

# Tennessee's Commercial Musseling Regulations

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**Abstract.** The mussel fauna in Tennessee is one of the most diverse in the Northern Hemisphere. As a result, a large mussel industry has developed in the state to take advantage of this renewable resource. This industry employs approximately 2,000 people and provides an estimated \$40 million to the state's economy. To protect the mussel fauna from overharvest and minimize industry impacts on rare and endangered species, regulations were developed to provide harvest information, legalize only abundant species for harvest, establish sanctuaries and management areas, and define legal methods of harvest. A goal of the Tennessee Wildlife Resources Agency, as stated in its strategic plan, is a commercial mussel harvest of 4,700 tons annually. Tennessee has met and exceeded this goal. The Tennessee Wildlife Resources Agency believes that through proper management, the mussel industry and an abundant mussel resource can coexist.

## Introduction

Tennessee's mussel fauna is one of the most diverse in North America (Starnes and Bogan 1988). Over 72 species have been collected in recent surveys, including 23 currently listed as endangered in Tennessee. Kentucky Reservoir has the most abundant mussel population of any body of water in the state. Relatively few species have been commercially harvested for various purposes such as button material, pearl culture nucleation material, or jewelry material.

Prior to World War II, most mussels were harvested for the button industry. Large, thick-shelled species provided an excellent material from which beautiful mother-of-pearl buttons could be cut. After World War II and the advent of plastics, the commercial musseling industry began harvesting mussels mainly for pearl culture purposes (Williams and Schuster 1989). Recently, mussels with nacre of unusual color have been collected for use in the jewelry industry.

Because Tennessee is endowed with an abundant mussel resource, a large commercial musseling industry has developed in the state. In 1990, this industry grew to employ 2,355 commercial musselers and many other people to process the shells. Almost all of the mussels harvested in Tennessee are processed and exported to other countries, mainly Japan, which use these shells to manufacture implants for pearl culture. A pearl culture industry has also developed in the state as a result of this natural resource. Tennessee produces more cultured pearls than any other state in the nation (Sikich et al. 1989).

As a result of this expanding industry, resource management efforts have increased to better protect the mussel resource from excessive harvest. In October 1990, the Tennessee Wildlife Resources Commission passed more restrictive regulations concerning the commercial mussel industry. These regulations were in response to concerns expressed by many members of the industry and information gathered by the Tennessee Wildlife Resources Agency. Commercial musselers were reporting mussel die-offs from 1983 to 1989. Many wholesale mussel buyers were expressing concerns for protecting the resource from depletion of marketable mussel stocks. To address these concerns, the Tennessee Wildlife Resources Agency decided to increase efforts to better manage the state's mussel resource. Surveys were designed to describe the species composition of the harvest, identify the locations of mussel beds, and sample mussel populations. Also, the economics of the industry and compliance of the mussel industry members to regulations were investigated.

Prior to 1990, all species other than endangered or threatened species of mussels were legal for harvest. Waters of the state that were open to commercial fishing were open to commercial musseling, except for areas designated as mussel sanctuaries. Mussel sanctuaries were established to protect mussel populations from harvest and prevent habitat degradation in order to provide a refuge from which mussel stocks could repopulate harvestable waters. Subsequent mussel surveys have indicated that some of these areas have concentrations of rare mussel species.

**Methods**

Commercial musseling license sales were monitored to determine the extent of the increase in commercial musseling pressure upon the resource. License sales were examined from 1973, when an annual license to harvest mussels was implemented, to 1990.

In 1990, a survey of commercial musselers was instituted to determine the species composition of the harvest. Musselers were interviewed while they were taking breaks between dives or brail tows. Mussels were identified and sorted to species, counted, and weighed. During the survey of the harvest, 15,787 mussels with a total weight of 10,198 pounds were examined. Representatives of each species were measured, weighed, and aged by external examination. This survey provided much-needed information about which species were commercially harvested, the number and weight of each species harvested, age at recruitment into the mussel fishery, and locations of mussel concentrations. Also, mussels harvested were "ringed," or measured by means similar to those employed by the industry, to determine the percentage of harvested mussels that were smaller than regulations allowed. Since regulations increasing the minimum harvestable size of mussels were being proposed and supported by the industry, the mussels harvested by the musselers were also "ringed" by the sizes proposed by the industry.

