

# **Early Detection & Education Plan for Eurasian Mussels**



## **SOLANO PROJECT**

Solano County Water Agency  
810 Vaca Valley Parkway, Suite 203  
Vacaville, CA 95688

July 1, 2012



Putah Creek

## Acknowledgments

The **Solano Project Early Detection and Education Plan for Eurasian Mussels** was developed from personal conversations, presentations at numerous mussel workshops, and other input from a variety of scientists including Renata Claudi (RNT Consulting), Dave Robinson USBR, Jeff Janik (CDWR), Tanya Veldhuizen (CDWR), Carl Dealy (USBR), Steven Woods (Center for Lakes & Reservoirs), Dr. Robert Mc Mahon (University of Texas, Arlington), Denise Hosler (USBR), Stephen Phillips (Pacific States Marine Fisheries Commission), David Wong (University of Nevada, Las Vegas), Catherine Mandella (DFG), Bill Zook, Wen Baldwin, staff from Lake County, East Bay Municipal Utilities District, and Metropolitan Water District.

Special acknowledgement and thanks to the USBR staff at Lake Berryessa for staff support and cooperation.

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Putah South Canal Grate

## Approval / Update Page

Date	Action Taken	Person	Agency
3/15/2012	Plan Approved	Chris Lee	Solano County Water Agency
3/17/2012	Sent Plan to DFG	Catherine Mandella	California Dept. Fish & Game
3/17/2016	Sent Plan Copy to	Jennifer Labay	California Dept. Fish & Game
5/15/12	DFG Changes complete	Ken W. Davis	Wildlife Survey & Photo Service
6/28/12	DFG Accepted	Catherine Mandella	California Dept. Fish & Game



Management Cove Dock - Lake Berryessa

## Updates to Mussel Plan

Date	Page	Actions Requested by California Department of Fish & Game
5/14/12	9	Added Golden Mussel physical parameters for moderate infestation
5/14/12	11	Note: SCWA does not have authority to manage boating on Lake Berryessa.
5/14/12	22	Map: Added map of Lake Berryessa monitoring sites
5/14/12	36	Changed: Notification Chain for Positive Mussel Determination - DFG Level 2
5/14/12	37	Update: Notification contact list
5/14/12	49-54	Update: DFG Required Invasive Species Decontamination Protocols (1/24/12)
5/30/12	64-65	Newspaper article - Solano Project Mussel Prevention
6/15/12	66-69	DFG Comments on Solano Project Mussel Plan
END		



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## ACRONYMS

CDFG	California Department of Fish & Game
CDWR	California Department of Water Resources
EPA	Environmental Protection Agency
ETOH	Ethyl Alcohol
MWDSC	Metropolitan Water District of Southern California
O&M	Operations and Maintenance
PDD	Putah Diversion Dam
SCWA	Solano County Water Agency
USFS	United States Forest Service
USBR	United States Bureau of Reclamation



Putah South Canal

# 1. Introduction

The Solano Project is a federal project that stores water in Lake Berryessa for delivery to agriculture, municipalities, and military facilities in Solano County via the Putah South Canal (PSC). The Project is owned by the U.S. Bureau of Reclamation (USBR), managed by the Solano County Water Agency (SCWA) on behalf of the USBR with operation and maintenance duties conducted by the Solano Irrigation District (SID) under SCWA direction.

The Solano Project ***Early Detection and Education Plan for Eurasian Mussels*** is a comprehensive document that provides guidance to SCWA and affiliated agencies by consolidating best management practices, defining issues, and communicating current “understanding” and research. The plan will be reviewed quarterly to maintain compliance with regulatory requirements and summarize scientific

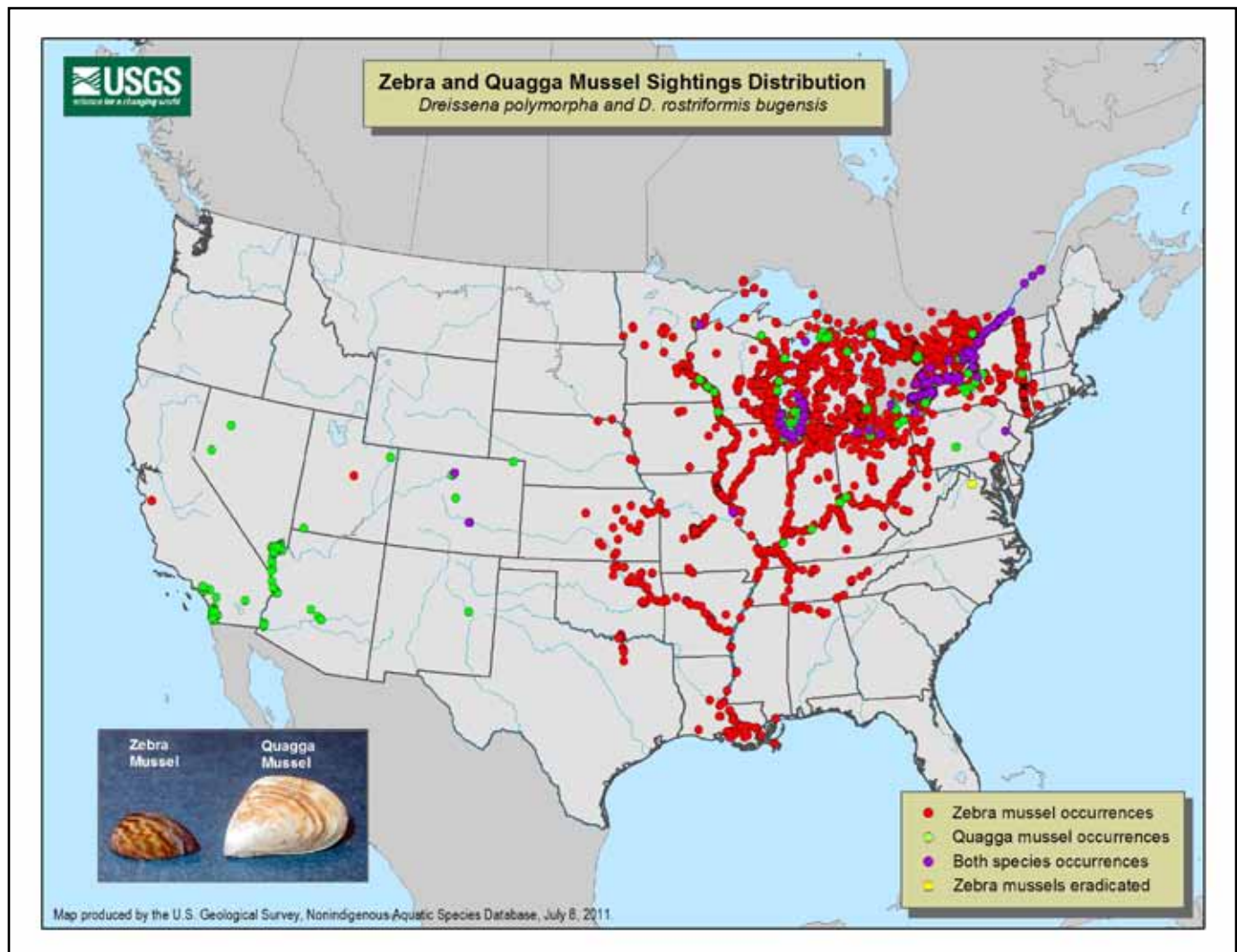
updates. Dreissena and Golden Mussels can cause substantial ecological and economic damage due to high density populations that filter copious volumes of water, produce significant amounts of fecal material, and colonize on hard surfaces including the insides of valves, pipes and screens. The added cost to maintain water supply systems that are infested with mussels will certainly lead to significant increases in O&M budgets. A 1995 National Zebra Mussel Clearinghouse study indicates an average annual cost of \$213,360 for a water treatment facility. Metropolitan Water District receives 740,000 to 800,000 acre-feet of water per year from the Colorado River and will spend \$10-15 million annually in operations and maintenance costs to address the mussel infestation (DeLeon 2008).

A simple Eurasian Mussel Detection Program was



Monticello Dam and Putah Creek.





Map 1: Zebra and Quagga Mussel Sightings Distribution in the United States

implemented on July 1, 2005 due to the risk assessment published by Cohn (2003) that rated the Monticello Dam section of Putah Creek as a high-risk site using six physical parameters including temperature, calcium, pH, dissolved oxygen, and salinity. The project was initiated with a program consisting of minimal plankton collections, placement of brick plates, and existing substrate surveys immediately below Monticello Dam. Part of the program included the development of a plankton inventory for the Solano Project, including Lake Solano, Putah Creek, Putah South Canal, and Terminal Reservoir. At the same time, the Solano Project below Monticello Dam was routinely monitored for New Zealand mudsnails using equipment and protocols that would also tend to discover adult mussels.

A Eurasian Mussel Survey and Education Program began on July 1, 2008 with an informal partnership between SCWA, USBR, and the Wildlife Survey & Photo Service. Plankton tows, colonization devices, and visual surveys were implemented throughout the system with an emphasis on early detection.

The Mussel Survey and Education Program was started primarily in response to adult quagga mussels found in Lake Mead and adult zebra mussels discovered in San Justo Reservoir, near Hollister California which is approximately 100 miles due south of Terminal Reservoir.

### Background

Zebra (*Dreissena polymorpha*) and Quagga (*Dreissena rostriformis bugensis*) mussels are small freshwater

biofouling mussels native to the Black, Caspian, and Aral seas. It is believed that both mussel species arrived in the United States via ballast water discharged from transoceanic ships. They were discovered in Lake St. Clair, Michigan in the 1986. By September 1991, mussels had spread into the Great Lakes, the St. Lawrence River, and the Lower Ohio, Tennessee and Cumberland rivers.

Golden mussels (*Limnoperna fortunei*) were introduced into Argentina from Asia in 1991 probably in ship ballast and as a contaminant in shipments of Asian clams (Ricciardi - 1998). They have since spread into four other South American countries. Although Golden mussels share physical characteristics with the *Dreissena* mussels, they potentially exhibit a wider tolerance of ecological parameters. There is concern that Golden mussels could be introduced into the West Coast via ship ballast from Asia or South America or in aquarium collections. Golden, zebra, and quagga mussels are collectively called Eurasian mussels.

### Ecological impacts of Mussel Infestations

Eurasian mussels reduce the amount of nutrients, particulate matter, and plankton in the water column by filtering large volumes of water. High densities of mussels can severely alter the ecosystem by decreasing the food source necessary for native wildlife and increasing water clarity. The increased clarity allows



Quagga mussels on vessel drain. Image by Ken W. Davis

for greater light penetration resulting in increased algal and aquatic macrophyte growth. Quagga, zebra, and golden mussels are able to accumulate organic toxins in their tissues at more than 3,000 times the concentration in the environment. While the mussel species do not directly impact drinking water standards, they are known to affect water quality by contributing to and/or causing blue-green (Cyanophyta) algae blooms. Wildlife that feed on mussels can increase the exposure of wildlife to pollutants. Recovery efforts for razorback suckers, humpback chub, several salmon species, and other threatened and endangered western fish would be significantly hindered by the establishment of the Eurasian mussels (Britton 2010).



Southern end of Lake Berryessa as viewed from Rocky Ridge. Lake Berryessa was formed in 1954 with the construction of Monticello Dam. Photo by Ken W. Davis.



## Economic impacts of Mussel infestations

It has been estimated that zebra mussels cost the power industry \$3.1 billion from 1993 to 1999, while their impact on industries, businesses and communities has exceeded \$5 billion (De Leon, 2008). Quagga and zebra mussels also negatively impact local economies by affecting recreation and commercial fishing. Attached mussels can increase the drag on the hull of watercraft which reduces speed, wastes fuel, and requires expensive repairs to the watercraft hull. Mussels jam watercraft steering components and block cooling systems. Degraded habitats also reduce sport fishing opportunities which affect recreational opportunities and tourism.

## Regulations and Regulatory Controls

### The Lacy Act

The Secretary of the Interior has designated Dreissenid mussels as ‘injurious wildlife’ under federal law and therefore the importation and interstate transport of zebra and quagga mussels are prohibited by the federal Lacy Act (18 U.S.C 42).

### California State Assembly Bill 1683

AB-1683 was sponsored by Assemblywoman Lois Wolk and signed by Governor Arnold Schwarzenegger

on October 14, 2007. This bill is aimed at controlling the spread of quagga mussels within the state of California and authorized California Department of Fish & Game (CDFG) to inspect and quarantine infected boats, close recreational facilities, and restrict access to lakes. It also authorizes public and private water agencies to maintain control of inspections, site restrictions and other control efforts by completing a control/eradication plan.

These requirements have been incorporated into Fish and Game Code beginning with Section 2300 - 2302. Senate Bill 215 (Huff), which authorized DFG to continue action on Section 2301, was signed by Governor Brown on September 26, 2011. See Appendix C for complete text of CA Fish & Game Code 2300-2302.

### Scientific Collection Permit

Scientific Collection Permit No. 6466 issued to Ken W. Davis by CDFG authorizes the collection of plankton samples, examination for mussel veligers, and the development of a mussel image library. The permit also allows the possession of *Dreissena* mussel voucher specimens (preserved in ethyl alcohol).

## Recommendations

1. Consider alternatives to the situation at Capell Cove that allows boats to enter the lake without inspection or documentation of water bodies where the vessel has been recently used. Inspections only occur on summer holidays and on some summer weekends. On those days, the boat inspections and educational efforts stop after 11:30 AM despite the fact that watercraft continue to be launched.
2. Develop data that documents the number of water vessels and the time they launch at Capell Public Ramp. This information does not currently exist.
3. The informal partnership with the USBR should continue and consider



Quagga mussel shells on Sterling Beach, Lake Erie. The beach is swept daily to prevent foot injuries to barefoot beach users.



additional work with the Pensus Group as the resorts expand.

3. Develop an annual SCWA Mussel Workshop to educate clients that receive water.

4. Conduct a more thorough study (report) of predators (calcium, pH, plankton density) throughout the Solano Project. Cursory information such as survivability of Asian clams suggests that conditions in the Solano Project could support at least a moderate infestation of Eurasian mussels.



Lake Berryessa: Capell Cove Public Launch Ramp.



Putah Diversion Dam

## 2. Situational Awareness

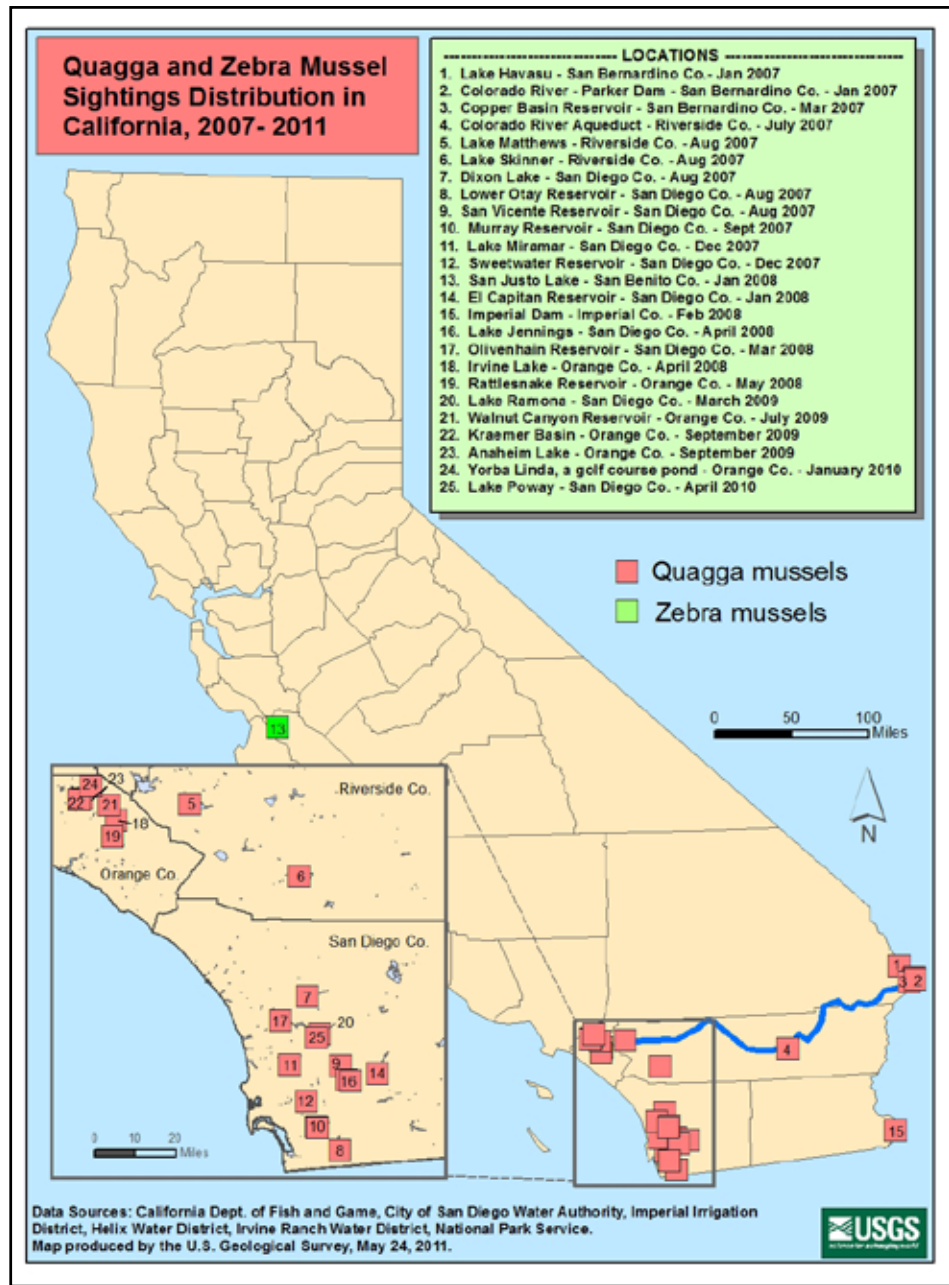
Awareness of the potential threat of a mussel infestation is crucial to protecting the Solano Project. Awareness includes defining the threat to the Solano Project, determining the proximity to mussel infestations, potential vectors, and vector pathways. Elements of situational awareness include:

- Vulnerability analysis
- Vector Identification
- Monitoring

### Vulnerability Analysis

#### Predictive Models:

Models predicting the probability for infestations on the West Coast primarily used calcium concentrations to predict that most of California was vulnerable except for the southeastern part of the state. Unfortunately, Drake and Bossenbroek (2004) using GARP models reached the conclusion that nearly all of the West is “uninhabitable for zebra mussels.” All three of the Drake /Bossenbroek models predicted “zero” chance of mussel invasion in Lake Mead. As we have witnessed, quagga mussels have successfully colonized Lake Mead and Southern California.



