A Retrospective Analysis of a Large-Scale Endangered Species Translocation Project

Andrew C. Miller, Barry S. Payne

During September and October of 2002, we collected and moved more than 2,000 endangered fat pocketbook pearly mussels, *Potamilus capax*, from a 5.7-km reach of a drainage ditch in eastern Arkansas. The translocation was to protect mussels from planned maintenance dredging and was required by the *Biological Opinion* prepared by the US Fish and Wildlife Service. The project did not proceed as planned, and we removed only about 80% of the *P. capax*. In this article we examine mistakes made, lessons learned, and discuss procedures that might have led to a more favorable outcome. We identified three key decisions that should have been thoroughly discussed prior to initiating the work: percentage of mussels to be removed, choice of recipient sites, and number of mussels to be marked and measured. Two other issues were important: the status of *P. capax* in Arkansas and the likelihood of future dredging needs at recipient sites. Initially, we felt that decision-analysis tools, used during planning, would have facilitated a better understanding of complex issues. Although such tools would have encouraged better discussion, it is now apparent that communication was hampered largely by the different perspectives of participants.

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The Endangered Species Act (ESA) of 1973 provides a mechanism to protect threatened and endangered species and the ecosystems upon which they depend. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species is one that is likely to become endangered in the foreseeable future throughout all or a significant portion of its range. Federal agencies are not to initiate an action (authorization, funding, or permit issuance) that is "likely to jeopardize the continued existence of any endangered species." The ESA prohibits "take," which is defined in Section 3(19) as "harass, harm, purse, hunt, wound, kill, trap, capture or collect, or attempt to engage in any such conduct." An agency can consult with the United States Fish and Wildlife Service (USFWS) about the likelihood that a proposed action will negatively affect a species. The action could then be stopped or modified. Alternatively, an agency could prepare an Incidental Take Statement, which declares that a specific loss is unavoidable and requests permission to proceed. Often the project is allowed to proceed if endangered organisms can be relocated outside the project area. The Incidental Take Statement could then discuss the likelihood that some might be missed or killed during relocation. A specified loss can be allowed if it does not jeopardize continued existence of the species.

Native freshwater mussels (Family: Unionidae) are considered by many aquatic biologists to be the most endangered organisms in North America (Williams et al., 1993). In 1976, 24 species were listed as endangered; as of January 2006, 62 were endangered and 8 were threatened (US Fish and Wildlife Service, 2006). Although they reach their greatest abundance (25 to more than 100/m^2) and species richness (20 to 30) in medium-sized to large rivers (Miller and Payne, 1998; Payne and Miller, 2000), they are also found in ponds, lakes, and sloughs (Parmalee and Bogan, 1998). They have a unique reproductive cycle in which the newly released larval stage must undergo a two- to three-week development period on the fins or gills of a fish; hence, successful recruitment depends on specific hosts (Fuller, 1974; Watters, 1994). They are sedentary suspension feeders, and aside from the development period, spend their lives partially buried in substratum. Although many reasons for their endangered status have been proposed and discussed

Affiliation of authors: Environmental Laboratory, US Army Engineer Research and Development Center, Vicksburg, Mississippi

Address correspondence to: Barry S. Payne, US Army Engineer Research and Development Center, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199; (fax) 601-634-2398; (e-mail) Barry.S.Payne@erdc.usace.army.mil.

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shell length of each mussel was measured and each shell was engraved with an identifying number. Mussels were then packed with wet towels in coolers and transported to recipient sites and placed in the substratum.

Stateline Outlet Ditch

Stateline Outlet Ditch originates near the Arkansas–Missouri border west of Blytheville, Arkansas. It flows south and connects to the St. Francis River, which in turn joins the Mississippi River near Mile 672, west of Tunica, Mississippi. Near the town of Marked Tree, Arkansas, the river splits into the 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 from the surrounding watershed by levees, the Huxtable Pumping Plant to the south, and a pair of siphons to the north (Figure 1). Siphons are primed with a mechanical pump, but they contain no turbines. Fish can go downstream into the St. Francis River through the siphons, but not back up against the current.

The upper one-third of the ditch was sinuous, 25 to 40 m wide, with mostly firm, silt–sand substratum. The lower two-thirds was 50 to 60 m wide and straight; substratum consisted of flocculent mud 20 to 100 cm deep, which made walking extremely difficult. The surrounding area was agricultural, although a strip of land between the ditch and the levees was vegetated with herbs, vines, silver maple, and willow. We estimated total benthic surface area at 66,500 m^2 and 170,000 m^2, in the upstream and downstream reaches, respectively. During retrieval there was no measurable water flow in the ditch.

Numbers of *P. capax*

In a previous survey, Harris (2001) estimated that there were 3,072 *P. capax* in the project area. Approximately 2,300 and 760 were in the upper and lower sections, respectively.

