

Musseling in Kentucky: The First 200 Years

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Abstract. The history of commercial mussel harvest in Kentucky was documented. Changes in regulatory control of the industry in response to the impacts of harvest on mussels and other aquatic communities were delineated. The effectiveness of regulations to alleviate specific problems or ameliorate impacts has been temporary. The rapid expansion of the industry in the mid-1980s, when shell prices quadrupled, created conflicts between musselers, commercial fishermen, and recreational interests, primarily anglers. A major revision of regulations was requested to resolve the conflicts. A public involvement process, soliciting input from identifiable interest groups, was initiated to address these conflicts. The process resulted in a better understanding of the complexity of the problems, a mutual respect among the groups, and a set of recommended regulatory changes. Changes in regulations that reflect the concerns of key stakeholders can enhance their acceptance, thus insuring greater success in reducing conflicts among resource users.

Introduction

Kentucky's freshwater mussel populations have been an abundant source of taxonomic information for scientific investigators and a greater economic boon for commercial exploiters for most of the 200 years since Kentucky became a state in 1792. Michaux (1805, cited by Williams 1969) stated "in the Ohio. . . they find in abundance a species of *Mulette* which is from five to six inches in length. They do not eat it, but the mother o'pearl, which is very thick in it is used in making buttons."

The focus of this paper is an abbreviated history of Kentucky's mussel fishery. Commercial musseling has prospered as a result of the easy accessibility to a dense and diverse mussel fauna. Recent conflicts within the mussel fishery and between other aquatic resource users provided the impetus for this documentation.

Species Diversity

Kentucky's diverse unionid fauna has been studied since the early 1800s. The early taxonomic studies conducted by C. S. Rafinesque in 1818–1819 (Cicerello et al. 1991) began to delineate the great diversity in the Kentucky fauna. Schuster (1988) and Cicerello et al. (1991) listed 103 unionid species as currently or historically occurring in the state. These represent two major faunal assemblages—the Mississippian, which includes the Ohio subregion, and the Cumberlandian, described by A. E. Ortmann (1926).

Additionally, Cicerello et al. (1991) included a single species citation by Johnson (1980) from the Atlantic Slope assemblage.

There is minor disagreement among researchers as to the number of taxa that are extinct or extirpated. Generally, they agree that only 84 or 85 species currently persist, with 28 to 34 species having federal or state endangered or threatened status because of their scarcity (Cicerello et al. 1991, Schuster 1988). Universal consensus holds that human activities have severely affected Kentucky's mussel populations over the past 200 years. Fuller (1974), Havlik and Marking (1987), and the U.S. Army Corps of Engineers (1981) attributed the decline in diversity to altered physiochemical conditions, channelization, dams, commercial exploitation, mining wastes, pesticides, improvements for navigation, and other industrial and agricultural development in response to human population expansion.

Economic Importance

Schuster (1988) lists 19 current or historical commercially important mussels in Kentucky. Of these, 12 were termed very important, four were considered less important, and three were "pinks," which are used in decorative items and costume jewelry. Recent harvest and sale records show that primarily three species (*Quadrula quadrula*, *Amblema plicata*,