Map 2: Dreissena Mussel Sightings in California

## Proximity to West Coast Infestations (as of 3/1/2012)

### Lake Mead, Nevada:

On January 6, 2007, a Las Vegas Harbor Marina employee discovered a live mussel on a steel cable anchoring a section of breakwater. Originally identified as a zebra mussel, subsequent surveys found the mussels throughout Lake Mead's lower basin. Populations with smaller densities were also found



Lake Mead Marina

in Lake Mojave, Lake Havasu and the Colorado River. Live mussels were collected at depths from 70 feet to over 200 feet. Within a couple weeks, taxonomists changed the original species determination to Quagga Mussel, *Dreissena rostriformis bugensis*. Personal conversations with National Park Service employees and volunteers confirmed that pre-Quagga surveys were directed at zebra mussels and did not include considerations (differences in life cycle and ecological preferences) for quagga mussels.

### Southern California - Metropolitan Water District Southern California (MWDSC):

MWDSC receives raw water from the Colorado River. A very rapid proliferation of quagga mussels was observed at the MWDSC water intake in Lake Havasu with mussel densities of 1-2 individuals per square meter in February 2007 to 10,000 mussels per square meter in less than one year (DeLeon - 2008). To prevent infrastructure colonization by mussel larvae from the Colorado River, MWDSC undertook rapid

action to control movement of mussel veligers including aqueduct shutdowns and facility upgrades for chlorination.

### San Justo Reservoir:

The first established population of Zebra mussels on the West Coast was found by an angler in January 2008 in San Justo Reservoir in San Benito County. San Justo is a small reservoir near Hollister that has been closed to the public since January 2008.

### Lahontan Reservoir, Nevada:

Lahontan Reservoir was classified as positive for quagga mussel veligers on August 5, 2011, even though follow-up surveys prior to the original determination in April 2011 were negative for veligers. The reservoir must test negative for three to four years before the reservoir can be removed from the positive list.

### Rye Patch Reservoir, Nevada:

Surveys in April 2011 were positive for mussel veligers and negative since the April finding.



Rye Patch Reservoir, Nevada.

## Vector Identification

### Vector Identification and ranking:

The routes by which invasive species enter new areas are known as pathways; while the way they travel





San Justo Reservoir boat ramp on 10/10/10. Photo by Ken W. Davis

to new destinations are known as vectors (UNEP 2001). Carlton (1993) outlined three dispersal vectors for the zebra mussels including three natural mechanisms and twenty human-related mechanisms. When assessing the importance of different vectors, it is important to consider the life stage of the mussel that is likely to be transferred and frequency of transfers. The single transfer of a few mussel adults or juveniles to an environmentally suitable lake will not guarantee the development of a new colony. Transfer of veligers between lakes may be less likely to create a founding community than the transfer of adults.

Vector identification, analysis, and interception - when possible - are crucial to prevent the introduction of *Dreissena* mussels into Lake Berryessa and the Solano Project. Possible vectors include:

#### Houseboats:

Houseboats represent a serious vector for the introduction of mussels into Lake Berryessa. Numerous houseboats have been intercepted that harbor live mussels. In February 2007 workers at Lake Pleasant Arizona intercepted a 55-foot houseboat from Lake Mead whose hull was covered with adult mussels. In summer conditions in North America, zebra mussels can survive for more than five days attached to a boat hull or trailer out of water (Ricciardi, 1995). The recent acceptance of Pensus Group Inc., in April 2010, to operate six resorts and marina services on Lake Berryessa creates some concern due to Pensus operations in mussel infested waters in other states.

#### Bass boats:

Bass boats that use live holds represent a real hazard for the translocation of mussel veligers from a wide variety of mussel-infested waterways.



Lake Mead Nevada. Biologists inspect a mussel infested houseboat at Callville Bay Resort.

Other vectors of concern include:

- Recreational watercraft
- Inflatable watercraft
- Angling equipment
- Fish introductions
- Migrating waterfowl

### Environmental Factors Necessary for Mussel Survival

Survival and growth rates for *Dreissena* mussels are influenced by several environmental factors including water chemistry, plankton concentration, water current and benthic characteristics. Under ideal

conditions, *Dreissena* mussels can grow .21 mm/day (Ackerman 1994), attaining sexual maturity in approximately 40 days. Important factors for growth and survival are calcium, alkalinity, total hardness, pH, dissolved oxygen, water temperature and a plentiful supply of plankton.

*Dreissenids* inhabit a wide range of temperatures in North America. Both *Dreissenids* are found in the Great Lakes at temperatures less than 5°C. Populations of zebra mussels in the lower Mississippi River are thriving where temperatures exceed 30°C and fall below 15°C for a few months (McMahon 1996).

### Can Eurasian mussels survive in the Solano Project System?

When considering the suitability of a waterbody for Eurasian mussel invasion, calcium levels in the water is of primary concern. Calcium is essential for the production of shell material in the Eurasian mussels. Without sufficient levels of calcium, introduced adults will not survive and veligers will not develop. Unless adequate calcium is present, all other physical parameters - other than pH - are irrelevant. If calcium levels are sufficient, then the other primary environmental parameters should be considered in the process of assessing potential mussel survival. Those parameters are pH, temperature, conductivity, and plankton levels.

Available information and observations conclude

<b>Table 1: Ideal Parameters for a moderate Eurasian Mussel Infestation</b>				
Parameter	Zebra Mussel	Quagga Mussel	Golden Mussel	Lake Berryessa
Calcium (mg Ca/L)	15-30	12 - 30	5 - 80	> 20
pH	7.4 - 9.0	7.4 - 9.0	5.0 - 7.0	> 8 - 8.5
Temperature (°C)	10-20	10 - 16	16 - 26	4 - 25
Oxygen (mg/L)	7 - 8	7 - 8	3 - 6	6 - 11
Conductivity $\mu$ S/cm	60-110	60 - 110	30 - 3800	311 - 351
Depth (meter)	Surface to 50	surface to 120	Surface - ?	84

Table 1: Mussel Infestation Parameters. From Claudi 2010 and collection data from Lake Berryessa.

that mussels could create a moderate infestation in the Solano Project. Data gleaned from water treatment plants along the Putah South Canal (Rabidoux 2011) shows that calcium and pH readings are above levels needed to support moderate mussel infestations. Observations and supportive data (conductivity, temperature, pH, and plankton levels) at Lake Berryessa also support concern about potential for a moderate infestation at Lake Berryessa, especially in some areas such Capell Cove.

Monitoring:

See Field Surveys (Page 15)



Boat Inspection - Capell Cove Ramp

### 3. Preventing a Mussel Introduction

#### **Actions to Prevent Infestations: Lake Berryessa**

1. Monthly plankton tows and processing plankton samples
2. Monthly examination of deployed artificial substrates.
3. Visual examination of various structures in Lake Berryessa, Putah Creek, Putah South Canal, and Terminal Reservoir.
4. On-site education Program that includes:
  - a. On-site education
    - i. Agency staff (rangers): Trained to inspect watercraft
    - ii. Marinas: trained to inspect watercraft
    - iii. Boaters
    - iv. Discussion with boaters and anglers
    - v. Onsite posters
  - b. Off-site education

- i. Newspapers articles
- ii. Presentations to civic groups, agencies, and angling clubs
- iii. Internet venues including blogs, LinkedIn, etc.

*Note: The Solano County Water Agency does not have the legal authority, management responsibility, or effective control over recreational boating on Lake Berryessa. USBR manages all recreational activities on Lake Berryessa.*

#### **Actions to Prevent Infestations: Putah Creek**

1. Monthly plankton tows and plankton samples below Monticello Dam
2. Monthly examination of artificial substrates below Monticello Dam
3. Visual examination of rip rap below Monticello Dam



Numbered brick used for early detection of adult mussels.



Putah Creek: Survey section immediately below Monticello Dam



4. Education Program that includes:
  - a. On site and off site education of anglers

#### **Actions to Prevent Infestations: Putah South Canal**

1. Monthly net drags across canal.
2. Monthly examination of artificial substrates
3. Visual examination of infrastructure (grates, banks, etc.)
4. Education Program that includes:
  - a. Solano Irrigation District staff

#### **Actions to Prevent Infestations: Terminal Reservoir**

1. Monthly examination of artificial substrates
2. Monthly plankton tows
3. Visual examination of infrastructure (grates, banks, rip rap)
4. Education Program that includes:
  - a. Vallejo Water Department staff

#### **Actions to Prevent Infestations: Other**

1. Speaker's Bureau for civic groups

2. Regular education with angling groups
3. Mussel Workshop for SCWA customers

#### **Concerns**

Several issues are germane to preventing a mussel infestation in Lake Berryessa and the downstream Solano Project:

1. Capell Launch Ramp: The Capell Launch Ramp is a free launch ramp on the western side of Lake Berryessa that allows vessels to enter the lake without inspection or documenting the use of the vessel in other water bodies. Vessels are inspected on summer holidays and on some weekends until 11:30AM.
2. Lack of operations staff at Lake Berryessa: The informal partnership with the USBR at Lake Berryessa is crucial to preventing a mussel infestation in the Solano Project. The partnership allows us to work with the existing marina concessionaires and The Pensus Group.



Terminal Reservoir, the terminus of the Putah South Canal near the city of Cordelia

## 4. Education



Educating anglers - Putah Creek

“The most effective strategy against invasive species is to prevent them from ever being introduced and established. Prevention includes education and outreach to raise the awareness of the invasive species problem and reduce the chance of unintentional introduction of invasive species.”

U.S Forest Service (USFS 2012)



Angler education on the Trinity River. Class about invasive species and native invertebrates.

### Background

The development of an effective education program is key to preventing the introduction of Eurasian mussels into the Solano Project. ***The Solano Project Early Detection and Education Plan*** implemented a comprehensive education and outreach program on July 1, 2008 using the following:

- Training watercraft inspectors at Lake Berryessa
- Presentations to PSC water users
- Presentations to angling groups

- Presentations to civic groups
- Presentations to Lake Berryessa concessionaires
- Development of educational flyer for boaters
- Discussions with boaters
- Newspaper articles

### Aquatic Nuisance Species:

The education and outreach program was developed using standard practices implemented to prevent the introduction of aquatic nuisance species.

- Identifying pathways
- Understanding life cycles
- Educating possible vectors (anglers / boaters)
- Changing behavior
- Rapid response plan

Our experience in Putah Creek with the New Zealand mudsnail infestation has documented that the above actions are effective at identifying vectors, changing behavior, and possibly preventing the spread of aquatic invasive species.

### Education Program

#### Watercraft Inspectors - Level one:

Soon after the discovery of quagga mussels in Lake Mead, the Pacific States Marine Fisheries Commission (PSMFC) and several partners offered Level One “Watercraft Inspection and Decontamination Training” for zebra and quagga mussels. The five-hour training was given at numerous locations and featured an overview of species, outreach and education programs, basic mussel biology, vectors, mussel impacts, techniques for inspecting watercraft and documentation of trailered watercraft. Level One Certification is now given on an annual basis at Lake Berryessa by Ken Davis, a Level Two instructor and



Lake Mead. Shows students in Level-Two Watercraft Inspection class decontaminating a mussel-infested boat.

certified mussel incident responder.

#### Watercraft Inspector - Level Two

Level Two training is an intensive two-day course at Lake Mead near Las Vegas that has a focus on field inspection of various types of watercraft leaving Lake Mead. The vessels and trailers may be contaminated with quagga mussels. Participants learn to use power-wash equipment to decontaminate mussel-infested watercraft at Callville Marina. Ken Davis graduated from the Level Two course in 2009 and annually teaches a Level One training and offers certification to USBR staff, Solano Resource Conservation District staff and volunteers, Lake Berryessa concessionaires, and others.



Quagga mussels on a boat motor. Image used effectively to get attention of young male boaters.

#### Boater Education:

An educational flyer for boaters was developed due to a request from Lake Berryessa concessionaires and a survey completed at Pleasure Cove Marina in 2008. The existing flyers and brochures did not adequately convey the danger of a mussel infestation to boats and watercraft. The flyer can be seen in Appendix E on page 42.

#### Speaker's Bureau:

Since 2009, Ken Davis has given Eurasian mussel presentations to a variety of groups including civic organizations, classes at U.C. Davis, Audubon, and others. A presentation flyer for the Eurasian Mussel Presentation is available in Appendix N on page 60.

#### Angling Groups:

There are approximately 20 fly fishing clubs in California that have members who fish in Lake Berryessa and Putah Creek. Ken Davis has given presentations to eighteen of the clubs that range from San Diego to Redding. The Power Point Presentation is about fishing Putah Creek, native invertebrates, New Zealand mudnails, Eurasian mussels, and how to prevent the introduction of other invasive species. A presentation flyer for the Fly Fishing Presentation is available in Appendix O on page 61.

#### Eurasian Mussel Workshops:

The first "Zebra/Quagga Mussel Workshop: Potential



Markley Cove Marina: Boaters are required to check-in and fill out appropriate forms before they launch.



Vulnerability & Impact to the NBA & Solano Project” was held on February 28, 2012 in Vacaville. The workshop was designed primarily for water users, but was open to anyone. The agenda is available in Appendix P on page 62.



Lake Berryessa News has published annual articles about Eurasian Mussels.

#### Newspaper Articles:

A concerted effort to have regional newspapers run articles about the mussel issue is a highly effective method of gaining support from the recreational public. In the past, we have appealed to the following press for coverage:

- The Lake Berryessa News
- Sacramento Bee
- The Reporter (Vacaville)
- Daily Republic (Fairfield)
- Davis Enterprise
- Woodland Daily Democrat
- Napa Valley Register

Beginning in March, we plan on getting additional newspaper coverage of the mussel program at Lake Berryessa.

#### Blogs and Online Media:

We have developed a cursory blog presentation concerning invasive species, have applied efforts on YouTube, Twitter, and LinkedIn. Those efforts are being increased beginning in March 2012.

## 5. Field Surveys



Inspecting mussel colonization device

### General Protocol Philosophy

Survey protocol used in the Solano Project was developed by Ken W. Davis (Aquatic Biologist – Wildlife Survey & Photo Service) using sources considered knowledgeable about mussel infestations, life cycles, and known mussel behavior. Sources include personal conversations with well-known researchers, best practices, research manuals, presentations at mussel conferences, observations at Lake Mead and San Justo Reservoir, personal knowledge of the Solano Project, and sampling experience. The following have been used in the Solano Project since July 2008.

### Preventing False Positive Determinations

False positive determinations are problematic for many reasons including increase costs for monitoring, additional survey equipment, altered facilities, and potentially additional water treatment systems. In an effort to avoid false positives the existing mussel plan for the Solano Project includes:

1. Primary surveys that require confirmation by three other taxonomists and intensive secondary plankton sampling. Suspected" organism consultations include images, measurements, environmental data transmitted to at least three scientists listed on notification schematic. See Appendix A: Notification Schematic for the Solano Project.



Google Image: Markley Cove Marina on 9/24/2009. Plankton samples are collected and colonization devices are deployed at the popular marina.

<b>Table 2: Monitoring Protocols</b>						
<b>Survey Type</b>	<b>Life Cycle stage</b>	<b>Optimal Sampling Frequency</b>	<b>Optimal Sampling Period</b>	<b>Equipment Costs</b>	<b>Labor Required</b>	<b>Sample Processing Costs</b>
Existing surfaces	Juveniles Adults	Monthly	Year around (warm climates) High Risk: March - November	Minimal	\$	n/a
Artificial surfaces	Juveniles	Monthly	Year around (warm climates) High Risk: March - November	Lines Substrates	\$\$	n/a
Plankton	Veliger Plankton	Monthly (depending upon temperature)	Year around (warm climates) High Risk: March - November	Nets Processing	\$\$\$\$	\$\$\$\$

Table 2: Monitoring Protocols. From Culver 2009.

2. Mussel Photo Manual: Photo Manual allows for direct comparison of images, size comparison with native organisms and voucher mussel veligers. Voucher specimens are from the USBR laboratory in Denver and authorized by Scientific Collection Permit No 6466.

