | 9 | 2 |
| Creek chub | *Semotilus atromaculatus* | - | - | 4 | - | - |
| **Suckers** | **Catostomidae** | | | | | |
| River carpsucker | *Carpiodes carpio* | 5 | - | 1 | - | - |
| Quillback | *C. cyprinus* | - | - | 6 | 13 | 2 |
| Highfin carpsucker | *C. velifer* | - | - | - | - | 7 |
| Blue sucker | *Cycleptus elongatus* | - | - | 1 | - | - |
| Northern hog sucker | *Hypentelium nigricans* | 10 | 11 | 13 | 2 | 8 |
| Smallmouth buffalo | *Ictiobus bubalus* | 4 | 13 | 23 | - | - |
| Silver redhorse | *Moxostoma anisurum* | 3 | 3 | 5 | 2 | - |
| River redhorse | *M. carinatum* | 17 | 33 | 93 | 27 | 18 |
| Black redhorse | *M. duquesnei* | 19 | 6 | 31 | 6 | 25 |
| Golden redhorse | *M. erythrurum* | 16 | 40 | 25 | 13 | 26 |
| Shorthead redhorse | *M. macrolepidotum* | 15 | 8 | 26 | 1 | 8 |

Table B5. Continued.

| Common Name | Scientific Name | Site 1 RM 8.5 | Site 2 RM 27.9 | Site 3 RM 42.1 | Site 4 RM 50.6 | Site 5 RM 60.6 |
|---|---|---|---|---|---|---|
| **Catfishes** | **Ictaluridae** | | | | | |
| Yellow bullhead | *Ameiurus natalis* | - | 2 | 1 | - | 1 |
| Channel catfish | *Ictalurus punctatus* | - | 3 | 4 | 1 | 10 |
| Mountain madtom | *Noturus eleutherus* | 205 | 2 | - | - | - |
| Flathead catfish | *Pylodictis olivaris* | 2 | 3 | 2 | - | - |
| **Livebearers** | **Poeciliidae** | | | | | |
| Western mosquitofish | *Gambusia affinis* | - | 3 | - | 17 | - |
| **Sculpins** | **Cottidae** | | | | | |
| Banded sculpin | *Cottus carolinae* | 2 | 4 | - | - | 26 |
| **Sunfishes** | **Centrarchiae** | | | | | |
| Rock bass | *Ambloplites rupestris* | 6 | 45 | 21 | 1 | 19 |
| Redbreast sunfish | *Lepomis auritus* | 19 | 54 | 23 | 41 | 31 |
| Green sunfish | *L. cyanellus* | 1 | - | - | - | 1 |
| Warmouth | *L. gulosus* | - | - | - | 9 | 1 |
| Bluegill | *L. macrochirus* | 5 | 10 | 8 | 8 | 18 |
| Redear sunfish | *L. microlophus* | 1 | - | 1 | 2 | - |
| Hybrid sunfish | hybrid *Lepomis spp.* | 1 | - | - | - | - |
| Smallmouth bass | *Micropterus dolomieu* | 8 | 13 | 16 | 3 | 13 |
| Spotted bass | *M. punctulatus* | 12 | 6 | 10 | 7 | 12 |
| Largemouth bass | *M. salmoides* | 1 | - | - | 5 | - |
| Black crappie | *Pomoxis nigromaculatus* | - | - | - | 4 | 2 |
| **Perches** | **Percidae** | | | | | |
| Sharphead darter | *Etheostoma acuticeps* | 81 | 26 | 6 | - | 92 |
| Greenside darter | *E. blennioides* | 30 | 34 | 27 | - | 6 |
| Bluebreast darter | *E. camurum* | 23 | 17 | 20 | - | 174 |
| Blueside darter | *E. jessiae* | 1 | - | 1 | - | - |
| Redline darter | *E. rufilineatum* | 377 | - | - | - | - |
| Snubnose darter | *E. simoterum* | 5 | 23 | 14 | - | 7 |
| Wounded darter | *E. vulneratum* | - | 1 | 1 | - | - |
| Banded darter | *E. zonale* | 52 | 7 | 4 | - | 1 |
| Tangerine darter | *Percina aurantiaca* | - | - | 1 | - | - |
| Logperch | *P. caprodes* | 1 | - | 3 | - | 1 |
| Gilt darter | *P. evides* | 13 | 1 | 2 | - | 14 |
| Sauger | *Stizostedion canadense* | - | - | 1 | - | - |
| **Drums** | **Sciaenidae** | | | | | |
| Freshwater drum | *Aplodinotus grunniens* | - | - | 2 | - | - |
| Number collected | | 1969 | 908 | 1559 | 1319 | 1251 |
| Species encountered | Overall 62 | 40 | 40 | 46 | 29 | 40 |

