



Guidance for Developing an Invasive Mussel Control Plan

California Department of Fish and Wildlife

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Purpose

This document is intended to provide guidance to public and private agencies that operate a water supply system where invasive mussels have been detected on developing an invasive mussel control plan (Control Plan). Use of the Control Plan Template (Appendix A) is not required to comply with Fish and Game Code (FGC) and California Code of Regulations (CCR), rather, it is offered as a tool to assist water supply system agencies, and others, in developing a Control Plan for each unique water supply system that fulfills the content requirements under the law.

Control Plan Requirements

California laws and regulations pertaining to Control Plans are FGC [Section 2301](#) (FGC §2301) and CCR Title 14, Section [672](#) and [672.1](#) (14 CCR §672-672.1). [FGC §2303](#) and [14 CCR §671](#) define the species regulated under these sections as “invasive mussels.” Note, 14 CCR §672-672.2 are currently being updated to reflect recent changes to FGC as a result of Assembly Bill 149. This document will be updated to reflect the final changes to the regulatory language.

As defined in state law, a Control Plan shall consist of a written document that describes the actions to be implemented to control invasive mussels that minimally includes:

1. Methods to delineate the infestation that addresses all species and all life stages of invasive mussels.
2. Methods to control or eradicate adult mussels and decontaminate water containing larval mussels.
3. Systematic monitoring to determine any changes in conditions.

California Department of Fish and Wildlife (CDFW) staff are available to assist throughout the development of a Control Plan. Please contact the [CDFW Invasive Mussel Regional Scientist](#) based on the [CDFW Region](#) where the water supply system is located. If the water supply system spans multiple CDFW regions contact invasive@wildlife.ca.gov for assistance.

Control Plan implementation is demonstrated by way of Annual Reports (January 1-December 31) submitted to the CDFW each year by March 31. These reports must summarize changes in invasive mussel populations, control activities implemented including planned and unplanned discharge events, and monitoring results.

General Considerations

Development and implementation of a Control Plan is intended to contain invasive mussels within the water supply systems and maintain operation of the water supply system. Completing a Control Plan for a complex water supply system may require an interdisciplinary team from within and outside the organization preparing the document to provide expertise on system operation, engineering solutions, regulatory compliance, etc. Control Plans can be inclusive of multiple agencies provided the facilities and roles of each agency are clearly described, and the Control Plan includes a statement of concurrence from each agency.

CDFW recognizes water supply system operators must develop a Control Plan while concurrently exploring what methods are adequate and appropriate to control or eradicate mussels within their unique system and environmental setting. Therefore, timely submission of a Control Plan may preclude precise details about the methods necessary to maintain operation of the water supply system; however, the Control Plan must include specific measures and actions to be implemented to prevent the overland spread of invasive mussels and eliminate or minimize their downstream spread resulting from anticipated and unanticipated water releases outside of the water supply system.

Many of the resources included in this document were developed to address quagga/zebra (dreissenid) mussels. Based on our current understanding, effective control and containment measures developed for quagga/zebra mussels are effective for golden mussel. Research is underway to better understand golden mussel biology and physiology in California, evaluate the efficacy of existing management tools on golden mussel, and to develop new management tools.

Control Plan Content

The following narrative describes the minimum content required within a Control Plan. Control Plans can include additional content and be structured and formatted as desired by the preparer. In an effort to assist water managers in preparing a Control Plan, a template is provided as an appendix (Appendix A) to this guidance. Use of the template is optional.

Introduction

The Control Plan's introduction provides the context for the Control Plan and should include descriptions of the following:

Regulatory Setting

Include a description of the public or private agency that operates the water supply system. Describe all additional agencies or entities that have roles in management of the water supply system or activities that take place within the water supply system, and a description of those roles and authorities. Describe any federal, state, or local licenses, permits, and agreements under which the water supply system operates (e.g., Federal Energy Regulatory Commission License, Lake and Streambed Alteration Agreement, etc.).

Note, CDFW approval of a Control Plan does not confer approval or authorization with respect to other federal, state, or local laws that pertain to activities described in the document.

Environmental Setting

Describe the water supply system, including all waterbodies and waterways associated with the system in sufficient detail for CDFW to understand the operation of the water supply system. Detail the areas within the system that will require control measures to prevent the movement of invasive mussels from the water supply system. Include a description of any additional information that relates to the potential for invasive mussels to impact the environment outside of the water supply system.

Details should include:

- Specific geographic location, including county(ies)
- Map(s) of the system depicting all points of water inflow and outflow (source of water, water contractors/customers, terminal destinations)
- Waterbodies, waterways, and canal systems within the water supply system (e.g. volume, area, depth, etc.)