### Types of Surveys

#### Plankton Tows

Plankton tows are subject to a variety of opinions and protocols. Plankton tow protocols used in the Solano Project have been developed after discussions with a variety of highly experienced scientists, including Dr. Robert McMahon (University of Texas), Steve Wells, (Center for Lakes and Reservoirs - Portland State), Jeff Janik (California Department of Water Resources, and Renata Claudi (RNK Consulting) .

Several survey techniques are currently being used in the Solano Project. Monthly plankton tows are conducted at all established Lake Berryessa marinas and launch ramps and biannually in the main channel and larger coves of the lake. Samples are also taken bimonthly immediately downstream from Monticello Dam. Early in the surveillance program the main emphasis was switched from plankton tows from a boat to tows taken off the marinas for several reason including:



EPA approved 64 micron plankton net used to collect Lake Berryessa plankton

1. Mussel infestations are most likely centered around docks, gas pumps, and launch ramps.
2. More direct control of plankton net including depth and angle of tow
3. Allowed discussion (direct education) with boaters and anglers
4. Less impact from inclement weather that prevented use of boats
5. Limited access to boats using USBR staff
6. More efficient protocol
7. Less cost due to number of personnel need for boat tows



## SOLANO PROJECT MAP AND SURVEY AREAS



### Survey Areas

- Lake Berryessa
- Monticello Dam
- Putah Creek (Interdam)
- Putah Diversion Dam
- Lower Putah Creek
- Putah South Canal
- Sweeny Creek
- Green Valley Creek
- Terminal Reservoir

Note: Most sites include sub-site survey areas.

Map 3: Solano Project map and survey areas

### Description of Plankton Tows:

Plankton tows are used to sample for the presence of the larval (veliger) free-swimming stage of Eurasian Mussels. Surveying for mussel veligers is useful for detecting an infestation before the density of adults is sufficient to locate using visual surveys. However, the overall process is technical requiring special equipment, taxonomic expertise, and is subject to false positives. A variety of techniques and protocol are used to help prevent false negative and false positives. All nets used in the system are dedicated and never used in other waterways.

U.S. Environmental Protection Agency (EPA) approved 64 micron mesh (20 inch diameter mouth) plankton nets are required to sample the industry standard of 500 liters (all samples collected in the Solano Project filter a minimum of 4000 Liters). The site

depth is determined by a sonar gun; the plankton net is lowered at least 70 feet and slowly retrieved. Enough tows are taken to adequately sample 4000 Liters. Each sample is condensed and preserved in a 70% Ethyl Alcohol (ETOH) solution. Smaller tow nets (8 inch mouth) are used in areas (such as Terminal Reservoir) when the larger net is impractical. The smaller nets are weighted which allows the net to be tossed and slowly retrieved.

### Sample Preservation:

Samples are preserved in a 70% ETOH solution by determining the volume of the sample and adding 3 times the volume with 95% ETOH to the sample. For example, if the plankton collection is at 1 inch in the collection bottle, you would add 3 inches of 95% ETOH so that the sample bottle would contain 4 inches of combined sample and ETOH (SDCWA 2008)



Decontamination:

All nets and equipment are decontaminated after each use. See Appendix H on Page 48: *Decontamination Protocols as recommended by the California Department of Fish & Game.*

Artificial Substrates:

Veligers move through the water column using cilia (hairs). At about six weeks, the veligers attach to a suitable surface. That process, called settlement, can be used to detect an infestation. Artificial substrates are suspended from existing structure and checked regularly for juvenile and / or adult mussels. Research (Kilgour 1993) has shown that mussel veligers prefer to settle on a variety of substances including, stainless steel, polypropylene, steel, vinyl, PVC, and concrete. A collection of materials attached to a cable (called a colonization tree) are deployed in sites with conditions ideal for mussel settlement. The cables are labeled with appropriate permit identification and



Putah Diversion Dam

attached to an existing structure such as a buoy or boat dock. Artificial substrates such as ordinary bricks that are numbered are used in several sites in the Solano Project.

**Visual (Physical) Inspections**Lake Berryessa:

A. Baseline surveys: In 2008, during a low water period in Lake Berryessa, all existing docks, many high and dry, were examined for any sign of an existing



Abandoned dock at former Putah Creek Resort Marina. Lake Berryessa.

mussel infestation. All visual surveys of the docks before they were destroyed by the USBR were negative.

- B. Routine visual surveys include:
- Docks: small percentage examined monthly
  - Boats: hulls visually examined while walking the docks. Boats are never touched or boarded.
  - Hydro lifts: visually examined while wading to plankton collection sites.
  - Banks: visually examined while walking to collection sites.
  - Cables: visually examined while walking to collection sites.

Putah Creek:

The rip rap immediately below Monticello Dam is visually surveyed every two months. The entire area and the downstream face of Monticello Dam are examined annually after the water level is lowered in September/ October.

Putah Diversion Dam (PDD):

Infrastructure at the PDD is visually surveyed every two months.

Putah South Canal (PSC):

Existing infrastructure (above water) in the PSC is surveyed during routine monthly sampling for New Zealand mudsnails and adult mussels. Visual surveys are casual. The initial section of the canal is entered



Putah South Canal: Sections are visually inspected for invasive species prior to annual canal cleaning.



Sediment and other material removed from Putah South Canal. Material is inspected for invasive species.



Sediment and aquatic invertebrates removed from Putah South Canal during the annual cleaning.

and physically examined annually in September / October when the canal is dewatered for cleaning.

#### Putah South Canal Sediment:

The Putah South Canal is cleaned on an annual basis after the agricultural season. The sediment and other materials removed is checked for invasive species.

#### Terminal Reservoir:

Rip rap, metal infrastructure, and cobble examined every two months.

#### Subsurface Video Inspections:

A video system has been tested on the upstream surface of the Putah Diversion Dam. It is not routinely used, but is available to examine subsurface structure if necessary.

### **Process for Reporting Results**

Updates are transmitted to Solano County Water Agency on a monthly basis and annually to the California Department of Fish & Game per the requirements of Scientific Collection Permit (SCP) No 6466 issued to Ken W. Davis. Permit valid 12/28/11 - 12 /28/13

**Dreissena Mussel Survey**  
For Information Call:

**Ken W. Davis**

Aquatic Biologist  
Wildlife Survey & Photo  
2443 Fair Oaks Blvd # 209  
Sacramento, CA 95825  
(916) 747-8537  
ken@creekman.com

**DFG Permit 6466**

Label required on all collection (traps) deployed under auspices of DFG Scientific Collection Permit



Putah Trap originally designed to capture New Zealand Mudsnails are also used for mussel detection in the Putah South Canal.

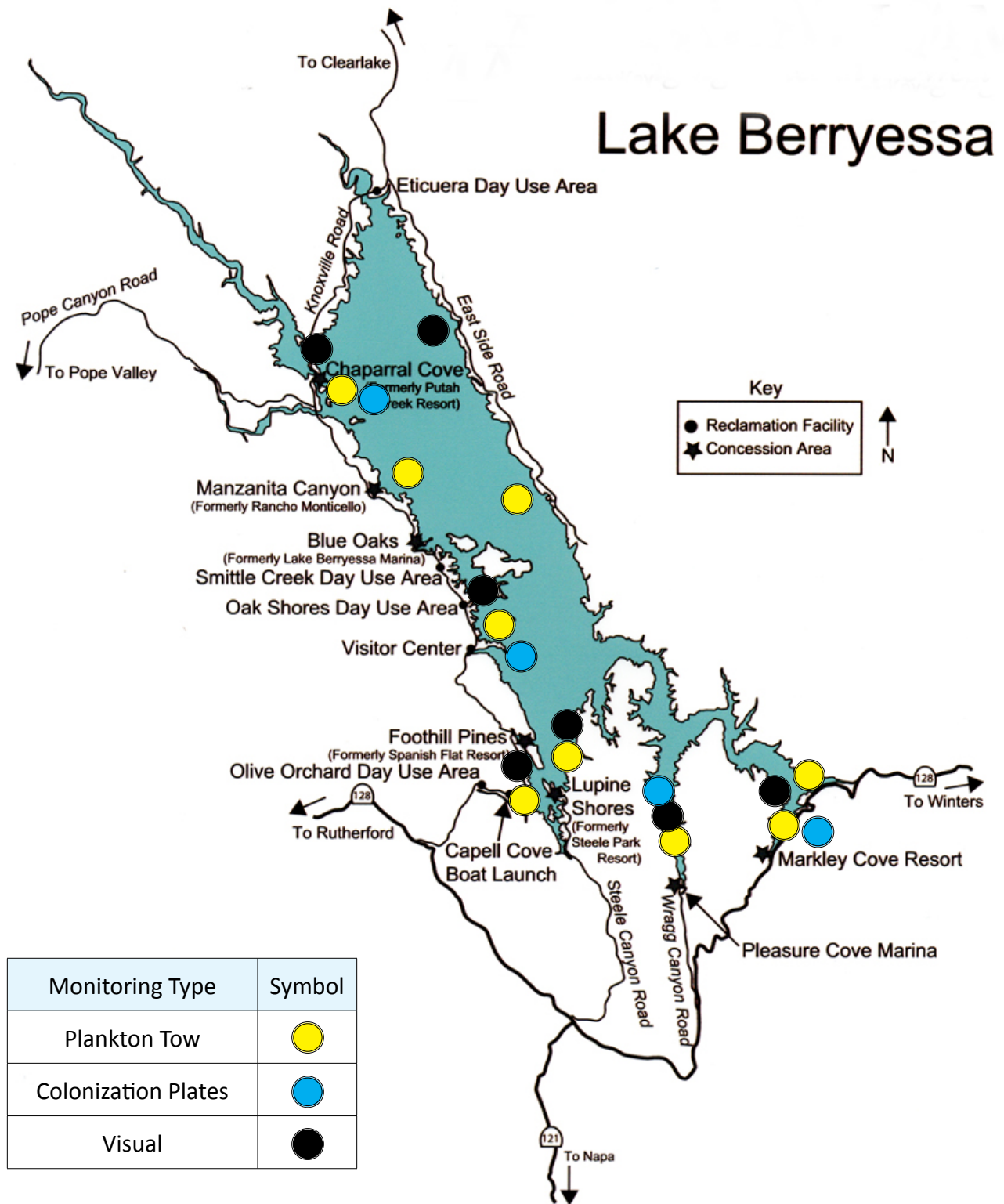


Eurasian Mussel Collection device deployed at several sites in Lake Berryessa, The one shown is locked to a dock at Markley Cove Marina. The device is attached to a series of other materials that are connected by coated aircraft cable.



Rip Rap at Terminal Reservoir. This small water supply reservoir is 100 miles due north of the zebra mussel infestation in San Justo Reservoir









Quagga mussels on boat hull

## 6. Eurasian Mussel Information

The term “Dreissena mussels” is commonly used to describe mussels in the genus *Dreissena* including the zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena rostriformis bugensis*). The term “Eurasian Mussels” includes the *Dreissena* mussels and the Golden Mussel (*Limnoperna fortunei*).

### Life Cycle

(Disclaimer: Information about *Dreissena* mussels is gleaned from research on the East Coast and infestations in Lake Mead, Southern California, and San Justo Reservoir near Hollister, California. It should be noted that the quagga population in Lake Mead has exhibited numerous differences - such as number of life cycles per year - from the population on the East Coast. Research on the Zebra Mussel infestation in San Justo Reservoir is on-going.)

The life cycle of the Eurasian Mussels consists of a planktonic free-swimming larval stage, a “settling” juvenile stage and a relatively sessile adult stage. Mussels reproduce by releasing eggs and sperm into the water column that produce microscopic larvae called veligers. Spawning occurs when the water temperature exceeds 12° C., typically between February - December in some areas of California. Veligers of both quagga and zebra mussels are microscopic, ranging in size from 39-500 microns (0.0039-0.05mm). The larvae move freely through the water column using a “velum” (cili-

ated structure) until they are more developed and find a suitable place to settle. That process – called “settlement” - can take from 5-240 days, although most settle out within six weeks. At that point, the veligers metamorphose into a juvenile that resembles a small adult and settle out of the water column. If the substrate proves appropriate, they secrete byssal threads (small thin fibers) from their foot and attach to hard surfaces, where they continue to develop into the adult mussel form (Nichols 1996). Attachment sites include aquatic life, boat and trailers, docks, trash, water conveyance pipes, and facilities. Successful colonization can also occur on soft, muddy substrate (Berkman, 1998). Quagga mussels have broader habitat and environmental tolerances than zebra mussels. For example, they can tolerate lower

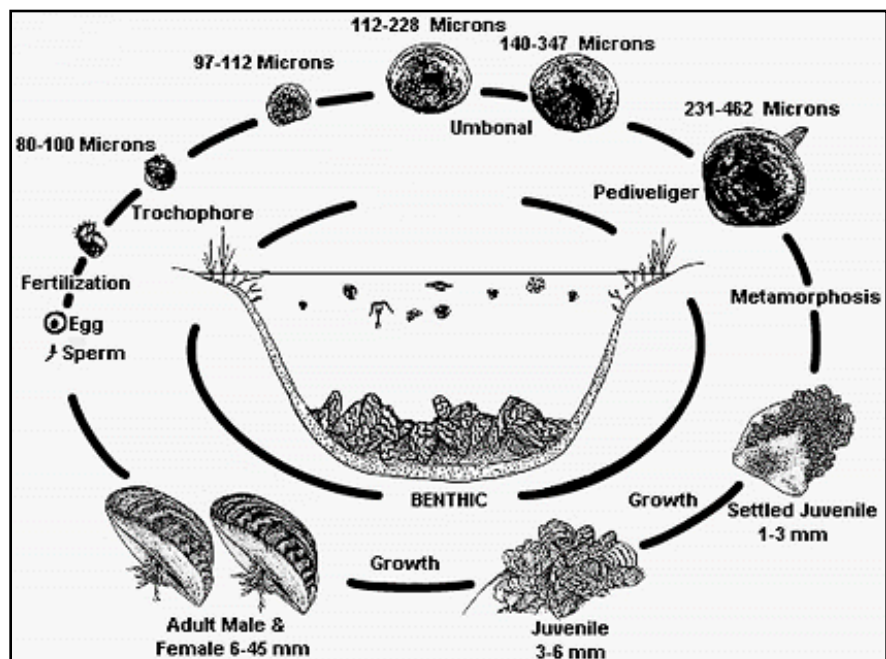


Table 3: Mussel life cycle. From Glenn Black.

water temperature and can be found at much greater depths. Quagga mussels have been found in Lake Mead as deep as 100 meters.

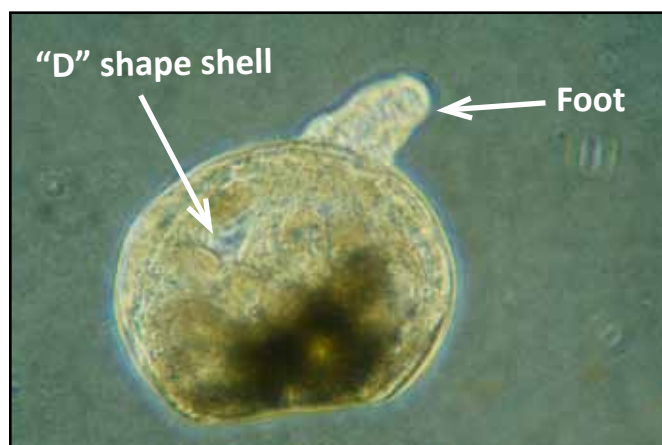
#### Veligers:

Zebra mussels, quagga mussels, golden mussels and Asian clams all produce veligers. Characteristics allowing for the most rapid and accurate separation of larvae are hinge length, shell length/height, shell shape, and the presence or absence of a foot and velum.

Mussel and clam veligers - and some zooplankton - are birefringent under cross-polarized light. Organisms with calcium containing shells show a Maltese cross - highlighted by a black background - when examined under a cross-polarized stereo microscope. Images below show Quagga Mussel veligers as



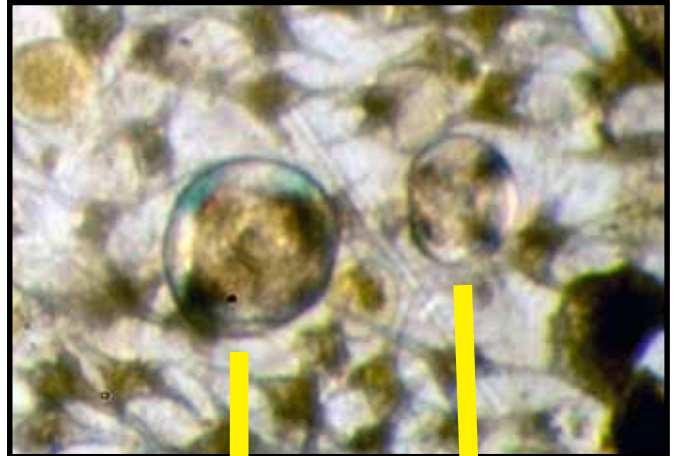
Mussel veliger



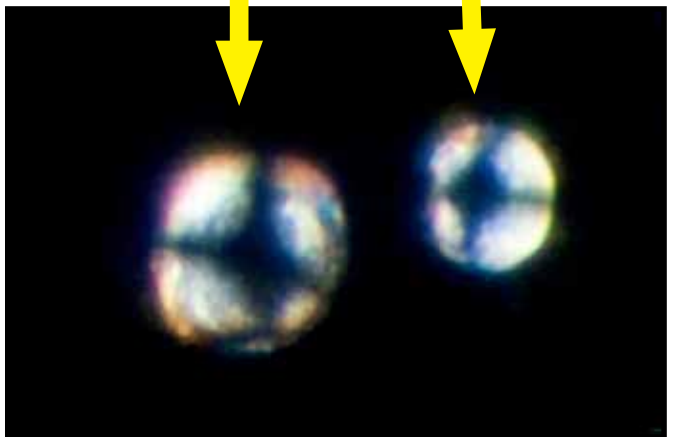
Asian Clam veliger

viewed through a microscope using (A) bright light and (B) using cross polarized light.