RM = River Mile

Table B6. Listing of Index of Biotic Integrity (IBI) Metrics, Scoring Criteria, Observations, Scores and IBI Values for Fish Community Surveys on the Nolichucky River, 2000.

| Metric | Scoring Criteria | | | Site 1 RM 8.5 | | Site 2 RM 27.9 | | Site 3 RM 42.1 | | Site 4 RM 50.6 | | Site 5 RM 60.6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 3 | 5 | Obs. | Score | Obs. | Score | Obs. | Score | Obs. | Score | Obs. | Score |
| Number of native fish species | <21 | 21-42 | >42 | 39 | 3 | 38 | 3 | 44 | 5 | 26 | 3 | 40 | 3 |
| Number of darter species | <4 | 4-8 | >8 | 9 | 5 | 7 | 3 | 10 | 5 | 0 | 1 | 7 | 3 |
| Number of sunfish species (less *Micropterus*) | <2 | 2 | >2 | 4 | 5 | 2 | 3 | 3 | 5 | 5 | 5 | 5 | 5 |
| Number of sucker species | <4 | 4-8 | >8 | 8 | 3 | 8 | 3 | 10 | 5 | 7 | 3 | 8 | 3 |
| Number of intolerant species | <3 | 3-5 | >5 | 7 | 5 | 6 | 5 | 6 | 5 | 2 | 1 | 4 | 3 |
| Percent tolerant individuals | >20% | 10-20% | <10% | 13.3% | 3 | 11.6% | 3 | 23.9% | 1 | 38.7% | 1 | 9.5% | 5 |
| Percent omnivores and stonerollers | >20% | 10-20% | <10% | 2.0% | 5 | 9.9% | 5 | 4.2% | 5 | 8.2% | 5 | 11.0% | 3 |
| Percent specialized insectivores | <25% | 25-50% | >50% | 77.8% | 5 | 55.1% | 5 | 54.7% | 5 | 41.3% | 3 | 60.3% | 5 |
| Percent piscivores | <2% | 2-4% | >4% | 1.5% | 1 | 7.4% | 5 | 3.6% | 3 | 1.5% | 1 | 3.6% | 3 |
| Catch rate (per 300 sq. ft.) | <7 | 7-15 | >15 | 36 | 5 | 21 | 5 | 34 | 5 | 35 | 5 | 33 | 5 |
| Percent hybrids | >1 | Tr.-1% | 0% | 0.1% | 3 | 0% | 5 | 0% | 5 | 0% | 5 | 0% | 5 |
| Percent of individuals with anomalies | >5% | 2-5% | <2% | 0.1% | 5 | 0.6% | 5 | 0.4% | 5 | 0.2% | 5 | 1.7% | 5 |
| IBI Score | | | | | 48 | | 50 | | 54 | | 38 | | 48 |
| Rating | | | | | G | | G | | G/E | | P/F | | G |

Abbreviations: % = Percent
> = Greater than; < = Less than
IBI = Index of Biotic Integrity
Obs. = Observations
RM = River Mile
E = excellent, F = fair, G = good, P = poor

