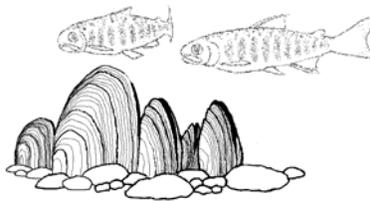


Freshwater Mussel Relocation Guidelines

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*A product of the
Pacific Northwest Native Freshwater Mussel Workgroup*



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Mussel relocation projects are undertaken for a variety of reasons. Many projects are intended to move mussels from the zone of impact of a construction project. Others are designed to create refuge populations for species threatened with extinction. In still other cases, relocation efforts have been used to try to establish new or re-establish extirpated populations. Each of these efforts has very different goals and levels of urgency. Therefore, while the Pacific Northwest Freshwater Mussel Workgroup (Workgroup) recommends all projects complete some level of analysis prior to project implementation; certain projects such as efforts to establish new populations and supplementing existing populations should undergo more rigorous evaluation than emergency relocation projects that are undertaken to move mussels from the zone of impact of an impending construction project.

Relocation efforts in the eastern United States have not been overwhelmingly successful (Copes and Waller 1995); and success is dependent on a variety of factors including the availability of suitable habitat, population density at the relocation site, and handling during relocation (Hamilton et al. 1997, Bolden and Brown 2002). In addition, there is a paucity of basic life history and distribution data for mussels of the Pacific Northwest. For these reasons, the goals and potential consequences of each relocation effort need to be carefully considered. The Workgroup would not recommend relocation in all circumstances. To help with the decision making process, the Workgroup has developed the following guidelines for future relocation efforts. In all cases, minimizing the amount of disturbance to and movement of mussels is the best alternative.

The Workgroup conducted a literature search on mussel relocation efforts as well as relocation guidelines for other aquatic species. That information as well as the collective experience of group members was used to develop the following guidelines to consider when proposing a relocation project. As with all projects, the specifics will vary. These guidelines do not replace the need for project specific comments from regional mussel experts. A list of experts with contact information has been attached for your convenience. These individuals should be contacted to discuss the specifics of your project and any recommendations beyond those described in this document.

General guidelines to consider while planning a mussel relocation project

1. Initial evaluation of the mussels targeted for relocation
 - A. Conduct surveys to identify the species, estimate the abundance, sex ratio (if possible), and age of the mussels present and evaluate the extent of the mussel distribution.
 - B. If location will be affected by a construction project, acquire plans for the project including footprint, schedule (one time, multiple activities, multi-year), and the extent of instream and riparian activities.
 - C. If listed fish or salmonids are at the construction site, there are likely prescriptions in place to salvage those fish and to reduce the impact of the project on the localized habitat. Consider if the project is small enough that the stress of moving the mussels could result in higher mortality than the stress of staying in place during construction.

2. Selecting the site for relocation

- A. Potential sites should be extensively evaluated for the presence of mussels and fish hosts (if known), habitat quality, and threat assessment. Mussel surveys should be conducted during warmer months when mussels will be closer to the substrate surface and can be located more easily (USFWS and VDGIF 2008).
- B. Where possible, mussels should be relocated to nearby sites that already contain mussels of the same species and sufficient, unoccupied habitat.
- C. If mussels do not currently inhabit any nearby areas, sites with suitable habitat should be identified that fall within the current or historic range of the species whenever possible. Only in cases where extant historic habitat is severely threatened or degraded beyond restoration should introduction outside of historic range be considered.
- D. Assess the sites to ensure that the life history requirements of the species can be fulfilled. This includes food and habitat for all life stages. The presence of appropriate fish hosts must be determined. In some cases, this information may not be readily available. A survey to determine fish species present should be conducted or local biologists consulted.
- E. Habitat variables should be measured, and water quality analyzed. This includes substrate, water temperature, pH, dissolved oxygen, and calcium concentrations. Flow characteristics and water quality of the site should be assessed across high and low flow situations to ensure that mussels will not be stranded or significantly stressed during low water periods. Gradient of the site should also be evaluated. Ideal water quality and habitat characteristics may not be known for every species and life stage. A regional expert should be contacted for more information or advice.
- F. As stated above and as is possible, the relocation site should be free of imminent or future threats. Limiting the number of times mussels are handled is important.
- G. Consider the possibility and desire for dispersal or expansion outside the reintroduction site. This is particularly important for introductions outside the historic range or habitat of the species, or cases where dispersal is a desired outcome.
- H. Select relocation sites that contain sufficient habitat to support a viable population. Habitat that supports many individuals may be required to avoid genetic issues of inbreeding and drift. The techniques or knowledge to determine these exact numbers may not be available currently. However, these issues should be considered to increase certainty of a successful relocation.
- I. For a variety of reasons, where possible, relocation sites should be within the watershed in which the source population occurred.
- J. Do not relocate mussels to sites where rare or endemic taxa could be adversely affected. This is especially important when introducing into areas outside the species' historic range. Preliminary surveys should be conducted with the consultation of experts in other branches of aquatic biology if necessary.
- K. Presence of and accessibility of the site to predators (e.g. raccoons, muskrats, etc.) should be considered. Be sure to consider seasonal fluctuations in flow in the evaluation of access.

