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Endangered Species UPDATE

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The Curious Case of the Fat Pocketbook Mussel, *Potamilus capax*

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Abstract
Native freshwater mussels (Family: Unionidae), often referred to as the most 'endangered' organisms in North America, typically reach their greatest abundance in gravelly shoals in medium-sized to large rivers in the United States. However, one species, the endangered fat pocketbook mussel, *Potamilus capax* Green 1832, is very common in deep deposits of fine-grained sediments in man-made ditches or in slow moving rivers, streams, sloughs, and bayous in the St. Francis Watershed in Arkansas. An early study reported the status of this species as 'tenuous;' however, research conducted in the last 20 years indicate that in appropriate habitat *P. capax* usually exhibits good evidence of recent recruitment and can comprise more than 10% of the mussel assemblage. Hundreds or even thousands of individuals can occur in 1- to 5-km-long reaches of rivers or ditches. Endangered species management should take advantage of accurate information on distribution, abundance, and life history. Confusion and misinformation about this mussel must be overcome to improve management plans and decisions concerning this species. In this article we examine the status of *P. capax* based on a review of the literature and our recent surveys in the St. Francis Watershed.

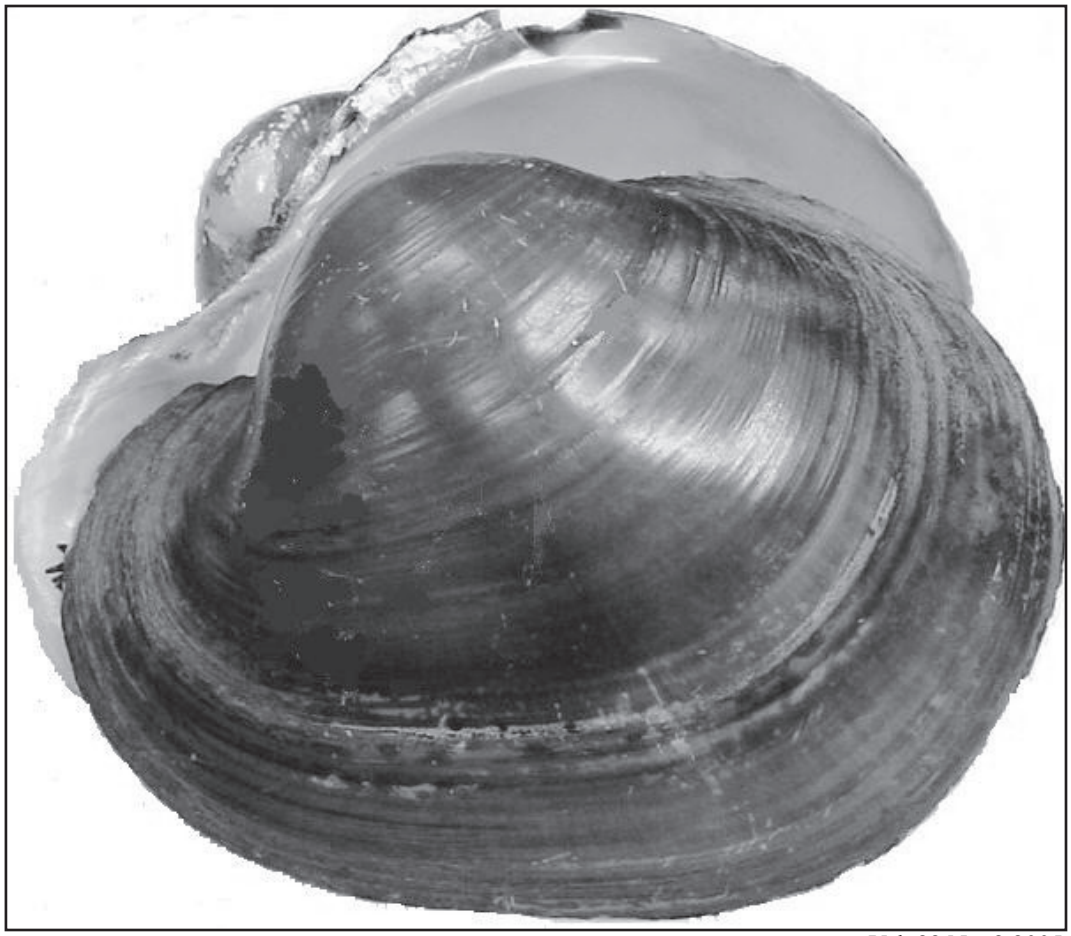
Resumen
Mejillones nativos de agua dulce (Familia: Unionidae), a menudo se llaman los organismos más en peligro de extinción en Norteamérica, atienen típicamente su abundancia más grande en bancos de arena y gravilla en ríos de tamaño medio a largo en los Estados Unidos. Sin embargo, un especie, *Potamilus capax*, es muy común en depósitos profundos de sedimentos de grano pequeño en zanjas hechas por humanos o en ríos lentos, arroyos, pantanos y ciénagas en St. Francis Watershed en Arkansas. Un estudio temprano dijo que el status del especie fue tenue, pero investigaciones realizadas en los últimos 20 años indican que en una habitación apropiado *P. capax* usualmente muestra evidencia buena de reclutamiento reciente y puede constituir más que 10% de la ensamblaje de mejillones. Cientos o miles de individuos pueden ocurrir en tramos de 1-5 kilómetros de los ríos o las zanjas. La gestión de los especies en peligro de extinción deben aprovechar la información correcta de la distribución, la abundancia, y la historia de la vida. La confusión y la desinformación sobre éste mejillón se deben superar para mejorar los planes de la gestión y las decisiones con respecto a éste especie. En este artículo examinamos el status de *P. capax* basa en un estudio de la literatura y nuestra investigación en St. Francis Watershed.