- Public access points including recreation permitted and prohibited (launch ramps, shorelines, types of vessels, day use, slips/moored, fishing, bait, etc.)
- Management of recreation (staffing, gate, kiosk, hours/seasons of operation, landing zones, etc.) and data on public usage

System Facilities and Water Management Operations

Describe the water supply system infrastructure and operations with sufficient detail for CDFW to understand the components within the system that will require control measures to prevent the release of invasive mussels from the water supply system.

Details should include:

- Intended use of water (domestic, ground water recharge, irrigation, etc.)
- Infrastructure, facilities, and in-water equipment (permanent and temporary) exposed to untreated raw water likely to be colonized by mussels (pumping plants, hydropower facilities, canals, pipelines, aqueducts, groundwater recharge basins, headworks, dams, valves, floodgate, etc.)
- How the water is managed, including the need for dewatering of discreet sections of water supply system to allow for maintenance

Methods to Delineate the Infestation, Including Both Adult Mussels and Veligers

The Control Plan should describe the status of the invasive mussel population at the time the plan is developed. This information should include the initial date of detection, species of invasive mussel(s) detected, and the efforts taken thereafter to determine the extent of invasive mussels within the water supply system. This should include a description of the method(s) used to survey for mussels, the dates, locations, life stage(s), densities, and the method/process used to identify the species of mussel.

CDFW has developed invasive mussel monitoring protocols that can be used to delineate the infestation. Use of these protocols is not required. They may not meet all water managers' needs or conditions, but water managers can use the protocols to develop their own methods. Whatever monitoring method(s) selected are recommended to be used consistently over time so that results across time can be compared to track changes in mussel populations as is

required in the third Control Plan element, a systematic monitoring program described below.

- [CDFW Artificial Substrate Monitoring Protocol](#)
- [CDFW Surface Survey Protocol](#)
- [CDFW Plankton Tow Monitoring Protocol](#)
- [CDFW Biobox Monitoring Protocol](#)

Methods to Control or Eradicate Adult Mussels and Decontaminate Water Containing Larval Mussels

The first step in developing a Control Plan is to define the management goal(s). Per 14 CCR §672.1, "Control" is defined as activities intended to eradicate or prevent the movement of adult or larval mussels from a waterbody by any means. Eradication is the elimination of all mussels from the system. While eradication may be possible in rare circumstances, is typically not a realistic management goal for mussel-infested water supply systems. If eradication is the ultimate Control Plan goal, management for control of mussels must still be addressed in a Control Plan until eradication is confirmed and declared. This guidance focuses on the more likely management goal of control.

As part of the development process of a Control Plan, the agency should assess all points within the water supply system that mussels may impact the operational function of the system and all points in which invasive mussels must be contained within the system. The biology of invasive mussels should be considered when identifying containment points and control measures.

Invasive mussels have two life stages: microscopic, free-floating larva (veliger) and attached, shelled adult. Veligers are free-floating in the water column and move within hydrologically connected waters. They can survive in damp conditions and in small volumes of water for several days, temperature and humidity permitting, and can be moved overland to non-hydrologically connected waterbodies on or within conveyances, such as trailed watercraft and on equipment. Adult mussels attach to submerged surfaces with byssal threads, but can be found detached within infested areas. They tightly close their shells when removed from water which protects them from drying out. As a result, adult mussels can survive out of water for days, and up to weeks in cool, damp conditions.

Assess Containment Points

The Control Plan should identify the specific containment points and control measures that will be implemented to eliminate or minimize any potential downstream spread of mussels. Though other means exist, the three primary mechanisms by which invasive mussels can spread are 1) downstream in hydrologically connected waters, 2) as a result of intentional or unintentional raw water releases outside the water supply system; and 3) overland via human-mediated activities.

The first step to addressing containment is identifying these containment points. Containment actions must be defined for each containment point. Adequate measures to address containment should be informed by the biology of invasive mussels briefly summarized above. If control measures are included for which uncertainty exists whether they will be implemented, clearly state that their implementation is uncertain.

Downstream Spread

Water containing adult and larval invasive mussels can be treated to kill all or some of the invasive mussels present and reduce, and possibly eliminate, downstream biofouling impacts. The practicality of implementing such methods will depend on the ability of the system to incorporate new equipment or processes into the system, and the volume of water being moved. Examples of control measures include filtration (e.g., fine mesh, sand, etc.), ultraviolet light, lethal water temperature, and chemicals. Water managers should consider all feasible options and opportunities within their system and favor those with the lowest environmental impact.

This section should also identify any existing legal requirements or agreements that pertain to downstream releases. For example, a Federal Energy Regulatory Commission License and water deliveries to other agencies.