**A.**



**B.**

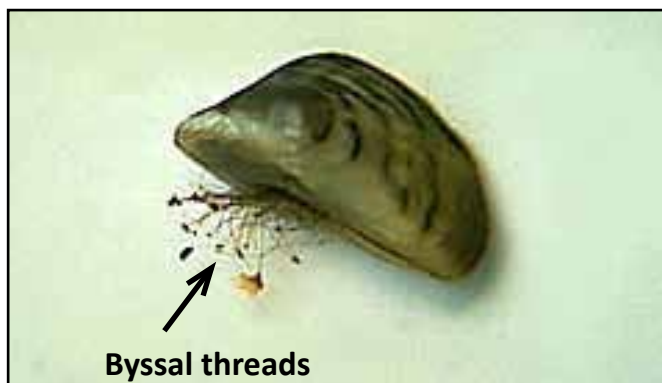


<b>Table 3: Eurasian Mussel Species</b>			
	<b>Zebra Mussel</b>	<b>Quagga Mussel</b>	<b>Golden Mussel</b>
Shell	Triangular shape, byssal side (ventral) flat. Obvious ridge between side and bottom	Rounded sides, byssal side rounded. Ridge lacking	Longer. Key is nacreous layer inside shell that dreissena mussels do not have
Shell length	Average 2.0 - 3.0 cm length. May reach 4.0 -4.5 cm	Average 2.0 - 3.0 cm length. May reach 4.0 - 4.5 cm	Average 2.0 - 4.0 cm. May reach 8 cm
Shell Color	Variable color and patterns, usually dark	Pale near hinge, dark concentric rings on shell.	Golden or yellowish
Byssal	Large groove in middle of flat side allows tight hold on rocks	Small byssal groove near the hinge	Byssal opening more posterior than in dreissenids
Depth in Lakes	1 -30 meters, rarely found below 15 meters	1-107 meters, commonly found down to 30 meters	unknown
Nacreous layer	No	No	Yes

Table 3: Eurasian Mussel Species. From Claudi 2010



Adult Golden Mussels (Anthony Ricciardi)



Quagga Mussel - Ohio Sea Grant



USGS Image





Adult Zebra Mussel

## 7. Laboratory Techniques

### Microscopy

Microscopic methods used for samples collected from the Solano Project are based on personal discussions with Dr. Robert McMahon (Uni. Texas / Arlington), Denise Walter (USBR Lab / Denver), Steven Wells (Center for Lakes and Reservoirs) and Jeff Janik (California Department of Water Resources). The following literature was also considered: Britton 2010, Claudi 1998, Claudi 2010, and Nichols 1993,

### Efficient Sample Processing

Sample processing is completed within twelve hours of collection at the Wildlife Survey office and is designed to be a first line of detection to avoid processing delays and misidentifications by other taxonomists. Ten subsamples of 15 milliliters (ml) each are centrifuged for 15 minutes at 1500 rpm. Approximately 5 ml. of the concentrate is placed in a watch glass and examined under a cross polarized microscope.

### Analytic Methods

#### Veliger Analysis Equipment:

- Cross-polarized stereo microscope with ocular micrometer and triocular camera port
- Compound polarized microscope with ocular micrometer and triocular camera port
- Digital camera mount, storage card, and processing software
- Segwick-Rafter cell and appropriate cover slips
- Multispeed Centrifuge
- Vinegar
- Dissecting tools
- Computer

#### Cross-polarization Microscopy:

Zooplankton, with calcareous skeletons, and some other materials are “birefringent” under cross-polarized light. Birefringent objects that contain calcium show a Maltese Cross when viewed under cross polarized light such as used in cross-polarized microscopes. The advantages of using cross-polarized examinations are monumental: The accuracy of counts is improved by 15% (over controls) and the time required for counts is reduced by 41%. See images of cross-polarized microscopy on Pages 21 and 23.

#### Treatment of Suspect Organisms:

Organisms that are considered suspect are measured and photographed. That data is transmitted to four other taxonomists for a second level of review and determination.

#### Equipment Decontamination:

All laboratory equipment is decontaminated between samples to prevent cross-contamination. Centrifuge vials, slides, slide cover, Segwick-rafter cells are decontaminated with vinegar. Vinegar dissolves calcites in the shells of Asian clams, Eurasian Mussel veligers, and ostracods.

#### Identification:

Misidentification (false-positive determinations) of mussel veligers is a significant problem that has caused unnecessary expense to watershed managers, upheaval of recreational activities, and infrastructure changes. Significant efforts are being made to eliminate the possibility of false positives by establishing a process for reporting suspicious organisms and a hierarchy plan for sharing images of those organisms with three other taxonomists. There is also a

follow-up plan for additional surveys and reports. A photo library of the plankton community found in the Solano Project has been established; it includes more than 500 *Dreissena* images.

### Readability of Samples

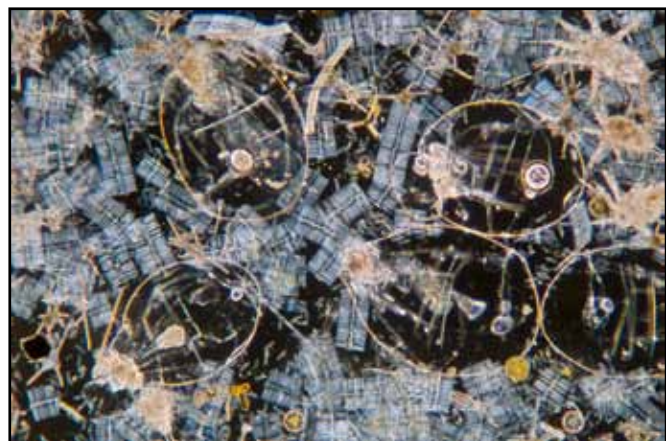
“Readability” defined as the ability to see suspicious organisms in dense plankton samples. Copious amounts of detritus, phytoplankton and zooplankton interfere with routine methods of seeing veligers. Efficacy is improved by using cross-polarized microscopy. Readability is confirmed by the retrieval of preserved mussel veligers that are counted and placed in collected samples. On a monthly basis, 10 preserved veligers (ETOH) are placed in a negative sample from the Solano Project and processed normally to determine the level of veliger recovery. All equipment used is decontaminated or destroyed to avoid cross-contamination.



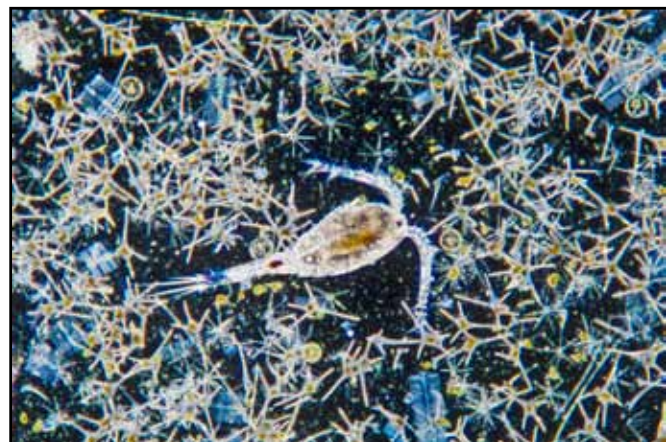
Microphotograph: Plankton collection with preserved mussel veligers placed (spiked) in the sample. Under bright light the veligers are difficult to see in the dense plankton collection. See veligers revealed below when cross-polarized light is used on the microscope.



Plankton collection from Capell Cove Public Launch Ramp, Lake Berryessa. Shows sample collected by filtering approximately 5000 Liters of lake water through a plankton tow net.



Dense plankton collection from Lake Berryessa.



Dense plankton collection from Lake Berryessa.



## Plankton and Veliger Image Library

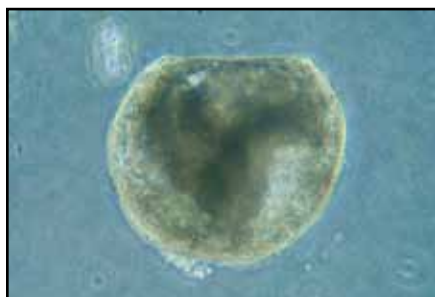
Image Library: Examples of more than 2000 images that are used to document the plankton community in the Solano Project and to compare suspect organisms to known members of the plankton community. See pages 28 and 29 for measurement data of some veligers. Images © Ken W. Davis

### Zooplankton



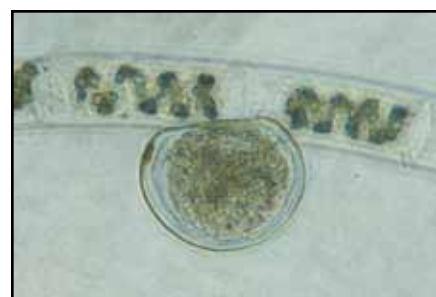
Seed Shrimp (Ostracod)

### Asian Clam Veligers

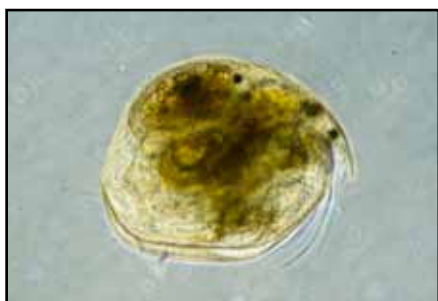


Asian Clam veliger

### Mussel Veligers



Zebra Mussel straight-hinge veliger



Water flea (Cladocera)



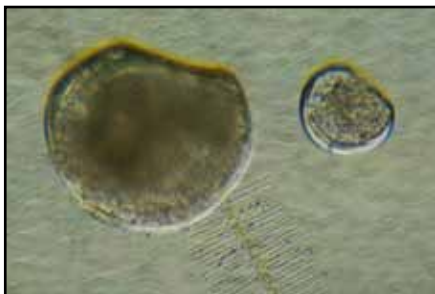
Asian Clam veliger



Zebra Mussel umbonal veliger



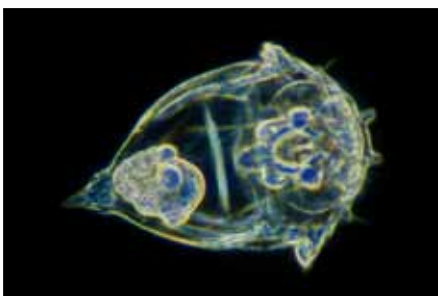
Water flea (Ostracod)



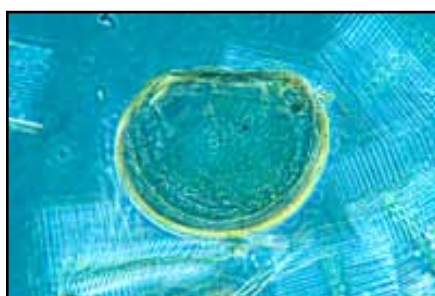
Asian Clam veliger (L) compared to Quagga Mussel veliger (R)



Quagga Mussel straight-hinge veligers



Rotifer:



Asian Clam veliger



Quagga Mussel pediveliger



## Comparative Images with Measurements

Veliger measurement (width, height and hinge) and shape are essential for accurate species determination. The sheets below show examples of veliger measurements taken for three species: Asian clam, Zebra mussel, and quagga mussel. Photos and comparative sheets by Ken W. Davis.

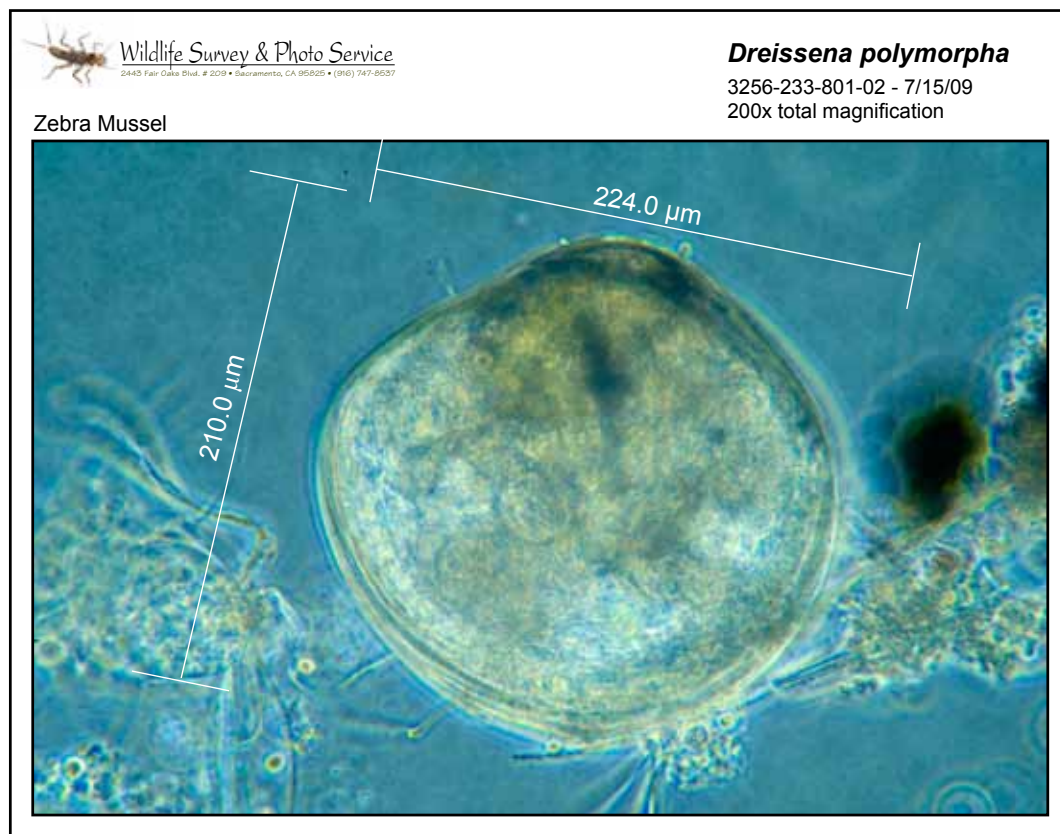
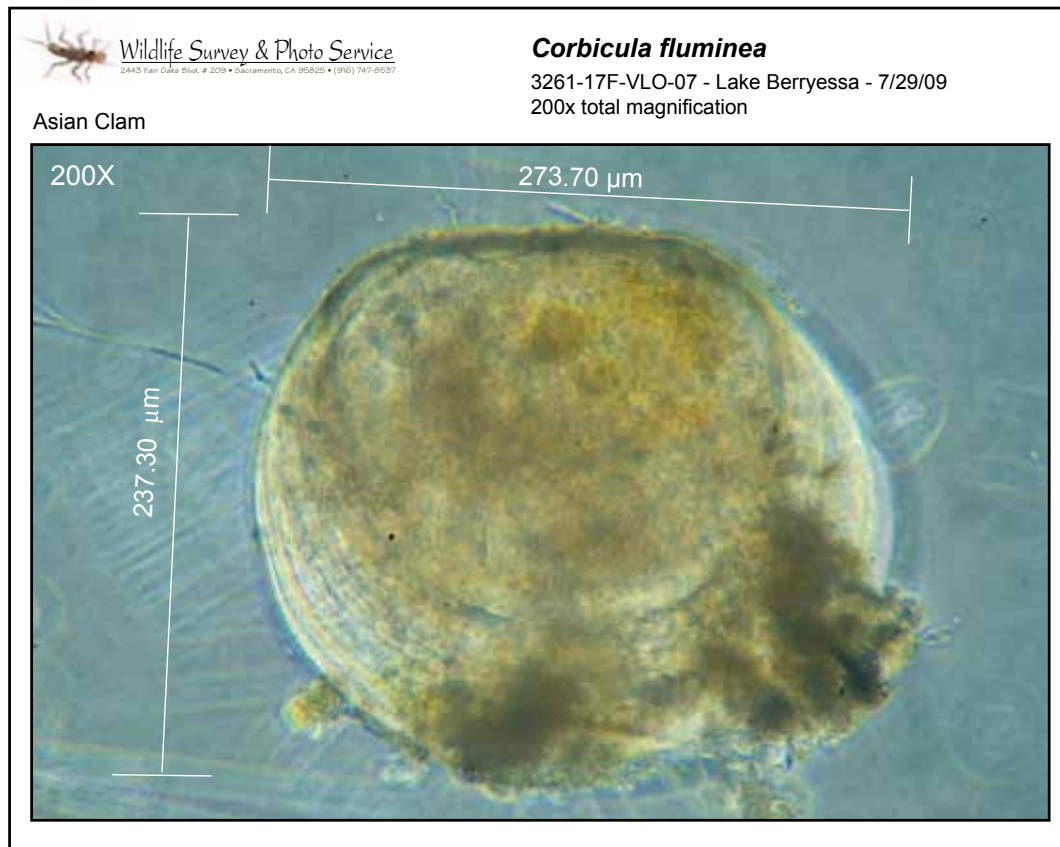


Quagga Mussel Veliger

### *Dreissena bugensis* - umbonal veliger

3178A-Mead-510-48 - USBR Collection - Lake Mead  
200x total magnification







Morning on Lake Berryessa

## 8. Glossary

**Asian Clam:** Common name for a species of biofouling clam, *Corbicula fluminea*, introduced from Asia.

**Benthic:** Of, or pertaining to, the bottom of a body of water the organisms living at the bottom.

**Birefringent:** The process of objects that refract light in slightly different directions to form two rays - a Maltese Cross. Mussel and clam larvae are strongly birefringent when viewed through a cross-polarized microscope.

