

**INVASIVE MUSSEL  
GUIDEBOOK FOR  
RECREATIONAL WATER  
MANAGERS AND  
USERS**

*Strategies for Local Involvement*

**California Resources Agency**  
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## INTRODUCTION

This guidebook provides an overview of the threat Quagga and Zebra mussels pose to California's water managers and users and recommends measures they can take to prevent the introduction of these invasive species into water bodies. Managers are advised to implement early-detection monitoring for mussels and users to take responsibility by checking boats, trailers and vehicles for mussels. Information presented in this guidebook deals exclusively with prevention and containment of invasive mussels and does not address control or eradication.

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## GENERAL INFORMATION ABOUT QUAGGA AND ZEBRA MUSSELS

Invasive Quagga and Zebra mussels were first detected in the Great Lakes in the late 1980s and since then have spread, largely unchecked by natural predators, throughout much of the eastern United States.

In addition to the Great Lakes basin, the mollusks currently infest much of the St. Lawrence Seaway and the Mississippi River drainage system and have begun to spread up the Missouri and Arkansas rivers. The mussels were first detected in the Colorado River system in January 2007 and were later found in San Diego, Riverside and Orange counties by state and local water agencies. Zebra mussels were discovered in San Justo Reservoir in San Benito County in January 2008.



Zebra mussels from San Justo Reservoir, San Benito County.

Both species of non-native aquatic mollusks wreak havoc on the environment by disrupting the natural food chain and can contribute to the release of harmful bacteria that affect other aquatic species. Quagga and Zebra mussels are filter feeders that consume large portions of the microscopic plants and animals that form the base of the food web. Their consumption of significant amounts of phytoplankton from the water decreases zooplankton and can cause disruption to the ecological balance of entire bodies of water. The mussels can displace native species, further upsetting the natural food web.

In addition to devastating the natural environment, Quagga and Zebra mussels pose an economic threat to California. The greatest impact will be on infrastructure and water conveyances. Mussels attach to surfaces such as piers, pilings, water intakes and fish screens. These invasives spawn multiple times a year and, as a result, intake structures can become clogged, hampering the flow of water threatening municipal water supply, agricultural irrigation and power plant operations. U.S. Congressional researchers have estimated that Zebra mussel infestation in the Great Lakes area cost the power industry \$3.1 billion between 1993-1999,<sup>1[1]</sup> with an economic impact to industries, businesses and communities of more than \$5 billion.<sup>2[2]</sup>

Mussels can also negatively impact recreational boating by colonizing the hulls, engines and steering components of boats and other recreational equipment, and can damage boat motors and restrict cooling. Boats are the primary transporters of Quagga and Zebra mussels to uninfected areas either as adults attached to vessels or as larvae in engine, bilge or live well water.

## Biology of the Quagga and Zebra Mussel

Quagga and Zebra mussels are freshwater mollusks with D-shaped, triangular shells. The shells are smooth or shallowly ridged and can be variable in color, from solid light to dark brown, or have alternating dark and light concentric stripes. At various stages of life mussels range in size from microscopic to the size of a fingernail and can attach to most surfaces.



Color variation in Zebra and Quagga mussels.

Adult mussels release eggs and sperm into the water column where fertilization and larva development takes place. Adults may spawn multiple times within a single year and have the potential to produce millions of offspring per spawning season. Free-floating microscopic larval mussels, called veligers, float for weeks before firmly attaching to substrates at the surface of the water down to depths of 180 feet (Zebra mussels) and 400 feet (Quagga mussels).

## Organisms Often Mistaken for Quagga and Zebra Mussels

[Click here](#) for information about organisms often mistaken for invasive aquatic mussels.

<sup>1[1]</sup> New York Sea Grant. (1994). "Policy issues." Dreissena polymorpha information review (Zebra Mussel Clearinghouse, 250 Hartwell Hall, SUNY College at Brockport, Brockport, NY 14420-2928), 5(1), 14-15.

<sup>2[2]</sup> Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (§1002(a)(4)).

## Threat of Mussel Infestation

The State of California is working to advance understanding about Quagga and Zebra mussels and their potential impacts, but it is local communities, water districts, boating enthusiasts and other recreationalists who must take the necessary steps to address this important issue. Local officials and residents have the highest stake when it comes to preventing the spread of invasive species.

Most areas of the state are vulnerable to future transport and contamination by Quagga and Zebra mussels. Because mussels are primarily transported by watercraft, water managers are encouraged to create policies that ensure invasive mollusks are not moved via boats or ballast water. Precautions must be taken to keep uninfested waters "mussel-free."