Introduction

Native freshwater mussels (Family: Unionidae) are often referred to as the most "endangered" organisms in North America (Williams et al. 1993). However, the status of one species, the fat pocketbook mussel (*Potamilus capax,* figure 1) has been reported to be "improving" (U. S. Fish and Wildlife Service (USFWS) 1996, State of Arkansas 2005). This has not happened recently: in a 1990 review of 81 listed invertebrates, the USFWS first gave this favorable report on *P. capax* (Bean 1993). These statements counter those made by Bates and Dennis (1983) in a report on mussels in the St. Francis, White, and Cache Rivers in Arkansas and Missouri. They concluded that *P. capax* had experienced a range reduction of 90% within the basin and the continued viability of a single refugial population located on an eight-mile reach of the lower St. Francis River was "tenuous." They felt that this was "probably the *only remaining viable population*" anywhere over its original range.

The simple reason for the above discrepancy is that Bates and Dennis (1983) missed virtually all *P. capax* in the St. Francis watershed. In a subsequent survey, Clarke (1985) collected from 1 to 10 live specimens at nearly 100 sites located along a 70-km reach of the St. Francis River and an adjunct slough. On six reaches he estimated *P. capax* density to range from one to seven individuals/1000 m^2 and total population size to range between several hundred to more than 2,000 individuals. Clarke concluded, "we are not dealing with a rare, sedentary, or spatially-restricted species, but rather a common, actively-moving and widespread one." The recovery plan for *P. capax* (USFWS 1989) cited Bates and Dennis (1983) and Clarke (1985) but did not address differences between

Figure 1. *Potamilus capax*.



the surveys. Additional studies in the watershed (Harris 1986, 2001, 2002; Ahlstedt and Jenkinson 1991; Jenkinson and Ahlstedt 1993; Dardeau et al. 1995; Miller and Payne 2002, 2003) have verified Clarke's original statement. In appropriate habitat in the St. Francis Watershed, *P. capax* is common.

This article examines the status of *P. capax* based on a review of the literature and our recent surveys in the St. Francis Watershed. We examine its past and present distribution, its habitat requirements, and its population and community dynamics. Our experiences were obtained during a mussel translocation project conducted in the fall of 2002. *Translocation* is defined as the capture and transfer of organisms from one part of their range to another (Kleiman 1989). This translocation took place in a 5.7-km reach of Stateline Outlet Ditch, located near Blytheville, Arkansas (Miller and Payne 2003). Work was funded by the Memphis District of the U.S. Army Corps of Engineers following Section 7 consultation with the USFWS. The goal was to hand collect 95% of the *P. capax* in the ditch, estimated to be 2000, and then move them to safe locations outside the project area.

