Appendix F

Aquatic Invasive Species Monitoring and Decontamination Protocols

Aquatic Invasive Species Monitoring at California Department of Fish and Wildlife Hatcheries

Aquatic Invasive Species Monitoring at CDFW Hatcheries
California Department of Fish and Game
February 2013

Invasive Species

"Invasive species" are defined as plants or animals that cause environmental or economic harm, or harm to human health. Invasive species tend to be adaptable to new environments and multiply quickly. It is difficult to predict where an invasion will occur, which species may invade, or the consequences of their invasion; therefore, to protect facilities and the environment it is necessary to monitor for invasive species so that if an invasion does occur, efforts can be made quickly to prevent their spread within an area and to adjacent areas.

Invasive species threaten the diversity and abundance of native and desirable non-native species through competition for resources, predation, parasitism, hybridization, transmission of diseases, and/or causing physical or chemical changes to the environment. Invasive species also threaten man-made systems and structures, including water delivery and flood protection systems, agriculture, and developed lands.

Invasive species are commonly introduced into new areas as a result of human activities. Natural barriers, such as mountains, oceans, etc., historically confined species to their native range. Commerce and the advent of travel between remote locations has circumvented natural barriers, and trains, planes, ships, and vehicles are capable of transporting organisms great distances, often unknowingly and unintentionally. Hatchery activities have the potential to spread invasive species to new waterbodies, as well as between waterbodies, when stocking fish.

Invasive species in hatcheries pose a number of concerns. First, they may become established within a hatchery and impact operations, including clogging pipes, aeration devices, screens, and encrusting equipment, necessitating added maintenance. Second, they may be spread to other hatcheries and/or into the environment along with transfered or planted fish. Alternatively, invasive species may not directly impact operations at a hatchery, and thus go unnoticed, or pass through a hatchery in its source water. Both of these situations present the opportunity for hatchery activities to move invasive species to new environments in transport water, and therefore must also be addressed.

This protocol is limited to monitoring for aquatic invasive species (AIS); however, it is recommended that precautions to prevent the spread of terrestrial invasive species also be taken. This protocol does not address fish health issues or disease prevention. Monitoring for AIS is a component of a comprehensive Hazard Analysis-Critical Control Point (HACCP) Plan, which identifies pathways and preventatives for the introduction of AIS into a hatchery, the spread of AIS within a hatchery, and the release of AIS from a hatchery.

Sources of Aquatic Invasive Species

Many hatcheries use surface water for operation. Surface waters are susceptible to AIS contamination, particularly if accessible for recreation (boating, fishing, etc.). Most of CDFW's anadromous mitigation hatcheries are located below dams and use water directly from an impounded reservoir that allow recreational access. Other hatcheries are located further down-river from reservoirs, or on rivers where recreation occurs, and are also at risk of AIS contamination. Well water pumped directly into a hatchery is at very low risk of being contaminated with AIS.

Other potential pathways for the introduction of AIS into a hatchery include the importation of eggs or fish, or by picking up an AIS on equipment or vehicles in the course of planting fish. These pathways, and all others, should be addressed in a comprehensive HACCP Plan.

Aquatic Invasive Species of Concern, and Aids to Their Identification

AIS believed to pose the greatest threat to California's hatcheries and the environment are quagga mussel, zebra mussel, and New Zealand mudsnail, and the monitoring methods described herin are specific for these three species. Other AIS of concern, including channeled apple snail, Brazilian waterweed, Eurasian watermilfoil, *Hydrilla*, and the algae *Didymosphenia geminata* (also known as didymo or rock snot), are described in Attachment A and should be reported if found. Refer to Attachment A for species descriptions, suitable environmental conditions, known range, and photos to assist in their identification.

QUAGGA MUSSEL AND ZEBRA MUSSEL

Dreissena bugensis and *Dreissena polymorpha*

Quagga and zebra mussels are separate species, but look very similar. The following description applies to both species. These freshwater mussels produce microscopic, free-floating larvae. The larvae eventually settle on surfaces and turn into the shelled adult form.

Species Description:

- Body form – Juveniles and adults are 2-shelled (bivalve); may have dark colored "threads" on one edge. Larval life-stage is microscopic and cannot be seen by the unaided eye.
- Size – Range in size from microscopic to up to 2" long; free-floating (planktonic) larvae are microscopic.
- Color – Shells usually have alternating light and dark brown stripes, but can also be solid light brown to dark brown.

Suitable Environmental Conditions:

- Temperature – Survives in water temperatures between 32° F and 88° F.
- Moisture – Aquatic, but can survive out of water for weeks under suitable conditions (longest at low temperatures and high humidity).
- Substrate – Usually attached to soft and hard surfaces, including aquatic plants, but also known to detach from surfaces and crawl or be carried by water. Small, newly settled mussels feel like gritty sandpaper when attached to a smooth surface. Larger mussels may feel coarser, like a small pebble or sunflower seed. Mussels often adhere to surfaces firmly and when lightly touched may rock back and forth.
- Known occurrences in California – San Bernardino, Riverside, San Diego, Imperial, Orange, and San Benito Counties. For current known locations visit http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/maps/CaliforniaDreissenaMap.jpg.