Wholesale mussel dealers were surveyed to determine the amount of the annual harvest and the economic value of the resource. The dealers were asked to provide this information by categories used by the industry. These surveys were conducted from 1987 through 1990. Historical data on harvest levels of mussels were obtained from various sources for comparative purposes and are illustrated in Table 1 (Isom 1969; Sample 1981; Conder 1988, 1989, 1990; Hargis 1968).

Population surveys were conducted in 1989 and 1990 by personnel of the Tennessee Wildlife Resources Agency to determine the composition of mussel "beds" by species. Mussels collected during these surveys were identified to species and measured by "ringing" to determine if they were legal for harvest. Small specimens of each species were measured, weighed, and aged to provide data not gathered by the survey of musselers since these shells were too small for legal harvest.

**Results**

Annual commercial musseling license sales gradually increased in Tennessee from 1973 to 1989. License sales jumped 74% from 1989 to 1990 (Figure 1).

**Table 1.** Tennessee's commercial mussel harvest, value, and number of license holders by year.\*

| Year     | Harvest (tons) | Value (\$) | Avg. price (\$/lb) | # of license holders |
|----------|----------------|------------|--------------------|----------------------|
| 1944     | 7,105          | 298,410    | 0.02               | NA**                 |
| 1945     | —***           | —          | —                  | NA                   |
| 1946     | 7,798          | 296,324    | 0.02               | NA                   |
| 1947     | —              | —          | —                  | NA                   |
| 1948     | 3,845          | 165,333    | 0.02               | NA                   |
| 1949     | 1,775          | 62,125     | 0.02               | NA                   |
| 1950     | 4,099          | 122,970    | 0.02               | NA                   |
| 1951     | 2,449          | 97,960     | 0.02               | NA                   |
| 1952     | 2,732          | 122,940    | 0.02               | NA                   |
| 1953     | 4,564          | 232,764    | 0.03               | NA                   |
| 1954     | 4,977          | 209,034    | 0.02               | NA                   |
| 1955     | 3,950          | 173,800    | 0.02               | NA                   |
| 1956     | 2,798          | 166,088    | 0.03               | NA                   |
| 1957     | 3,251          | 242,526    | 0.04               | NA                   |
| 1958     | 2,472          | 148,320    | 0.03               | NA                   |
| 1959     | 1,449          | 100,705    | 0.03               | NA                   |
| 1960     | 3,652          | 439,108    | 0.06               | NA                   |
| 1961     | 1,450          | 181,250    | 0.06               | NA                   |
| 1962     | 1,536          | 216,576    | 0.07               | NA                   |
| 1963     | 4,284          | 646,884    | 0.08               | NA                   |
| 1964     | 1,701          | 236,439    | 0.07               | NA                   |
| 1965     | 2,183          | 312,169    | 0.07               | NA                   |
| 1966     | 2,619          | 552,609    | 0.11               | NA                   |
| 1967     | 2,078          | 388,586    | 0.09               | NA                   |
| 1968     | 2,074          | —          | —                  | NA                   |
| 1969     | 1,371          | —          | —                  | NA                   |
| 1970     | 1,174          | —          | —                  | NA                   |
| 1971     | 154            | —          | —                  | NA                   |
| 1972     | 445            | —          | —                  | NA                   |
| 1973**** | 740            | 188,170    | 0.13               | 1                    |
| 1974     | —              | —          | —                  | 16                   |
| 1975     | —              | —          | —                  | 62                   |
| 1976     | —              | —          | —                  | 85                   |
| 1977     | —              | —          | —                  | 89                   |
| 1978     | —              | —          | —                  | 138                  |
| 1979     | —              | —          | —                  | 341                  |
| 1980     | —              | —          | —                  | 442                  |
| 1981     | —              | —          | —                  | 679                  |
| 1982     | —              | —          | —                  | 357                  |
| 1983     | —              | —          | —                  | 663                  |
| 1984     | —              | —          | —                  | 877                  |
| 1985     | —              | —          | —                  | 953                  |
| 1986     | —              | —          | —                  | 1,211                |
| 1987     | 2,356          | 4,169,800  | 0.88               | 1,054                |
| 1988     | 4,493          | 9,122,854  | 1.02               | 1,136                |
| 1989     | 3,730          | 6,533,875  | 0.88               | 1,351                |
| 1990     | 4,760          | 8,808,581  | 0.93               | 2,355                |
| 1991     | —              | —          | —                  | 1,431                |

