



# Zebra and Quagga Mussel Artificial Substrate Monitoring Protocol\*

## California Department of Fish and Game

\*This protocol was adapted from the California Department of Water Resources *Monitoring Instructions for Zebra/Quagga Mussel Plate Samplers*, April 2, 2008.

### Description of Zebra and Quagga Mussels

The zebra mussel, *Dreissena polymorpha*, and the quagga mussel, *Dreissena bugensis*, are small mussels found only in freshwater. They look very similar to each other. They commonly have alternating light and dark brown stripes, but can also be solid light brown or dark brown. They have 2 smooth shells that are shaped a little bit like the letter "D". These mussels are usually less than 2 inches in length. In new populations, most mussels are young and therefore very small (under ¼ -inch long).

<b>Quagga Mussel</b> <i>Dreissena bugensis</i>	<b>Zebra Mussel</b> <i>Dreissena polymorpha</i>
 <ul style="list-style-type: none"><li>• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or dark concentric rings; paler near hinge</li><li>• Attaches to hard and soft surfaces</li></ul>	 <ul style="list-style-type: none"><li>• Shell: D-shaped and triangular; thin, fragile; smooth or shallowly ridged; solid light to dark brown or striped</li><li>• Attaches to hard surfaces</li></ul>



### *Color variation in zebra and quagga mussels*

Quagga and zebra mussels are freshwater mussels that can physically attach onto hard substrates. Like the mussels found clinging to the rocks along the California coastline, zebra and quagga mussels attach onto hard surfaces (e.g. pipes, screens, rock, logs, boats, etc.). They form colonies made up of many individuals attached onto an object and even onto each other. Small newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels will feel coarser (like a small pebble or sunflower seed) or be visually apparent.

## Other Organisms Mistaken for Zebra/Quagga Mussels

### *Asian clam, Corbicula fluminea*

People often mistake the very common Asian clam (also introduced) for zebra or quagga mussels. The Asian clam is widespread and abundant in California. It is brown and has ridges in concentric rings on its shells. The shells of older clams or of dead clams are white at the hinge (where the two shells join together). These clams do not attach onto surfaces. They live in mud or sand.



### *Snails and Freshwater Limpets*

Small snails and freshwater limpets cling to hard substrates and can be mistaken for small juvenile mussels. They are similar in color and size to small zebra and quagga mussels. Snails have a spiral shape. Limpets have one shell and are flat. Zebra and quagga mussels attach on the edge of their shell and stick up and away from the surface.



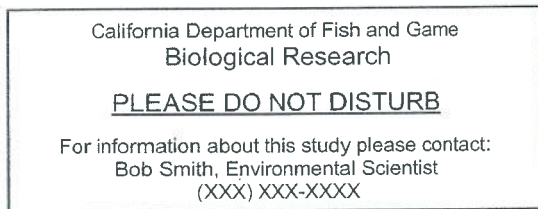
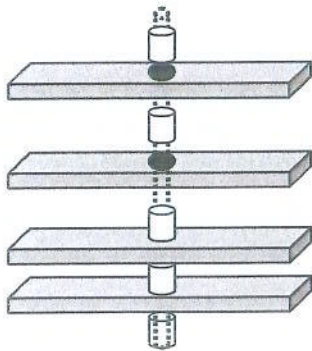
## Artificial Substrate Construction and Assembly

To construct the artificial substrate you will need the following materials cut to size:

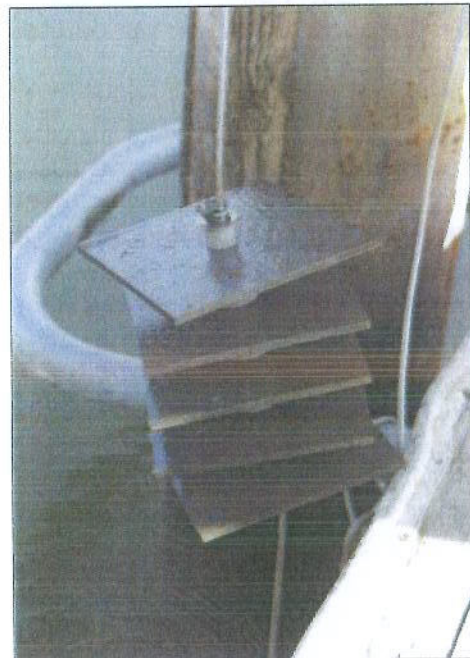
- (4) 6" x 6" x 0.25" black/grey PVC with 1" hole through center
- (5) 1.5" x 1.375" (35mm) exterior diameter PVC or ABS tube
- (1) 8.5" x 0.8125" (21 mm) exterior diameter PVC or ABS tube

~25 ft plastic coated cable or rope  
Some form of attachment to keep plates from floating up  
Weight  
Laminated label with your contact information

To assemble the substrate, run the cable or rope through the 8.5" tube and secure at one end. From the loose end of the rope string on the remaining pieces, alternating between the short segments of tube and the plates, beginning and ending with the short tubes (see figure). Secure the top tube to the rope to prevent the pieces from floating up. If necessary, attach a weight to the bottom of the assembly. Attach the label to the cable where the cable is secured to the structure.