Key Features for Identification:

Quagga and zebra mussels are not the only freshwater bivalve found in California, however they are the only freshwater bivalves that attach to surfaces. In the absence of attachment, a combination of characteristics including their alternating bands of color and evidence of "threads" can be used to identify.

Size and color variation in mussels

Quagga mussel showing 'threads'

NEW ZEALAND MUDSNAIL

Potamopyrgus antipodarum

Small, fresh to brackish water aquatic snail that can be easily overlooked because it often blends in with its surroundings. New Zealand mudsnails are self-reproducing and give birth to live offspring, therefore a single snail can create a population.

Species Description:

Body form – Single shell that is elongated and spiraled, when fully grown having 5-7 spirals.

Size – From microscopic up to ¼" long.

Color – Variable; light to dark brown in color.

Suitable Environmental Conditions:

Temperature – Survives in waters between 32° F and 83° F.

Moisture – Aquatic, but can survive for weeks under suitable temperatures and humidity.

Substrate – Soft (mud, silt, plants, etc.) and hard substrates. Also capable of detaching and floating in the water.

Known occurrences in California – For current known locations visit http://nas.er.usgs.gov/queries/collectioninfo.aspx?SpeciesID=1008.

Key Features for Identification:

A key feature of live New Zealand mudsnails is the presence of an operculum (flap covering the shell opening). New Zealand mudsnails require expertise to accurately identify. Any snail ¼" or less should be forwarded for identification (see page 10).

Dead New Zealand mudsnail on metric ruler (5 millimeters = ~¼"). Operculum often absent in dead specimens.

Live New Zealand mudsnail showing operculum and spirals, numbered 1-5.

Dense colony of New Zealand mudsnails attached to the underside of a rock.

Monitoring for Quagga and Zebra Mussels and New Zealand Mudsnail

General Guidelines

Early detection monitoring concentrates efforts on areas where AIS are most likely to be found, rather than by randomly sampling. Attention should be directed to protected areas, such as crevasses, corners, and edges.

Hatchery personnel should always be on the look-out for unfamiliar plants and animals during daily operations. Current maintenace-intensive hatchery operations provide considerable opportunity to watch for AIS. Intensive maintenance could, however, inhibit the detection of AIS. Routine cleaning may prevent organisms from attaching to surfaces, becoming established, growing large enough to detect, or keep them at such low densities that they remain undetected.

In addition to watching for AIS during routine operations, hatcheries must inspect their facilities quarterly for AIS. Inspections provide only a snapshot in time, and do not guarantee that a facility is AIS-free. Increasing the frequency of inspections and using a variety of methods will improve the likelihood that an AIS is detected. In addition, monitoring may be useful in identifying the point of AIS introduction, should an infestation occur.

Because each AIS is different, no one method is effective for detecting all species. A combination of methods, including specialized sampling devices and examination of existing surfaces, is necessary. Monitoring methods and specific directions, as well as proceedures for documenting and reporting monitoring, are provided below.

Monitoring Source Water and Outflow

A means for continuous monitoring of non-well water entering the hatchery is necessary. Detecting AIS in water coming into a hatchery can exclude hatchery activities as the source of an AIS infestation. A portion of the inflow is routed into a flow-through system, referred to as a “biobox”, designed to provide a suitable environment for some AIS species, making their detection possible. In addition, hatchery staff should examine debris, including plants, entrained on intake screens and trash-racks for AIS.

Because hatchery water is released into the environment untreated, AIS may be released as well. Monitoring hatchery outflow samples all the water passing through the hatchery, and is the final opportunity to detect AIS. Outflow monitoring can be achieved using either a biobox, artificial substrates and surface survey for depths three feet and greater, or surface survey for depths less than three feet.

Bioboxes

- ***This method is suitable for detection of quagga and zebra mussels***

Bioboxes are flow-through aquaria, designed specifically to sample for the

larval/settlement stage of quagga and zebra mussels. Microscopic larvae are suspended in the water, and upon reaching settlement stage, attach to surfaces. The biobox provides suitable conditions (surface and flow) for this to occur. Flow rates greater than 5 feet/sec inhibit mussel settlement, so a flow-through system must not exceed this velocity.