The California Department of Fish and Game (DFG) coordinates with the U.S. Geological Survey (USGS) to generate a map of known locations of Quagga and Zebra mussels in the state. New locations are posted as soon as samples are positively identified. View the map [here](#).

USGS also generates a map of known locations of Quagga and Zebra mussels in the United States. New locations are posted as soon as samples are positively identified. View the USGS map [here](#).

A map of counties with suitable environmental conditions for mussel establishment was developed using existing water quality data. Water quality parameters included temperature, calcium, pH, dissolved oxygen and salinity. Given suitable environmental conditions, Quagga and Zebra mussels colonize where there is adequate calcium in the water. Counties determined to be vulnerable to colonization include those with sites with calcium concentrations of 15mg/L or greater or that already have an established mussel population. Find this map [here](#).

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## PREVENTION TECHNIQUES

To truly prevent the spread of Quagga and Zebra infestation, assume all boats entering a water body have come from infested waters.

The following five sections outline techniques for prevention of the spread of Quagga and Zebra mussels into uninfested water bodies. The techniques detailed here include: How to Clean, Drain and Dry a Boat; Refusal to Launch; Water Body Inspections; Boat Inspection Training and Public Education.

### How to Clean, Drain and Dry a Boat

This [downloadable book](#) teaches recreational watercraft users how to properly clean, drain and dry any type of watercraft. It is important to drain watercraft immediately after leaving a water body to prevent runoff that could potentially contain mussels or mussel larvae from reaching storm drains that meet California's rivers and streams.

### Washing and Complete Drying

Washing to disinfect involves cleaning procedures detailed in the link above, followed by complete drying – the time necessary to ensure that there is no water on or within any recess of a vessel. This level of drying can be accomplished by towel-drying and/or allowing water to evaporate and will take at least five days to ensure that all absorbent materials such as carpeting, upholstery, ropes, etc. are also dry. Complete drying is necessary because it eliminates any water that may harbor larval mussels – larvae cannot survive in the absence of water. Settled adult mussels, on the other hand, need to be "dried" for extended periods of time because they have protective shells that they can close to maintain moisture, allowing them to survive out of water. Adults can live out of water for five days in California heat, and up to 30 days in cooler, moist or wet weather.

The actual time necessary for drying will depend on temperature and humidity, both of which vary seasonally, regionally and even daily. Under high humidity or low temperature, complete drying may be prolonged and disinfection by decontamination may be necessary.

To view an interactive demonstration of how season, relative humidity and geography can influence recommended drying times, please visit the 100th Meridian Initiative's [Quarantine Estimator](#). Results generated from this site carry the disclaimer of being estimates, as actual circumstances will vary.

For more information about the 100th Meridian Initiative, a cooperative effort between state, provincial and federal agencies to prevent the westward spread of invasive mussels and other aquatic nuisance in North America, visit [www.100thmeridian.org](http://www.100thmeridian.org).

## **Wash Stations: An Alternative to Drying**

If sufficient drying time is not available for water in recesses to evaporate and/or attached adult mussels to die, decontamination is required. Decontamination is accomplished by washing the boat, trailer and all equipment with scalding hot water of at least 140 degrees Fahrenheit. Working with hot water is potentially dangerous, so water managers are urged to take all necessary safety precautions.

Wash stations that use hot and high-pressure water are effective at killing and removing mussels that could become attached to boat trailers, cooling systems, boat hulls and steering equipment. In some areas, water managers have identified car washes near their lake or reservoir that will achieve this effect.

Other water managers have invested in wash stations designed to help prevent the spread of Quagga and Zebra mussels. These stations vary in size and price, but can include chemicals or hot water to kill mussels. Water managers can obtain portable wash stations by contacting local farm equipment dealers and all-terrain vehicle dealers.

## **Refusal to Launch**

If a boat owner refuses inspection, water managers should have protocol in place to refuse them the right to utilize the water body. Additionally, a watercraft found to have Quagga or Zebra mussels must be reported to DFG as possession of live mussels is a violation of the Fish and Game Code. To report mussels, water managers can call the department's confidential CalTip line, (888) 334-2258, or contact the appropriate DFG Regional staff person listed below.

## Watercraft Inspections at Water Bodies

In order to be most effective, all watercraft and vehicles entering a waterway should be subject to inspection prior to launching.

The watercraft inspector should ask permission prior to conducting the inspection. Inspectors should also ask watercraft owners a series of questions that will help determine the vessel's prior locations; similarly, inspectors should be aware of the known Quagga and Zebra mussel locations in California and neighboring states by referencing the maps listed above.