Freshwater Mussels and *Potamilus capax*

Background

Worldwide, there are approximately 31,000 species of bivalve molluscs. There are approximately 300 freshwater species in North America with 55 to 60% listed as extinct or imperiled (Master 1990, Eisner et al. 1995). Bivalves are characterized by a pair of calcareous shells, or valves, held together with an elastic hinge ligament. The organism is laterally compressed and the visceral mass lies within fleshy folds of tissue that secrete the shell. The majority of bivalves feed by removing particulate organic matter from water that is circulated through the gills by cilliary activity. In addition to their alimentary function, the gills are also used for respiration. Sexes are separate and the female incubates the young for a variable period of time on its gills. In most freshwater species the immature forms, once released from the female, must spend a development period of several weeks on the fins or gills of a fish. When immature forms are released they burrow into suitable substratum where they usually remain for their entire lives (Fuller 1974, Russell-Hunter 1979).

Although freshwater mussels can be collected in virtually any permanent waterbody, they typically reach their greatest density (50-100 individsuals/m^2) and richness (25-35) in stable sand and gravel shoals in medium-sized to large rivers in the United States (Miller and Payne 1993, 1998, 2004; Payne and Miller 1989, 2001). Because of their longevity, sedentary nature, and reliance on suspended food and clean water, biologists frequently express concern over the effects of water resource development on these organisms (Stansbery 1970, Fuller 1974, Master 1990, Bogan 1993, Seddon et al. 1998, Hayes 1998, Williams et al. 1993, Neves 1999).

Potamilus capax *Distribution*

Potamilus capax was proposed for listing by the USFWS on September 26, 1975 (40 FR 44392-44333) and formally listed as endangered on June 14, 1976 (41 FR 24062-24067). Although the Federal Register did not state why it was listed, range reduction, based on historical records, and the present or threatened destruction, modification, or curtailment of its habitat or range, were probably significant factors. Reasons for its range reduction were not discussed in the plan (USFWS 1989) although there were general references to the negative effects of water resource developments such as channelization, impoundments, dredging, water pollution, and sedimentation.

Based on information in Bates and Dennis (1983) and the recovery plan (USFWS 1989), the historical distribution of *P. capax* included the St. Francis River, Arkansas, upper Mississippi River north of St. Louis, and the Wabash River, Indiana. Information on distribution comes from two sources: actual physical specimens catalogued in museums and descriptive material in early papers. Typically these records do not include details such as the number of organisms collected (i.e., density estimates), or quantitative data on types of habitats sampled. This is a well-known reality of distributional data for virtually all species; one cannot always be sure whether designated locations represent a single find, multiple finds, or a viable population.