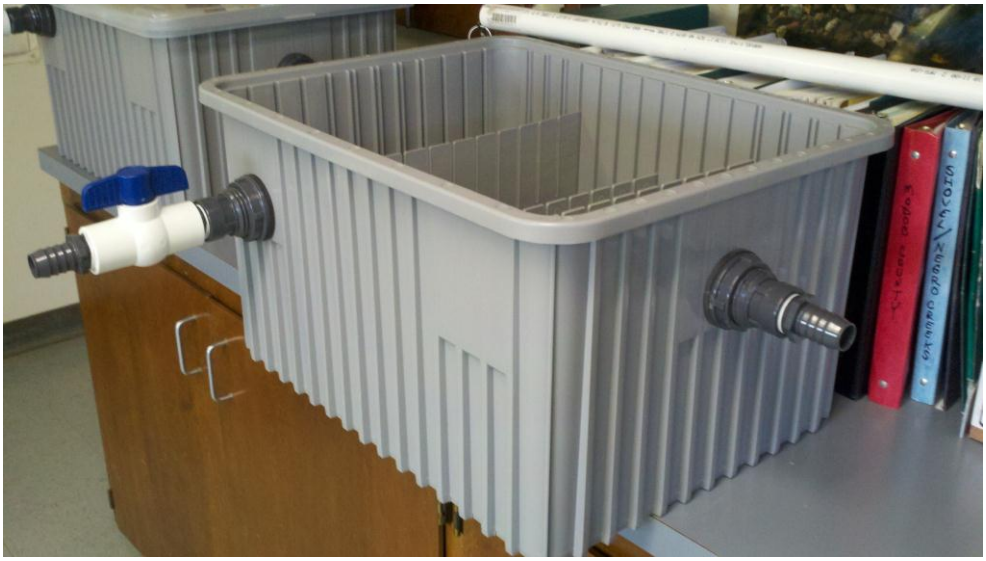
Location(s):
One biobox will be installed where raw water enters the facility and, if feasible, at each (if more than one) hatchery outflow, prior to discharge. Bioboxes are not needed on water drawn directly from a well. Bioboxes should be placed on a stable surface adequate to support its weight. If the water temperature inside the biobox is more than 2° F above the hatchery water temperature then the biobox must be shaded. Bioboxes should be located in areas that will not be damaged by water if the box were to overflow. Individual hatcheries may need to modify the Biobox during installment to adequately meet all flow and temperature requirements. There may also be infrastructure modifications needed to connect the Biobox to individual hatcheries inflow and outflow water supply.

Monitoring frequency:
Bioboxes should be checked as needed to ensure they are operating correctly and maintaining the appropriate flow rate. A visual and tactile (touch) examination is conducted quarterly.

Requirements for biobox design:
- Minimum internal volume of 12 gallons
- Flow rate of 1.32 gallons/minute

The following design specifications meet the biobox requirements, above.

<u>Biobox Construction and Assembly (Figure 1)</u>
(Designed by Jody Rightmier, CDFW Yreka Screen Shop)



BIO-BOX MATERIALS PARTS LISTING: material to cover single box

1” PVC Ball Valve Female threaded ends, quarter turn design…..1 each

Nipple TBE SCH 80 1” x close PVC……..1 each

1” PVC 90 degree elbow slip x slip SCH 40…….1 each

1” pipe x MIPT PVC insert male adapter……2 each

1’ PVC Tank adapter SOCXFPT NPRN Gasket……...2 each

1’ x 2” (length) SCH 40 PVC pipe……1 each

22 x 17 x 12” Grey Bins and Divider box……1 each

Snap F/DC3000 Bins & Divider box cover……1 each

Short Divider F/DC3080 (sold in 6 pk). Bins & Divider box…….3 each/box

ER308L 3/32 x 36” TIG welding rod……1 each

1/2 “ bolt size medium flat washer 18-8 stainless/steel……6 each

The plates slide down into “channel guides” on either side of the interior walls of the box (Figure 2) and water flows over and under the plates as it passes through the box. Plates are kept submerged with stainless steel wire and washers that allow for removal when inspecting the plates. Flow into the box is regulated by a valve on the incoming water line. The outlet is an overflow pipe that ensures the water level in the box remains at a constant level. All interior surfaces and plates are roughed up with fine (150-180 grit) sandpaper to maximize suitability for settlement.

Figure 2. Interior view of biobox plates that provide suitable surfaces for mussel settlement.

Monitoring procedure:

To inspect biobox, begin by closing the inflow valve. One at a time, carefully remove each plate. Do not set the plates down as small or delicate organisms could be crushed. Hold the plate over a separate container to catch any dislodged organisms, and visually inspect it. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small quagga or zebra mussels may be more easily felt than seen. Do not leave the plates out of the water so long that they dry; examine and return to the water immediately if no suspect organisms are found. When finished with the first plate, reinsert it and inspect the remaining plates the same way. Also examine the inner walls of the biobox. If walls are transparent, look in from the outside. If not, view from above. Next, gently run fingers over the walls as with the plates. When finished, open the valve to resume appropriate flow.

Artificial Substrates

- ***This method is suitable for detection of quagga and zebra mussels***

If it is not feasible to use a biobox at the outflow, then a minimum of two (2) artificial substrates should be deployed in settling ponds.

