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Quantitative Evaluation of Commercial Mussel Populations in the Tennessee River Portion of Wheeler Reservoir, Alabama

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Abstract. A stratified random sampling design was used to obtain data on densities, age and growth, and recruitment of commercial species in 75 miles of Wheeler Reservoir. A total of 293 quadrat samples were excavated by divers using a 0.25-m^2 quadrat sampler. Sample contents were sieved down to 6 mm to collect juvenile mussels. Twenty-four species were found; six were relicts. For all strata sampled, the total number of mussels was estimated at 460 million, at an average density of 2.33/m^2. Densities in line transects in four mussel beds identified by commercial musselers averaged 1.42/m^2. Nineteen of 38 species reported in the literature were relict or not collected and are uncommon or rare riverine species that have not adapted to impoundment. A 1960 study had estimated 39 million mussels (20.6 million pigtoes) representing 18 species in an 8-mile reach of Wheeler Reservoir. During the present study, for the same 8-mile reach, only five species were found, totaling 14.3 million mussels. For the entire reservoir, *Megalonaias nervosa* (estimated population of 87.7 million) is now the most valuable commercial species. Drought conditions (1983–1988) may have affected reproduction and/or survival of thick-shelled species. With the exception of *Obliquaria reflexa* and *Quadrula pustulosa*, only thin-shelled species were represented in the 1–5 age-class.

Introduction

The Tennessee Valley Authority (TVA) conducts periodic water resources issues analyses in local drainage basins that constitute the larger Tennessee River system. As part of this continuing series of analyses, an initial assessment was made in 1989 of the Wheeler Reservoir watershed region (Cox 1990). The purpose of the study was to develop information and increased awareness by TVA, other federal and state agencies, industries, lake-user associations, citizens interest organizations, and the general public of significant water resources problems within Wheeler Reservoir. One issue of concern identified in this assessment was reported declines in densities of commercial mussel stocks, especially in the area of Decatur, Alabama.

The primary objective of the present follow-up study was to determine the status of commercial mussel populations throughout Wheeler Reservoir. To meet this objective, size and age-class composition, standing crop estimates, and distributions were determined for all mussel species in 1991. Davies et al. (1992) conducted a roving mussel census funded by the Alabama Universities/TVA Research Consortium to describe the economic importance of commercial mussels in Wheeler Reservoir.

Background

Beginning in 1936, the Tennessee River was impounded by TVA primarily for hydroelectric power, flood control, and navigation. Construction of Wheeler Dam, the first built by TVA, was started in 1933 and completed in 1936. Predictions made by the U. S. Bureau of Fisheries, TVA, and commercial musselers that impoundments would eliminate or destroy mussel habitat resulted in a complete halt of musseling on Wheeler Reservoir as soon as it filled (Scruggs 1960, Isom 1969).

Nine years after the impoundment of Wheeler Reservoir (1945), commercial musselers found large beds of mussels during exploratory sampling in the lake. Musseling resumed throughout the Tennessee River, and shell harvest, primarily for the button industry, increased from 3,700 tons in 1945 to 10,000 tons in 1947 (Isom 1969). Post-impoundment mussel harvest on the lower Tennessee River gradually moved upstream as productive mussel beds were discovered in the newly created reservoirs. However, with the development of the plastic button in the late 1940s, the demand for shells for the button industry was short-lived.

Beginning in the early 1950s, the Japanese discovered that freshwater mussel shells from the

toxicity to 8-day old *Anodonta imbecillis* (Wade 1990). Toxicity was observed at two of the sites (Dry Branch embayment TRM 303.4L and south end of canal TRM 301.1L). Un-ionized ammonia concentrations in sediment porewater appeared to have been sufficiently high to cause mussel mortality. Further studies will be conducted to evaluate the role of ammonia and other sediment contaminants with respect to mussel impacts.

