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# QUAGGA AND ZEBRA MUSSEL ERADICATION AND CONTROL TACTICS

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## 5. EMERGING TECHNOLOGIES

Revised June 2013

*This series of information sheets is provided for educational purposes only. It is intended to provide a general overview of what is required for implementing tactics to eradicate and control aquatic invasive species (AIS). Although prevention is the best approach, it also is important to be prepared to respond quickly to new infestations and to reduce risks posed by existing infestations. No work should be conducted without first consulting the California Department of Fish and Wildlife (formerly California Department of Fish and Game) and the Regional Water Quality Control Board or, if in another state, the lead local resource management and water quality agencies for the AIS you are interested in managing. Consult the California Department of Pesticide Regulation or corresponding agency in another state before applying chemical tactics.*

### OVERVIEW

New eradication and control tactics are being evaluated for potential use in lake and reservoir systems. The emerging tactics presented below have not been implemented in these habitats, but theoretically and in some cases experimentally they show some promise.

### ZEQUANOX®

Zequanox® is a biological, environmentally compatible product developed specifically to control invasive zebra and quagga mussels (*Dreissena* species).<sup>1</sup> Derived from the naturally occurring microbe, *Pseudomonas fluorescens*, Zequanox® is highly selective and has been proven to be lethal to zebra and quagga mussels without harming humans, infrastructure, nontarget species, or the environment. The product—comprised of dead cells of the microbe—is seen as a nonthreatening food source; the target mussels readily consume the product along with their normal phytoplankton diet from the water. Once ingested, the active ingredient in Zequanox® deteriorates the mussel's digestive lining, causing death. Toxicological studies have been completed on numerous species of fish, molluscs, plants, algae, crustaceans and insects, as well as mallard ducks, with no indication that Zequanox® has any harmful effects on other species.

### Potential Uses

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In March 2012, the Environmental Protection Agency (EPA) approved the commercial formulation of Zequanox® for use in enclosed/semi-enclosed systems with an inlet and an outlet (e.g., water facility pipes). Trials in these systems have achieved greater than 90% mortality in both adult and juvenile mussels. Zequanox® has been registered in several states for this type of application, but not in California (as of December 2012).

Marrone Bio Innovations—maker of Zequanox®— is currently collecting data to complete an EPA application for the use of this biocide in open water settings, such as lakes and reservoirs. In July 2012, an open-water trial was completed in Deep Quarry Lake, DuPage County, IL, where the product achieved greater than 97% mortality of adult mussels. These data, along with post-application survey data, will be reviewed as part of the approval process for open-water application of Zequanox® to control mussel infestations in lakes/reservoirs. However, even if approved, such system-wide open-

water application may be cost prohibitive, depending on the concentration required to treat the system and the volume of water to be treated. Zequanox® may be most appropriate for site-specific applications for population control, nuisance abatement, infrastructure maintenance, habitat protection or in applications where there is a strong environmental concern for nontarget species. Trial studies indicate this biopesticide will be particularly effective when used with in-lake barrier systems to help maintain product concentration during treatment periods. For more information visit [Marrone Bio Innovations](#).

## FISH BIOCONTROL

Research is underway to evaluate whether resident fish in a mussel-infested system could be used for *site-specific* control of quagga and zebra mussel infestations. System-wide application, where the overall density of fish is increased within a lake to increase predation on a target species, is not currently being considered. Several fish species feed on various life stages of quagga mussels.<sup>2</sup> Redear sunfish (*Lepomis microlophus*), common carp (*Cyprinus carpio*) (Fig. 5-1) and blue catfish (*Ictalurus furcatus*) are molluscivores that are known to feed on both juvenile and adult mussels, while threadfin shad (*Dorosoma petenense*) and small (<90 mm, <3.5 inch) bluegill (*Lepomis macrochirus*) are planktivores and consume the planktonic larval stage of the mussel. These species are not native to western waterways, but they were introduced long ago and are now common sportfish in many water bodies of the region. Unfortunately, no native fishes have been identified as promising biocontrol agents for quagga and zebra mussels. While the non-native species may prove useful where they already **occur**, the researchers and others do not promote their introduction anywhere else.