*Example of a label*



### **Selection of Monitoring Site**

Zebra and quagga mussels are transported between waterbodies by watercraft (boats, wave runners, etc), water diversions, and the natural downstream flow of a river system. Monitoring sites are selected with these factors in mind. Prime sites are areas with high boat traffic and downstream of source water. If you are sampling at a waterbody that allows boating, select a site that has a lot of boat traffic. Examples are boat ramps, gas docks or dockside marina stores. Then find a location with low flow and protection from vandalism. Marinas often offer all of these features. Within a marina, find a location with restricted public access. Avoid placing the artificial substrate at unsupervised boat ramps because of tampering by the general public and entanglement with the dock cabling system when the water level changes or the ramp is moved. If these types of structures are not available, find a site downstream of the boat traffic that offers as much protection from vandalism as possible. Examples include water quality monitoring

stations or towers and government agency boathouses. Always ask for permission before attaching artificial substrates to structures. Again, find a location that offers protection from vandalism and has low flow.

### **Deployment and Inspection of the Artificial Substrate**

Depending on water clarity and depth, the artificial substrate should be set below the euphotic zone (below the depth of light penetration) or 6 feet, whichever is deeper, and at least two feet above the bottom. One to two substrates are deployed per site. If the site is shallower than 2 m, then raise the substrate about 0.5 m (2 ft) off of the bottom. Record the actual sampling depth. At sites that are deep and have little vertical mixing, a second substrate is installed at a depth of approximately 15 meters (50 feet) below the surface (or 1 meter off the bottom if the depth is less than 15 meters).

A visual and tactile examination of the artificial substrate is conducted every month for attached zebra and quagga mussels. When mussels first attach they are very small (invisible to the naked eye) and are very delicate (shells are thin and easily crushed). A single mussel may feel like a grain of sand. If many mussels cover a surface, the surface feels gritty like sandpaper. In approximately 1 to 2 months a mussel grows large enough (1/4 inch) to be seen upon close inspection, but the shell is still very delicate. At this size it feels like a small pebble or sunflower seed.

To check an artificial substrate, first carefully lift it out of the water and place it in a large plastic tub (the tub will capture any mussels that fall off). Avoid knocking the substrate as you pull it out of the water because you may dislodge or crush any attached mussels. First visually inspect each plate (top, bottom, and sides), the spacers, the cable and the weight. After looking closely, attempt to gently push any attached organism that might be a mussel. Freshwater limpets and snails easily move or slide across the plate. Zebra and quagga mussels stick in place or are more securely attached. In all cases, if in doubt, bag it.

If no mussels are detected, lower the substrate back into the water and check again in a month. Zebra and quagga mussels are more likely to attach to a substrate that has some algal growth, however if the substrate becomes too heavily coated it may be unsuitable for mussel settlement. As necessary, gently remove heavy accumulations of algae to maintain suitable conditions for settlement.

### **Specimen Collection**

If you suspect you have found a mussel immediately contact the appropriate DFG regional mussel contact (list attached). To aid identification, first take a close-up digital photograph of each specimen. Next, collect the specimen(s) and place in a vial with 70% ethanol. Label the vial with location, date, and name of collector. If ethanol is not available, place the sample in a rigid container (to prevent crushing) without water, label, and refrigerate. E-mail the photos to the DFG contact and they will try to identify

the specimens from the photographs, and may request the actual specimen(s) to make a positive identification.

If the entire artificial substrate needs to be retained for laboratory processing, place the entire unit in a large Ziplock bag or small garbage bag and keep it in a cooler with ice while in the field. Store the substrate in the freezer until ready to mail. Mail it "overnight delivery" on ice.

### **Replacement of Artificial Substrate**

Replace a missing or broken artificial substrate with a new one. If the substrate is repeatedly lost or damaged look for a new deployment site that offers more protection. Report any incidents and the action(s) taken.

To prevent any possibility of contamination between monitoring sites (should mussels be present and not yet detected), never take a substrate from one site and place it at a different site (even within a single waterbody).