No mussels were found in the overbanks of the middle reservoir between Decatur (TRM 305) and the state route 231 bridge (TRM 333.2), a short reach of about 5 river miles upstream from Decatur. The annual drawdown of Wheeler Reservoir during the winter for flood control exposes the overbanks to drying, and the reservoir is also periodically drawn down for weed and mosquito control, which may explain the absence of mussels in this reach.

Table 2. Freshwater mussel species reported from Wheeler Reservoir.

	Scruggs (1960)	Isom (1969)	Bates (1975)	TVA (1979)	Ahlstedt (1991)
Actinonaias ligamentina[1,2]	-	X	-	-	-
Amblema plicata[1]	X	X	X	X	X
Anodonta grandis	-	-	X	X	X
Anodonta imbecillis	-	-	-	X	-
Anodonta suborbiculata	-	-	X	X	X
Cumberlandia monodonta[1,2]	-	-	-	-	R
Cyprogenia stegaria[1,2,3]	-	X	-	X	R
Cyclonaias tuberculata[1]	X	X	X	X	X
Ellipsaria lineolata[1]	X	X	X	X	X
Elliptio crassidens[1]	X	X	X	X	X
Elliptio dilatata[1,2]	X	X	-	X	-
Fusconaia ebena[1]	-	X	-	X	-
Lampsilis abrupta[1,2,3]	-	X	-	X	X
Lampsilis ovata[1,2]	-	X	-	X	-
Lampsilis teres[1,2]	-	-	-	X	X
Lasmigona complanata	-	-	X	X	X
Leptodea fragilis	-	-	X	X	X
Ligumia recta[1,2]	-	-	-	X	R
Megalonaias nervosa[1]	X	X	X	X	X
Obliquaria reflexa[1]	X	X	X	X	X
Obovaria olivaria[1,2]	X	-	-	-	-
Obovaria retusa[1,2,3]	-	-	-	-	R
Plethobasus cooperianus[1,2,3]	X	-	-	X	-
Plethobasus cyphyus[1,2]	X	-	-	X	-
Pleurobema coccineum[1,2]	-	-	-	X	-
Pleurobema cordatum[1,2]	X	X	X	X	X
Pleurobema oviforme[1,2]	-	-	-	X	-
Pleurobema pyramidatum[1,2]	-	-	-	X	-
Potamilus alatus[1]	X	X	X	X	X
Potamilus ohiensis	-	-	X	-	-
Ptychobranchus fasciolaris[1,2]	X	-	-	-	-
Quadrula fragosa[1,2,3]	X	-	-	-	-
Quadrula metanevra[1]	X	X	X	X	-
Quadrula pustulosa[1]	X	X	X	X	X
Quadrula quadrula[1]	-	X	X	X	X
Toxolasma lividus[1,2]	-	-	-	X	R
Toxolasma parvus	-	-	X	X	R
Tritogonia verrucosa[1]	X	X	X	X	X
Truncilla donaciformis	X	-	X	X	X
Total number of species	18	18	19	32	24

[1] Riverine species.
[2] Nonreproducing riverine species in Wheeler Reservoir.
[3] Federally endangered.
X Live.
R Relict.

The upper reservoir old river channel upstream from the state route 231 bridge (TRM 333.2).to Guntersville Dam (TRM 349) had the highest species diversity (11) and was the second-most productive area for mussels in the reservoir, with commercial populations estimated near 150 million (Table 3). *Elliptio crassidens* was the most abundant species (56.82 million), followed by *P. alatus* (23.24 million) and *Q. pustulosa* (15.46 million). This area was also identified during the 1991 study and during the roving mussel census as a high-use area for commercial musseling, especially brailers.

Old river channel sections in the lower and middle reservoir had considerably fewer species and total numbers of mussels than the upper reservoir river channel. Seven mussel species were found in the lower river channel, six species in the middle, and 11 species in the upper river channel. The most abundant mussel in the lower river channel was *M. nervosa*, and the most common species in the middle and upper river channel was *E. crassidens* (Table 3).