\* Data for 1944–1967 are taken from Hargis (1968) and Isom (1969). Data for 1987–1990 are for Kentucky Reservoir only (Conder 1988, 1989, 1990).

\*\* Not applicable.

\*\*\* Data not available.

\*\*\*\* First year license required.

The increase in license sales was probably related to recent increases in the average price per pound paid for good quality mussel shells by wholesale mussel dealers. Musseling was viewed by some people as a very lucrative way to supplement their income. The 2,355 commercial musseling licenses sold in 1990 were more than had ever been sold in Tennessee.

Surveys of mussel harvest from Kentucky Reservoir as reported by wholesale mussel dealers indicated a drastic increase from 2,356 tons in 1987 to 4,760 tons in 1990 (Figure 2). The value of the mussel shells was estimated at \$8.8 million (Table 1).

The species composition of the mussel harvest was examined by numbers and weight through interviews of mussel harvesters. *Fusconaia ebena* constituted the greatest percentage of the harvest for Kentucky Reservoir, 46% by number, with *Amblesma plicata* constituting 26%, *Quadrula quadrula* 13%, and *Fusconaia flava* and *Megaloniais nervosa* 7% each (Figure 3). The composition of the harvest for Kentucky Reservoir by weight differed drastically from the number estimates for some species. *Fusconaia ebena* made up 34% of the harvest by weight, *Amblesma plicata* 26%, *Megaloniais nervosa* 21%, *Quadrula quadrula* 14%, and *Fusconaia flava* 7% (Figure 4).

The species composition of the harvest for the Cumberland River was very different from what was observed for Kentucky Reservoir. *Megaloniais nervosa* constituted 97.7%, and all other mussel species together accounted for only 2.3% of the harvest from the Cumberland River by number. The composition by weight was similar to the composition by number. *Megaloniais nervosa* constituted 98.9%, and all other mussel species combined made up 1.1% of the harvest by weight.

The composition of the harvest in size classes designated legal prior to October 1990, and in size classes proposed by wholesale mussel dealers, was investigated by examining the harvest of musselers

working Kentucky Reservoir from 14 June to 9 August 1990. It was estimated that 64% by number and 69% by weight of the harvest would still be of legal size if the increased minimum size regulations were implemented. It was estimated that a 22% economic loss would occur if these increased size limits were implemented, or a 10% loss if increased size regulations did not include *Megaloniais nervosa*, one of the heaviest mussels for its size and most valuable.

Age at recruitment into the fishery was determined by external examination of mussels and measuring the height of the valves in a manner that would be applicable to measurements used in "ringing" by the harvesters. Maximum, minimum, and mean size for each age group were calculated by SAS (Statistical Analysis System, Version 6 Edition) regression analysis for mussel species constituting a major portion of the harvest in 1990. A trend line of best fit, illustrated growth trends for the selected mussel species which were useful in evaluating minimum size regulations.

One hundred thirteen specimens of *Amblesma plicata* were measured and aged to obtain growth information. This information indicated that the old minimum size limit of 2 1/2 inches, which was in effect until October 1990, was reached by this species at age 5+ (Figure 5). The growth data showed that *Amblesma plicata* obtained the current minimum size limit of 2 3/8 inches at age 6+.