ARTIFICIAL SUBSTRATE MATERIALS PARTS LISTING: material to cover single substrate

(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

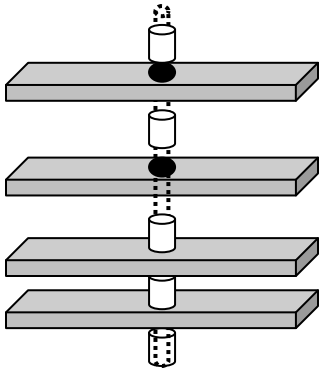
~25 ft plastic coated cable or rope

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.



California Department of Fish and Game

Biological Research

PLEASE DO NOT DISTURB

Deployment of the Artificial Substrates:

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 few 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).

Monitoring procedure:

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. Use a magnifying glass if necessary. Next, gently run fingers over the plates to feel for any organisms. Very small quagga or zebra mussels may be more easily felt than seen. 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. 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.

Monitoring In-Hatchery and Outflow

In addition to monitoring at the inflow and outflows, surface surveys must be conducted within the hatchery facilities and outflows if a biobox is not used.

Surface Surveys

- ***This method is suitable for detection of quagga and zebra mussels and New Zealand mudsnail***

When areas are dewatered during hatchery operations, surfaces must be inspected for AIS. Many AIS blend in with their surroundings and prefer sheltered areas, so close inspection is necessary and most easily conducted when dewatered. In addition, surfaces and structures within the hatchery must be inspected quarterly. Specific instruction on how to inspect surfaces is provided below.

Locations and frequency:
Inspect 5% of dewatered surfaces as dewatering occurs. In addition, inspect 5% of surfaces throughout the facility each quarter. For example, if there are ten raceways, inspect the safely accessible surfaces equivalent to one-half of a raceway (10 raceways x 0.05 = 0.5 raceways), divided among the ten raceways. Spreading the 5% over all of the raceways increases the chance of finding an AIS if it is in the facility.

The 5% applies to surfaces, outflow settling ponds (if applicable) as well as equipment such as screens, tubing, lines, etc. As with all forms of early detection monitoring, the more you look, the more likely you are to find something if it is there. Always err on exceeding the minimum sampling requirement, rather than just meeting it.

If monitoring is conducted outside of secured areas of the hatchery there is greater potential that they are infested with invasive species. Do not allow gear that will be returned to the hatchery (including, but not limited to boots, waders, nets, etc) to contact the settling ponds. In these cases gear dedicated to this purpose should be used and prominently labeled, and stored separately from other gear. If dedicated gear is not feasible, then gear must be decontaminate after monitoring outside of the hatchery according to the following protocols:

http://www.dfg.ca.gov/invasives/quaggamussel/

Monitoring procedure:

Carefully examine surfaces both visually and tactilely by running fingers over them, with particular attention given to protected areas such as crevasses, corners, and edges, and areas where fish are excluded from. If needed, use a magnifying glass, flashlight, or other aides to thoroughly examine.

Summary of Monitoring Methods and Minimum Monitoring Frequencies

	Biobox	Surface Survey	Artificial Substrates
Inflow	Quarterly (January, April, July, October)	N/A	N/A
In hatchery	N/A	Dewatering and 5% Quarterly (January, April, July, October)	N/A
Outflow	Quarterly (January, April, July, October)	5% Quarterly (January, April, July, October)	Quarterly (January, April, July, October)

Specimen Identification and Collection

If a suspect AIS is detected either during daily operations or monitoring, immediately contact your CDFW Regional AIS Scientist (page 12). To aid their identification, first take a close-up digital photograph of the organism next to a ruler so that there is a size reference. Next, collect the specimen(s) and place in a container where it will not be crushed and add enough 70% ethanol to cover it. Label the sample with hatchery name, location within the hatchery, date, suspected species, and the name of who collected it. If the entire substrate needs to be retained, place the entire unit in a plastic bag. E-mail the photos to the CDFW Regional AIS Scientist and they will try to identify the specimens from the photographs. If they are unable to identify the species from photographs, they may request the specimen(s) or substrate.

Data Recording and Reporting

Quarterly monitoring is to be conducted during the months of January, April, July, and October. Quarterly monitoring datasheets must be completed to document monitoring, and are to be submitted by the end of the month of monitoring. Absence data is as important to document as presence, so complete and submit a datasheet (electronic form provided) even if no AIS are found. Hatcheries are to send an electronic copy of the datasheet to their respective regional Senior Hatchery Supervisor, Regional AIS Scientist, to the Fisheries Branch Fish Production Program Manager and Hatchery Coordinator via email, and retain the originals on-site. All data will be entered into a centralized monitoring database maintained by the Habitat Conservation Planning Branch AIS Program.

CDFW Regional Office Contacts for AIS Monitoring

Contact information subject to change. For the most up to date information refer to: http://www.nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=4955.