Methods

We divided the ditch into 18 reaches. Five to thirteen collectors lined up and crawled, walked, or swam, depending on water depth and the amount of mud, retrieving all live *P. capax*. Retrieval was done tactilely because of low water clarity. The area of each reach was measured, and collecting time was recorded to estimate density, catch per unit effort, and depletion rate (Lockwood and Schneider, 2000). We collected mussels by hand while wading because the size of the project area (236,500 m^2) made it unreasonable to use divers equipped with scuba or surface-supplied air.

Work was not consecutive and spanned nearly two months, because collecting was restricted to low water periods. Twenty-four people participated in the 11-day project. Our inability to maintain a constant crew was partially a function of the disagreeable aspects of the work (labor intensive, tedious, dirty, involved exposure to extremes of heat and cold, etc.). Two people left for health reasons, four commercial shell fishermen left the site with no explanation, and a commercial fisherman who had worked in delta streams all his life told us that this was his worst field experience.

Relocation Sites

Three relocation sites were to be used, one in a nearby ditch (Ditch 29) and two in the St. Francis River south of Marked Tree. Ditch 29 was contiguous with the Stateline Outlet Ditch and less than 2 km away. Physical conditions in Ditch 29 (depth, water velocity, and substratum), which supported substantial numbers of *P. capax*, were virtually identical to those in Stateline Outlet Ditch. Sites on the St. Francis River were 120 km from the project area. River flow was moderate and substratum consisted of coarse sand silt.

Mistakes Made

Preliminary Removal

We conducted a pilot test of retrieval methods in the upper reach of the ditch, where an earlier study (Harris, 2001) indicated that most of the *P. capax* would be found. Results suggested that translocation was feasible, and we made an estimate of the time required to remove all *P. capax*. Unfortunately, these results were misleading, because the larger and muddier lower reach was not included in the pilot study.

Inability to Remove 95% of the *P. capax*

If we had examined the downstream reach in detail, we would have concluded that most of the *P. capax* were located there and that they would be very difficult to remove because of deep mud. Ultimately, we worked downstream reaches repeatedly without fully depleting the population. For example, in the first three passes along arated from the others and was not noticed because of turbid water. Several days later, Memphis District personnel found the bag, which was still in the water, and took the juveniles to the St. Francis River.

Replacement Methods

We were required to individually hand place mussels on the substrate at recipient sites. At Ditch 29, the crew distributed mussels by dragging partially opened bags across the substratum. This resulted in uneven distribution of mussels on top of the substratum; however, the crew leader was concerned that placing mussels individually could lead to them being stepped on because of the difficulty of walking on soft sediments and of seeing the bottom. Later we were criticized for using this method.

Lessons Learned

We removed more than 2,000 live *P. capax* from Stateline Outlet Ditch, with the majority (78%) taken from the downstream, most-difficult-to-sample reaches. Using the depletion method of Lockwood and Schneider (2000), we estimated that between 2,165 and 2,680 *P. capax* were in the project area. Therefore, we removed and relocated between 76% and 94% of the population. Translocation was stopped when it became increasingly clear that we were having difficulty removing all mussels. The following is an assessment of mistakes made and lessons learned.

The Pilot Survey

We made a major error by not conducting more thorough test removals at various locations throughout the project area. Sufficient preliminary work should have been done to determine that the majority of the mussels were in the downstream reach and that 95% removal might not be possible. This would have provided a clearer picture of the magnitude of this translocation.

Misplaced Bag of Mussels

Although no endangered species were killed when the bag of juvenile mussels was lost, this incident damaged our credibility. A chain of custody procedure would have identified this mistake immediately.

Lack of Clarity on Project Details

We did not participate in project planning and therefore were unaware of many project details and past discussion of issues. If we had been more knowledgeable about the rationale for various plans, we might have been able to influence some of the decisions. A case in point is the dredging plan for Stateline Outlet Ditch, which will be discussed in more detail in the next section. We only reviewed that document after the project had been completed. This was a major error on our part.

Communication

When blunders occur, it is often concluded that more and better communication was needed. If we had discussed concerns and problems as they arose in the field, such as the difficulty of replacing mussels in Ditch 29, some plans might have been modified.

Key Issues

All participants (USFWS and the Memphis District) were aware of publications describing the ecology and distribution of *P. capax* (Bates and Dennis, 1983; Clarke, 1985; Harris, 2001; Jenkinson and Ahlstedt, 1993), the recovery plan (US Fish and Wildlife Service, 2001), and details of previous mussel translocations (Cope and Waller, 1995). Despite the fact that everyone was aware of this literature, different perspectives on four key issues, discussed in detail below, affected decision making and project design.

What Percentage of the Local *P. capax* Population Should Have Been Moved?

In the *Biological Opinion* (US Fish and Wildlife Service, 2001), it was stated that dredging would have direct and indirect effects on *P. capax*. Mussels removed by the dredge would be killed, and increased "siltation associated with the work" would have a deleterious effect on all others. These secondary effects would be severe enough to warrant complete (or near-complete) removal.