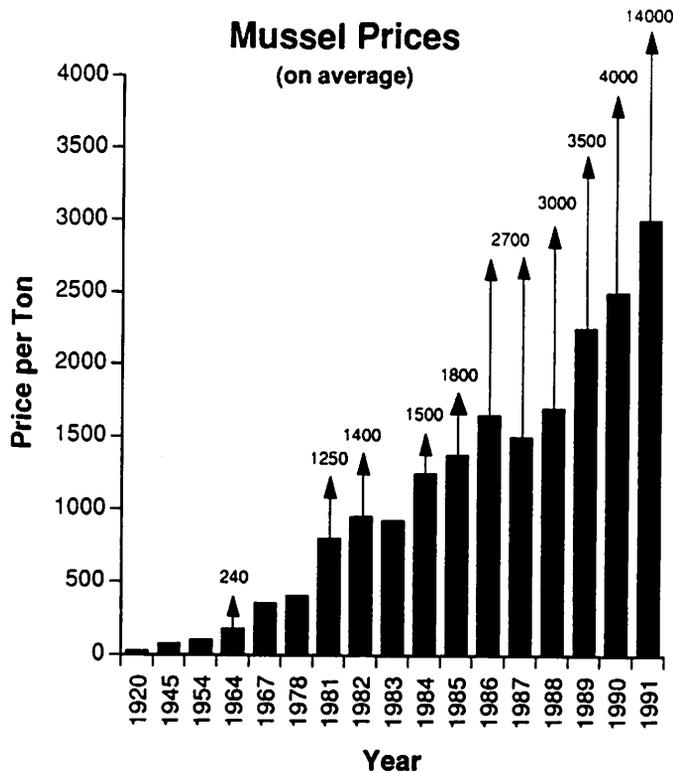


Figure 1. Average price per ton paid for mussels 1920–1991. Numbers at arrows are maximum price paid for highest quality shells.

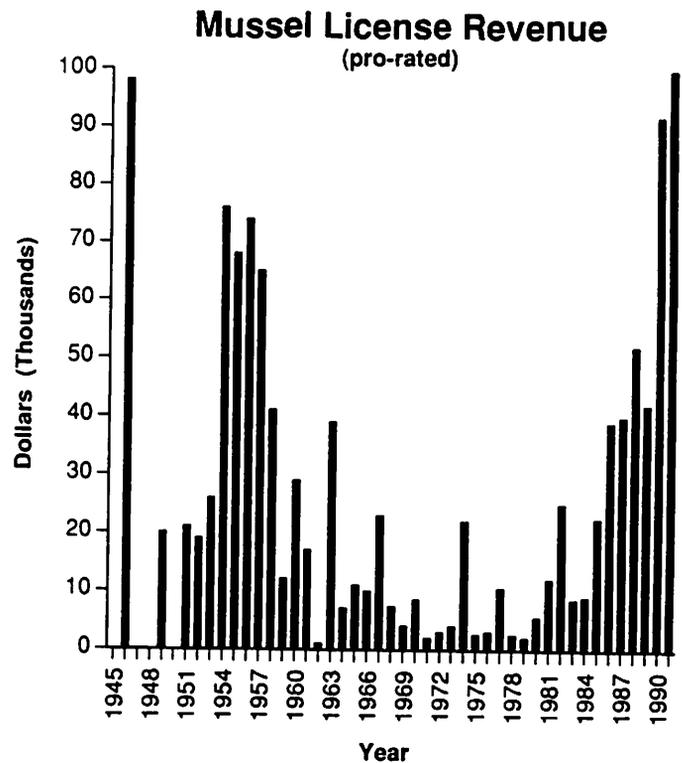


Figure 2. Mussel license revenues 1945–1991. All amounts have been adjusted to 1991 dollars to illustrate changes in mussel harvesting activity through time.

and *Megalonaias nervosa*) are being sought by buyers.

Historically, the commercial exploitation of unionids in Kentucky can be traced to the late 1700s to early 1800s. Michaux (1805, cited by Williams 1969) mentioned seeing buttons circa 1802 in Lexington that were as beautiful as European-made buttons. We could not find any substantiation, but the implication was that the buttons were made from shells taken from the nearby Ohio River.

Isom (1966) stated the existence of a button factory in Knoxville, Tennessee, in 1883 that operated for a short time but failed due to unsuitable machinery. The first successful button venture according to Coker (1919) was in Iowa in 1891. The industry expanded into Kentucky in the Tennessee, Ohio, and Green rivers and was flourishing by the turn of the century. From then until the 1940s, musseling for the pearl button industry was carried out on many river systems. Button factories were mobile enough to move as new mussel beds were discovered. The sites of these factories can still be found where there are large piles of discarded shells with button blanks cut from them. Williams (1969) noted such piles near

Paducah, Kentucky, on the Tennessee River and at Portsmouth, Ohio; Vanceburg, Augusta, and Cloverport, Kentucky; Leavenworth, Indiana; and Metropolis, Illinois, on the Ohio River.

As expected, the species used in the button industry varied, largely due to availability of high-quality shells. Most reports, including those of Williams (1969) and Coker (1919), indicated that the yellow sandshell, *Lampsilis teres*, was the predominate species used in the button industry. Other "yellows" and mixed "whites" (mucket, *Actinonaias ligamentina*; pocketbooks, *Lampsilis ovata* and *L. cardium*; black sandshell, *Ligumia recta*; ebony shell, *Fusconaia ebena*) were variously utilized.