Growth information was collected from 166 *Fusconaia ebena* mussels. This information was collected during population surveys and from mussels harvested by commercial musselers. The trend line produced was much steeper than for other mussel species, probably due to the presence of younger individuals in the population samples (Figure 6). Under the old minimum size limit of 2 1/4 inches, this species entered the mussel fishery at age

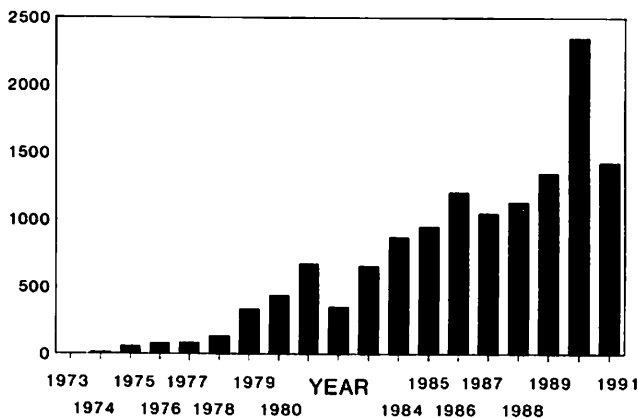


Figure 1. Number of licenses sold for commercial musseling by year.

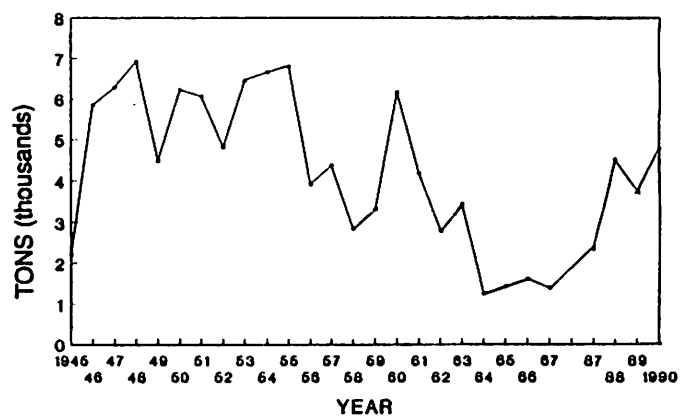
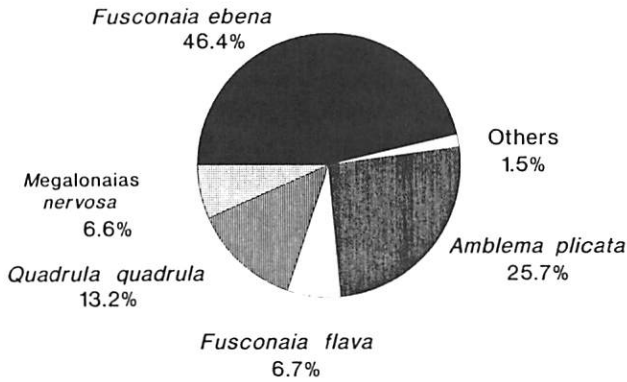
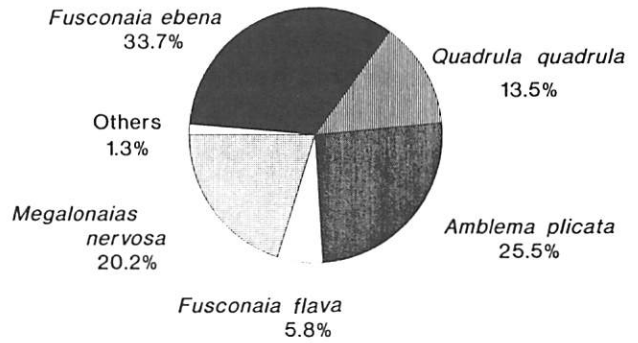


Figure 2. Weight of mussels harvested from Kentucky Reservoir, 1945-1990.