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
Louis.McAlexander@wildlife.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 Julienne
Jason.Julienne@wildlife.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
Catherine.Mandella@wildlife.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
Kelley Aubushon
Kelley.Aubushon@wildlife.ca.gov
Office: (559) 243-4017 X-285
Fax: (559) 243-4004

Region 5 – South Coast Region

Counties: San Diego, Orange
3883 Ruffin Road, San Diego, CA 92123
Russell Black
Duane.Black@wildlife.ca.gov
Office: (858) 467-4262

Fax: (858) 467-4299

Counties: Los Angeles, Santa Barbara and Ventura
4665 Lampson Avenue, Los Alamitos, CA 90720
Eloise Tavares
Eloise.Tavares@wildlife.ca.gov
Office: (562) 342-7155
Fax: (562) 342-7153

Region 6 – Inland Deserts Region

Counties: Imperial, Inyo, Mono, Riverside and San Bernardino
P.O. Box 2160, Blythe, CA 92226
David Vigil
David.Vigil@wildlife.ca.gov
Office: (760) 922-4928
Fax: (760) 922-5638

Other Aquatic Invasive Species of Concern

The following species are known to occur in California and should be reported if found. Additional species accounts may be added as warranted.

Animals

- Channeled apple snail

Plants and Algae

- Eurasian watermilfoil
- Brazilian waterweed or Brazilian elodea
- Hydrilla
- Rock snot or didymo

CHANNELED APPLE SNAIL

Pomacea canaliculata

Freshwater aquatic snail. Channeled apple snails leave the water to lay eggs and eat terrestrial vegetation. Eggs hatch and juvenile snails return to the water. Reproduction is dependant on food availability and water temperature, but usually occurs in the early spring and early fall.

Species Description:

Body form – Single shell with compact spirals that are deeply indented, hence the common name “channeled”. Eggs are reddish in color, and loosely attached to each other in masses of 200-600.

Size – Adult shells can reach up to 3” long, individual eggs are 0.09-0.14” in diameter.

Color – Shell color is yellowish to brown.

Suitable Environmental Conditions:

Temperature – Survives in water between 65° F and 90° F.

Moisture – Aquatic, but commonly leaves water to lay eggs and eat. Can survive out of water for several months by closing the opening of its shell and bedding in the soil.

Substrate – Soft (mud, silt, plants, etc.) and hard surfaces.

Known occurrences in California – Lake Miramar, San Diego County, Norton Simon Museum pond, Los Angeles County, and Riverside County near the Salton Sea.

Key Features for Identification:

The large size of adult channeled apple snails and their egg masses is unique. Smaller specimens may be identifiable by their round, deeply indented shell.

Adult channeled apple snail shells

Egg masses

Newly hatched (5 day) channeled apple snail.

EURASIAN WATERMILFOIL

Myriophyllum spicatum

Species Description:

Plant – Reddish-brown or whitish-pink

Stems – Branched and 20-30” long, reddish-brown or whitish-pink.

Leaves – Olive green and occasionally reddish tinted and arranged circularly around the stem in groups of 3-6 (usually 4). Each leaf is less than 2” long, soft, and feather-like. Each leaf has a rib and 14-24 or so slender segments on each side of the rib.

Flowers – Individual flowers are reddish, very small, and many together form spikes several inches long that are held above the water.

Roots – Fibrous, often developed on small pieces broken off larger plant.

Suitable Environmental Conditions:

Temperature – Able to overwinter in frozen lakes and ponds in northern states and Canada; also able to grow in shallow, over-heated bays.

Moisture – Underwater; often found in water 1½” to 12’ deep, and up to 30’ in very clear water. Prefer lakes, ponds and slow-moving rivers and streams but can also grow in fast-moving water. Tolerates a wide range of water conditions, including spring water and even brackish water of tidal creeks and bays with salinity of up to 10 parts per thousand.

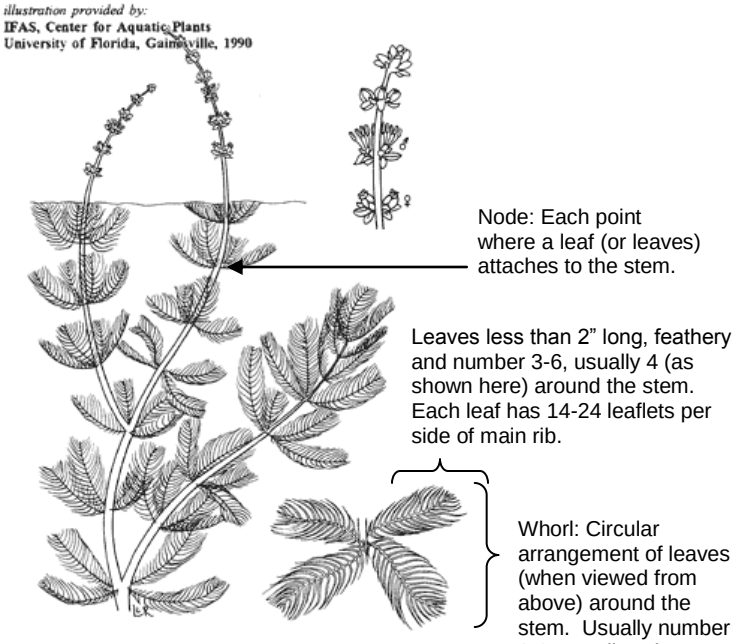
Substrate – Root in all types of substrates, and broken pieces float freely.

