U.S. Department of the Interior
Bureau of Reclamation

Quagga and Zebra Mussel Management Options

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. The following activities represent options for consideration as part of any readiness planning as well as options for dealing with mussels following detection. Actions taken to prevent or respond to infestation must be tailored to each specific location.

Prior to the detection of mussels:

1. **Develop a Coordinated Response Plan** - This plan would detail policies, command and authority structure, strategies, communications, roles and responsibilities, and response actions to be implemented. A response plan typically involves multiple federal, state, and local agencies and stakeholders. For more information on response planning- see the Federal Emergency Management Agency website: https://www.fema.gov/emergency-managers/national-preparedness/frameworks/response. An example Response Plan for the Columbia River Basin may be found at https://www.westernais.org/rapid-response.
2. **Perform Risk of Infestation Assessments –** The purpose of this activity 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 and additional management strategies. There is currently no one standard for risk assessments, information regarding risk assessments in general can be found at https://www.epa.gov/risk/about-risk-assessment
3. **Perform Facility Vulnerability Assessments –** This activity 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 a Monitoring Program** –Monitoring programs are designed to provide early detection of mussel larvae through water sampling and lab analysis and 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. 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. Additional information on monitoring can be found at https://www.usbr.gov/mussels/detection/index.html and https://www.westernais.org/monitoring

Following the 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 and monitoring within the facility 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 technologies have been used with reasonable success. Table 1 below identifies several options, each of which has advantages and disadvantages. Treatment selection for each application depends on several considerations including periodic or continuous mussel exclusion requirements, operations and maintenance requirements, permitting requirements, environmental impacts, and cost: to name a few. Operational strategies may also be available to reduce or eliminate mussel impacts however, these depend on the type of system and available operating flexibility. Additional information on control strategies and facilities protection methods may be found at https://www.usbr.gov/research/projects/detail.cfm?id=1876 and https://www.usbr.gov/research/projects/detail.cfm?id=1868
4. **Identify Ecological Impacts –** This activity involves developing and initiating actions to measure and track ecological changes, develop mitigation plans, and implement long-term mitigation actions that consider endangered species, food webs, aquatic weeds, water quality, etc. There is currently no one standard for identifying ecological impacts however, similar considerations are often covered in National Environmental Policy Act Environmental Impact Statements or Environmental Assessments.

Table 1 – Control and facilities protection options for various applications

Technology	Example Applications
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.	Low volume systems - Facilities service water, unit or transformer cooling water, HVAC, pumped systems, and delivery pipelines
Ultraviolet (UV) light treatment of water in piped systems – In-line UV systems have been proven to prevent mussel settlement. UV has additional water treatment benefits and is not expected to require discharge permitting.	Low volume systems using low turbidity water - Facilities service water, unit or transformer cooling water, HVAC, pumped systems, and delivery pipelines

Chemical treatments – Injection or delivery of chemicals (oxidizing and nonoxidizing) to kill mussels or impair ability to attach to surfaces. • Bromine • Chlorine • Chlorine dioxide • Hydrogen peroxide • Ozone • Potassium salts • Potassium permanganate • Sodium Hypochlorite • Salinity • Copper	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
Alternative treatments – Alternatives to kill mussels or impair ability to attach • Thermal • Biological † • Desiccation	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
Coatings to protect exposed surfaces – Prevents mussel attachment or facilitates cleaning (anti-fouling & foul-release) †	Hydraulic Structures & Equipment - Gates, valves, penstocks, intake structures, trashracks, fish screens
Alternative materials – To prevent mussel attachment or facilitate cleaning • Copper • Galvanizing	Intake grating, piping/tubing, heat exchangers, HVAC systems
Mechanical removal – For routine maintenance • Mechanical raking/scraping • Hydro jetting/water spraying • Pipeline pigging • Traveling intake screens (self-cleaning)	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
Redundant systems – Multiple intakes or duplicate systems for switching during treatment or cleaning to provide uninterrupted service	All systems for which retrofit is possible/practical

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