**Figure 3.** Commercial mussel harvest composition by number from Kentucky Reservoir during 1990. "Others" are *Pleurobema cordatum*, *Quadrula metanevra*, *Quadrula nodulata*, *Cycloniaias tuberculata*, and *Elliptio crassidens*.



**Figure 4.** Commercial mussel harvest composition by weight from Kentucky Reservoir during 1990. "Others" are *Pleurobema cordatum*, *Quadrula metanevra*, *Quadrula nodulata*, *Cycloniaias tuberculata*, and *Elliptio crassidens*.

8+. At the new minimum size limit of 2 3/8 inches, *Fusconaia ebena* enters the fishery at age 9+.

Only 72 specimens of *Fusconaia flava* were measured for growth analysis. These specimens were sampled from mussels harvested by commercial musselers. The data indicate that under the old size limit of 2 1/2 inches, this species entered the mussel fishery at age 6+ (Figure 7). Under the current size limit of 2 5/8 inches, this species enters the fishery at age 9.

One hundred three specimens of *Megaloniaias nervosa* were measured and aged to obtain growth information. The data indicated that under the old size limit of 3 3/4 inches, this species entered the mussel fishery at age 10+ (Figure 8). A portion of the *Megaloniaias nervosa* population entered the mussel fishery at age 7. Under the new size limit of 4 inches, this species enters the fishery at 14+ years.

Growth information was obtained from 135 specimens of *Quadrula quadrula*. This species grew to the old minimum size limit of 2 1/2 inches by age 5+ (Figure 9). Under the current minimum size limit of 2 5/8 inches, this species enters the fishery at age 7+ in Tennessee.

## Discussion

In view of the increase in harvest pressure, as indicated by an increase in license sales, on the state's mussel resource and the large harvests in recent years, the Tennessee Wildlife Resources Agency decided to propose more conservative regulations for the commercial musseling industry. One of the first regulations proposed was to limit which species could be harvested commercially. Based on harvest data, the 12 most abundant species

in the commercial harvest were proposed for legal status. One other species, *Potamilis alatus*, was added to the list of legal species at the request of the pearl culture industry.

In 1992, a color pamphlet titled "Commercial Musseling In Tennessee" (McGregor and Gordon 1992) was printed and distributed to the commercial musseling industry to aid in the identification of legal species and to provide resource information. This publication is intended to reduce the harvest of rare species and other species not legal for harvest.

The Tennessee Wildlife Resources Commission has passed minimum size limit regulations designed to protect commercial species from harvest until they reach maturity and have an opportunity to spawn at least once (Tennessee Wildlife Resources Commission 1990). It is thought that most mussel species do not reach sexual maturity until age 5. However, some species do not reach sexual maturity until much later in life, such as *Megaloniaias nervosa*, which is thought to mature at age 8 (Woody and Holland-Bartels 1990). The preliminary growth data obtained during the 1990 survey indicate that the current size limits are providing the necessary protection for most species, although the data indicate that a small percentage of the *Megaloniaias nervosa* population is harvested prior to reaching sexual maturity. Depending on information from more intensive data collection efforts currently being conducted, size limits may have to be re-evaluated in the future.

Harvest estimates for the commercial musseling industry prior to 1991 were obtained from several sources. Most of these estimates were derived from surveys of wholesale mussel dealers. Tennessee has instituted a receipt system which requires the

wholesale mussel dealer to issue a receipt to the mussel harvester for each business transaction. The information required to be completed by the wholesale mussel dealer is as follows: license number of the mussel harvester, name of the mussel harvester, date of transaction, pounds of mussels bought by size category, location from which the mussels were harvested, license number of the wholesale mussel dealer, and the name of the agent buying the mussels for the wholesale mussel dealer. The harvest information obtained from the receipt system should provide a more accurate estimate of the harvest.