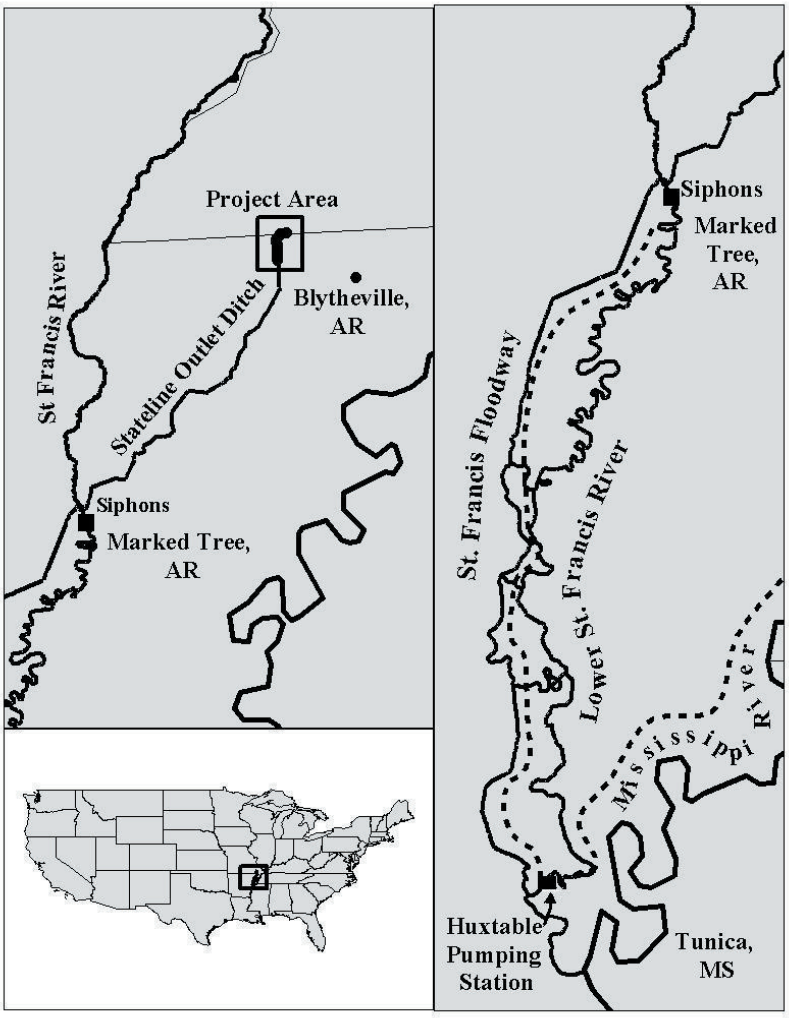


Figure 2. Location of the project area, west of Blytheville, Arkansas (left panels). Relationship of the St. Francis River, St. Francis Floodway, and levee system (heavy dashed line), located south of the project area (right panel).

Although range maps depict this species along the Ohio and Wabash Rivers, large numbers of live *P. capax* have not been reported outside the St. Francis watershed. For example, Sickel (1987) collected only two live specimens (one was gravid) where the Cumberland River joins the Ohio River. Cummings et al. (1987) found nine live adult and juvenile *P. capax* in the lower Wabash River. A subsequent search of the upper and middle Wabash River and the Little Wabash River failed to yield live *P. capax* (Cummings et al. 1988, 1989). *Potamilus capax* has not been collected recently in the upper Mississippi River, although shells were found in the 1980s. In a 1930–1931 survey along a 1100-km reach of the upper Mississippi River between Cairo, Illinois, and Point Au Sable, Minnesota, Max Ellis (as reported by van der Schalie and van der Schalie (1950)) collected nearly 7,000 live mussels and 39 species but found only 47 live *P. capax* (0.68%). Even by modern standards this was an extensive survey; Ellis sampled 254 stations (live mussels were found at 86) using sieves and rakes, a 6-ft^2 dredge, and hand collecting.

Most species of freshwater mussels are nondescript and difficult to distinguish from one another. Although *P. capax* has some obvious distinguishing features (size, inflation, condition of shell) it is often confused with closely related species, even by experts. Bates and Dennis (1983) describe four cases of mistaken identity with *P. capax* either in published reports or museum specimens. One of these errors was made by Green, who originally described the species (see Frierson (1927)). None of these identification errors are responsible for the historical distribution records in the recovery plan (USFWS 1989); however, these errors emphasize that this is an uncommon species about which little is known.

Potamilus capax *Habitat Requirements*

Ahlstedt and Jenkinson (1991) reported that *P. capax* was most likely to be found in a mixture of sand, clay, and silt, which they referred to as "sticky mud." The description "sticky mud" hardly does justice to the reality of these habitats in Arkansas. The mud in these areas can be up to 100 cm deep, which is virtually impossible to walk through. Because of its very thin and globose shell, *P. capax* tolerates deep deposits of fine-grained silt substratum and would not survive in gravel substratum with erosive flows—habitats usually dominated by heavy, thick-shelled bivalves. Historically, *P. capax* was probably most common in large river sloughs and oxbows with silt substratum, which were more common at the mouths of rivers before developments such as locks, dams, levees, and bank protection measures. Such modifications virtually eliminated all adjacent depositional habitats. The few specimens collected by Ellis in the early part of the 20th century (as reported by van der Schalie and van der Schalie (1950)), and Sickel (1987) must represent remnants of much earlier populations. It is possible that before the development of the inland waterway system, *P. capax* was locally abundant in depositional habitats adjacent to the Mississippi and Ohio Rivers. However, we are unaware of any extensive slack water systems outside the watershed, such as the system of ditches and sloughs along the St. Francis River, which could support large numbers of *P. capax*.