### **Data Recording and Reporting**

Every time an artificial substrate is checked the data must be recorded on a datasheet before leaving the field. Absence data is as important to document as presence, so complete and submit a datasheet even if no mussels were found. Send datasheets to the appropriate DFG regional contact. All data will be entered into a data reporting system and the datasheets will be retained on-site.

**Artificial Substrate Datasheet**  
**California Department of Fish and Game**  
 (One datasheet for each artificial substrate)

Collection Information		
Date: _____		
Waterbody: _____		
Substrate location (GPS or site description): _____		
Substrate depth (meters): _____		
Collector(s): _____		Affiliation: _____
Contact information (email or phone # if not DFG): _____		
Substrate		
Substrate (circle one): Present		Missing
Condition (circle one): Intact		Damaged
Comments: _____		
Mussels		
Mussels (circle one): Present		Absent
Species (circle one): Quagga		Zebra
		Unknown
Where (circle all that apply):		Total # of mussels on each part of substrate
Plate surface		_____
Plate edge		_____
Spacers		_____
Rope (depth _____)		_____
Other (_____)		_____
Plate dimensions (units): ____ x ____ (____)		Plate area (multiply plate dimensions): _____
Plates:		Number of mussels
		Density (# of mussels ÷ area)
Side 1 (top side of top plate)		
Side 2 (bottom side of top plate)		
Side 3 (top side of second plate)		
Side 4 (bottom side of second plate)		
Side 5 (top side of third plate)		
Side 6 (bottom side of third plate)		
Side 7 (top side of bottom plate)		
Side 8 (bottom side of bottom plate)		
Additional Information		
Other organisms present: _____		
Comments: _____		

Return completed datasheets to the appropriate California Department of Fish and Game Regional office.

## DFG Regional Office Contacts for Quagga Mussel Monitoring

### Region 1 – Northern Region

Counties: Del Norte, Humboldt, Lassen, Mendocino, Modoc, Shasta, Siskiyou, Tehama, and Trinity

601 Locust Street, Redding, CA 96001

L. Breck McAlexander

[LMCALEXANDER@dfg.ca.gov](mailto:LMCALEXANDER@dfg.ca.gov)

Office: (530) 225-2317

Fax: (530) 225-2381

### Region 2 – North Central Region

Counties: Alpine, Amador, Butte, Calaveras, Colusa, El Dorado, Glenn, Lake, Nevada, Placer, Plumas, Sacramento, San Joaquin, Sierra, Sutter, Yolo and Yuba

1701 Nimbus Road, Rancho Cordova, CA 95670

Jason Roberts

[JDROBERTS@dfg.ca.gov](mailto:JDROBERTS@dfg.ca.gov)

Office: (916) 358-2895

Fax: (916) 358-2912

### Region 3 – Bay Delta Region

Counties: Alameda, Contra Costa, Marin, Napa, Sacramento, San Mateo, Santa Clara, Santa Cruz, San Francisco, San Joaquin, Solano, Sonoma, and Yolo

4001 North Wilson Way, Stockton, CA 95205

Catherine Mandella

[CMANDELLA@dfg.ca.gov](mailto:CMANDELLA@dfg.ca.gov)

Office: (209) 942-6107

Fax: (209) 946-6355

### Region 4 – Central Region

Counties: Fresno, Kern, Kings, Madera, Mariposa, Merced, Monterey, San Benito, San Luis Obispo, Stanislaus, Tulare and Tuolumne

1234 E. Shaw Avenue, Fresno, CA 93710

Mark Watson

[MWATSON@dfg.ca.gov](mailto:MWATSON@dfg.ca.gov)

Office: (559) 243-4017 x244

Fax: (559) 243-4022

### Region 5 – South Coast Region

Counties: Los Angeles, Orange, San Diego, Santa Barbara and Ventura

4949 Viewridge Avenue, San Diego, CA 92123

Daniel Schrimsher

[DSCRIMSHER@dfg.ca.gov](mailto:DSCRIMSHER@dfg.ca.gov)

Office: (858) 467-6926

Fax: (858) 467-4299

### Region 6 – Inland Deserts Region

Counties: Imperial, Inyo, Mono, Riverside and San Bernardino

P.O. Box 2160, Blythe, CA 92226

David Vigil

[DVIGIL@dfg.ca.gov](mailto:DVIGIL@dfg.ca.gov)

Office: (760) 922-4928

Fax: (760) 922-5638

Rick Francis

[RFRANCIS@dfg.ca.gov](mailto:RFRANCIS@dfg.ca.gov)

Cell: (760) 828-7582

Fax: (760) 922-5638