Tennessee has a year-round season for the harvest of mussels, but Kentucky Reservoir is closed to commercial musseling on Saturday, Sunday, and national holidays from 1 May to 15 September. The Tennessee Wildlife Resources Commission passed this season modification in an attempt to reduce conflicts between user groups on this popular and productive body of water. One of the effects of this regulation was to reduce the harvest due to the elimination of some of the days mussels could be harvested. Also, individuals who were musseling on a part-time basis had their opportunities for harvest reduced. The reduction in license sales from 1990 to 1991 may be attributed to a great extent to part-time musselers quitting the business due to these lost opportunities.

To pay for the increased costs associated with the more intensive management program, the Tennessee Wildlife Resources Agency (TWRA) sought legislation to require the wholesale mussel dealer to pay a fee of \$0.0124 per pound on mussels with meat in them and \$0.0145 per pound on mussels without meat in them to TWRA. These revenues are earmarked for mussel management, mussel research, and law enforcement efforts associated with the mussel program. The proposed legislation, both supported and opposed by representatives of the commercial musseling industry,

was passed in June 1991. Part of this legislation included the formation of a Mussel Advisory Board, composed of representatives of the commercial mussel industry who are appointed by the governor and whose responsibility is to advise TWRA and the Commission on mussel management. It is hoped that the Mussel Advisory Board will be a real asset to the program by helping to target goals and improve communication between TWRA and the industry.

Although the revenues derived from the mussel export fee will not completely fund the management and enforcement of the mussel program, it will help pay the \$225,000 cost of this program. Because of the reduction in harvest associated with the new regulations, the mussel export fee generated only \$36,005 for the first year it was instituted. TWRA anticipates that revenues from this fee will increase in the future as recruitment into the fishery continues.

TWRA has hired a new mussel biologist whose responsibilities are focused on the commercial musseling program and a technician to assist him in data collection. Also, a new law enforcement officer was employed to enforce the state's commercial musseling regulations. The mussel biologist is currently collecting quantitative and qualitative data on mussel populations, harvest, growth, age at sexual maturity, and habitat in the state's mussel sanctuaries. The revenues derived from the mussel export fee help fund these positions.

### Summary

The Tennessee Wildlife Resources Agency has intensified its management program in response to the increased effort exerted upon the state's mussel resource by the commercial musseling industry. In response to the preliminary information gathered, more restrictive regulations on mussel harvest have been implemented by the Tennessee Wildlife

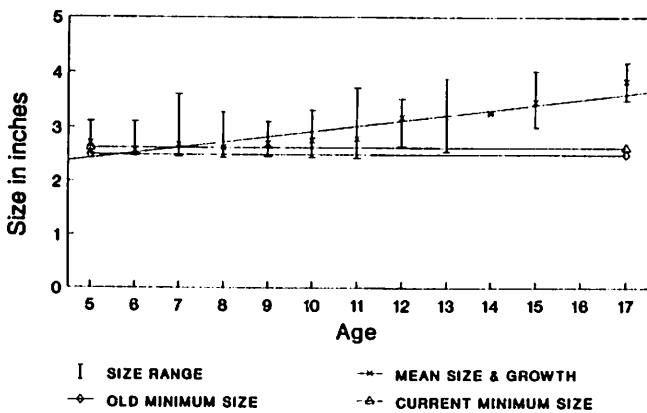


Figure 5. Size at age for *Amblema plicata*, Kentucky Reservoir.

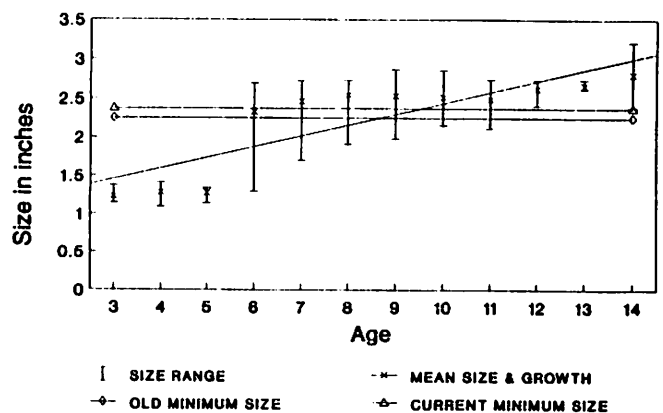


Figure 6. Size at age for *Fusconaia ebena*, Kentucky Reservoir.