**Biofouling:** The fouling of pipes and underwater surfaces by organisms such as algae, barnacles, and mussels.

**Byssal threads:** Tufts of hair-like threads produced by glands in the base of the foot of Dreissenid mussels. Consists of a root, shaft, and adhesive disk.

**Calcite:** A white or colorless mineral consisting mainly of calcium carbonate.

**Cilia:** Hair-like structures that veligers use in coordinated wave motion to aid movement.

**Colonization:** The process of veligers settling on and attaching their shell to a suitable surface.

**Colonization Device:** Any structure or combination of materials placed in a waterbody and used to monitor for adult Eurasian Mussels. Many use a wide variety of materials that mussels prefer such as PVC, cement, steel, aluminum, even tennis shoes.

**Colonization Tree:** A series of devices connected by cable and suspended in a water body from an exist-

ing structure such as a boat dock.

**Corbicula:** Scientific name for the Asian Clam.

**D-form:** Specific larval stage in Dreissena mussels and Asian Clams.

**Dreissenids:** a group of mussels belonging to the family Dreissenidae.

**Dreissena polymorpha:** The scientific name for the zebra mussel

**Dreissena rostriformis bugensis:** scientific name for quagga mussel.

**Eurasian Mussels:** General name for zebra, quagga, and golden mussels.

**Golden Mussel:** a macrofouling bivalve that was introduced into Argentina from Asia in 1991. The golden mussel has a wider tolerance for ecological parameters.

**Limnoperna fortunei:** Scientific name for the Golden Mussel.

**Mussel:** Any bivalve mollusk that produces a bysuss or byssal threads.

**Nacreous Layer:** Resembles nacre (mother of pearl). Used to identify some mollusks such as golden mussel which have a nacreous layer on the inside of their shells.

**Pediveliger:** The stage of larval development of Dreissenids immediately following the appearance of a



foot. *Dreissena pediveligers* range in size from approximately 231 to 462 microns.

**Plankton:** Microscopic plants and animals that live in marine and freshwater, consisting chiefly of algae, protozoans, and the eggs of certain larger animals. Plankton are the food source for Eurasian mussels.

**Polymerase Chain Reaction (PCR):** A technique in molecular biology by which a small fragment of DNA can be rapidly cloned - or duplicated - to produce multiple copies. PCR is most useful prior to initial confirmation of mussel presence. Mussel identification is made by comparison against specific genetic markers.

**Quagga Mussel:** A species of *Dreissena* mussel introduced into the Great Lakes in 1990. Named after an extinct zebra.

**Trochophore:** The larval stage that swims with cilia before the presence of a velum. *Dreissena* trochophores range in size from 97 to 112 microns.

**Umbonal:** Refers to the umbo which is hump on the dorsal margin of a bivalve shell.

**Veliger:** An early larval stage mollusk that has developed the velum, a ciliated swimming organelle. *Dreissena* veligers range in size from approximately 97 microns to 347 microns.

**Velum:** Ciliated structure on veliger larvae that is used for swimming.

**Zebra Mussel:** *Dreissena* mussel (*Dreissena polymorpha*) named for the zebra stripe pattern on its shell.



Inspecting a mussel-infested houseboat

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Putah South Canal - Vacaville California

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## Appendix A

### SOLANO COUNTY WATER AGENCY - Eurasian Mussel Notification

1.

#### LEVEL ONE

(All samples are negative, reports filed with SCWA, and DFG notified of survey sites.)

Routine surveys that include plankton tows, colonization plates, and visual surveys

Plankton Negative

Survey NEGATIVE. File report with SCWA and DFG.

Adult Positive

Plankton Positive (suspect)

2.

#### LEVEL TWO

(To avoid false-positives, several taxonomists will examine images and/or video of suspect organisms.)

##### ADULT Dreissena Mussel Found:

1. Report immediately to SCWA
2. Specimen photographed, measured, and preserved in ETOH. Deliver to appropriate taxonomist. (Jeff Janik, CDWR).

SUSPECT microorganism detected (SCWA notified)

Specimen photographed and measured. Information transmitted to four independent taxonomists:  
Denise Walter, USBR Denver  
Robert McMahon, Uni. Texas  
Jeff Janik, CDWR  
Steve Wells, CLR Portland

##### POSITIVE DETERMINATION from taxonomist. Request:

1. Emergency PCR (USBR)
2. Intensive survey for veligers

Three / four confirm specimen is Dreissena sp.

3.

#### LEVEL THREE

(Infestation Positive. Two positive plankton samples and one positive PCR OR discovery of Dreissena adults represents infestation that must be reported to DFG.)

Notify Calif. Dept. Fish & Game.

Report immediately to SCWA & USBR. Consider the following:

1. Emergency PCR (USBR)
2. Survey for adults
3. Intensive plankton tows
4. Expand survey area

4.

#### LEVEL FOUR

(Management and Control of Dreissena infestation. Initiate plan to protect infrastructure.)

Initiate management and control plans to protect Putah South Canal. (TO BE DETERMINED)

**Appendix B**

<b>Contact List for Notification of Mussel Sighting</b>				
<b>Name</b>	<b>Title</b>	<b>Organization</b>	<b>Email</b>	<b>Phone Number</b>
Catherine Mandella	Environmental Scientist	CDFG	cmandella@dfg.ca.gov	(209) 639-2671
Susan Ellis	Invasive Species Program Manager	CDFG	sellis@dfg.ca.gov	(916) 653-8983
Chris Lee	Principal Water Resources Specialist	Solano County Water Agency	clees@scwa2.com	(707) 455-1105
Ken W. Davis	Aquatic Biologist	Wildlife Survey & Photo	ken@creekman.com	(916) 747-8537
Jeff Laird	Park Manager (Lake Berryessa)	USBR		(707) 966-2111 Ext. 105
Lt. Jim Jones	Warden - Northern District	CA Dept. Fish & Game	jjones@dfg.ca.gov	
<b>Other individuals to be determined</b>				



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CA Codes (fgc:2300-2302)

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**FISH AND GAME CODE  
SECTION 2300-2302**

2300. (a) No person shall sell, possess, import, transport, transfer, release alive in the state, or give away without consideration the salt water algae of the Caulerpa species: taxifolia, cupressoides, mexicana, sertularioides, floridana, ashmeadii, racemosa, verticillata, and scapelliformis.

(b) Notwithstanding subdivision (a), a person may possess, for bona fide scientific research, as determined by the department, upon authorization by the department, the salt water algae of the Caulerpa species: taxifolia, cupressoides, mexicana, sertularioides, floridana, ashmeadii, racemosa, verticillata, and scapelliformis.

(c) In addition to any other penalty provided by law, any person who violates this section is subject to a civil penalty of not less than five hundred dollars (\$500) and not more than ten thousand dollars (\$10,000) for each violation.

2301. (a) (1) Except as authorized by the department, a person shall not possess, import, ship, or transport in the state, or place, plant, or cause to be placed or planted in any water within the state, dreissenid mussels.

(2) The director or his or her designee may do all of the following:

(A) Conduct inspections of conveyances, which include vehicles, boats and other watercraft, containers, and trailers, that may carry or contain adult or larval dreissenid mussels. Included as part of this authority to conduct inspections is the authority to temporarily stop conveyances that may carry or contain adult or larval dreissenid mussels on any roadway or waterway in order to conduct inspections.

(B) Order that areas in a conveyance that contain water be drained, dried, or decontaminated pursuant to procedures approved by the department.

(C) Impound or quarantine conveyances in locations designated by the department for up to five days or the period of time necessary to ensure that dreissenid mussels can no longer live on or in the conveyance.

(D) (i) Conduct inspections of waters of the state and facilities located within waters of the state that may contain dreissenid mussels. If dreissenid mussels are detected or may be present, the director or his or her designee may order the affected waters or facilities closed to conveyances or otherwise restrict access to the affected waters or facilities, and shall order that conveyances removed from, or introduced to, the affected waters or facilities be inspected, quarantined, or disinfected in a manner and for a duration necessary to detect and prevent the spread of dreissenid mussels within the state.

(ii) For the purpose of implementing clause (i), the director or his or her designee shall order the closure or quarantine of, or restrict access to, these waters, areas, or facilities in a manner and duration necessary to detect and prevent the spread of dreissenid mussels within the state. No closure, quarantine, or restriction shall be authorized by the director or his or her designee without the concurrence of the Secretary of the Natural Resources Agency. If

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CA Codes (fgc:2300-2302)

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a closure lasts longer than seven days, the department shall update the operator of the affected facility every 10 days on efforts to address the dreissenid infestation. The department shall provide these updates in writing and also post these updates on the department's Internet Web site in an easily accessible manner.

(iii) The department shall develop procedures to ensure proper notification of affected local and federal agencies, and, as appropriate, the Department of Boating and Waterways, the Department of Water Resources, the Department of Parks and Recreation, and the State Lands Commission in the event of a decision to close, quarantine, or restrict a facility pursuant to this paragraph. These procedures shall include the reasons for the closure, quarantine, or restriction, and methods for providing updated information to those affected. These procedures shall also include protocols for the posting of the notifications on the department's Internet Web site required by clause (ii).

(iv) When deciding the scope, duration, level, and type of restrictions, and specific location of a closure or quarantine, the director shall consult with the agency, entity, owner, or operator with jurisdiction, control, or management responsibility over the marina, boat launch facility, or other facility, in order to focus the closure or quarantine to specific areas and facilities so as to avoid or minimize disruption of economic or recreational activity in the vicinity.

(b) (1) Upon a determination by the director that it would further the purposes of this section, other state agencies, including, but not limited to, the Department of Parks and Recreation, the Department of Water Resources, the Department of Food and Agriculture, and the State Lands Commission, may exercise the authority granted to the department in subdivision (a).

(2) A determination made pursuant to paragraph (1) shall be in writing and shall remain in effect until withdrawn, in writing, by the director.

(c) (1) Except as provided in paragraph (2), Division 13 (commencing with Section 21000) of the Public Resources Code does not apply to the implementation of this section.

(2) An action undertaken pursuant to subparagraph (B) of paragraph (2) of subdivision (a) involving the use of chemicals other than salt or hot water to decontaminate a conveyance or a facility is subject to Division 13 (commencing with Section 21000) of the Public Resources Code.

(d) (1) A public or private agency that operates a water supply system shall cooperate with the department to implement measures to avoid infestation by dreissenid mussels and to control or eradicate any infestation that may occur in a water supply system. If dreissenid mussels are detected, the operator of the water supply system, in cooperation with the department, shall prepare and implement a plan to control or eradicate dreissenid mussels within the system. The approved plan shall contain the following minimum elements:

(A) Methods for delineation of infestation, including both adult mussels and veligers.

(B) Methods for control or eradication of adult mussels and decontamination of water containing larval mussels.

(C) A systematic monitoring program to determine any changes in conditions.

(D) The requirement that the operator of the water supply system permit inspections by the department as well as cooperate with the department to update or revise control or eradication measures in the approved plan to address scientific advances in the methods of

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controlling or eradicating mussels and veligers.

(2) If the operator of water delivery and storage facilities for public water supply purposes has prepared, initiated, and is in compliance with all the elements of an approved plan to control or eradicate dreissenid mussels in accordance with paragraph (1), the requirements of subdivision (a) do not apply to the operation of those water delivery and storage facilities, and the operator is not subject to any civil or criminal liability for the introduction of dreissenid mussel species as a result of those operations. The department may require the operator of a facility to update its plan, and if the plan is not updated or revised as described in subparagraph (D) of paragraph (1), subdivision (a) shall apply to the operation of the water delivery and storage facilities covered by the plan until the operator updates or revises the plan and initiates and complies with all of the elements of the updated or revised plan.

(e) Any entity that discovers dreissenid mussels within this state shall immediately report the discovery to the department.

(f) (1) In addition to any other penalty provided by law, any person who violates this section, any verbal or written order or regulation adopted pursuant to this section, or who resists, delays, obstructs, or interferes with the implementation of this section, is subject to a penalty, in an amount not to exceed one thousand dollars (\$1,000), that is imposed administratively by the department.

(2) A penalty shall not be imposed pursuant to paragraph (1) unless the department has adopted regulations specifying the amount of the penalty and the procedure for imposing and appealing the penalty.

(g) The department may adopt regulations to carry out this section.

(h) Pursuant to Section 818.4 of the Government Code, the department and any other state agency exercising authority under this section shall not be liable with regard to any determination or authorization made pursuant to this section.

(i) This section shall remain in effect only until January 1, 2017, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2017, deletes or extends that date.

2302. (a) Any person, or federal, state, or local agency, district, or authority that owns or manages a reservoir, as defined in Section 6004.5 of the Water Code, where recreational, boating, or fishing activities are permitted, except a privately owned reservoir that is not open to the public, shall do both of the following:

(1) Assess the vulnerability of the reservoir for the introduction of nonnative dreissenid mussel species.

(2) Develop and implement a program designed to prevent the introduction of nonnative dreissenid mussel species.

(b) The program shall include, at a minimum, all of the following:

(1) Public education.

(2) Monitoring.

(3) Management of those recreational, boating, or fishing activities that are permitted.

(c) Any person, or federal, state, or local agency, district, or authority, that owns or manages a reservoir, as defined in Section 6004.5 of the Water Code, where recreational, boating, or fishing activities of any kind are not permitted, except a privately owned

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reservoir that is not open to the public, shall, based on its available resources and staffing, include visual monitoring for the presence of mussels as part of its routine field activities.

(d) Any entity that owns or manages a reservoir, as defined in Section 6004.5 of the Water Code, except a privately owned reservoir that is not open to the public for recreational, boating, or fishing activities, may refuse the planting of fish in that reservoir by the department unless the department can demonstrate that the fish are not known to be infected with nonnative dreissenid mussels.

(e) Except as specifically set forth in this section, this section applies both to reservoirs that are owned or managed by governmental entities and reservoirs that are owned or managed by private persons or entities.


(f) Violation of this section is not subject to the sanctions set forth in Section 12000. In lieu of any other penalty provided by law, a person who violates this section shall, instead, be subject to a civil penalty, in an amount not to exceed one thousand dollars (\$1,000) per violation, that is imposed administratively by the department. To the extent that sufficient funds and personnel are available to do so, the department may adopt regulations establishing procedures to implement this subdivision and enforce this section.

(g) This section shall not apply to a reservoir in which nonnative dreissenid mussels have been detected.

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## Appendix D

Example of form developed by the U.S. Bureau of Reclamation for Lake Berryessa. The form is filled out by boaters at marinas before they are allowed to launch. The form is also used at the Capell Cove public launch ramp during boat inspections on some holidays and certain other weekends.

	<b>2010</b>
<b>Lake Berryessa</b>	
Has your watercraft been launched anywhere in the past 30 days? Yes <input type="checkbox"/> No <input type="checkbox"/>	
If so, where? _____	
_____	
Watercraft CF#: _____	
_____	
<i>I certify the above statements to be true and correct to the best of my knowledge.</i>	
Owner's Signature _____	Date _____
Staff Signature _____	Date _____

## Appendix E

Example of educational flyer used at Lake Berryessa. The flyer was developed due to request from marina concessionaires about the ineffectiveness of existing flyers. The flyer has been tested with recreational boaters and has proven effective. Flyer developed by Ken W. Davis.

# PROTECT Your Boat...and Lake Berryessa



**Zebra and Quagga Mussels** can clog engine cooling systems, obstruct propeller assemblies and block water intakes.

**DRAIN, INSPECT, WASH & DRY** boats, trailers, and other equipment.



Lake Mead, Nevada



Developed by Ken W. Davis  
www.creekman.com  
ken@creekman.com

Wildlife Survey & Photo  



**SOLANO COUNTY**  
WATER AGENCY

Lake Berryessa Watershed Partnership  
for Lake Berryessa



## Appendix F

Example of electronic transmission of image(s) to potentially confirm the taxonomy of planktonic organisms and/or Eurasian Mussel veligers. This PDF was transmitted to Dr. Robert McMahon (University of Texas, Arlington) in 2008.

