

Survey Procedures and Decision Criteria for Estimating the Likelihood that *Lampsilis higginsii* Is Present in Areas Within the Upper Mississippi River System

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Abstract. Surveys for unionids are often conducted in areas where dredging or construction is proposed. Surveys must be designed to effectively sample mussels and to determine whether endangered species are present. Criteria are proposed for estimating the likelihood that the federally endangered species *Lampsilis higginsii* is present within surveyed areas. The criteria are based on habitat and faunal associations of this species. Size of the survey area, water depth, substrate type, bottom configuration, and current velocity affect selection of survey procedures. Survey procedures are proposed for the variety of site conditions encountered in the Upper Mississippi River System.

Introduction

Mussel surveys are often conducted to assess potential impacts where construction or dredging actions are proposed, in order to avoid or minimize impacts to the mussel community. Preliminary mussel surveys are inherently different from mussel distribution surveys, stock assessments, or mussel surveys for other research purposes. Preliminary mussel surveys are conducted to provide information for early project planning, rather than to test specific hypotheses. Decisions concerning the choice of alternative sites, methods for limiting the extent of disturbance, and the need to transplant mussels to undisturbed areas are based on information from this type of survey. Preliminary surveys can also be used as initial field surveys for more detailed investigations for impact assessment or research purposes. The purpose of this paper is to describe decision criteria for estimating the likelihood that *Lampsilis higginsii* is present and procedures for preliminary mussel surveys.

Preliminary mussel surveys in the Upper Mississippi River System (UMRS) are performed to (1) determine whether mussels are present, (2) estimate their density and species composition, (3) determine the spatial distribution of mussels in the survey area, and (4) estimate the likelihood of occurrence of endangered species, such as *L. higginsii*. Criteria for estimating the presence of *L. higginsii* should be based on habitat conditions and estimates of mussel density, species richness, and species composition.

There are no standard procedures or decision criteria for preliminary mussel surveys in the UMRS. The U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, and the UMRS states all conduct preliminary mussel surveys. In many cases, permit applicants are required to perform their own preliminary mussel surveys. Lack of standard procedures and decision criteria is especially troublesome for individuals without training in the environmental sciences. Most preliminary surveys on the UMRS are custom-designed, depending on site conditions, equipment, and time available. Without standard survey procedures and decision criteria for estimating the presence of *L. higginsii*, the results of preliminary mussel surveys can be subject to different interpretations.

Application of the decision criteria proposed below requires that mussel surveys be conducted to obtain specific data with reasonable certainty. Because preliminary surveys are usually constrained by time and cost, survey procedures must be efficient and adapted to site conditions.

Historically, mussel surveys in the UMRS have been performed using a variety of sampling methods. Until recently, crowfoot brails were the gear of choice in water deeper than could be sampled by hand (snorkel diving, wading, "pollywogging") (e.g., Fuller 1978, Clymer and Eberly 1980). The numerous biases of the brail make it useful mainly as an exploratory device. Rakes and pitchforks have

been used in shallow water for qualitative surveys (e.g., Mathiak 1979). The Danglade dredge, a large rake with a long handle (Starrett 1971), was used for a number of surveys on the UMRS, but with limited success due to depth restrictions and the difficulty of deploying the gear.

Since 1981, scuba divers have been increasingly used for mussel surveys in the UMRS, in both qualitative searches and quantitative sampling using quadrats (Miller and Payne 1988). Quadrat sampling with complete substrate removal by divers can provide statistically valid quantitative estimates of density, population structure and species composition. Surveys with divers are expensive, and can cost \$1,000 to \$5,000 per day. In addition, quantitative sampling with divers is comparatively slow. A competent, four-person dive crew can be expected to obtain at least 30 0.25-m quadrat samples in one day. Divers cannot practicably survey large areas in deep, turbid, and fast-flowing rivers for safety reasons, and must remain within about 50 m of the diving boat. Stratified-random quantitative mussel surveys of larger areas by divers are possible, but expensive and time-consuming.

A skimmer dredge (Miller et al. 1989) has been used since 1988 for preliminary mussel surveys in the upstream 10 pools of the UMRS. The skimmer dredge has proved to be a time- and cost-effective tool for large-scale mussel surveys, providing good estimates of mussel density and species composition. The skimmer dredge provides an alternative to diving if funds are limited.

Proposed Decision Criteria for Estimating the Likelihood of Occurrence of *L. higginsi*

A preliminary survey should provide evidence of the presence of an endangered species, or an estimate of the likelihood of finding that organism in the survey area. Complete certainty about the presence of an endangered species would require total removal of all substrate within the survey area, an obviously impracticable and inappropriate action. To conserve time and funds, as well as protect the resource from unnecessary disturbance, the extent of the survey should be guided by carefully considered decision criteria. The decision criteria proposed are intended as guidance for making estimates of the presence of *L. higginsi* in a survey area.