Known occurrences in California – Sacramento-San Joaquin Delta, San Francisco Bay Area and Central Valley ditches and lakes; margins of Southern California’s south-east border.

Key Features for Identification:

Finely divided, feather-like leaves ½ to 2“ long.

Color variation of Eurasian watermilfoil



BRAZILIAN WATERWEED OR BRAZILIAN ELODEA

Egeria densa

Species Description:

Plant – Green

Stems – Highly branched and can reach 25' or more in length.

Leaf attachment to stem (nodes) – Densely spaced at growing tip and indistinguishable. Points of attachment are more widely spaced near the main stem and stems deeper in the water. Double nodes bear branches and flowers.

Leaves – Thin, ¾ – 1½" in length and 1/16 – 1/8" wide, arranged circularly around the stems when viewed from above (whorls) of 3-6 leaves. Spear-shaped leaves have tiny teeth that may require a magnifying glass to see. The number of leaves doubles or triples (up to 12 leaves per whorl) every 8-12 whorls.

Flowers – Three white petals and are about ¾" across on 1" stems above the surface of the water.

Roots – Thin

Suitable Environmental Conditions:

Temperature – Survives in water between 40°F and 90°F.

Moisture – Underwater, in both flowing and shallow and standing water.

Substrate – Roots in all types of substrates; broken pieces float freely

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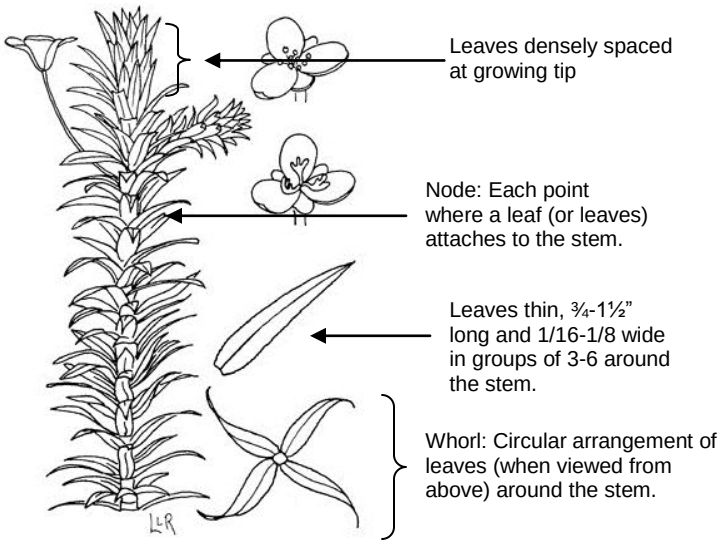
Known occurrences in California – Throughout the Sacramento-San Joaquin Bay-Delta.

Key Features for Identification:

Robust 1-inch leaves closely spaced in whorls of 3-6 around the stem. Also refer to page 7 for a comparison with similar species.



HYDRILLA

Hydrilla verticillata

Species Description:

Plant – Green, up to 25' long.
Stems – Slender, branched.
Leaves – Spear-shaped, ½ - ¾" long and 1/16" wide arranged in groups of 4-8 leaves around the stem. Leaf margins distinctly saw-toothed. Often 1-2 sharp teeth along the underside of the leaf rib.
Flowers – Tiny, white flowers born on long stalks at the surface of the water.
Roots – Roots are white and may have yellowish, potato-like structures ½" long and ½" wide at the tips of the roots.

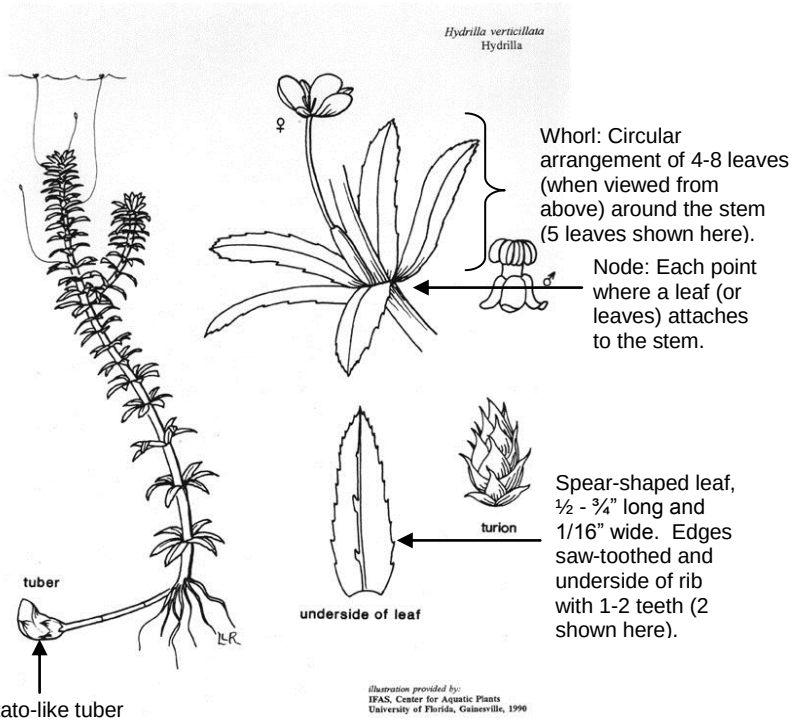
Suitable Environmental Conditions:

Temperature – Somewhat winter-hardy; its optimum water temperature is 68° F - 81° F; its maximum temperature is 86° F.
Moisture – Underwater, from a few inches deep to more than 20'.
Substrate – May be found in all types of water bodies including springs, lakes, ponds, marshes, ditches, canals, rivers, tidal zones. Broken pieces float freely.

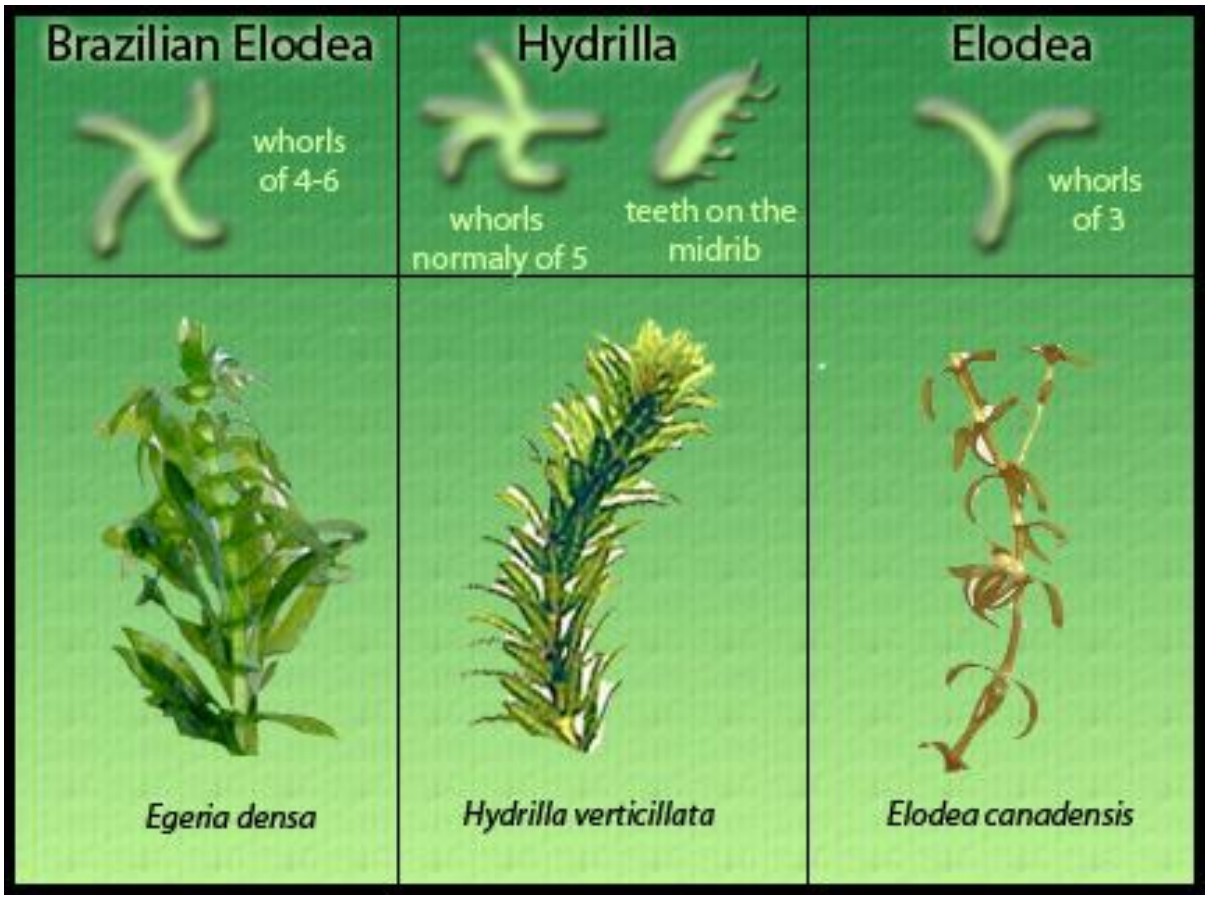
Known occurrences in California – Sacramento-San Joaquin Delta.