We recently analyzed archived project specifications to determine extent of proposed dredging. Results of a hydrographic survey had been used to divide the project area into 142 sections, each 30 m (100 ft) long. Based on dredging requirements, we grouped these sections into five reaches. Half the channel in the first reach, and a 3-m strip along one bank, would be affected in two downstream reaches. Two upper reaches would be completely dredged. Thus,

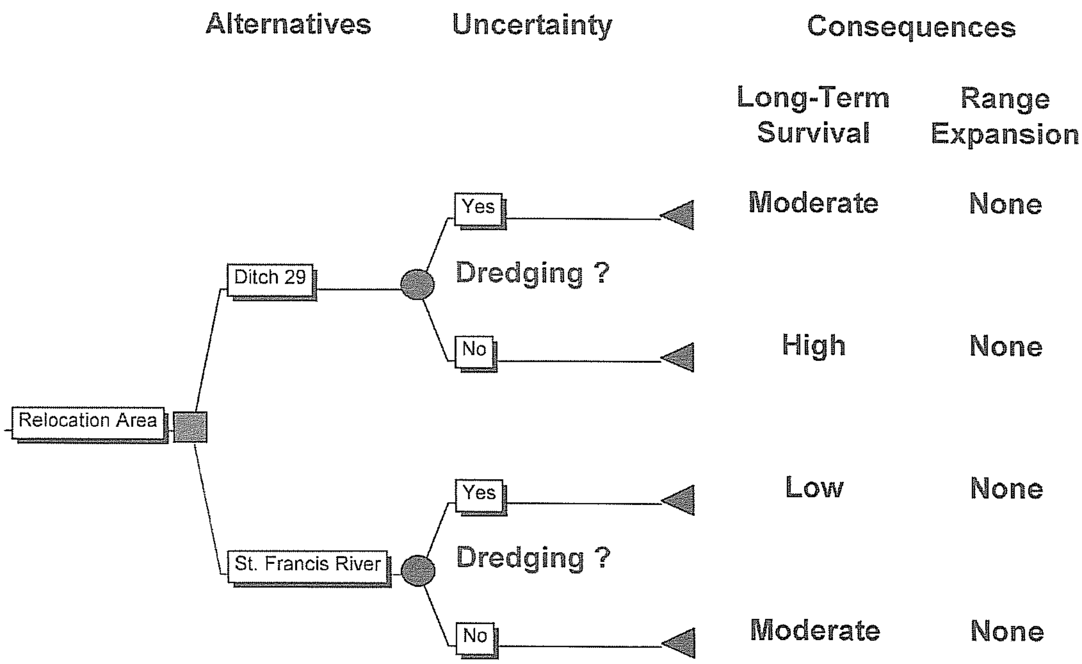

Figure 2. Decision tree illustrating alternatives and consequences of two translocation options.

A second consequence of site selection, range expansion, would not be accomplished (none) at Ditch 29 or in the St. Francis River because *P. capax* naturally occurs there, although in low numbers. Actually, because the river is isolated from the remainder of the drainage, this alternative has no effect on overall range. Jenkinson and Ahlstedt (1993) indicated that fish host for *P. capax* do not regularly go through the siphons. It is likely that the USFWS was unaware of this problem.

Measuring and Marking Mussels

Although not essential, most mussel translocations have a secondary goal of obtaining growth and survival data. This could have value for future projects, although in practice results can be confounded by predation, natural emigration, unexplainable mortality, and difficulty in finding translocated organisms (Cope and Waller, 1995). It might seem logical to mark and measure all mussels because they had to be collected and transported anyway; however, potential logistical problems associated with holding and processing 2,000 organisms that each can weigh 300–350 grams are not trivial, especially when they are endangered, must be kept moist, and have to be carried through deep mud. Likewise, there was no reason to process the entire collection; a subset of 100–200 should represent all size classes and be sufficient to estimate mortality. Finally, a sample obtained by hand-searching mud overlain by turbid water is biased toward large organisms, and length frequency histograms would underestimate recent recruitment. Unbiased samples for demographic analysis are best obtained by collecting and sieving sediments, which was done previously by Harris (2001).

Using a decision tree, we judged the first three consequences of the chosen treatment scenario to vary from moderate (measure all) to low (measure a subset) to none (do not measure) (Figure 3). We judged the value of measuring all or a subset as moderate, because sufficient mussels could be easily collected to obtain these data as part of another study. Regardless, it is unclear how resulting demographic or survival data would substantially contribute to the long-term success of this species. Figure 3 applies to *P. capax* and probably to most endangered species. The question for managers is simple: Do the increased chances of mortality justify the need to collect such data?

Should *P. capax* Be Endangered?

Bates and Dennis (1983) conducted a survey in the St. Francis drainage and reported that this species was rare and likely would soon become extinct. In a later, more thorough study in the same area, however, Clarke (1985) found many hundreds of *P. capax* and concluded that the

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