Wildlife Survey & Photo Service 2443 Fair Oaks Blvd. # 209 • Sacramento, CA 95825 • (916) 747-8537		Berryessa - 2863-17G			
<b>Taxonomic Worksheet - Microscopic Examination</b>					
Exam Date:	7/24/08	Time:	8:30AM		
Results:	Confirmed by Dr. Robert McMahon that organisms are <i>Corbicula fluminea</i>				
Collection Site:	Lake Berryessa	Subsite:	Headquarter's Cove / Ramp side		
Collection Date:	7/23/08 (repeat collection)	Collection Time	10:30AM		
Collection Protocol:	Plankton tow / 63 micro Wildco Net / Vertical, Horizontal, Oblique / 7 - 21 feet deep				
Collection No:	2863-17G (collected by Ken Davis)	Videotape No:	513 & 514		
GPS:					
Cross-polarized light:	Positive with Maltese Cross on CPL Stereo microscope.				
Phase Contrast:	Videotaped (shell) at 100x power				
Comments:					
Taxonomist:	Ken W. Davis	(916) 747-8537	ken@creekman.com		
IMAGES OF ORGANISM OF CONCERN		Identification			
		Examined:	Alive <input type="checkbox"/> <b>Dead</b> <input checked="" type="checkbox"/> Preserved - ETOH		
		Length:	260 microns	Height:	217 microns
		Foot Present: YES			
		D-Shape Shell: YES			
		Water Temp:	25.3 C	Depth Collected:	7 - 20 feet
		***** Actions Taken *****			
		<p>Note: I'm certain specimen is <i>Corbicula fluminea</i>.</p> <p>Sending images to Dr. McMahon to check effectiveness of confirming taxonomy of specimens via image transmission.</p> <p>1. Send images / video to second taxonomist a. Dr. Robert McMahon (University of Texas).</p>			
		<b>Taxonomic Results:</b> <i>Corbicula fluminea</i> (confirmed by Dr. McMahon)			

## Appendix G - page 1

List of sites in the Solano Project that are surveyed with GPS data, protocols used, and frequency of the surveys. Some sites have sub-sites that are not listed. List provided to California Department of Fish & Game on an annual basis.

Ken W. Davis  
Wildlife Survey Photo  
2443 Fair Oaks Blvd. # 209  
Sacramento, CA 95825

Submitted 1/24/2012

Survey Sites 2010-2011

		GPS							
CODE	SITE	SUBSITE	N	W	Primary Target	METHOD	FREQ.	Pos / Neg	
17I	Lake Berryessa	Putah Creek Resort	38.66588	122.27397	mussels	visual	monthly	Negative	
17I	Lake Berryessa	Putah Creek Resort	38.66588	122.27397	mussels	plankton	monthly	Negative	
17I	Lake Berryessa	Monticello Resort	38.59697	122.26483	mussels	visual	biannual	Negative	
17I	Lake Berryessa	Monticello Resort	38.59697	122.26483	mussels	plankton	biannual	Negative	
17L	Lake Berryessa	Spanish Flats	38.51836	122.21185	mussels	visual	biannual	Negative	
17L	Lake Berryessa	Spanish Flats	38.51836	122.21185	mussels	plankton	biannual	Negative	
17D	Lake Berryessa	Lake Berryessa Resort	38.57992	122.24755	mussels	plankton	biannual	Negative	
17D	Lake Berryessa	Lake Berryessa Resort	38.57992	122.24755	mussels	visual	biannual	Negative	
17G	Lake Berryessa	Management Cove	38.55003	122.22951	mussels	plankton	monthly	Negative	
17G	Lake Berryessa	Management Cove	38.55003	122.22951	mussels	visual	monthly	Negative	
17G	Lake Berryessa	Management Cove	38.55003	122.22951	mussels	Plates	monthly	Negative	
17F	Lake Berryessa	Steele Park	38.49942	122.2019	mussels	plankton	monthly	Negative	
17F	Lake Berryessa	Steele Park	38.49942	122.2019	mussels	visual	monthly	Negative	
17A	Lake Berryessa	Capell Cove	38.50861	122.22017	mussels	plankton	monthly	Negative	
17A	Lake Berryessa	Capell Cove	38.50861	122.22017	mussels	visual	monthly	Negative	
17A	Lake Berryessa	Capell Cove	38.50861	122.22017	mussels	banks	monthly	Negative	
17E	Lake Berryessa	Pleasure Cove	38.50690	122.16414	mussels	plankton	monthly	Negative	
17E	Lake Berryessa	Pleasure Cove	38.50690	122.16414	mussels	visual	monthly	Negative	
17E	Lake Berryessa	Pleasure Cove	38.50690	122.16414	mussels	Plates	monthly	Negative	
17B	Lake Berryessa	Markley Cove	38.49783	122.12374	mussels	plankton	monthly	Negative	
17B	Lake Berryessa	Markley Cove	38.49783	122.12374	mussels	visual	monthly	Negative	
17B	Lake Berryessa	Markley Cove (Bank Rip Rap)	38.51995	122.13299	mussels	Check Rip Rap	bimonthly	Negative	
17B	Lake Berryessa	Markley Cove	38.49783	122.12374	mussels	Plates	monthly	Negative	
17MO	Lake Berryessa	Monticello Dam	38.51295	122.10689	mussels	plankton	biannual	Negative	
17MO	Lake Berryessa	Monticello Dam	38.51295	122.10689	mussels	plates	biannual	Negative	
17	Lake Berryessa	Other non-regular inspections			mussels	visual		Negative	
22T	Putah Creek	Monticello Dam	38.51326	122.10161	Mussels	plankton	monthly	Negative	

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Submitted 1/24/2012

## Survey Sites 2010-2011

Ken W. Davis  
Wildlife Survey Photo  
2443 Fair Oaks Blvd. # 209  
Sacramento, CA 95825

22T	Putah Creek	Monticello Dam	38.51326	122.10161	Mussels / NZMS	visual	monthly	NZMS Positive Mussel Negative
22T	Putah Creek	Monticello Dam	38.51326	122.10161	Mussels / NZMS	Plates	monthly	NZMS Positive Mussel Negative
22T	Putah Creek	Monticello Dam	38.51326	122.10161	mussels	banks	monthly	NZMS Positive Mussel Negative
22P	Putah Creek	Cold Creek	38.51263	122.09735	NZMS / Didymo	D Net	monthly	NZMS Positive Mussel Negative
22L	Putah Creek	Fishing Access 3	38.51661	122.05857	NZMS / Didymo	D Net	monthly	NZMS Positive Mussel Negative
22H	Putah Creek	Fishing Access 5	38.51008	122.04801	NZMS / Didymo	D Net	monthly	NZMS Positive Mussel Negative
22H	Putah Creek	Fishing Access 5	same	same	NZMS / Didymo	D Net	monthly	NZMS Positive Mussel Negative
22F	Putah Creek	Lake Solano	38.49337	122.02629	NZMS / Didymo/ Mussels	D Net	monthly	NZMS Positive Mussel Negative
22D	Putah Creek	Putah Diversion Dam	38.49385	122.00437	NZMS / Mussels	D Net	monthly	NZMS Positive Mussel Negative
22D	Putah Creek	Putah Diversion Dam	same	same	NZMS / Mussels	D Net	monthly	NZMS Positive Mussel Negative
22D	Putah Creek	Putah Diversion Dam	same	same	NZMS / Mussels	D Net	monthly	NZMS Positive Mussel Negative
22CA	Lower Putah Creek	Pickrel Weir	38.49321	122.00193	NZMS	D Net	monthly	NZMS Positive
22AE	Lower Putah Creek	Morales	38.50005	121.99462	NZMS	D Net	biannual	NZMS Positive
22AA	Lower Putah Creek	Dry Creek Confluence	38.51443	121.97337	NZMS	D Net	biannual	NZMS Positive
22A	Lower Putah Creek	Design Channel	38.51619	121.97039	NZMS	D Net	monthly	NZMS Positive
22A2	Lower Putah Creek	Neil Property	38.52455	121.95516	NZMS	D Net	biannual	NZMS Positive
22RP	Lower Putah Creek	River Park	38.52347	121.95825	NZMS	D Net	monthly	NZMS Positive
22R18	Lower Putah Creek	I-505	38.52621	121.95141	NZMS	D Net	monthly	NZMS Positive
22R12	Lower Putah Creek	Yolo Housing	38.5333	121.94046	NZMS	D Net	biannual	NZMS Positive
22R10	Lower Putah Creek	Hasbrook	38.52992	121.92645	NZMS	D Net	biannual	NZMS Positive
22R4	Lower Putah Creek	Russell Ranch	38.52831	121.82166	NZMS	D Net	biannual	NZMS Positive



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Submitted 1/24/2012

## Survey Sites 2010-2011

Ken W. Davis  
Wildlife Survey Photo  
2443 Fair Oaks Blvd. # 209  
Sacramento, CA 95825

22R1	Lower Putah Creek	Pedrick Road	38.52709	121.80318	NZMS	D Net	monthly	NZMS Positive
22S04	Lower Putah Creek	UCD Reserve - Fire Pit	38.52313	121.78545	NZMS	D Net	biannual	NZMS Positive
22S10	Lower Putah Creek	Mace Blvd.	38.51912	121.69348	NZMS	D Net	monthly	Negative
22R15	Lower Putah Creek	Los Rios Farm	38.51375	121.6203	NZMS	D Net	biannual	Negative
X0.18	Putah South Canal	Mile 0.18 (Parshall Flume)	38.49288	122.00125	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
X1.01	Putah South Canal	Mile 1.01 (Holmes Road)	38.49356	121.98719	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
X1.50	Putah South Canal	Mile 1.50 (University Bridge)	38.49571	121.97412	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
X1.99	Putah South Canal	Mile 1.99 (Wintu Way Bridge)	38.49576	121.96933	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
X2.42	Putah South Canal	Mile 2.42 (Campos)	38.49332	121.96118	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 3.23 (Hines Nursery)	38.47005	121.94388	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 3.76 (Dry Arroyo)	38.46619	121.94282	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 4.50 (Hines 2)	38.46076	121.94245	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 5.25 (Entry Ramp)	38.45676	121.94238	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 5.62 (Weyand Canal)	38.45358	121.93983	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 6.18 (Sweeney Check)	38.44767	121.94332	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 6.94 (Udell Road)	38.43501	121.9524	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 7.55 (Paddon Road)	38.42641	121.95321	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 7.77 ( Robinson Road)	38.42367	121.95591	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 8.31 (Midway Road)	38.41722	121.95912	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 9.46 (Aldridge Road)	38.40075	121.96149	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 9.92 (Vaca Valley Prkwy)	38.39688	121.96279	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 13.0 (Elmira - Vacaville)	38.34635	121.95757	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 16.10 (Peabody Rd - Vacaville)	38.32269	121.95887	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 17.90 (Cement Hill Outlet)	38.28755	121.99515	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 18.81 (Cement Plant)	38.27797	121.99466	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 21 (North Texas - Fairfield)	38.28766	122.03411	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 22.75 (Trevino Rd - Fairfield)	38.27735	122.06659	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 24.25 (Rancho Solano)	38.27416	122.08047	Mussels / NZMS	Visual / traps	bimonthly	NZMS Positive
	Putah South Canal	Mile 25.81 (Mankas Corner)	38.27944	122.10393	Mussels / NZMS	Visual / traps	monthly	NZMS Positive
	Putah South Canal	Mile 27.67 (Meredith Road)	38.26599	122.13031	Mussels / NZMS	Visual / traps	bimonthly	Negative

## Appendix G - Page 4

Ken W. Davis

Wildlife Survey Photo

2443 Fair Oaks Blvd. # 209

Sacramento, CA 95825

## Survey Sites 2010-2011

Submitted 1/24/2012

	Putah South Canal	Mile 30	38.24454	122.12446	Mussels / NZMS	Visual / traps	bimonthly	Negative
	Putah South Canal	Mile 32	38.24151	122.1277	Mussels / NZMS	Visual / traps	bimonthly	Negative
XTR-1	Terminal Reservoir	Intake	38.22196	122.15999	Mussels / NZMS	plankton	monthly	Negative
XTR-2	Terminal Reservoir	Floatsom Site	38.21942	122.15838	Mussels / NZMS	visual	monthly	Negative
XTR-3	Terminal Reservoir	Outtake	38.21883	122.15925	Mussels / NZMS	plankton	monthly	Negative
XTRW	Terminal Reservoir	Entire Reservoir	38.22049	122.15987	Mussels / NZMS	plates	monthly	Negative
143	Green Valley Creek	Reservoir Road	38.22719	122.15221	Mussels / NZMS	Visual / collection	quarterly	Negative
132	Suisun Creek	PSC Management Road	38.27455	122.12291	Mussels / NZMS	Visual/Collection	quarterly	Negative
117	Sweeny Creek	Hartley Road	38.44747	122.94332	Mussels / NZMS	Visual/Collection	quarterly	Negative
115	Pope Creek	Upper Lake Berryessa	38.66565	122.33204	Ironodes sp.	D Net	March / April	Positive
115	Pope Creek	Upper Lake Berryessa	38.66565	122.33204	Leucrocuta sp.	D Net	March / April	Positive
115	Pope Creek	Upper Lake Berryessa	38.66565	122.33204	Drunella coloradensis	D Net	March / April	Positive
127	Capell Creek	Lower Lake Berryessa	38.50607	122.23666	Pteronarcys californica	D Net	April	Positive
22	Putah Creek	Upper Putah Creek	38.80434	122.70395	Rhithrogena sp.	D Net	March / April	Positive
226	Thompson Creek	Confluence with Putah Creek	38.51722	122.09789	Paraleprophelbia sp.	D Net	April	Positive
160	Dry Creek	Bobcat Ranch	38.52509	122.04139	Calineuria californica	D Net	April	NEGATIVE
119	Prosser Creek	Below Dam	39.37121	120.12865	Didymosphenia geminata	Grab	May	Positive
1	American River	William Pond Area	38.58765	121.32864	Mystacides sp.	Grab	June	Positive
1b	American River	Sailor Bar	38.63432	121.23237	Didymosphenia geminata	Grab	one-time	Positive
111	Hat Creek	Hat Creek Ranch	40.83868	121.51072	Drunella spinifera	Grab	October	Positive
111	Hat Creek	Hat Creek Ranch	40.83868	121.51072	Dicosmoecus sp.	Grab	October	Positive
220	Miller Creek	All	38.44213	122.87946	Ironodes sp.	D Net	April	Positive
21	Cold Creek	Confluence with Putah Creek	38.51111	122.0977	Kogatus	D Net	March / April	Positive
248	North Fork Feather	Upstream from Chester	40.31191	121.28512	Unidentified Stonefly	D Net	May	Negative
137	Cache Creek		38.82694	122.1838	NA	NA	NA	NA
228	North Fork American	Confluence with Middle Fork	38.91558	121.03809	No Target	D Net	April	NA
END		END			END			END

## Appendix H - page 1



### California Department of Fish and Game Aquatic Invasive Species Decontamination Protocol

The California Department of Fish and Game (DFG) is committed to protecting the state's diverse fish, wildlife, and plant resources, and the habitats upon which they depend. Preventing the spread of aquatic invasive species (AIS) in both DFG's activities, as well as those activities DFG permits others to conduct is important to achieving this goal. The protocols outlined below are a mandatory condition of your DFG authorization to work in aquatic habitats. They are intended to prevent the spread of AIS, including New Zealand mudsnail (*Potamopyrgus antipodarum*), quagga mussel (*Dreissena rostriformis bugensis*) and zebra mussel (*Dreissena polymorpha*). Information about New Zealand mudsnails and quagga and zebra mussels is summarized in Attachments A and B. For complete information on the threats of AIS and aids to their identification, please visit the Department's Invasive Species Program webpage at [www.dfg.ca.gov/invasives](http://www.dfg.ca.gov/invasives) or call (866) 440-9530.

Many AIS are difficult, if not impossible to see in the environment and can be unknowingly transported to new locations on equipment. Therefore, decontamination is necessary to prevent the spread of AIS between collection locations. Equipment shall be decontaminated between each use in different waterbodies. All equipment, including but not limited to, wading equipment, dive equipment, sampling equipment (e.g., water quality probes, nets, substrate samples, etc.), and watercraft, must be decontaminated using one or more of the protocols listed below. As an alternative to decontaminating on-site, you may wish to have separate equipment for each site and to decontaminate it all at the end of the day. Listed below are three options for equipment decontamination. Use your judgment and field sampling needs to select the method(s) that are appropriate for your equipment and schedule. **Because there are currently no molluscicides registered with the California Department of Pesticide Regulation that have been demonstrated to be effective for these three species, DFG cannot recommend chemical decontamination.** If you would like training on implementing these protocols please contact the Invasive Species Hotline at (866) 440-9530 or e-mail [invasives@dfg.ca.gov](mailto:invasives@dfg.ca.gov)

General field procedures to prevent the spread of AIS:

- If decontamination is not done on site, transport contaminated equipment in sealed plastic bags and keep separate from clean gear.
- When practical, in flowing water begin work upstream and work downstream. This avoids transporting AIS to non-infested upstream areas.
- For locations know to be infested with AIS, use dedicated equipment that is only used in infested waters. Store this equipment separately.

Page 1 of 6

January 24, 2012



## **Appendix H - page 2**

### **Equipment Decontamination Methods**

#### **Option 1: Dry**

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Allow equipment to thoroughly dry (i.e., until there is complete absence of moisture), preferably in the sun. Keep dry for a minimum of 48 hours to ensure any organisms are desiccated.

#### **Option 2: Hot water soak**

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Immerse equipment in 140° F or hotter water. If necessary, weigh it down to ensure it remains immersed.
- Soak in 140° F or hotter water for a minimum of five minutes.