Potamilus capax Translocation in Stateline Outlet Ditch

Study Area and Field Methods

Stateline Outlet Ditch is located west of Blytheville, Arkansas, in predominantly flat, agricultural land (figure 2). Mussels were removed from a 5.7-km-long reach of the ditch that was scheduled for cleanout to improve water conveyance. The upper two thirds of the ditch in the project area was approximately 35 m wide, and sinuous with reasonably firm, silt-sand substratum. The downstream section was 50 to 60 m wide, straight, and substratum consisted of flocculent mud, 20 to 100 cm deep. Water depth varied from 20 to 200 cm when the translocation was done. The ditch originates near the Arkansas-Missouri border, flows south, then connects to the St. Francis River, which ultimately joins the Mississippi River near mile 672, west of Tunica, Mississippi.

The St. Francis River was extensively modified in the early to mid-20th century to reduce flooding and improve drainage. Near the town of Marked Tree, Arkansas, the river splits into the manmade St. Francis Floodway to the west and the lower St. Francis River to the east. The lower reach of the St. Francis River, south of Marked Tree, is isolated by surrounding levees, the Huxtable Pumping Plant to the south, and a pair of one-way siphons to the north. The St. Francis Floodway is an unconstrained link between the upper watershed (including Stateline Outlet Ditch) and the Mississippi River (figure 2).

Figure 3. Collecting *P. capax* in a reach of Stateline Outlet Ditch, Arkansas, 2002.

The project area was divided into 18 reaches and 5 to 13 collectors formed a line and then walked or crawled along each reach retrieving live mussels by digging or feeling in the top 5 to 10 cm of substratum (figure 3). The water was too turbid to collect visually. Sampling per reach varied from 45 to 90 minutes, depending on the number of mussels collected. Poor retrieval, due to the number of mussels present and the difficulty of collecting, meant that some reaches were worked as many as seven times without removing all live *P. capax* (figure 4). After a single pass along a reach, live mussels were sorted, counted, and identified, and all *P. capax* were measured. Eleven days were spent on the project and 1,090 person hours were expended collecting. General information on mussel sampling can be found in Miller and Payne (1993) and Strayer and Smith (2003). A more detailed description of this translocation can be found in Miller and Payne (2003) and results of two smaller translocations in this watershed can be found in Dardeau et al. (1995) and Miller and Payne (2002).