**Figure 5-1.** Common carp, *Cyprinus carpio*, a predator of and potential biocontrol agent for quagga and zebra mussels. Lake Mead, NV.  
Photo Credit:Carolynn Culver

### Potential Uses

If proven effective, cages may be used to apply higher fish densities at specific sites to control quagga and zebra mussels. For example, mussel infestations on docks, water towers, dams and irrigation canals may potentially be controlled by caging fish around these structures or in the canals. If shad or other planktivores consume sufficient mussel larvae, they could minimize the number of larvae that settle. If redear sunfish or other predatory fish consume sufficient juvenile and adult mussels, they could minimize populations of these stages. If fish biocontrol is proven effective, using a combination of planktivores and molluscivores may be more effective at reducing mussel populations than using just one or the other. Depending on the research results, applications of contained fish could be focused on periods of high mussel settlement. For more information visit [United States Bureau of Reclamation](#) and [California Sea Grant/UCSB](#) Western Region IPM Project.

## ADDITIONAL ALTERNATIVES

The following tactics are still in the beginning stages of development for lakes/reservoirs and are most likely best suited for facilities and infrastructure. Visit the websites provided below to learn more about development and use of these tactics.

### pH Manipulation

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Mussels have a relatively narrow range of pH tolerance, with the optimum from 7.5 to 9.3. Research is underway to determine if manipulating the pH above or below this range will prove to be an effective control strategy or a preventative measure against initial mussel settlement.<sup>3</sup> For more information visit [RNT Consulting](#).

### Pulse Pressure Technology

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Pulse pressure technology using seismic guns has recently been used to combat various invasive fish species. Investigators hypothesize that fine manipulation of seismic waves may effectively kill all life stages (larvae, juveniles and adults) of quagga and zebra mussels.<sup>4</sup> If this tactic is found to be effective for invasive mussels, it may provide a more cost-effective means for controlling these pests. For more information visit [U.S. Geological Survey](#).

## CITED WEB LINKS

California Sea Grant/UCSB Western Region IPM Project -

<http://www.wripmc.org/CenterProjects/RIPM%20grants.html#2011>

Marrone Bio Innovations - <http://marronebioinnovations.com/products/zequanox/>

Quagga Mussel Eradication and Control Workshop – [http://ca-sgep.ucsd.edu/quaggazebra\\_mussel\\_control/new\\_workshop](http://ca-sgep.ucsd.edu/quaggazebra_mussel_control/new_workshop)

RNT Consulting - [http://www.rntconsulting.net/People/Principals/Claudi\\_Renata.aspx](http://www.rntconsulting.net/People/Principals/Claudi_Renata.aspx)

United States Bureau of Reclamation - <http://www.usbr.gov/mussels/research/current.html>

U.S. Geological Survey (USGS) - <http://www.nrmcs.usgs.gov/staff/jgross/research>

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<sup>1</sup> Link, Carolyn and Sarahann Rackl. 2012. Zequanox: Invasive mussel control for watershed management. [Quagga Mussel Eradication and Control Workshop](#). Presenter Abstracts.

<sup>2</sup> Carp, Kathy. 2012. Summary of laboratory experiments to evaluate consumption of juvenile/adult quagga mussel by redear sunfish and bluegill. [Quagga Mussel Eradication and Control Workshop](#). Presenter Abstracts.

<sup>3</sup> Claudi, Renata. 2012. Adjustment of background pH as a control strategy for dreissenid mussels in raw water conveyance systems. [Quagga Mussel Eradication and Control Workshop](#). Presenter Abstracts.

<sup>4</sup> Gross, Jackson. 2012. UV light and seismic technology as potential control strategies for dreissenid mussel invasion. [Quagga Mussel Eradication and Control Workshop](#). Presenter Abstracts.

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[http://ca-sgep.ucsd.edu/quaggazebra\\_mussel\\_control](http://ca-sgep.ucsd.edu/quaggazebra_mussel_control)