Tributary embayments in the lower reservoir were home to five species, with a population estimate of over 15 million mussels; the most common was *Anodonta grandis*. Only one species, *Quadrula quadrula*, was found in the middle reservoir embayments, and populations were estimated at just over 4 million. No mussels were found in the upper reservoir embayments (Table 3).

Line Transects and Random Search

Sixteen mussel species (610 specimens) were collected during four line transects and three qualitative random searches in mussel beds identified by commercial musselers (Table 4). One of the six sites (TRM 347.2) is a state-protected mussel sanctuary. A total of 462 mussels were collected during line transects for an average of 1.42/m². The most abundant species were *E. crassidens*, *Q. pustulosa*, and *M. nervosa*. The most productive sample from a commercial bed was in First Creek embayment (TRM 276.9), with densities averaging 1.31/m². Line transects were also taken in the state-protected mussel sanctuary for comparisons between densities there and in nearby commercial beds. Mussel densities were the highest (3.24/m²) in the sanctuary (Table 4). In contrast, quadrat sampling in the upper reservoir river channel produced considerably higher mean numbers of mussels (16.57/m²) than did line transects (Table 5). The differences in densities are probably the result of sampling techniques. Typically, only larger adult mussels are found during line transects because small individuals are buried in the substrate or overlooked because of smaller size or water clarity. Quadrat excavations produced specimens of all sizes.

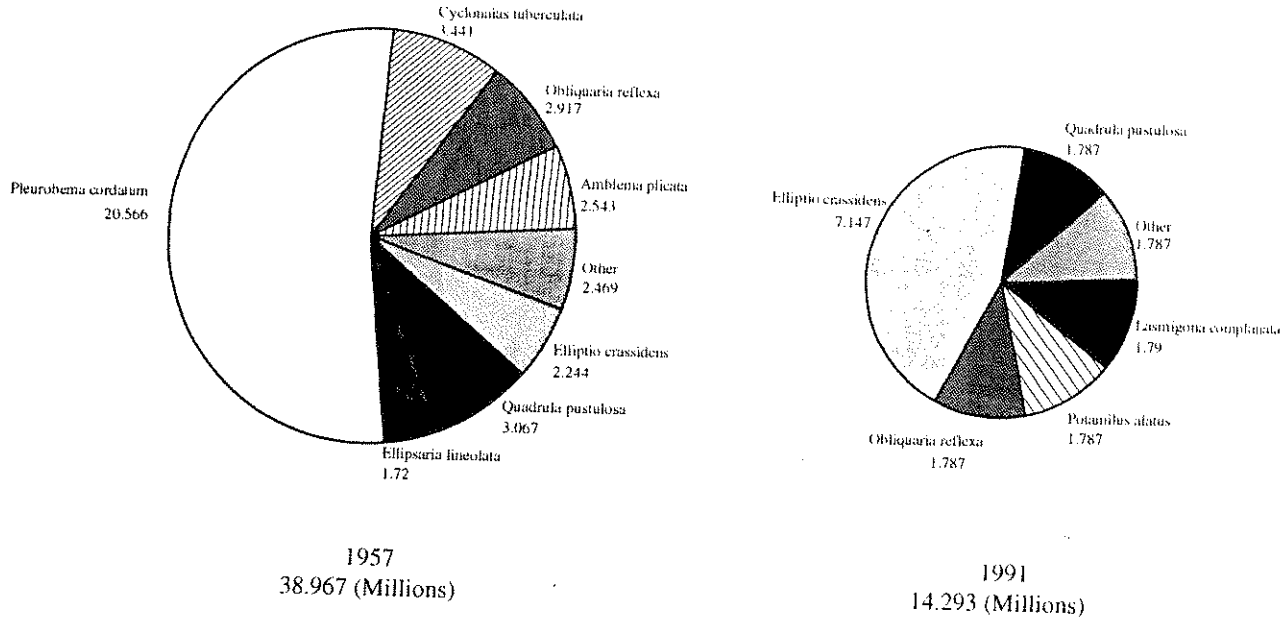

Figure 2. Comparison of estimated numbers of freshwater mussels, by species, between Scrugg's (1960) Study and 1991 results for the same 8-mile reach of Wheeler Reservoir (TQM 308-316).