Table B7. Index of Biotic Integrity (IBI) scores and ratings for fish community samples collected in the Nolichucky River and its source streams in North Carolina, 1990-2000 (This study and TVA unpublished data).

| Stream and Site Location (RM) | 1990 | 1991 | 1992 | 1993 | 1994 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nolichucky River | | | | | | | | | | |
| 8.5 (Site 1) | 42 (F) | 48 (G) | 40 (F) | 48 (G) | 52 (G) | 52 (G) | 48 (G) | 50 (G) | | 48* (G) |
| 27.9 (Site 2) | | | | | | | | | | 50* (G) |
| 42.1 (Site 3) | | | | | | | | | | 54* (G) |
| 50.6 (Site 4) | | | | | | | | | | 38* (F/P) |
| 60.5 (Site 5) | | | | | | | 48 (G) | | | 48* (G) |
| 89.0 | | | | | | | 44 (F) | | | 56 (G/E) |
| 97.5 | 48 (G) | | | | | | | | | |
| 106.8 | | | | | | | 50 (G) | | | |
| North Toe River | | | | | | | | | | |
| 7 | | | | | | | 48 (G) | | | |
| 15.5 | | | | | | | 40 (F) | | 56 (G/E) | |
| 23 | | | | | | | 40 (F) | | 50 (G) | |
| 27.6 | | | 46 (F/G) | | | | | | | |
| 42.4 | | | | | | | | | 50 (G) | |
| South Toe River | | | | | | | | | | |
| 6.9 | | | 44 (F) | | | | 48 (G) | | 48 (G) | |
| Cane River | | | | | | | | | | |
| 5 | | | | | | | 46 (F/G) | | | |
| 10.5 | | | | | | | 40 (F) | | | 48 (G) |
| 21 | | | 44 (F) | | | | 44 (F) | | | 50 (G) |

* - conducted as a part of this study
Abbreviations: E - excellent, F - fair, G - good, P - poor

Table B8. Numbers of Selected Benthic Fish Species Encountered at Nolichucky River Mile 8.5 During Various Sampling Visits, 1990-2000

| Common Name | 1990 | 1991 | 1992 | 1993 | 1994 | 1996 | 1997 | 2000 |
|---|---|---|---|---|---|---|---|---|
| Blotched chub | 9 | 15 | 5 | 5 | 12 | 32 | 29 | - |
| Fatlips minnow | - | - | - | - | - | 16 | Q* | - |
| Stargazing minnow | - | - | 1 | 4 | 3 | - | Q* | - |
| Logperch | 1 | - | - | - | - | 1 | - | 1 |
| Gilt darter | - | 1 | - | - | 1 | 8 | 7 | 13 |

*Observed only during qualitative sampling.
Note: Source of data for this table was obtained from this study and TVA unpublished data

Table B9. Condition of Various Nolichucky River Tributaries Based on IBI Analysis of Fish Communities (TVA unpublished data)

| General Location and Tributary Name | Mouth at Nolichucky River Mile | IBI Date | IBI Score | IBI Rating |
|---|---|---|---|---|
| **Below Nolichucky Dam** | | | | |
| Long Creek | 4.0 | 5/14/97 | 30 | P |
| Bent Creek | 14.7 | 4/28/97 | 32 | P |
| Lick Creek | 16.0 | 6/10/97 | 38 | P/F |
| Little Chucky Creek | 23.5 | 5/6/97 | 36 | P/F |
| Meadow Creek | 41.9 | 4/3/97 | 40 | F |
| Cove Creek | 43.4 | 4/2/97 | 34 | P |
| **In Nolichucky Reservoir** | | | | |
| Richland Creek | 47.3 | 5/8/00 | 28 | P |
| Camp Creek | 55.9 | 5/7/97 | 32 | P |
| **Above Nolichucky Reservoir** | | | | |
| Horse Creek | 62.4 | 5/15/97 | 28 | P |
| Sinking Creek | 64.6 | 4/7/00 | 34 | P |
| Big Limestone Creek | 68.6 | 5/19/97 | 40 | F |
| Little Limestone Creek | 72.6 | 5/30/00 | 44 | F |
| North Indian Creek | 94.2 | 6/20/97 | 44 | F |
| South Indian Creek | 95.6 | 3/30/99 | 48 | G |

Note: Source of data for this table was obtained from TVA unpublished data
Abbreviations: F - fair, G - good, P - poor.