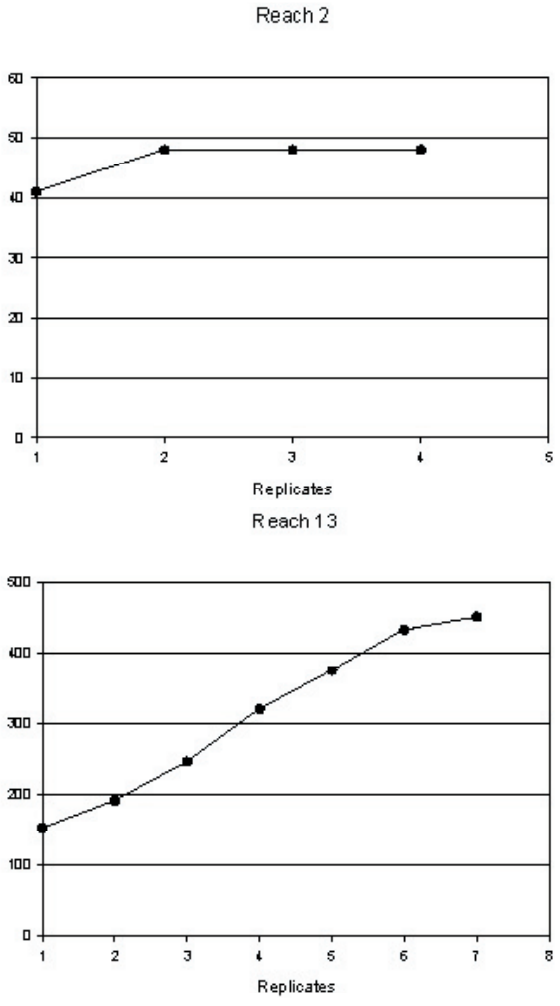


Figure 4. Cumulative number of *P. capax* collected along 106-m-long Reach 2 (top) and 498-m-long Reach 13 (bottom) of Stateline Outlet Ditch. Sandy substratum in Reach 2 allowed for all *P. capax* to be removed in just a few passes. In Reach 13 extensive deposits of fine-grained sediments required 7 passes, which probably still did not remove all *P. capax*.

Community and Population Dynamics

In Stateline Outlet Ditch, *P. capax* was fourth in abundance among 19 species and overall represented approximately 13% the fauna. In two downstream reaches of Stateline Outlet Ditch it comprised nearly 20% of the fauna. Total mean density was 6.1 and 10.8 individuals / 1,000 m^2, and average catch per unit effort was 4.4 and 6.1 individuals / hour in the up- and downstream reaches, respectively. More *P. capax* (77.7%) were taken from the downstream silty reaches than the upstream more sandy reaches.

A shell length frequency histogram was prepared for *P. capax* based on slightly more than 2,000 organisms (figure 5). Because of the sampling method (search by feel while crawling or swimming), collectors were slightly biased toward large individuals and probably missed small specimens. The population of *P. capax* in Stateline Outlet Ditch included individuals ranging in length from approximately 10 to 145 mm with about 70% between 75 and 110 mm long. The overall demography of the population suggests low but relatively steady annual recruitment, high longevity, and moderately low annual mortality during the middle, relative to the earliest and latest parts of the lifespan. The rapidly declining abundance between 110 to 145 mm probably indicates the size at which age-related mortality takes place. The findings of this study are similar to those of Harris (2001), who collected by searching within 1-m^2 quadrats, a method that could obtain small individuals. However, he collected only 30 live specimens as compared to the more than 2,000 collected and measured in this study. Regardless,

results of both studies indicated that moderately large mussels comprised most of the population, although juveniles were present.

Summary and Conclusions

Since it was originally listed, much has been learned much about *P. capax;* the Endangered Species Act (ESA) was the impetus for elucidating much about its density, distribution, and habitat requirements. First, it is tolerant of depositional areas that are indisputably the antithesis of high-quality freshwater mussel habitat described by Stansbery (1970). This is not a "lotic" organism as indicated in the Recovery Plan (USFWS 1989) that is negatively affected by high sedimentation rates. Second, we have found no evidence that *P. capax* was ever abundant outside Arkansas although it was collected along the Ohio and Wabash Rivers. However, based on habitat conditions in the St. Francis drainage, it is difficult to imagine it being very common at those locations. Finally, man-made ditches, as well as existing bayous, sloughs, and streams in the St. Francis Watershed, provide suitable habitat for *P. capax*. The decision in 1989 to move 2,000 specimens to a reach of the Mississippi River in Missouri (USFWS 1989) was not in the best interest of *P. capax* (see also Clark et al. (2001)).

Although this is a low-density species, current numbers in appropriate habitat are not what one would consider to be dangerously low. For example, Eisner et al. (1995) noted that a median population size of species when listed is usually about 1,000. Although restricted, this watershed is approximately 5,180 km^2 and provides sufficient habitat (see Shaffer 1981). In comparison with at least some federally listed molluscs, *P. capax* comprises a fairly large component of the species assemblage. For example, in the upper Mississippi River, the endangered *Lampsilis higginsii* comprised approximately 0.5% of the unionid assemblage in archeological deposits (Havlik and Marking 1981) as well as at sites not affected by zebra mussels (*Dreissena polymorpha*) (Miller and Payne 1998). The endangered pink pearly mucket mussel (x*Lampsilis abrupta*) comprises less than about 1 percent of the molluscan assemblage in the Tennessee River (Miller and Payne, unpublished information). The endangered orange-footed pimpleback mussel (*Plethobasus cooperianus)* makes up approximately 0.1 percent of the unionid fauna at a species-rich bed in the lower Ohio River (Payne and Miller 2001).