Button manufacturing peaked in the 1920s and 1930s. In Kentucky, an estimated 100 to 150 men worked the lower Tennessee River from mile 31 downstream to the mouth at Paducah. During that same period, Ohio River musselers were working in crews of six to 20 boats per 40-mile river segment. Mussel buyers were paying \$15/ton for mixed whites and \$70/ton for yellows (Figure 1). At the beginning of World War II, the button industry rapidly declined. Jobs were suddenly plentiful, gasoline for outboard motors was

scarce, many known mussel beds were probably showing signs of over-exploitation, and most importantly, plastics began to replace mussels as button material (Williams 1969).

Musseling began another surge in the early 1950s when the Japanese cultured pearl industry "discovered" freshwater mussels (Figure 2). They found that the thick white shells from the Tennessee and Ohio rivers were ideal material for pearl nuclei or "seeds" placed in pearl oysters for cultured pearl production (Sickel 1991). By the early 1960s, over 900 mussel boats were active on the Tennessee River (Williams 1969). Musseling peaked on the Ohio River in the mid-1960s, when 75 to 100 boats were active between Cattelletsburg, Kentucky, and Cairo, Illinois. By 1966, only six boats worked the lower Tennessee and only 24 were musseling the Ohio along Kentucky's northern boundary.

During this boom period, shell prices gradually increased from an average of \$40/ton in 1945 to \$180/ton in 1967 (Isom 1969). Musselers first ventured into Kentucky Lake in 1967 and enjoyed short-lived success in harvesting shells from the inundated Tennessee River channel. Prices ranged to \$240/ton, but poor shell quality quickly halted the lake harvest.

The total number of musselers remained low from 1968 to 1984 despite some elevated prices for shells. Two minor exceptions are noted. The first increase in activity in 1974 was probably related to poor national economic conditions. Another minor surge occurred in 1981-1982 when a few enterprising brailers began to explore the overbank areas of Kentucky Lake outside the original Tennessee River channel. Their efforts were rewarded when those shells commanded much higher prices. Through most of the 1970s, mussel prices remained in the \$400-\$500/ton range (Sample 1980). In 1981, prices more than doubled to \$1,250/ton for overbank threeridges (*Amblema plicata*), which eventually reached \$1,400/ton in 1982. Only 76 brailers were licensed in 1985, with prices peaking at \$1,800/ton for washboards, *Megaloniaias nervosa*.

From the spring of 1986 through the fall of 1991, increases in musseling activity and shell prices have been astonishing. By 1990, the Kentucky Department of Fish and Wildlife Resources (KDFWR) licensed 815 brailers and had an estimated equal number of illegal divers, "hand-pickers" and "toe-diggers." Shell prices averaged \$2,580/ton, with \$4,000/ton paid for selected washboards. A temporary buyers "war" in the summer of 1991 pushed average shell prices above \$3,000/ton, with large washboards commanding up to \$14,000/ton. A minor (4%) reduction in license sales occurred in 1991, but this was most likely accompanied by a much larger increase in numbers of illegal harvesters. To date, in

1992, license sales are less than 500, with prices generally in the ranges seen in 1990. A surge in interest in Ohio River shells temporarily reduced the harvest pressure on Kentucky and Barkley lakes in 1992 but appears to be another short-lived phenomenon.

History of Mussel Regulations

The Kentucky Game and Fish Commission was established in 1912, and the first law addressing mussel harvest was enacted in 1926. This original legislative act provided the framework for the statute that exists today. In the 1926 act, a commercial license (resident and nonresident) was established entitling the holder to operate one boat only. By the end of the calendar year, each musseler was required to submit a report delineating the total weight of mussels harvested, amount received from their sale, and location of harvest. Enforcement power was granted to agents and game wardens of the state Game and Fish Commission. No method of mussel harvest was described in this original law, but interestingly, a provision specified that only four boats could operate per mile of shell bed. Concern of overharvest was evident during this time frame because the law granted the Game and Fish Commission authority to close any mussel bed following publication of closure in the county newspaper.

The statutes have remained similar through time except for minor wording and numbering changes. There was an addition in 1948 establishing a mussel buyer's license. Also, in 1944, an emergency law was passed declaring the portions of the Tennessee River that were to be inundated by Kentucky Lake as a license-free zone. No mussel license was required to harvest shells within this zone, because the impoundment was deemed lethal to the shells.