- L. If this is a reintroduction effort, the reason for the current lack of mussels should be determined and corrected before mussels are introduced.
3. Biological considerations when conducting an introduction (range expansion, reintroduction to historic habitat) or translocation
- A. Carefully select the source population for reintroductions. Knowledge of the life history and genetics of the potential source population will greatly inform the selection process. A variety of factors may be considered in the choice of source population including genetic characteristics, rarity or status, geographic proximity to the introduction site, and ecological similarity.
 - B. Identify the taxonomic status of the mussels to be introduced. Representative specimens of the introduction stock should be examined by an expert prior to transport. If the taxonomy is questionable but the introduction proceeds, a subsample of the mussels should be preserved for future analysis.
 - C. Examine the source population for presence of pathogens, parasites, and invasive species. Representative samples of the source population should be examined by a pathologist prior to transport. Quarantine is recommended for organisms held in culture facilities prior to relocation. The transfer of wild mussels within a drainage basin presents a lower risk of disease or parasite introduction.
 - D. Select a source population of sufficient number and genetic character. The number of individuals selected for introduction should be adequate to represent the genetic variation and composition in the entire source population. The sex ratio and age classes of the introduced organisms should mimic those of the source population.
4. Specific considerations for the transport and relocation activity.
- A. Carefully and quickly transport mussels. Transported mussels can be stressed by physical handling. Handling errors, such as roughly removing animals from the substrate, leaving animals out of water or in warm or stagnant water, and not replacing animals in a natural position in the substrate, are minimized by using personnel familiar with mussel biology. Keep mussels cool and moist minimizing the amount of time spent out of the water.
 - B. Mussels should not be held for long periods in aquaria or holding ponds without food as starvation may result.
 - C. If mussels are being relocated due to instream construction activities, the impact area should be surveyed at least twice (USFWS and VDGIF 2008). Each survey should be separated by at least 7 days and should consist of at least two passes. If during the second pass of the survey, the number of mussels collected is greater than 20% of the number collected during the first pass, additional passes should be conducted until the number of individuals collected is less than 20% of the initial number.
 - D. Avoid extreme air and water temperatures.
 - E. Mussels can be effectively transported in coolers. The mussels should be covered with towels or burlap wetted with stream water and free from detergents or chlorine. The towels should then be covered in a layer of non-chlorinated ice cubes. Avoid overcrowding mussels and be sure to segregate smaller mussels to

- avoid shell damage during transport. Large numbers of mussels can also be transported using a fish transportation truck with clean, recirculating water.
- F. Avoid moving mussels during spawning and when glochidia are released. This timing is species and location specific. Consult a regional expert to discuss the information known about the species involved.
 - G. Consider marking the relocated individuals to facilitate monitoring the success of introduction or relocation efforts.
 - H. Most practitioners recommend placing the mussels partially into the substrate, anterior end down, mimicking the position in which they were originally found (USFWS and VDGIF 2008, Frest and Johannes, pers. comm). However, some evidence suggests that mussels can be safely placed directly on the substrate surface, and they will position themselves appropriately. If mussels are partially buried, this should be done carefully to avoid damaging internal tissues.
 - I. Document the relocation. The procedures and location of introductions should be made available in the scientific literature. The following should be reported: names of those conducting the introduction, species (taxa) and numbers involved, source of the introduction sample, the sex and approximate age (if possible), size distribution, date of introduction, and exact location of the receiving habitat.
5. Post-Relocation Activities
- A. Conduct systematic monitoring of introduced populations. Regular surveys should be conducted to determine initial survival, recruitment, and persistence through the range of environmental conditions at the site. During the first year, more frequent monitoring may be needed. If the population becomes established, annual monitoring should be continued for many years to determine long-term survivorship and recruitment.
 - B. To determine if reproduction is occurring, consider surveys of the resident or migratory fish populations to determine presence of glochidia on gills and fins.
 - C. In some reintroduction efforts, subsequent relocations may be necessary to facilitate establishment or increase gene flow. Genetic studies should be conducted to identify any problems.
 - D. In cases of failure the causes should be identified and eliminated before restocking. As many mortalities as possible should be collected and tested.
 - E. Document findings and conclusions reached during the post-introduction process in the scientific literature.

Permits to handle fish and wildlife (including mussels):

Note that any projects in which mussels are handled may require approval from state and/or federal fish and wildlife agencies. Information on scientific take/collection permits from each of the Pacific Northwest states can be found at the following web sites:

Idaho: <http://fishandgame.idaho.gov/cms/licenses/apps/>

Oregon: http://www.dfw.state.or.us/fish/license_permits_apps/index.asp

Washington: <http://wdfw.wa.gov/scp/>

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