It is misleading, although not inaccurate, to state that the status of *P. capax* is improving. The survey by Clarke (1985) illustrated that this species was more common than previously thought. Funding for field surveys and translocations, made available by passage of the ESA, was responsible for a better understanding of *P. capax*. This species was simply listed before obtaining detailed information on its distribution, local density, and abundance. It is ironic, but the status of *P. capax* probably *is* improving in the St. Francis watershed—as a result of increased agricultural developments and therefore construction of more ditches. A negative feature is the isolation of the lower St. Francis River

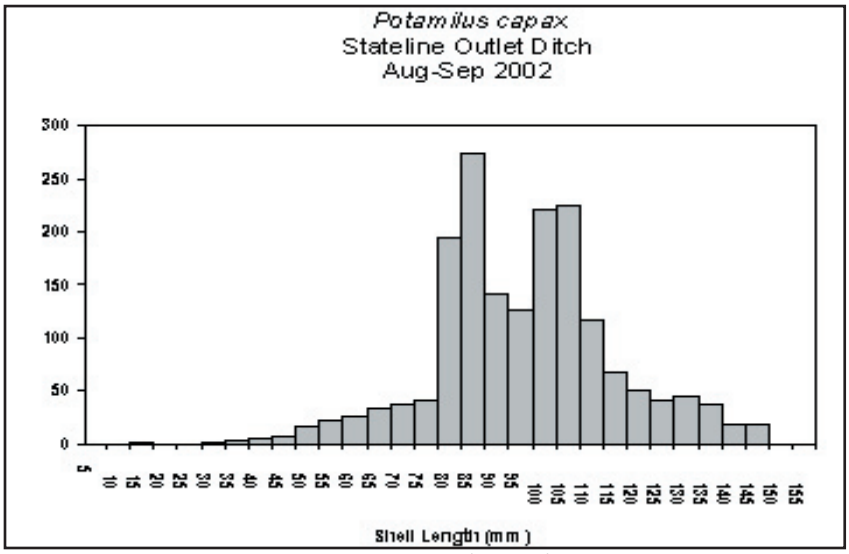


Figure 5. Length-frequency histogram for *P. capax* collected in a 5.6-km reach of Stateline Outlet Ditch using qualitative (search by feel) methods.

by the siphons and pumping plant (figure 2), which restricts passage of potential host fishes. However, fishes and mussels do have access to ditches and streams outside the isolated areas.

Our intent in reviewing the status of *P. capax* is similar to that of Peterson (2001), who cautioned that the interests of the ESA are not necessarily served if peripheral species, those at the extension of their range, are afforded federal protection. With respect to this species, lotic habitats in the Wabash, Ohio, and Mississippi rivers are peripheral and probably not critical to its continued existence. Regardless, we agree that invertebrates do not receive the attention from the ESA that they deserve (Kellert 1985, 1993; Opler 1987; Bean 1993; Murphy 1991; Hughes et al. 2000; Black et al. 2001). There can be no doubt that converting free-flowing rivers to run-of-river-reservoirs for commercial use can limit species that require firm substratum and pool-riffle habitat (Bogan 1993, Williams et al. 1993, Neves 1999). Palmer (1985) lists 18 and Eldredge (1998) lists 13 now extinct species of freshwater mussels; most were lost in the 20th century as the navigation system was developed. However, not every freshwater mussel is dependent on gravel substratum and sediment-free conditions for survival. Furthermore, the philosophical and practical difficulties of translocations (Cope and Waller 1995, Losos et al. 1995; Griffith et al. 1989; Parmalee and Bogan 1998) beg the question as to why *P. capax*, which is surviving well in man-made ditches in Arkansas, needs to be moved at all. Such translocations do little to further an overarching goal of the ESA, that of protecting the ecosystems on which vulnerable species depend (Doremus 1991, Eisner et al. 1995).

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