The KDFWR was formed in 1953, and recent control of mussel harvest has been in the form of administrative regulations in addition to the previous statutes. A 1952 regulation declared all mussel beds in all streams to be open year round. This remained unchanged until 1965, when the first mussel sanctuary was established below Kentucky Lake from the dam to river mile 18. This 1965 regulation also established musseling hours between 6 a.m. and 6 p.m. Method of take was first described in this regulation, prohibiting the use of mechanical dredges, forking, and/or divers. The legal method of taking was established as brailing with a limit of two brails per boat and specifications on brail wire size and prong length. A minimum size limit of 2.5 inches was established for all mussel shells.

The 1965 regulation has become the core regulation for the Department. Sanctuaries have been extended to 200 yards below all dams and to Highway 62 below

Barkley Lake (1966), embayments of Kentucky and Barkley lakes (1987), river mile 418–419 of the Ohio River (1987), Big South Fork National River and Recreational Area (1988), and further sections of the Ohio, Green, and Barren rivers (1991). These latter extensions of sanctuaries have been solely for the protection of federally endangered mussels. Asian clam shells (*Corbicula* sp.) were exempted from the minimum size limit in 1966 to allow their use as bait by commercial fishermen. Licensed fishermen were also permitted to harvest 100 mussels by hand for their personal use until 1982, when this privilege was revoked (except for *Corbicula* sp.) via a separate regulation describing live bait for personal use. Also in 1982, wording in this regulation was qualified to specifically prevent diving as a method of mussel harvest.

In 1987, changes were promulgated addressing size limits and brailing times. The minimum size limit was increased to 3.75 inches for washboard and 2.75 inches for threeridge. The 2.5 inch size limit remained for all other mussels except the Asian clam. Brailing hours were restricted to 8 a.m. until 6 p.m. on Kentucky and Barkley lakes to lessen conflicts associated with other commercial fisheries.

Most recent amendments (1991–1992) to the mussel regulations and statutes have been to curtail growth of the mussel fishery and illegal activity associated with the fishery. Waters open to musseling have been limited to areas presently or historically brailed, thereby automatically closing all other waters in the state. New mussel license sales were restricted to individuals who had purchased a musseling license in either of the previous two years, essentially placing a temporary cap on the fishery. All musselers must have their current musseling license number clearly painted or affixed to their boats and visible from the air. Specific wording has been added to the regulation, making it unlawful for any person or persons to possess “green” mussels without possessing a commercial mussel or commercial mussel buyer’s license. Musseling regulations have been modified temporally and spatially on Kentucky and Barkley lakes to again reduce conflicts with other commercial fisheries. Statute changes, effective in 1992, have substantially increased penalties for violations of mussel regulations, particularly for using illegal methods of harvest. Previously, penalties were a meager \$25-200; now the penalties are as follows:

	Fine	Imprisonment
First offense	\$ 100 - 1,000	≤ 30 days
Second offense	\$ 500 - 1,500	≤ 6 months
Subsequent offense	≥ \$ 2,000	≤ 1 year

Conflicts and Surveys

Historical changes in statutes and regulations indicated there was a minimal level of user conflict and some concern regarding overharvest of shells. The authority to close mussel beds and the restrictions on the number of musselers per bed are evidence of these problems.

The KDFWR perceived an overharvest of mussels in the lower Tennessee River and established a sanctuary there in 1966. The Department subsequently funded a three-year study to determine the extent of mussel beds, species composition, population density, harvest, recruitment, and reproduction of mussels in the Kentucky portions of the Tennessee and Ohio rivers and on the Green River (Williams 1969). It is curious to note that this study was initiated because overharvest was apparent, and then data were collected to document overharvest.