Summary

Commercial mussel stocks in Wheeler Reservoir have changed considerably since impoundment in 1936. Commercial species harvested historically from the reservoir have been replaced by mussels that were uncommon, or of no commercial value, in the past. The present fauna consists of riverine and thin-shelled invader species that have adapted to lenthic conditions and soft-bottomed substrates that now predominate the reservoir. Nineteen of 38 species reported in the literature are presently uncommon or rare and may survive as old, nonreproducing individuals.

Historically, the most valuable commercial species in Wheeler Reservoir was *Pleurobema cordatum*, which accounted for 80% of all mussels harvested during 1956 and 1957. This species has since been replaced by *Megalonaias nervosa* as the most valuable commercial shell, constituting 45% of all shells harvested.

Reservoir-wide populations were estimated at 460.15 million mussels, at an average density of 2.33/m^2. Approximately 58 million were noncommercial species. *Elliptio crassidens* was the most common mussel, with populations estimated at 116 million, followed by *M. nervosa* (88 million), *P. alatus* (56 million), and *O. reflexa* (44 million). The overbanks in the lower reservoir and the old channel in the upper section were the most productive areas sampled. *Megalonaias nervosa* (45 million) was the most abundant species in the lower reservoir overbank, and *E. crassidens* dominated the upper old channel.

Embayments sampled near Decatur had no live mussels, and substrate washed during sampling produced an oil or petroleum smell. Bioassay tests identified un-ionized ammonia in sufficiently high concentrations to kill 8-day-old *A. imbecillis*. Commercial musselers refer to this area as the "dead zone."

The most productive area sampled during line transects in commercial mussel beds was in First Creek embayment. In comparison, mussel densities were greater in the state-protected mussel sanctuary. Quadrat excavations throughout the upper reservoir old river channel produced considerably higher mean densities of mussels than line transects.

Mussel recruitment was extremely limited in the 1–5 year age-class. Only three commercially valuable species, *P. alatus*, *O. reflexa*, and *Q. pustulosa*, were collected in this age-class, and they were collected in relatively low numbers. Severe drought conditions from 1983 to 1988 may have affected the reproductive life cycle and survival of thick-shelled species. Most thick-shelled species had apparently reproduced before the onset of the drought.

Based on the results of a one-year mussel census on Wheeler Reservoir, *M. nervosa*, *P. cordatum*, and *E. lineolata* constituted 45%, 25%, and 10% of all shells harvested. Measurement data for *M. nervosa* found mostly larger size-classes for harvesting. No recruitment was reported for *C. tuberculata*, *E. lineolata*, *P. cordatum*, and *T. verrucosa*. All four species reported were of harvestable size. Recruitment was also poor for *A. plicata*, *E. crassidens*, *P. alatus*, and *Q. quadrula*, with most specimens of commercial legal size. Both *O. reflexa* and *Q. pustulosa* showed some recruitment; however, *O. reflexa* had not attained harvestable size.

Both age and size-class data show poor recruitment of commercial species, except *O. reflexa* and *Q. pustulosa*. This may be the result of the small number of individuals found during the 1991 study or may be an indication that certain mussels had not recovered from the effects of drought. Another possible explanation for poor recruitment is overharvesting. Because commercial musseling is open year-round, shells are being taken during spawning seasons, and possibly, before they reach sexual maturity. This may be having long-term effects on future recruitment of mussel stocks in the reservoir. Studies are needed to determine proper management strategies for controlling and regulating commercial species and harvest. The mussel fauna in Wheeler Reservoir will continue to change as older, nonreproducing, riverine species die off and are replaced by commercial and noncommercial species that have invaded and/or adapted to impoundment conditions.

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