A determination of the likelihood of finding *L. higginsi* in a survey area could be based solely on exclusionary information. Exclusionary evidence includes habitat attributes such as current velocity or substrate conditions that could be unsuitable for the species. Conversely, the habitat conditions could

appear suitable, but certain biotic attributes (mussel density, species richness, and species diversity) may be so low that it is unlikely that uncommon organisms such as *L. higginsi* will be found.

The estimate that it is reasonably certain that *L. higginsi* does not occur in the survey area can be reached using the exclusionary decision criteria and supporting rationale described below. Similar decision criteria could be developed for other endangered species, based on their faunal and habitat associations.

Habitat Conditions

- Substrate

If the substrate in the survey area is entirely firmly packed clay, flocculent silt, organic material, bedrock, concrete, or unstable, moving sand, *L. higginsi* probably does not occur there. *Lampsilis higginsi* has not been found to occur in these substrate types.

- Current velocity

If current velocity exceeds 1 m/s throughout the survey area during periods of low discharge, *L. higginsi* probably does not occur there. *Lampsilis higginsi* has not been found in locations with a fast current.

Biotic Criteria

Data from preliminary surveys should provide quantitative information on the general condition of the mussel community in the study area and the likelihood of finding uncommon or endangered species. This information about the mussel community and likely presence of *L. higginsi* provides a basis for selecting alternatives. In addition to exclusionary criteria based on physical habitat characteristics, estimates of the likelihood of finding *L. higginsi* in a survey area should be based upon the following biotic criteria.

- Relative abundance of *L. higginsi*

In suitable habitat, such as in the East Channel at Prairie du Chien, Wisconsin, *L. higginsi* represents approximately 0.5% of the total unionid assemblage by numbers of individuals. If 2,000 individual mussels are sampled, and no live or fresh dead *L. higginsi* are found, then this species probably does not occur within the site. Collecting 2,000 individuals from locations distributed throughout the survey area without finding one *L. higginsi* indicates a percent composition less than 0.05%. A percent species composition difference of 10-fold less than what has been found in good habitat for this species indicates that the site probably does not support *L. higginsi*. If *L. higginsi* are present in very low numbers, they may not be able to successfully reproduce.

- Density

If mussel density throughout the survey area is estimated to be less than 10/m², then *Lampsilis higginsii* probably does not occur there. *Lampsilis higginsii* tends to be found in areas with higher density, ranging from 10/m² to over 150/m². Also, if rare species are estimated to occur at densities less than 0.01 individual/m² (corresponding to a regular spatial distribution of individuals spaced 10 m apart), then they are probably not part of a reproducing population.

- Species richness

If the total number of unionid species is 15 or less, then *L. higginsii* probably does not occur in the survey area. *Lampsilis higginsii* is known to occur in areas with high species richness, where the cumulative total of species vs. cumulative number of individuals sampled rises rapidly to more than 15 species after sampling 250 individuals. If, after collecting 500 individuals, less than 15 species are found, it is reasonable to assume that *L. higginsii* will not be found.

Recommended Procedures for Conducting Preliminary Mussel Surveys

A set of procedures for efficient and effective preliminary mussel surveys is described below.

Compile Existing Information on Mussels in the Area

Prior to fieldwork, obtain the results of any previously conducted mussel surveys in the area, as well as any information available about habitat conditions, such as river geometry and substrate type.

Site Delineation

Using plans of the proposed dredging or construction, delineate the entire area of proposed disturbance, plus an area the same width as the proposed disturbance area, extending up to 500 m downriver (depending on the nature of the proposed disturbance). The boundaries of the site should be marked with high-visibility buoys. The dimensions of the site should be checked with an optical rangefinder or an electronic distance measuring instrument. It is important to ensure that the entire area proposed for disturbance is surveyed.

Bathymetric Survey

If recent bathymetric maps are not available, a limited bathymetric survey of the site should be performed. If a recording fathometer is not available, numerals from a digital display instrument can be recorded manually and placed on a hand-drawn field map. Distance to shore should be estimated

with an optical rangefinder or measured with an electronic distance measuring instrument. Water surface elevation should be estimated from daily river discharge and the backwater curve in impounded river reaches, or the stage:discharge profile for open river reaches. The goal is to characterize river bed geometry and water depth to aid in data collection and interpretation.

Current Velocity Measurements

Current velocity near the substrate-water interface should be measured and recorded. Refer to the previously conducted bathymetric survey to assist with choice of sampling sites. A Price™ meter or an electromagnetic current velocity meter can be used. A field map record of the current velocity distribution within the survey area should be prepared.

Substrate Survey

If a substrate map of the survey area is not available, a limited substrate survey should be performed. The investigator should attempt to collect samples that reflect the range of substrate conditions within the survey area. Collect samples in areas that differ with respect to water depth, distance to shore, and current velocity. A Ponar dredge works well in deeper areas, and a simple scoop on the end of a pole is effective in shallow areas. Visually inspect and classify the sediment according to estimated particle size gradation (percent by weight) into categories: rock, gravel, coarse sand, medium sand, sand/silt, silt/clay, and clay. Note the presence of shell or organic material. Prepare a field map that includes substrate type distribution. If the area is entirely rock, silt/clay, or clay substrate, further mussel survey work is not necessary (see first decision criteria).