The major conflicts associated with the mussel fishery began in the mid-1980s, when numbers of musselers began to increase commensurate with the higher shell prices. In the summer of 1986, shell prices reached \$2,700/ton for cooked out (meat removed) washboard shells, and harvesters numbered 168, which was twice the number licensed in the previous year. Most of the effort was directed in the two major lakes, Kentucky and Barkley lakes. By July 1987, licensed musselers doubled again to over 350. During this time, the Department initiated the regulation change for reduction of musseling hours, closure of Barkley and Kentucky lake embayments, and increased size limits. Public outcry officially began with letters of complaint from tourism promotion groups in the area of Kentucky and Barkley lakes area. While most complainants perceived a threat to water quality from resuspension of “toxins” by brailing activity, the list of issues quickly grew. The most prevalent conflicts involved the widespread destruction of natural and human-made fish habitat such as stumps and brushpiles; the destruction of spawning sites; the overharvest of mussel resources by legal brailers and illegal divers; and the presence of brail boats on historic recreational fishing areas that precluded fishing through physical interference and intimidation. Secondary conflicts that subsequently became issues were temporal and spatial overlap of musseling and commercial fishing; competition among groups for launching facilities; threats to benthic invertebrate (primarily mayfly) populations; discourteous behavior of brailers; inadequate control of illegal musseling; and lack of substantive biological information on the magnitude and species composition of Kentucky’s mussel fauna.

A significant reduction in the white bass (*Morone*

chrysops), sauger (*Stizostedion canadense*), and white crappie (*Pomoxis annularis*) fishery in Kentucky Lake served to exacerbate the situation. The mussel harvesters became somewhat of a scapegoat for a number of problems that originated as a result of relatively severe drought conditions that prevailed over much of the region during the mid-1980s.

Department personnel attended public meetings in the Kentucky Lake area and discussed solutions with varied interest groups. Subsequently, in August 1987, the Department recommended a cap on further mussel license sales, a five-month closed season, no weekend musseling, and an increase in mussel license fees. Opposition to musselers was not well-organized, and shell harvesters successfully impeded the more restrictive recommendations except for the fee increase.

By December 1987, 448 musselers were licensed, and the recreational public was fully engaged in the debate. Chambers of commerce opposed musseling because it was "destroying sportfishing resources." They requested increased law enforcement to vigorously deal with illegal activity and research to determine brailing impacts on mussels, fish habitat, fish spawning, water quality, and benthic macroinvertebrates. Sportfishing guides wanted brailing stopped. Conversely, the Kentucky Lake Shell Harvesters and League of Kentucky Sportsmen supported the musseling industry's viewpoint. The Division of Fisheries was directed to develop a mussel brailing impact study. The Division contracted a two-year study to investigate the effects of brailing on spawning fish, the impact of the removal of bottom structure by brails, the impact of brailing on mussel resources, the impact on benthic invertebrate fauna, the release of pollutants from sediments, and the role of mussels in the system and the effect of their harvest.

By 1990, the number of licensed brailers almost doubled (815) again, with high-quality washboards commanding \$4,000/ton. The number of law enforcement citations for illegal methods of mussel harvest reached record levels. Most of this activity remained directed at Kentucky and Barkley lakes, and public demand for "change" had peaked.

A survey of brailing boats was conducted on the two lakes to quantify brailing activity (Kinman, Kentucky Department of Fish and Wildlife Resources, unpublished report 1991). The survey, which included aerial counts of brailers on both lakes and an on-the-water survey of Kentucky Lake activity, documented area use from March through November 1990. Findings included the following: activity on Kentucky Lake was 1.7 times higher than that on Barkley Lake; August was the peak month for activity, with an average of 79 brailers/day on

Kentucky Lake and 43 brailers/day on Barkley Lake; the single highest number of brailing boats was 106 on Kentucky Lake in October; some level of brailing was conducted on 78% of the available main lake on Kentucky Lake; 67% of the total brailing activity was restricted to 27% of the Kentucky main lake area. Preliminary conclusions of the brailing impact study (Sickel 1989) did not support the views of those wanting to ban mussel brailing; therefore, the study failed to meet their expectations. The main findings included the following: the regulations restricting brailing to the main lake excluded 30% of the Kentucky portion of Kentucky Lake and 67% of the shoreline from impact; mussel density increased since an earlier study by Sickel and Chandler (1982); relatively large numbers of juvenile mussels indicate healthy populations that should sustain the resource into the near future; growth characteristics of three important commercial mussel species indicate adequate food supply and good water quality; a low harvest efficiency of 1.5% makes it unlikely that brailers could destroy mussel resources before being forced to move for economic reasons; and no main lake areas suitable for crappie nesting were located. Conclusions from the second year of the brailing impact study (Sickel 1991) were that brailing reduced numbers of fingernail clams (*Sphaeriidae*) and mayfly nymphs (*Hexagenia bilineata*) in test areas. The reduction in numbers was speculated to be a result of disruption of burrows and subsequent movement of nymphs out of the study area. Fingernail clams were likely destroyed by brail hooks. Most suitable fish spawning habitats for crappie and black bass (*Centrarchidae*) were located in embayments where brailing is prohibited.