Resources Commission to protect the resource from overharvest and to ensure that mussel stocks will be of sufficient size to allow sustainable commercial harvest. These regulations established mussel sanctuaries, restricted the harvest to the most abundant and marketable species, increased mini-

imum size limits, reduced the number of days during which mussels can be harvested from the reservoir with the most pressure exerted upon it, and specified areas in which mussel harvest is legal.

Increased data collection efforts have been implemented to evaluate current regulations and provide needed information to best manage the state's mussel resource. These efforts are focused on, but not limited to, population inventories, determination of species composition of harvested mussels, the collection of growth data, the gathering of information on age at sexual maturity, and mussel industry economic surveys.

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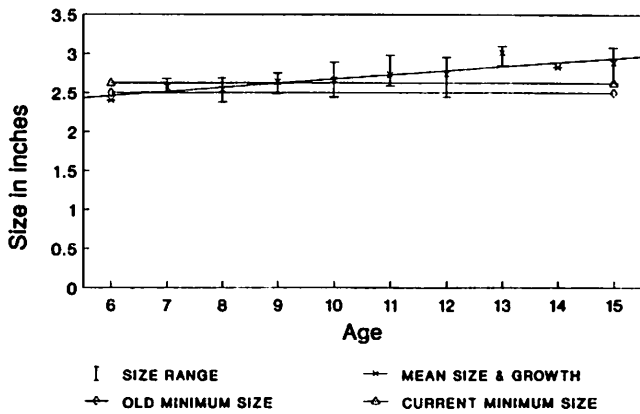


Figure 7. Size at age for *Fusconaia flava*, Kentucky Reservoir.

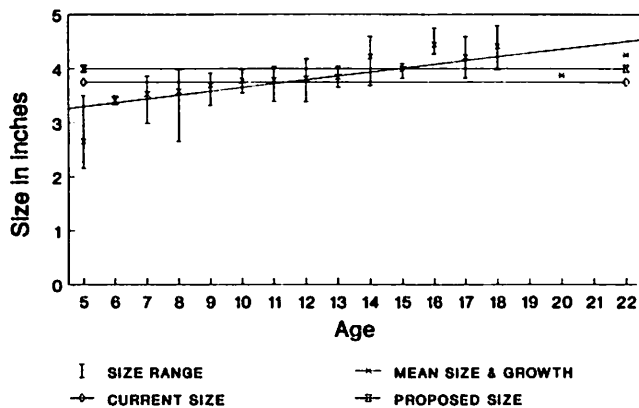


Figure 8. Size at age for *Megaloniais nervosa*, Kentucky Reservoir.

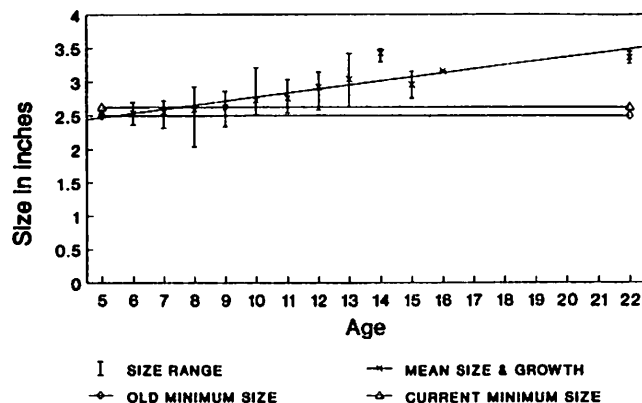


Figure 9. Size at age for *Quadrula quadrula*, Kentucky Reservoir.