

Management Options for Quagga & Zebra Mussel Infestations

Concurrent with Prevention & Public Outreach/Education Actions

Most water bodies in the western United States are now at risk of infestation by invasive quagga and zebra mussels. While the actions taken to prevent or respond to infestation must be tailored to each specific location, the following activities represent options for consideration as part of any readiness planning as well as options for dealing with mussels following detection. Information on preventing the spread of invasive mussels can be found at the 100th Meridian Initiative website <http://100thmeridian.org/>.

Actions to consider prior to detection of mussels:

- 1. Develop Coordinated Response Plan(s)** - This plan would detail policies, command and authority structure, strategies, communications, roles and responsibilities, and response actions to be implemented – Involves multiple federal, state, and local agencies and stakeholders. An example Response Plan for the Columbia River Basin may be found at the 100th Meridian website <http://www.100thmeridian.org/ColumbiaRT.asp>. The National Parks Service also has information and guidelines for prevention and response planning that can be found at <http://www.nature.nps.gov/biology/Quagga/index.cfm>.
- 2. Perform Infestation Risk Assessment(s)** – This activity may be completed as standalone or as part of the Coordinated Response Plan. The purpose is to identify which water bodies are most at-risk of infestation within the geographic region of interest or management jurisdiction. The likelihood of infestation is typically based upon recreational usage, nearest known infestation, and the extent to which environmental conditions (including calcium, pH, dissolved oxygen, temperature, etc...) are likely to support mussel establishment. This information can be used to prioritize facility vulnerability assessments (below). A variety of examples for risk assessments are available on the web. Information specific to environmental suitability based risk assessments is available at the U.S. Army Corps of Engineers Zebra Mussel Information System (ZMIS) website <http://el.erdc.usace.army.mil/zebra/zmis/zmishelp.htm>.
- 3. Perform Facility Vulnerability Assessment(s)** – This activity may be completed as standalone or following the infestation risk assessment(s) and consists of a detailed inventory of critical water related infrastructure at a water body and how each component is likely to be affected by mussels should infestation occur. The results can be used to prioritize facility protection needs and actions. A facility vulnerability assessment template can be found at www.usbr.gov/mussels/.
- 4. Implement Monitoring Program(s)** – Monitoring programs should be considered for high priority water bodies where infestation is either most likely or would cause significant harm to water systems or other key resources. Monitoring programs, designed to provide early detection of mussel larvae (through water sampling and lab analysis), potentially provide 2-5 years of lead time for planning and implementing protective actions before the infestation impairs operations via adult settlement on hydraulic structures or within critical systems. Additional information on monitoring can be found at the U.S. Army Corps of Engineers Zebra Mussel Information System (ZMIS) website <http://el.erdc.usace.army.mil/zebra/zmis/zmishelp.htm>.

Actions to consider following detection of mussels in a water body:

1. **Execute Coordinated Response Plan** – Involves notification, information exchange, and implementation of containment and control actions (i.e., components of the response plan).
2. **Increase Monitoring** – Transition from monitoring for detection to monitoring with increased frequency to confirm detection, identify or locate the presence of adults, and track infestation levels. This activity may also include regular facilities inspections to determine when facilities are being impacted by adult colonization. This information can guide facilities protection actions and assists in anticipating ecological impacts for future mitigation planning.
3. **Identify and Implement Appropriate Facilities Protection Measures** – Identify which actions or technologies are best suited for maintaining water operations and reducing O&M costs or other expenses. Various conventional technologies have been used with reasonable success. The table below provides some conventional as well as experimental options, each of which has advantages and disadvantages. It should be noted that there are a number of commercial treatment products that have not been listed, but may be applicable in various situations.

Table 1 – Control and facilities protection options for various applications

Technology	Example Applications
<p>Filtration to prevent mussel entry to piped systems – self-cleaning 40-80 micron filters may be adequate depending on exclusion requirements. Exclusion avoids the need for treating infested systems. †</p>	<p>Low volume systems - Facilities service water, unit or transformer cooling water, HVAC, pumped systems, and delivery pipelines</p>
<p>Ultraviolet (UV) Treatment of water in piped systems – In-line UV systems are being evaluated to prevent mussel settlement. UV has additional water treatment benefits and is not expected to require discharge permitting †</p>	<p>Low volume systems - Facilities service water, unit or transformer cooling water, HVAC, pumped systems, and delivery pipelines</p>
<p>Chemical Treatments – Injection or delivery of chemicals (oxidizing and nonoxidizing) to kill mussels or impair ability to attach to surfaces</p> <ul style="list-style-type: none"> • Bromine • Chlorine • Chlorine dioxide • Hydrogen peroxide • Ozone • Potassium salts • Potassium permanganate • Sodium Hypochlorite • Salinity 	<p>Low and medium volume systems - Facilities service water, unit or transformer cooling water, HVAC, pumped systems, and delivery pipelines. Permitting often required for chemical treatment methods</p>

<p>Alternative Treatments – Alternatives to kill mussels or impair ability to attach</p> <ul style="list-style-type: none"> • Thermal • Biological † • Desiccation 	<p>Low and medium volume systems – Facilities service water, unit or transformer cooling water, HVAC, pumped systems and delivery pipelines. Desiccation requires capability to dewater system for extended durations</p>
<p>Coatings to protect exposed surfaces – Prevents mussel attachment or facilitates cleaning (anti-fouling & foul-release) †</p>	<p>Hydraulic Structures & Equipment - Gates, valves, penstocks, intake structures, trashracks, fish screens</p>
<p>Alternative Materials – To prevent mussel attachment or facilitate cleaning</p> <ul style="list-style-type: none"> • Copper • Galvanizing 	<p>Intake grating, piping/tubing, heat exchangers, HVAC systems</p>
<p>Mechanical Removal – For routine maintenance</p> <ul style="list-style-type: none"> • Mechanical raking/scraping • Hydrojetting/water spraying • Pipeline pigging • Traveling intake screens (self-cleaning) 	<p>All structures, systems, equipment, and instrumentation where access is possible – Diversion structures, pipelines, trashracks, intakes, fish screens. For instrumentation, noncontact methods should be considered where possible</p>
<p>Redundant Systems – Multiple intakes or duplicate systems for switching during treatment or cleaning to provide uninterrupted service</p>	<p>All systems for which retrofit is possible/practical</p>

† - Experimental - Under development or being field tested/demonstrated

Technologies selection for each application depends on a number of considerations including periodic or continuous mussel exclusion requirements, operations and maintenance requirements, permitting requirements, environmental impacts, and cost; to name a few. If conventional technologies are not applicable then alternatives should be developed and demonstrated as early as possible to meet unique facilities requirements. Operational strategies may also be available to reduce or eliminate mussel impacts. However, such strategies are often limited depending on the type of system and available flexibility. Additional information on control strategies and facilities protection methods may be found in The Practical Manual for Zebra Mussel Monitoring and Control, R. Claudi & G.L. Mackie, CRC Press, Inc. (2000) and at the U.S. Army Corps of Engineers Zebra Mussel Information System (ZMIS) website <http://el.erdc.usace.army.mil/zebra/zmis/zmishelp.htm>

4. **Identify Ecological Impacts** – Involves developing and initiating actions to measure and track ecological changes, develop mitigation plans, and implement long-term mitigation actions (considers endangered species, food webs, aquatic weeds, water quality, etc...)