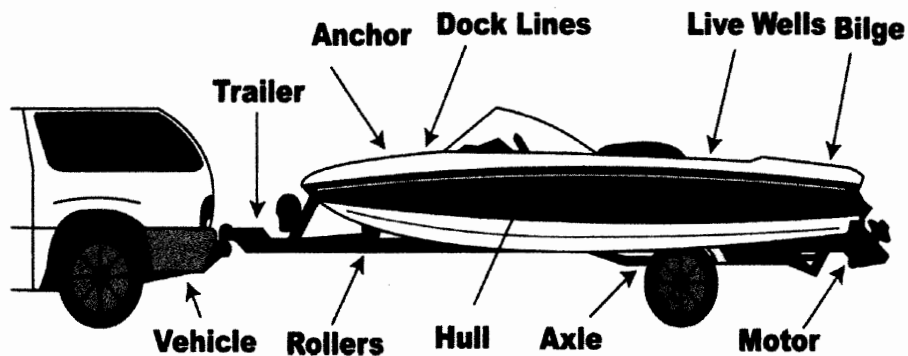
#### **Option 3: Freeze**

- Scrub gear with a stiff-bristled brush to remove all organisms. Thoroughly brush small crevices such as boot laces, seams, net corners, etc.
- Place in a freezer 32°F or colder for a minimum of eight hours.

### **Watercraft Decontamination**

- Prior to leaving the launch area, remove all plants and mud from your watercraft, trailer, and equipment. Dispose of all material in the trash.
- Prior to leaving the launch area drain all water from your watercraft and dry all areas, including motor, motor cooling system, live wells, bilges, and lower end unit.
- Upon return to base facilities, pressure wash the watercraft and trailer with 140° F water\*, including all of the boat equipment (i.e. ropes, anchors, etc.) that came into contact with the water.
- Flush the engine with 140° F water for at least 10 minutes and run 140° F water through the live wells, bilges, and all other areas that could contain water.

\*To ensure 100% mortality the water needs to be 140° F at the point of contact or 155° F at the nozzle.

**Appendix H - page 3****Reporting Aquatic Invasive Species**

If you suspect you have found New Zealand mudsnail, quagga and zebra mussels, or other AIS, please immediately notify the DFG Invasive Species Program at (866) 440-9530 or e-mail [invasives@dfg.ca.gov](mailto:invasives@dfg.ca.gov). Please provide your contact information, specific location of discovery, and digital photographs of the organisms (if possible).

## **Appendix H - page 4**

### **Attachment A**

#### **New Zealand Mudsnaill**

#### **The threat posed by New Zealand mudsnails (NZMS):**

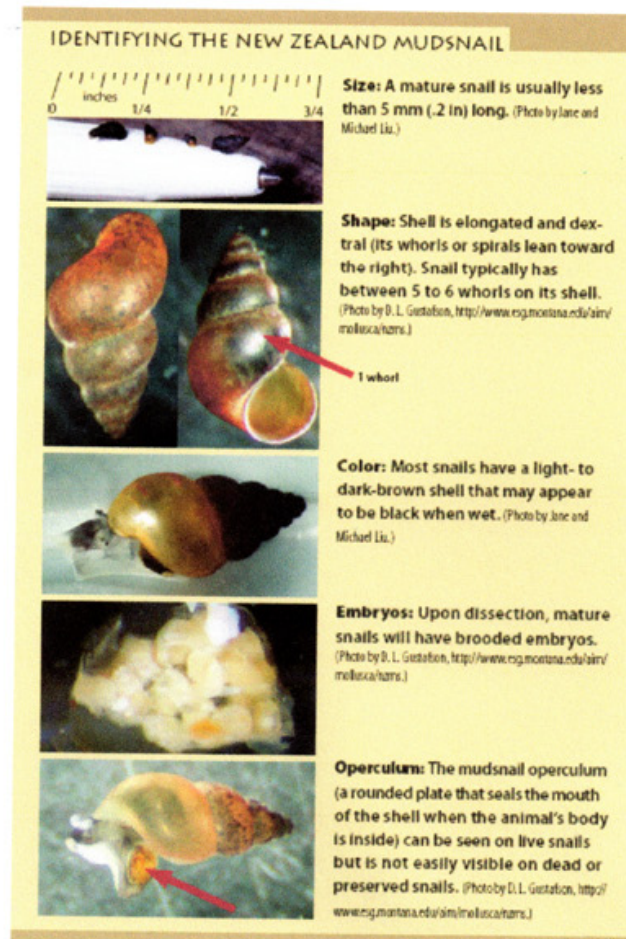
- NZMS reproduce asexually therefore it only takes a single NZMS to colonize a new location.
- NZMS are prolific, and a single NZMS can give rise to 40 million snails in one year.
- Densities of over 750,000 NZMS per square meter have been documented.
- NZMS out-compete and replace native invertebrates that are the preferred foods of many fish species and alter the food web of streams and lakes.

#### **Identifying NZMS:**

- NZMS average 1/8 inch in length, but young snails may be as small as a grain of sand. Adults bear live young.
- See the photos, below, for assistance identifying NZMS. Expert identification will be necessary to confirm identification.



## Appendix H - page 5



### NZMS Habitat:

- NZMS can live in most aquatic habitats, including silted river bottoms, clear mountain streams, reservoirs, lakes and estuaries.
- NZMS have a temperature tolerance of 32-77° F.
- NZMS can survive out of water for more than 25 days in cool, moist environments, and have been found over 40 feet from water.

Current known locations of NZMS in California can be found at <http://nas.er.usgs.gov/taxgroup/mollusks/newzealandmudsnaildistribution.aspx>

## Appendix H - page 6

### Attachment B

#### Quagga and Zebra Mussels

The threat posed by quagga and zebra mussels (Dreissenid mussels):

- Dreissenid mussels multiply quickly and out-compete other species for food and space.
- Their presence can alter food webs and alter environments, negatively affecting native and game fish species.
- Dreissenid mussels attach to hard and soft surfaces, and negatively impact water delivery systems, hydroelectric facilities, agriculture, recreational boating and fishing.
- Adults can survive up to 30 days out of water in cool, humid conditions.
- Produce microscopic larvae that can be unknowingly transported in water, including live-wells, bilges, and motors.

Identifying Dreissenid mussels:

- Typically the same size as a fingernail but can grow up to about 2 inches long.
- Variable, usually dark and light alternating stripes. May also be solid cream, brown, or black.

Dreissenid mussel habitat:

- Variable, including both hard and soft surfaces in freshwater.
- From surface depth to more than 400 feet in depth.



Current known locations of Dreissenid mussels in California can be found <http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/CaliforniaDreissenaMap.jpg>

## **Appendix I**

### **Information and Resources about Quagga Mussels (*Dreissena bugensis*), Zebra Mussels (*Dreissena polymorpha*) and Golden Mussels (*Limnoperna fortunei*)**

- California Department of Fish & Game: <http://www.dfg.ca.gov/invasives/>
- California Department of Water Resources: <http://www.des.water.ca.gov/>
- 100th Meridian Initiative: <http://www.100thmeridian.org>
- Center for Lakes and Reservoirs - Portland University: <http://www.clr.pdx.edu/>
- U.S. Geological Survey: <http://www.usgs.gov>



**Appendix J - page 1**

**RECLAMATION**  
*Managing Water in the West*

U.S. Department of the Interior  
 Bureau of Reclamation

## **Quagga and Zebra Mussel Prevention Program**

This Certificate Must Be Placed  
 On Your Dashboard

# **MUSSEL FREE**

Failure to display this certificate on the dashboard of your vehicle while parked with an empty boat trailer may result in a citation.

### **QUAGGA AND ZEBRA MUSSELS POSE A MAJOR THREAT TO LAKE BERRYESSA!**

**Mussels in any lake could:**

- Disrupt the food chain and fishing
- Foul facilities like docks, ramps, and dams
- Encrust boats and clog engines
- Litter beaches with sharp, smelly shells
- Could cause an increase to water bills in Napa and Solano County
- Could result in complete Lake Closure

**I affirm that my vessel(s) does not threaten Lake Berryessa  
 with quagga or zebra mussels.**

Please check one: \_\_\_\_\_ Boat not used in last 30 days in infested waters

\_\_\_\_\_ Boat washed and allowed to completely dry for at least 5 days  
 in hot weather and at least 30 days in cool damp weather.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**THANK YOU FOR PROTECTING  
 LAKE BERRYESSA!**

If you have questions, please contact the Lake Berryessa Recreation Resources Branch at 707-966-2111.  
 For more information, visit [www.protectyourwaters.net](http://www.protectyourwaters.net)

## Appendix J -page 2

# RECLAMATION

*Managing Water in the West*

U.S. Department of the Interior  
Bureau of Reclamation

## Quagga and Zebra Mussel-Free Certification

Save Time and Self-Certify

Has your boat been used in Lakes Mead, Mohave, Havasu, or any of the waters listed on the previous page, within the last 30 days?

NO

You are ready to launch. Sign the certificate on page 4 and display it on your dashboard at all times while your vehicle and boat trailer are at Lake Berryessa.

YES

Was your boat and trailer thoroughly washed and allowed to **completely** dry for at least 5 days in hot weather or 30 days in cool damp weather since you last launched? (You must have removed all dirt and organic material from the boat. You must have drained and flushed all live wells and bilge areas. The boat must be allowed to dry for at least 5 days.)

YES

You are ready to launch. Sign the certificate on page 4 and display it on your dashboard at all times while your vehicle and boat trailer are at Lake Berryessa.

NO

**You are required to decontaminate your boat at a boat yard professionally equipped with high pressure, hot water equipment, that is qualified to decontaminate for Quagga and Zebra Mussels.** For information on the quagga/zebra mussel issue, please contact the DFG website at [www.dfg.ca.gov](http://www.dfg.ca.gov) or call 866-440-9530

If you have questions, please contact the Lake Berryessa Recreation Resources Branch at 707-966-2111.  
For more information, visit [www.protectyourwaters.net](http://www.protectyourwaters.net)

## Appendix K

# RECLAMATION

*Managing Water in the West*

U.S. Department of the Interior  
Bureau of Reclamation

## Quagga and Zebra Mussel Prevention Program

Save Time and Self-Certify

### Mussel-infested waters in the US

List last Updated October 2, 2011

For an updated list of infested waters visit the USGS Website at

[http://fi.biology.usgs.gov/Nonindigenous\\_Species/Zebra\\_mussel\\_distribution/zebra\\_mussel\\_distribution.html](http://fi.biology.usgs.gov/Nonindigenous_Species/Zebra_mussel_distribution/zebra_mussel_distribution.html)

#### Alabama

Tennessee River  
Guntersville Lake  
Bayou Lafourche

#### Arizona

Colorado River  
Imperial Res. (AZ & CA)  
Lake Havasu (AZ & CA)  
Lake Mohave (AZ & NV)  
Lake Pleasant  
Martinez Lake (AZ & CA)  
Mittity Lake  
Salt River  
Topock Marsh

#### Arkansas

Arkansas River  
Bull Shoals Lake  
Dardenelle Reservoir  
Mississippi River  
Plum Bayou  
White River

#### California

Anaheim Lake  
Colorado River aqueduct  
Copper Basin Reservoir  
Dixon Lake  
El Capitan Reservoir  
Imperial Dam  
Irvine Lake  
Kraemer Basin Reservoir  
Lake Arrowhead  
Lake Havasu  
Lake Jennings  
Lake Matthews  
Lake Miramar  
Lower Otay Lake  
Lake Poway  
Lake Ramona  
Lake Skinner  
Murray Reservoir  
Olivenhain Reservoir  
Rattlesnake Reservoir  
San Justo Reservoir  
San Vicente Reservoir  
Sweetwater Reservoir  
Walnut Canyon Reservoir

#### Colorado

Blue Mesa Reservoir  
Grand Lake  
Jumbo Lake  
Lake Granby  
Missouri Reservoir  
Pueblo Reservoir

Shadow Mountain Res.  
Tarryall Reservoir  
Willow Creek Res.  
Wilson Reservoir

#### Connecticut

East Twin Lake  
West Twin Lake

Illinois: 24 waters

Indiana: 60 waters

#### Iowa

Clear Lake  
Lake Delhi  
Lake Odessa  
Lake Rathburn  
Willow Creek  
Winnebago River  
Shell Rock River  
Cedar River  
Iowa River  
Mississippi River

#### Kansas

Cheney Reservoir  
Council Grove City Lake  
El Dorado Reservoir  
Jeffrey Energy Center Lake  
John Redman Reservoir  
Kansas River  
Lake Afton  
Marion Reservoir  
Milfred Reservoir  
Missouri River  
Perry Reservoir  
Wilson Reservoir  
Winfield City Lake

#### Kentucky

Cumberland River  
Dewey Lake  
Green River  
Kentucky River  
Mississippi River  
Ohio River  
Tennessee River

#### Louisiana

Atchafalaya River  
Bayou Courtableau  
Bayou Lafourche  
Bayou Teche  
Intercoastal Waterway  
Mississippi River  
Sheridan Canal  
Wax Lake

#### Maryland

Susquehanna River

#### Massachusetts

Housatonic River  
Laurel Lake

#### Michigan

Lake Huron  
Lake Michigan  
250 other waters

#### Minnesota

Charley Lake  
Lake Erie  
Lake Le Homme Dieu  
Lake Superior  
Lower Prior Lake  
Mille Lacs Lake  
Mississippi River  
Ossawinnamakee Lake  
Pelican Lake/Red River  
Pike Lake  
Pine River  
Pleasant Lake  
Rebecca Lake  
Rice Lake  
St. Croix River  
St. Louis River  
Sucker Lake  
Upper Prior Lake  
Vadnais Lake  
Zumbro Lake and River

#### Mississippi

Mississippi River

#### Missouri

Bull Shoals Reservoir  
Lake Lotawana  
Lake of the Ozarks  
Lake Taneycomo  
Meramec River  
Mississippi River  
Missouri River  
Osage River  
White River

#### New Mexico

Sumner Lake

#### Nebraska

Offutt Base Lake  
Missouri River  
Zorinsky Reservoir

#### Nevada

Colorado River  
Lake Mead  
Lake Mohave (AZ & NV)  
Labontan Reservoir  
Rye Patch Reservoir

New York: 27 waters

#### North Dakota:

Red River

Ohio: 39 waters

#### Oklahoma

Arkansas River  
Eufaula Lake  
Fort Gibson Lake  
Grand Lake O' the Cherokees  
Kaw Reservoir  
Keystone Lake  
Lake Texoma  
Lynn Lane Reservoir  
Oologah Reservoir  
Robert S. Kerr Reservoir  
Skiatook Reservoir  
Sooner Reservoir  
Verdigris River  
Sooner Reservoir  
Verdigris River

#### Pennsylvania

Allegheny River  
Canadohta Lake  
Clover Creek Quarry  
Cowanesque Lake  
Dutch Springs Reservoir  
Edinboro Lake  
French Creek  
Lake Erie  
Monongahela River  
Muddy Run Reservoir  
Ohio River  
Sandy Lake  
Susquehanna River

#### Tennessee

Cumberland River  
French Broad River  
Mississippi River  
Tennessee River

#### Texas

Lake Texoma

#### Utah

Electric Lake  
Lake Powell  
Red Fleet Reservoir  
Sand Hollow Reservoir

#### Vermont

Lake Bomoseen  
Lake Champlain  
Lake Dunmore  
Lake Horton

#### West Virginia

Buckhannon River  
Kanawha River  
Monongahela River  
Ohio River

Wisconsin: 89 waters

If you have questions, please contact the Lake Berryessa Recreation Resources Branch at 707-966-2111.

For more information, visit [www.protectyourwaters.net](http://www.protectyourwaters.net)



## Appendix L

# RECLAMATION

*Managing Water in the West*

U.S. Department of the Interior  
Bureau of Reclamation

## Quagga and Zebra Mussel Prevention Program Save Time and Self-Certify

You are asked to comply with the Bureau of Reclamation's Quagga and Zebra mussel prevention program before you launch your boat into Lake Berryessa. For most boaters, this will be a simple process.

Here is what you need to do before you can launch:

- Look at the questions on the other side of this page.
- If your answers to these questions tell you to get your boat professionally decontaminated before launching in Lake Berryessa, you must do so.
- If your boat is ready to launch now, just complete the self certification statement. **Be sure to display the certificate on your dashboard while your vehicle is parked in the boat launch areas.** You can use the certificate all year long, but you must ensure that your boat is clean each time you launch at Lake Berryessa. Don't let quagga/zebra mussels hitchhike on your boat.

In January 2007, quagga mussels were discovered in Lakes Mead, Mohave, and Havasu. This was the first time zebra or quagga mussels were discovered west of the Rocky Mountains. The first confirmed find of zebra mussels in California occurred at San Justo Reservoir on January 10, 2008. Quagga and zebra mussels have already invaded much of the Eastern U.S.

**Fortunately, Lake Berryessa is free of quagga and zebra mussels. It depends on all of us to keep it this way.**

Quagga and zebra mussels can be spread by your boat, but they cannot live out of the water for long periods of time. Simply washing boats and equipment and allowing them to fully dry is an effective way to reduce the risk of spreading these aquatic hitchhikers.

These mussels, and other harmful plants and animals, may be hiding under your trim tabs, in your engine, or even on your anchor chain. Quagga and zebra mussels are microscopic in their earliest life stages, making them impossible to detect with a visual inspection.

Quagga and zebra mussels have the potential to:

- Disrupt the food chain and fishing
- Foul facilities like docks, ramps, and dams
- Increase water bills to Napa and Solano county residents.
- Encrust boats and clog engines
- Litter beaches with sharp, smelly shells
- An infestation could result in a complete LAKE CLOSURE!