Skimmer Dredge

Where water depth exceeds 1 m, and where substrate conditions allow, use of a skimmer dredge (Miller et al. 1989) is recommended. A skimmer dredge can sample a much greater area in less time for much less cost than can divers. Dredge tow paths should be randomly located within the survey area. If previously conducted habitat characterization surveys revealed substantially different conditions of depth, substrate, and current velocity, then the different habitat patches should be sampled separately. The skimmer dredge should be towed no more than 200 m at a time to avoid overfilling the collecting bag. Tow the dredge in a downriver direction, to make use of current in pulling the dredge. Using measured runs and buoys, estimate the length of each tow and area sampled. Make repeated tows of the dredge until at least 100 m² of

bottom has been sampled within each habitat type. Abandon the sample and start a new run if the dredge becomes snagged. Record tow locations on a field map.

Wading

If the site includes shallow areas less than 1 m deep, and if substrate conditions allow, these parts of the site should be searched by wading. A modified garden rake (the hoop connecting the tine bar to the handle should be enlarged) fitted with a mesh collecting bag can be used without resorting to snorkeling or "pollywogging." An attempt should be made to randomly search shallow areas of the site with different habitat conditions. Sample with the rake until at least 100 m² of the area is covered. The total search area should be estimated and each location recorded on a field map.

Scuba Diver Search

If a skimmer dredge cannot be used, a systematic search covering a premeasured area can be performed by divers. A measured cable should be placed parallel with the current using end anchors and buoys for marking and retrieval. Divers can search a 1.5-m-wide strip by collecting all mussels detected by feel while following the cable. Collecting bags can be attached to the cable at intervals for the divers. The cable can be placed randomly in areas with different habitat characteristics. At least 100 m² of each area should be searched. Record search locations on a field map.

Sample Processing

All live and fresh dead mussels collected should be identified and enumerated. If time permits, measure total length of individuals using calipers, so that length-frequency distributions for the more common species can be prepared. Estimate the average mussel density in each skimmer dredge tow path, rake, or diver search area. Maintain a running average of estimated density by skimmer dredge tow path, rake, or diver search area, and cumulative totals of the number of individuals and species sampled. Continue sampling until decision criteria are met or rejected.

Reporting

A report of each preliminary mussel survey should be prepared, describing the proposed dredging, construction, or research activity, boundaries of the survey area, physical habitat conditions, sampling methods, results, and conclusions. Reports of mussel surveys conducted on the UMRS should be distributed to the U.S. Fish and Wildlife Service Region III

Endangered Species Office, the U.S. Fish and Wildlife Service Environmental Management Technical Center, and the state natural resource management agencies.

Conclusion

Preliminary mussel surveys have to be conducted in the UMRS as part of early project planning to determine whether endangered species are present. Currently, many organizations are conducting these surveys, and there is little similarity among field procedures. In addition, agencies conducting this work do not have a standard set of decision-making criteria to determine whether an endangered species is present or whether valuable resources are likely to be affected by proposed development. If mussels are to be protected in the UMRS, planners and engineers must base their decisions on results of standardized surveys and a uniform set of decision criteria.

A standard set of decision criteria, and field procedures for conducting these surveys, are proposed for determining the presence of *L. higginsi* in the UMRS. Adherence to these criteria by resource agency personnel would reduce the time and funds required for this work. In addition, data obtained by different organizations would be comparable if collected in a similar manner. It is recommended that those conducting endangered species surveys in the UMRS document their findings and file them at a central location. This would enable development of a standardized data set on endangered species for resource managers and researchers.

Literature Cited

- Clymer, G., and L. Eberly 1980. Results of a mussel survey conducted near Northern States Power Company Prairie Island Nuclear Generating Plant. Miscellaneous paper. Minnesota Department of Natural Resources, Ecological Services Section, St. Paul. 17 pp.
- Fuller, S.L.H. 1978. Fresh-water mussels (Mollusca: Bivalvia: Unionidae) in the Upper Mississippi River: observations at selected sites within the 9-Foot Channel Navigation Project on behalf of the United States Army Corps of Engineers. Volume 1. Academy of Natural Sciences of Philadelphia. 400 pp.
- Mathiak, H.A. 1979. A river survey of the unionid mussels of Wisconsin, 1973–1977. Sand Shell Press, Horicon, Wisconsin. 75 pp.
- Miller, A.C., and B.S. Payne 1988. The need for quantitative sampling to characterize size, demography, and density of freshwater mussel communities. *American Malacological Bulletin* 6(1):49–54.

- Miller, A.C., R. Whiting, and D.B. Wilcox 1989. An evaluation of a skimmer dredge for collecting freshwater mussels. *Journal of Freshwater Ecology* 5(2):151-154.
- Starrett, W.C. 1971. A survey of the mussels (Unionacea) of the Illinois River: a polluted stream. *Illinois Natural History Survey Bulletin* 30(5):267-403.