Discharge Events

Control measures should also be considered and implemented to eliminate or minimize the spread when water is discharged from the water supply system, typically for maintenance activities, into waters that are not otherwise hydrologically connected to the infested water supply system. Include a list of all potential discharge sites where discharged water may be released and control measures that will be implemented. Control measures could include, but are not limited to, percolation and desiccation, filters, chemical treatment, etc.

The Control Plan should include actions that will be taken should an accidental, unmanaged discharge of raw water be released into a waterway. The response should include immediate actions to mitigate the release and reporting the release to CDFW. Include a description of all planned and unplanned discharge events in the Annual Report.

This section should also identify any existing permits or agreements in place pertaining to planned discharges. For example, include that a discharge event is covered by a Lake and Streambed Alteration Agreement.

Overland Spread

A Control Plan should inventory all activities that occur within the infested water supply system and whether those activities are a potential pathway to move mussels and/or water containing mussels and veligers overland. After identifying the pathways, actions to contain the mussels should be developed and instituted. This section should identify the specific containment measures that will be implemented.

Table 1 summarizes some common pathways for invasive mussels to be moved overland from an infested waterbody, and potential management actions that could be taken to prevent it from occurring. This table is a starting point, and not exhaustive of all potential pathways. Each water manager must consider their own unique system and address each pathway as adequately as possible.

Table 1. Common Pathways and Potential Containment Actions

Containment Need	Potential Management Actions to Contain Invasive Mussel within the Water Supply System
<p>Watercraft – Single Day Use</p> <ul style="list-style-type: none"> Motorized Non-motorized Law enforcement Agency Rentals 	<p>Require all exiting watercraft to clean, drain, and dry; require boat plugs to be pulled on exit; inspect and/or decontamination watercraft prior to leaving; offer banding for returning boats to expedite launching and facilitate local users; limit boating season to highest use times; restrict public access.</p>

<p>Watercraft – Multiple Day Use, Slipped, and Moored</p> <ul style="list-style-type: none"> Motorized Non-motorized Law enforcement Agency Rentals 	<p>Prohibit; inspect and decontaminate upon exit</p>
<p>Fishing</p> <ul style="list-style-type: none"> Equipment Tournaments Live bait Fish stocking 	<p>Provide gear cleaning stations; include conditions on fishing tournaments; restrict live bait; etc.</p>
<p>In-Water Equipment</p> <ul style="list-style-type: none"> Construction equipment Docks Buoys Floating restrooms Firefighting tanker trucks or equipment 	<p>Inspect and/or decontaminate all exiting equipment; require sufficient dry time if equipment cannot be drained; coordinate with firefighting agencies for inspections of equipment; decontaminate equipment prior to moving it to another water; etc.</p>
<p>Facility Maintenance</p> <ul style="list-style-type: none"> Large equipment Field gear 	<p>Inspect maintenance gear and equipment; if managing multiple waterbodies have dedicated equipment for uninfested and infested sites; require all exiting maintenance gear and equipment be clean, drain, and dry prior to use at the next location; decontaminate prior to next use; etc.</p>

<p>Aerial contact</p> <p>Float planes</p> <p>Firefighting aircraft</p>	<p>Provide the USGS NAS map to firefighting agencies and encourage them to follow aquatic invasive species protocols developed by USFS; prohibit private planes; etc.</p>
<p>Research</p>	<p>Require all equipment be cleaned, drained, and dried and/or decontaminated after use; etc.</p>

In addition to addressing each pathway, the Control Plan should include a description of any management activities that are currently underway and anticipated to continue, as well as any new efforts that will be implemented. If actions are discrete or anticipated to cease, their date of completion should be included in the Control Plan. If actions contained in the Control Plan are not currently being implemented, the date that they are anticipated to begin should be provided.

If partner agencies are responsible for implementing actions, the agency and their role should be identified. The agency should agree and commit to their role prior to submitting the Control Plan for review and approval.

Public outreach and education is an important component of preventing the overland spread of invasive mussels. The water manager's efforts should be explained in the Control Plan, including the types of outreach and education being implemented such as direct communication, signage, handouts, seminars, interpretive displays, etc. Describe outreach and education that will be used to support control and containment measures. CDFW has developed outreach materials that agencies are welcome to use or modify to meet their individual needs, and are available in the [Invasive Mussel Toolkit](#).