The Department began a public involvement effort in late 1990 to help diffuse the situation and to empower stakeholders on all sides of the issue to participate in seeking solutions. A total of 22 individuals who were identified as key "players" in the issue were contacted. They were asked to give their views and concerns, to provide names of others who should be involved, and, if they were willing, to participate in a problem-solving effort. Telephone interviews led to a group of 19 individuals representing musselers, mussel buyers, fishing guides, commercial fishermen, chambers of commerce, sport fishermen, resort owners, tourism promotion groups, fishing tournament promotion, marina owners, and bait dealers, all willing to serve to find a solution.

The Mussel Advisory Group was finally established with 31 representatives and convened to develop recommendations to the Fish and Wildlife Commission to deal with the issues surrounding commercial musseling on Kentucky and Barkley

lakes. The Department provided a facilitator and a recorder, and the Department's interests were represented by staff from the Fisheries and Law Enforcement divisions. During its 22 three-hour meetings from 5 April 1991 through 30 May 1992 the group adopted and enacted procedures that enabled its members to understand the issues, identify and evaluate alternative solutions, reach agreements, and develop recommendations. The group based all of its decisions upon consensus and worked together to develop recommendations all of its members could accept. As additional interest groups were discovered, they were admitted as members or otherwise provided opportunity for input. Group members attempted to keep their constituents informed throughout the process.

By April 1992, the group had identified 23 issues and had agreed upon 60 solutions. Some 16 solutions that had been discussed during the 13-month process were dropped by group consensus as unnecessary or unworkable. The single issue of closure of the lakes to brailing on weekends and holidays could not be resolved. Changes in the mussel harvest reporting system were recommended by this group, and amendments to statutes, regulations, and departmental procedures were implemented as a result of this group's recommendations.

Toward the latter stages of the group problem-solving process, several of the interest groups began to push for consideration of diving as a legal harvest method. The desire by sportfishing and tourism interests to eliminate mussel brailing apparently superseded other considerations. A decision was deferred pending an evaluation of the effectiveness of other solutions recommended and a report by KDFWR on the feasibility of implementing a pilot project to evaluate the pros and cons of diving.

The following observations were presented to the Department at the completion of the advisory group's primary mission:

The group was diverse. The perceptions were deeply rooted and each point of view strongly represented. However, by the end of the process, most participants felt they had learned a great deal about each other and had a better understanding of more than their initial point of view... we reached consensus (no winners, no losers, just recommendations everyone can live with) on many items that, at first, would have seemed impossible to resolve. I must commend the Department for not backing away from such a complex issue... and for its decision to allow the process to continue in the face of pressures to "get this thing over with." The recommendations that result... are more successfully implemented and generally more widely accepted than those where a single person, or department "mandates" a

change (Mrs. Robert Wittman, mussel brailer's wife, spokesperson for the Mussel Advisory Group, comments to Kentucky Department of Fish and Wildlife Resources Commission, June 1992).

The Mussel Advisory Group will reconvene on 22 October 1992, to review the progress in the implementation of their recommendations and to identify what is working and what is not. Mussel prices have stabilized to 1989-1990 levels, and license sales are less than 500, or approximately 40% fewer than 1991 sales. Illegal harvesting continues.

The proliferation of the mussel fishery in Kentucky has been a learning experience for the Department. The biological, economic, social, and political considerations associated with both the commercial and recreational fisheries in western Kentucky were simultaneously activated by the demand for mussels. The viewpoints of the various interest groups were often completely opposed. The Department did some active soul-searching of our management philosophies for strategies concerning multiple use of resources. For the first time, the Department involved the public in some of the decision-making process. Many unanswered questions remain, and most solutions will be influenced by changes in the demand for mussels, the availability of high-quality shells, and, most importantly, the prices offered to harvesters. The Department plans to continue to regulate the mussel fishery by size limits, limitation on gear, areas open to musseling, time of day, and a reduced number of mussel licenses issued. Strategies to monitor commercially valuable mussels and other mussels, including endangered or threatened species, have not been formulated.

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