Table B10. Presence and Estimated Abundance of Fish Species Encountered During Boat Electrofishing in Two Stretches of the Nolichucky River

| Common Name | Scientific Name | Below Enka Dam 3/28/2000 | Enka Dam to Douglas Reservoir 4/20/2000 | Nolichucky Dam to Allen Bridge 4/21/2000 |
|---|---|---|---|---|
| **Lampreys** | **Petromyzontidae** | | | |
| Ohio lamprey | *Ichthyomyzon bdellium* | C | | |
| **Gars** | **Lepisosteidae** | | | |
| Longnose gar | *Lepisosteus osseus* | C | C | A |
| Spotted gar | *Lepisosteus oculatus* | R | R | |
| **Herrings** | **Clupeidae** | | | |
| Gizzard shad | *Dorosoma cepedianum* | A | A | A |
| **Minnows** | **Cyprinidae** | | | |
| Common carp | *Cyprinus carpio* | A | A | A |
| Striped shiner | *Luxilus chrysocephalus* | R | | |
| River chub | *Nocomis micropogon* | R | | |
| **Suckers** | **Catostomidae** | | | |
| River carpsucker | *Carpiodes carpio* | A | C | A |
| Quillback | *Carpiodes cyprinus* | A | C | C |
| Highfin carpsucker | *Carpiodes velifer* | | R | C |
| Blue sucker | *Cycleptus elongatus* | | | R |
| Northern hog sucker | *Hypentelium nigricans* | A | C | C |
| Smallmouth buffalo | *Ictiobus bubalus* | A | C | A |
| Black buffalo | *Ictiobus niger* | C | C | C |
| Silver redhorse | *Moxostoma anisurum* | A | C | C |
| River redhorse | *Moxostoma carinatum* | A | C | A |
| Black redhorse | *Moxostoma duquesnei* | A | C | A |
| Golden redhorse | *Moxostoma erythrurum* | A | C | C |
| Shorthead redhorse | *Moxostoma macrolepidotum* | A | C | A |
| **Catfishes** | **Ictaluridae** | | | |
| Channel catfish | *Ictalurus punctatus* | A | C | C |
| **Pikes** | **Esocidae** | | | |
| Muskellunge | *Esox masquinongy* | R | | * |
| **Temperate basses** | **Moronidae** | | | |
| White bass | *Morone chrysops* | C | A | |
| Striped bass | *Morone saxatilis* | | R | |
| **Sunfishes** | **Centrarchiae** | | | |
| Rock bass | *Ambloplites rupestris* | C | | |
| Bluegill | *Lepomis macrochirus* | C | C | C |
| Smallmouth bass | *Micropterus dolomieu* | C | C | C |
| Spotted bass | *Micropterus punctulatus* | C | C | C |
| Largemouth bass | *Micropterus salmoides* | C | C | R |
| White crappie | *Pomoxis annularis* | R | R | R |
| Black crappie | *Pomoxis nigromaculatus* | R | R | |
| **Perches** | **Percidae** | | | |
| Sauger | *Stizostedion canadense* | | R | |
| **Drums** | **Sciaenidae** | | | |
| Freshwater drum | *Aplodinotus grunniens* | C | C | R |
| | **Total species observed** | **28** | **26** | **22** |

Abundance abbreviations: A - abundant, C - common, R - rare

***** Most likely, muskellunge habitat could not be sampled without disturbing fishermen.