Additional Resources

- [Uniform Minimum Protocols and Standards for Watercraft Inspection and Decontamination](#) Programs for Dreissenid Mussels in the Western United States
- [Watercraft Inspection and Decontamination Training Materials](#)
- California Boat Inspection and Banding Program - Contact the [CDFW Invasive Mussel Regional Scientist](#) for more information
- Watercraft Inspection and Decontamination Database - Contact the [CDFW Invasive Mussel Regional Scientist](#) for more information

- [US Bureau of Reclamation's Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species](#)
- [Guide to Preventing Aquatic Invasive Species Transport by Wildland Fire Operations](#)
- [Decontaminating Firefighting Equipment to Reduce the Spread of Aquatic Invasive Species](#)

Systematic Monitoring Program to Determine Any Changes in Conditions

The Control Plan should describe the systematic monitoring occurring within the water supply system to determine any changes in the mussel population. At minimum, identify the specific locations within the water supply system, method(s) that will be used, protocols that will be used, and approximate dates/frequency. Mussel monitoring results can be compared to water quality data, for example, temperature, calcium, salinity, to understand the mussel's biology in California waters and effectiveness of control efforts. Monitoring results should be included in the Annual Report.

If protocols other than CDFW's are used, include them as appendices to the Control Plan. If monitoring or sample analysis will be conducted by a partner or contractor, identify the agency, the frequency, and what methods they will use.

The monitoring program can be described in a table or narrative, or a combination of both. A suggested table format follows but should be adapted as needed.

Example 1. Monitoring Plan Table

Waterbody: WATERBODY NAME

Monitoring Method	Location(s)	Dates	Frequency	Agency
Plankton sampling	Include list of locations	Monthly or year-round, based on water temperature	Twice per month	Plankton sampling: AGENCY Sample analysis: Define Laboratory

Monitoring Method	Location(s)	Dates	Frequency	Agency
Surface surveys	Include list of locations	Monthly	Once per month	AGENCY
Artificial substrates	Include list of locations	Year-round	Once per month	AGENCY
Water quality (temperature, calcium, DO, salinity, pH, etc.)	Include list of locations	Year-round	Once per month	AGENCY

Permitting and Regulatory Compliance

Per 14 CCR §672.1(a)(6) “Monitoring activities associated with an approved control plan per Fish and Game Code section 2301 do not require a separate permit for collection, transport to laboratories, or analysis, unless activities are associated with scientific research.”

An approved Control Plan does not relieve the agency from obtaining any other permits or authorizations that might be required under other federal, state, or local laws or regulations.

Maintain functionality of the water supply facility

14 CCR §672.1(a)(5), states a “Control Plan may also include a description of maintenance activities to maintain functionality of the water supply facility.”

Include a description of measures that will be implemented within the system to maintain operations. This includes infrastructure, facilities, and in water equipment exposed to untreated raw water vulnerable to mussel colonization (pumping plants, hydropower facilities, canals, pipelines, aqueducts, groundwater recharge basins, headworks, dams, valves, floodgate, etc.)

This could include, but is not limited to:

- Manual removal (hand removal, hot water high pressure removal)
- Filtration
- Ultraviolet light

- Oxygen deprivation (tarping, stratification, lake management)
- Chemical applications (ozone, chlorine, potassium chloride, copper-based products, bacteria-based products)
- Anti-fouling coatings

Additional Resources

- US Bureau of Reclamation's [Facility Vulnerability Assessment Template](#)
- Additional resources related to vulnerability assessments
<https://www.westernais.org/assessments>
- [US Bureau of Reclamation's Quagga/Zebra Mussel Management Options](#)
- DeBruyckere, L.A. 2025. [Invasive Mussel Control at Hydropower Facilities - An Update](#). A report prepared for the Engineering Solutions for Invasive mussels in Raw Water Infrastructure Working Group

Control Plan Submittal for CDFW Review and Approval

Submit the draft Control Plan via email to the respective [CDFW Invasive Mussel Regional Scientist](#) based the county the water supply system is in [CDFW's Regional Map](#). If the water supply system spans multiple regions, please email the draft Control Plan to invasive@wildlife.ca.gov.

CDFW will confirm receipt of the document and begin reviewing the document. Per FGC §2301(d)(4) "...The department shall approve plans or provide written comments and suggestions on plan deficiencies within 180 days from the date of plan submission." Contact CDFW to schedule a meeting if there are any questions about the comments provided. Once revised, resubmit the revised Control Plan to CDFW.

Upon the Control Plan satisfying all statutory requirements in FGC §2301, CDFW will prepare and mail a letter approving the Control Plan.

Per FGC §2301(d)(1)(D), there is a statutory requirement "...to update or revise the control or eradication measures in the approved plan to address scientific advances in the methods of controlling or eradicating mussels and veligers." Updates should be submitted to CDFW following the same process as review of a new Control Plan.