Key Features for Identification:

Hydrilla has distinctly saw-toothed leaf edges and teeth on the leaf underside. In addition, potato-like tubers on roots are diagnostic. Also refer to page 7 for a comparison with similar species



Side-by-side comparison of two invasive aquatic plants, *Egeria densa* and *Hydrilla verticullata*, to that of the common native *Elodea canadensis*.



INVASIVE	**INVASIVE**	**NOT INVASIVE**

ROCK SNOT OR DIDYMO

Didymosphenia geminata

Rock out of water, colonized with rock snot.

Species Description:

Growth form – Single-celled algae that forms thick mats.

Size – Starts as small clumps and can spread to cover entire wetted areas.

Color – Pale yellowish-brown to white.

Suitable Environmental Conditions:

Temperature – 32° F - 72° F

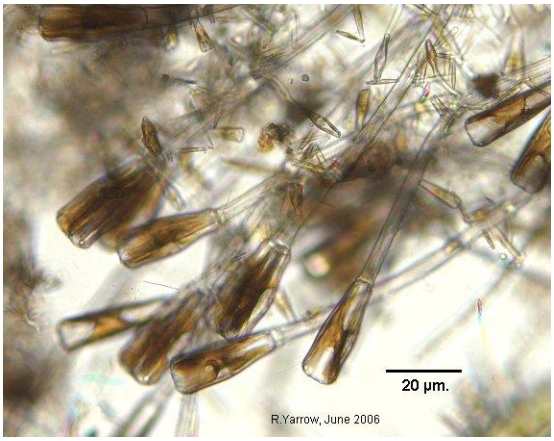
Moisture – Under water.

Substrate – Attaches to hard and soft substrates at depths of 4" to 6½'. Fragments float freely

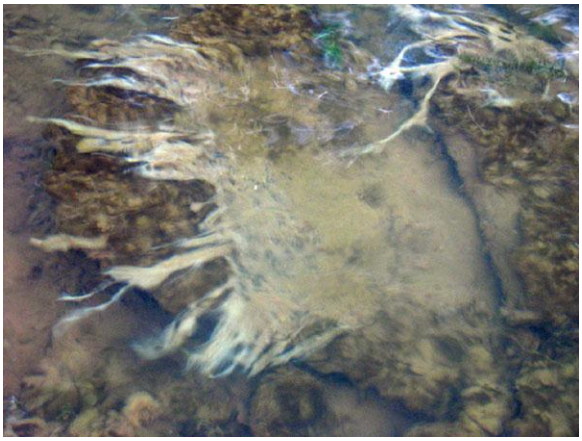
Known occurrences in California – South Fork of the American River, Sierra Nevada.

Key Features for Identification:

Looks like slimy blobs attached to rocks or wet toilet paper trailing from rocks and aquatic plants in streams, and as mats in slow moving water. Appears slimy but feels coarse, like damp wool.



Rock snot structure, as seen under a microscope



Rock snot in flowing water

California Department of Fish and Wildlife
Aquatic Invasive Species Decontamination Protocol

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 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

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.

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.

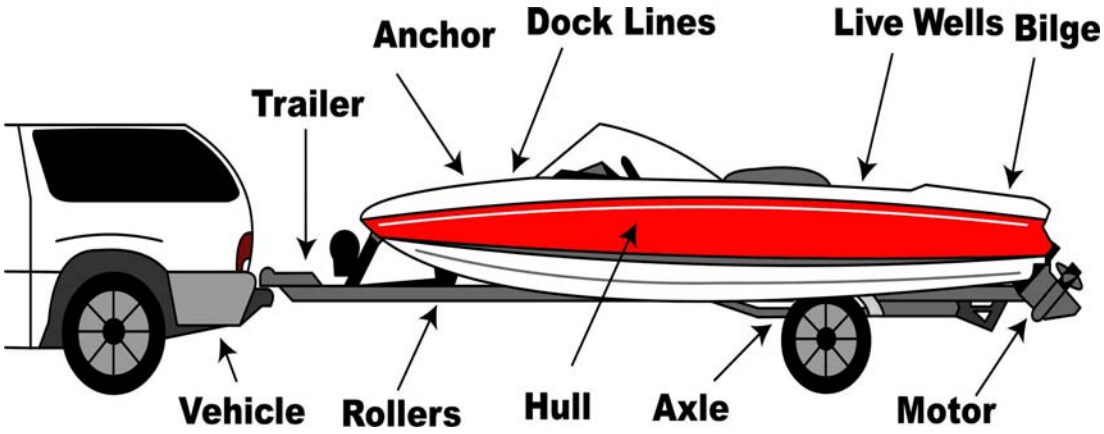
Option 3: Freeze

- 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.



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. Please provide your contact information, specific location of discovery, and digital photographs of the organisms (if possible).

Attachment A

New Zealand Mudsnail

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.

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

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