If you have questions, please contact the Lake Berryessa Recreation Resources Branch at 707-966-2111.  
For more information, visit [www.protectyourwaters.net](http://www.protectyourwaters.net)



## Appendix M

Example of certificate for completion of three-hour course "Watercraft Inspection and Decontamination Training for Zebra/Quagga Mussels" which is given annually at Lake Berryessa and the RCD Office in Dixon

<b>Course Completion Certificate</b>	<b>Watercraft Inspection and Decontamination Training for Zebra/Quagga Mussels</b>	
	<b>Level One</b> Presented To:	Jane Doe
Has successfully completed a three-hour course on "Inspection and Decontamination of Watercraft for zebra/quagga mussels". Presented by the Pacific States Marine Fisheries Commission, United States Fish and Wildlife Service and the 100 <sup>th</sup> Meridian Initiative and its State and Federal partners and is		
Certified as:		
<b>Watercraft and Equipment Inspector</b>		
Location: Solano RCD - Dixon, California	Date: 5/16/2011	
Presented by:		
Ken W. Davis, Aquatic Biologist, Wildlife Survey & Photo (916) 747-8537		



## Appendix N

### **“Protecting the Solano Project”**

#### **Zebra / Quagga Mussel Presentation**

Zebra and quagga mussels represent a major threat to the native biota, recreation, and infrastructure within the Solano System. This free presentation available to angling clubs, civic organizations, and government agencies outlines the problem and what is being done to prevent the introduction of mussels into the Solano System.

The thirty minute Power Point Presentation is delivered by Aquatic Biologist, Ken Davis. An expert on invasive species, Ken is currently under contract with the Solano County Water Agency to conduct mussel surveys in the Lake Berryessa, Putah Creek, Putah South Canal, and ancillary reservoirs.

More Information: Ken W. Davis  
Wildlife Survey & Photo Service  
(916) 747-8537  
[ken@creekman.com](mailto:ken@creekman.com)



Quagga mussels on boat hull. Lake Mead, Nevada



Left: Zebra Mussel Infestation at San Justo Reservoir, near Hollister, California. Above: Quagga mussels on boat hull, Lake Mead, NV.



## Appendix O

### **EMERGENCE:** A New Vision of Bugs and Fly Fishing.

Hungry trout key on emergers, stillborns, and flip-flopping cripples. Ken Davis, aquatic biologist, studies the phenomenon of emergence and has developed *"Emergence: A New Vision of Aquatic Invertebrates and Fly Fishing"* to share his findings with the fishing community. This innovative Power Point presentation covers nymphs, the miracle of emergence, adult insect behavior, and how it relates to successful fly fishing. You'll see world class images that reveal the obstacles facing aquatic invertebrates as they mature and emerge from their watery seclusion. These unique images are only possible due to Ken's lifetime of studying aquatic invertebrates, an extensive photo career, and new Nikon digital technology. During the presentation, he also covers the hazards of invasive species including New Zealand Mudsnaills, Eurasian Mussels and Didymo. Ken is a consultant to numerous corporations and government agencies on invertebrate and invasive species issues. For more information contact:

**Ken W. Davis**  
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(916) 747-8537  
[ken@creekman.com](mailto:ken@creekman.com)



**Appendix P**

SOLANO COUNTY WATER AGENCY

**Zebra/Quagga Mussel Workshop:****Potential Vulnerability & Impact  
To the NBA & Solano Project**

**Feb. 28, 2012**  
**08:30 – 12:00**

SCWA/SID Board Room  
 810 Vaca Valley Parkway, #203  
 Vacaville, CA 95688

**Workshop Schedule:**

08:30 AM.....Introduction to Zebra/Quagga Mussels  
 09:15 AM.....Preparing for Mussels in the SWP, Management, and Research  
 10:00 AM.....10 minute Break  
 10:10 AM.....Vulnerability of the Solano Project  
 10:45 AM.....Current Monitoring for the Solano Project  
 11:30 AM.....Questions & Discussion



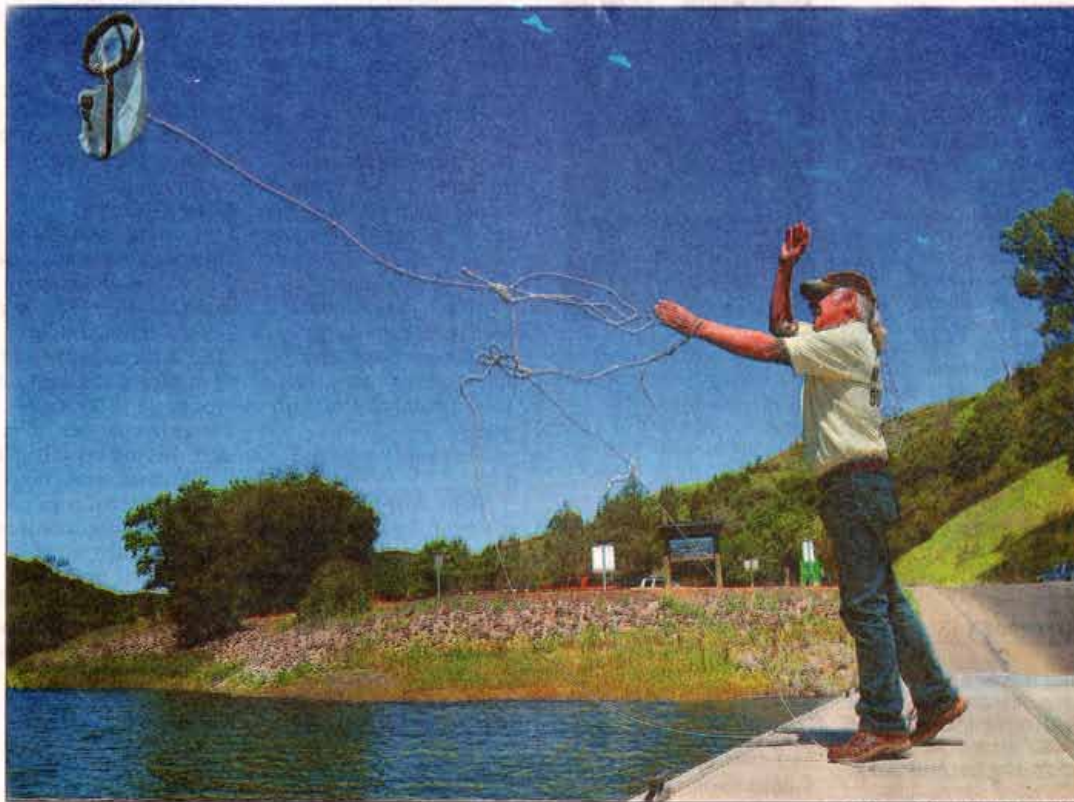
810 Vaca Valley Parkway, Suite 203 Vacaville, CA 94588  
 (707) 451-6090, FAX (707) 451-6099





## Appendix Q

Mussel prevention article appeared in the Daily Republic (Fairfield, CA) on June 3, 2012. Written by Barry Eberling



Robinson Kuntz/Daily Republic

Biologist Ken Davis throws a net into Lake Berryessa, testing for invasive mussel larvae, at the Capell Cove boat launch.

# Boaters: Keep mussels out

## *Lake invasion would be detrimental*

By BARRY EBERLING  
DAILY REPUBLIC

FAIRFIELD — Ken Davis approached two men getting ready to launch a boat into Capell Cove at Lake Berryessa and talked about a potential threat to the well-being of the reservoir -- invasive Eurasian mussels.

"I'm just curious if you're aware of the problem," Davis said.

Davis wanted to make certain that the boaters knew that Eurasian mussels move to lakes by hitching rides on boats. Put a boat from an infested lake into Lake Berryessa and Lake Berryessa could become infested.

Should Berryessa become infested, everyone from water users



Courtesy photo by Ken Davis

**Quagga mussels, an invasive species that can cause various environmental problems, are seen on a boat motor that was in Lake Mead, Nev.**

in Solano County cities to recreational boaters to anglers could pay the price. A draft report by Davis' Wildlife Survey and Photo Service

for the Solano County Water Agency spells out the possible consequences.

Eurasian mussels could clog intake systems and other mechanisms that transport Lake Berryessa water to Solano County cities and farms. That in turn could cost local water agencies money to clean out the water systems.

Mussels could also change the environment in the lake, since they filter large amounts of water. That can lead to fewer nutrients for native species, to algae blooms and to problems for some fish, such as certain species of salmon.

Davis has another point for boaters, one that hits close to home -- the mussels can clog engine cooling

*See Mussels, Page A12*



## Appendix Q

# Mussels: Lake Berryessa is safe – for now

*From Page One*

systems and obstruct propeller assemblies on boats. He even has a photograph of a boat with parts caked in mussels to demonstrate the potential problem.

The two boaters, Gary Perkins and Kevin Henderson of Santa Rosa, said they'd heard about the mussels. They said their boat hadn't been in infested waters.

"How do you eradicate them?" Perkins asked.

"It's tough," Davis said, adding that educating boaters to keep the mussels out of the lake in the first place is the answer.

"I'm all for that," Perkins said.

In this case, Davis seemed to have an easy sell for his anti-mussel campaign.

"We don't want them in the lake," Henderson said.

Zebra mussel. Quagga mussel. These are the small enemies that Davis is constantly looking for on behalf of the Solano County Water Agency and hoping never to find.

Davis is an aquatic biologist, not a boat inspector who has legal power to stop boats from launching. He comes to Lake Berryessa to collect data and scan docks for signs of the mussels. He casts a net into the water that funnels water samples into a small bottle, so he can check the samples for

mussel larvae.

While he's at it, he talks to boaters to spread the word about potential mussel infestations and how to prevent them. He's using the power of persuasion, not the law, to help keep Lake Berryessa mussel-free.

Lake Berryessa has high enough calcium levels to support a "moderate" infestation of the mussels, according to the draft report Davis did for the Solano County Water Agency. Mussels use calcium to create their shells.

The nearest zebra mussel infestation is at San Justo Reservoir in San Benito County near Hollister. But Davis doesn't see much chance of the mussels moving from there to Lake Berryessa. San Justo has been closed to the public since 2008 in the wake of the infestation.

But other lakes are infested or suspected of having mussel larva and are still open to the public, such as Rye Patch reservoir in Nevada and a couple dozen reservoirs in Southern California. A boat that has spent time in those lakes and gets launched into Lake Berryessa could bring the mussels with them. Davis said he'd want to see a boat that had been kept in an infested lake dry out at least a month.

It's illegal to transport

quagga and zebra mussels. Boats found with mussels can be quarantined. Some reservoirs have mandatory inspection programs, according to the state Department of Fish and Game.

But at Lake Berryessa, boaters are largely on the honor system when it comes to keeping the lake mussel-free.

"It's almost impossible to check all boats," Davis said. "There's so many ramps and the cost, and nobody can pay for it. So education has to be the main factor, and cooperation."

Lake Berryessa has the free Capell Cove boat launch operated by the U.S. Bureau of Reclamation, as well as boat launches at several privately run resorts.

Davis is particularly concerned that the mussel could be introduced to the lake at the Capell Cove launch. The Bureau of Reclamation had no inspectors there to check boats for mussels on a recent Friday.

Jeff Laird, the U.S. Bureau of Reclamation acting park manager for Lake Berryessa, said park rangers are at Capell Cove from about 7:30 to 9 a.m. on weekends from Memorial Day through Labor Day. Then interns take over and remain at the launch to about 11:30 a.m. to talk to boaters about the mussels and other issues involving

the lake's welfare.

But, Laird noted, park rangers are not law enforcement officers. They cannot stop a boat from going into the lake.

"To actually do inspections, personal inspections, would require a very large amount of staff and time that we -- Reclamation -- doesn't have here," Laird said.

Boaters have to take responsibility themselves, Laird said. The main job of the rangers is to educate as many people as they can, he said.

The mussels are native to the Black, Caspian and Aral seas, according to Davis' draft report. They are believed to have come to the United States in ballast water and were discovered in Lake St. Clair, Mich., in 1986.

Now they have been found as close as 100 miles from Lake Berryessa, at San Justo reservoir. The effort is under way to make certain they don't get any closer.

Boaters can go to <http://www.dbw.ca.gov/boater-info/quaggaloc.aspx> to get information on how to inspect and clean their boats to avoid transporting mussels.

Reach Barry Eberling at 427-6929 or [beberling@dailyrepublic.net](mailto:beberling@dailyrepublic.net). Follow him on Twitter at [www.twitter.com/beberlingdr](http://www.twitter.com/beberlingdr).



## Appendix R

## Solano County Water Agency: Early Detection &amp; Education Plan for Eurasian Mussels, March 15, 2012

Comments by: Jennifer LaBay - (916) 653-3868

Chapter, Section, Comments #	Line, Figure, Page or Table No.	Comments	Ken Davis Comments
General Comment Comment #1		It is unclear if the existing prevention program will be changing based on the recommendations in this report. If SCWA does change the program, DFG would like to see future updates to the Plan.	Page One. Plan will be reviewed quarterly.
General Comment Comment #2		The Plan refers to Eurasian Mussels as Dreissena mussels and golden mussels; however, the program does not seem to consistently incorporate golden mussels. SCWA may want to consider changing the program from Eurasian mussels to Dreissena mussels, or incorporate information on golden mussels throughout the prevention program (outreach & education, lab analysis, identification etc). Comments below will be based on the assumption that golden mussels will continue to remain as a part of the prevention program.	Golden Mussels will remain a part of the plan. Appropriate changes have been made.
Section 2 Comment #3	Pg. 9	Table 2 needs to include golden mussel parameters.	Completed
Section 3 Comment #4	Pg. 11	Please provide a description of the existing boat inspection program – where inspections occur, what an inspection includes, how often they occur, etc.	Solano County Water Agency is not responsible for boat inspections at Berryessa. I will in the future add current actions being taken by all agencies.

## Appendix R

Section 3 Comment #5	Pg. 11 – 12	Under "Actions to Prevent Infestations: Lake Berryessa," item 4 indicates that agency staff are trained to inspect watercraft; however, watercraft inspections are not listed as a prevention action. Please update list. In addition, if inspections occur at other waterbody locations please include them as an action item under the appropriate waterbody.	The Bureau is responsible for watercraft inspections. The Bureau does not have any staff that is certified to train watercraft inspectors.
Section 3 Comment #6	Pg. 12	Under "concerns," item 1 indicates that boat inspections at Capell launch ramp stop at 11:00 a.m.; however, in the recommendations on page 4 it states that inspections stop at 11:30 a.m. Please update so information is consistent.	Appropriate changes made
Section 5 Comment #7	Pg. 16	Please include maps of the different waterbodies that show where substrate sampling and plankton tows are taken	Map included in amended document
Section 5 Comment #8	Pg. 17	Under "Types of Surveys: Plankton Tows," the document states that samples are taken bimonthly immediately downstream from Monticello Dam; however, on page 11 under "Actions to Prevent Infestations: Putah Creek" it says that samples are taken monthly. Please update so both are consistent.	Appropriate changes made
Section 5 Comment #9	Pg. 18	Under "Description of Plankton Tows," the document states that a variety of techniques and protocols are used to help prevent false negatives and false positives. Please provide more information on this.	Already explained on pages 16, 17, 26, & 36
Section 5 Comment #10	Pg. 19	Under "Visual (Physical) Inspections – Please provide the frequency of the routine visual surveys for Lake Berryessa and the frequency of routine infrastructure checks for Putah South Canal.	Appropriate changes made.
Section 7 Comment	Pg. 25	Please indicate what laboratory samples are sent to.	Added

Date Last Updated 6/27/2012

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## Appendix R

#11 Section 7 Comment #12	Pg. 25	Under "Identification" please provide information on how SCWA will positively identify a dreissena mussel in comparison to a golden mussel.	Any unusual mussel will be reported to DFG
Section 7 Comment #13	Pg. 26	Under "Readability of Samples" – The document states that on a monthly basis 10 preserved veligers are placed in a negative sample from the Solano Project and processed normally to determine level of veliger recovery. Please provide more information. Where do the veligers come from? Is this approach covered under Ken Davis's SCP? If not SCWA must obtain a permit from DFG to possess dreissena veligers.	Veliger from USBR Lab (Denver). Voucher specimens are covered under my SCP with DFG.
Section 7 Comment #14	Pg. 26	Under "Readability of Samples" – This section appears to be unfinished. The last sentence was cut off.	Fixed
Section 7 Comment #15	Pg. 27	Please include photos of golden mussel veligers in the "Plankton and Veliger Image Library" and in the "Comparative Images with Measurements" sections.	Not sure if they are veliger images are available. I will investigate and include if possible
Section 8 Comment #16	Pg. 30	Add the scientific name for the golden mussel.	Completed.
Appendix A Comment #17	Pg. 35	Fish and Game Code Section 2301(e) states that "Any entity that discovers dreissenid mussels within this state shall immediately report the discovery to the department." Please update this chart so that DFG is notified at "Level Two" instead of at "Level Three."	DFG notified on Level Two

Date Last Updated 6/27/2012

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## Appendix R

Appendix H Comment #18	Pg. 48	DFG has updated the Aquatic Invasive Species Decontamination Protocols. Please replace the September 16, 2010 version with the January 24, 2012, which can be found on the DFG Quagga and Zebra Mussel website ( <a href="http://www.dfg.ca.gov/invasives/quaggamussel/">http://www.dfg.ca.gov/invasives/quaggamussel/</a> ).	New protocols downloaded and added to plan.
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Date Last Updated 6/27/2012