If a watercraft is suspected of having Quagga or Zebra mussels, the vessel should not be granted access to the waterway and inspectors should be prepared to notify DFG personnel immediately. Regional contact information can be found [here](#).

During the inspection process, inspectors should explain to boat owners how to effectively clean watercraft and equipment each time the boat leaves a waterway. Education material should also be distributed (see Public Education and Outreach section below).

Upon exiting a waterway, the watercraft owner should clean, drain and dry their vessel. Watercraft owners should ensure there are no mussels or plant material attached to the vessel or trailer and that all water has been properly drained.

## Boat Inspection Training

To learn more about boat inspections, watch the 100th Meridian Initiative's "Don't Move a Mussel" video:

### Windows Media Player

[Don't Move a Mussel, Part I](#)

[Don't Move a Mussel, Part II](#)

### Apple QuickTime

[Don't Move a Mussel, Part I](#)

[Don't Move a Mussel, Part II](#)

Additionally, DFG regional staff is available to train local communities about how to properly inspect boats. In order to schedule a training session, a community representative must contact the appropriate regional contact from the list linked above. A date, venue and time should be selected and the community will be responsible for providing local outreach for the event. At least 10 people must attend the training session but attendance should not exceed 50 people. DFG regional staff can each offer up to two trainings a month per region.

Once trained, inspectors will be able to examine equipment for Quagga and Zebra mussels.

[Watercraft Inspection Guidelines](#)

[Inspection Training Power Point Presentation](#)

[Quagga/Zebra State Biologist Contacts by Region](#)

## Public Education and Outreach

There is no better prevention technique than proper education of and outreach to water body users. Materials have been created to educate the public about invasive Quagga and Zebra mussels and are available for download and self-printing for distribution and posting in local communities. All materials were created in an electronic PDF format and are camera ready for printers. It is recommended that these materials be distributed at park kiosks, chambers of commerce, local businesses and at any point of entry to a water body. The material should also be provided to each vessel operator at the time of inspection.

### Materials

Informational cards provide facts about the threat of non-native species and explain how to best clean, drain and dry watercraft to help prevent their spread. The cards are designed to be handed out at informational kiosks or events and can also be inserted in direct mailings. Click [here for English](#) and [here for Spanish](#).

A poster has been developed to encourage boaters and water users to think about the Quagga and Zebra mussel threat. This [poster](#) can be hung at kiosks, boat ramps and other locations where the public can review proper cleaning techniques and boat care. The design can be used for paper, synthetic papers (tyvek, polyart synthetic, Teslin, etc.), or hard vinyl signs (PVC). It is suggested that standard paper posters be laminated.

### Publications

Below are links to DFG publications that further detail the threat of the Quagga and Zebra mussels to the state.

[Fact Sheet](#)

[Frequently Asked Questions](#)

[What Boaters Can Do](#)

Additionally, this [downloadable book](#) teaches recreational watercraft users how to properly clean, drain and dry any type of watercraft.

### Trainings

DFG regional staff is available to train local communities about how to properly inspect boats. See more information on the previous page.

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# HOW TO DETERMINE IF A WATER BODY HAS QUAGGA OR ZEBRA MUSSELS

## Survey Protocols

To determine if a water body has Quagga or Zebra mussels, there are a number of survey protocols that can be followed. Most are highly scientific, so it is suggested that a scientist, biologist, or water quality specialist be utilized to employ the following survey protocols.

[Zebra and Quagga Mussel Surface Survey Protocol](#)

[Zebra and Quagga Mussel Surface Survey Data Sheet](#)

[Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol](#)

[Zebra and Quagga Mussel Veliger Sampling Protocol Vertical Tow](#)

## Contact DFG to Initiate Plan

After following the survey protocols:

If Quagga or Zebra mussels are found, contact DFG immediately at [invasives@dfg.ca.gov](mailto:invasives@dfg.ca.gov) to initiate a management plan.

If Quagga or Zebra mussels have not been found but water managers would like to initiate a prevention plan, please contact DFG at [invasives@dfg.ca.gov](mailto:invasives@dfg.ca.gov).

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## RELATED LINKS

Additional information about Quagga and Zebra mussels is available by visiting these links:

- [DFG Quagga/Zebra Mussel Fact Sheet](#)
- [DFG Frequently Asked Questions About Quagga/Zebra Mussels](#)
- [U.S. Fish & Wildlife Service Western Quagga Mussel Background Information Sheet](#)
- [100th Meridian Initiative](#)