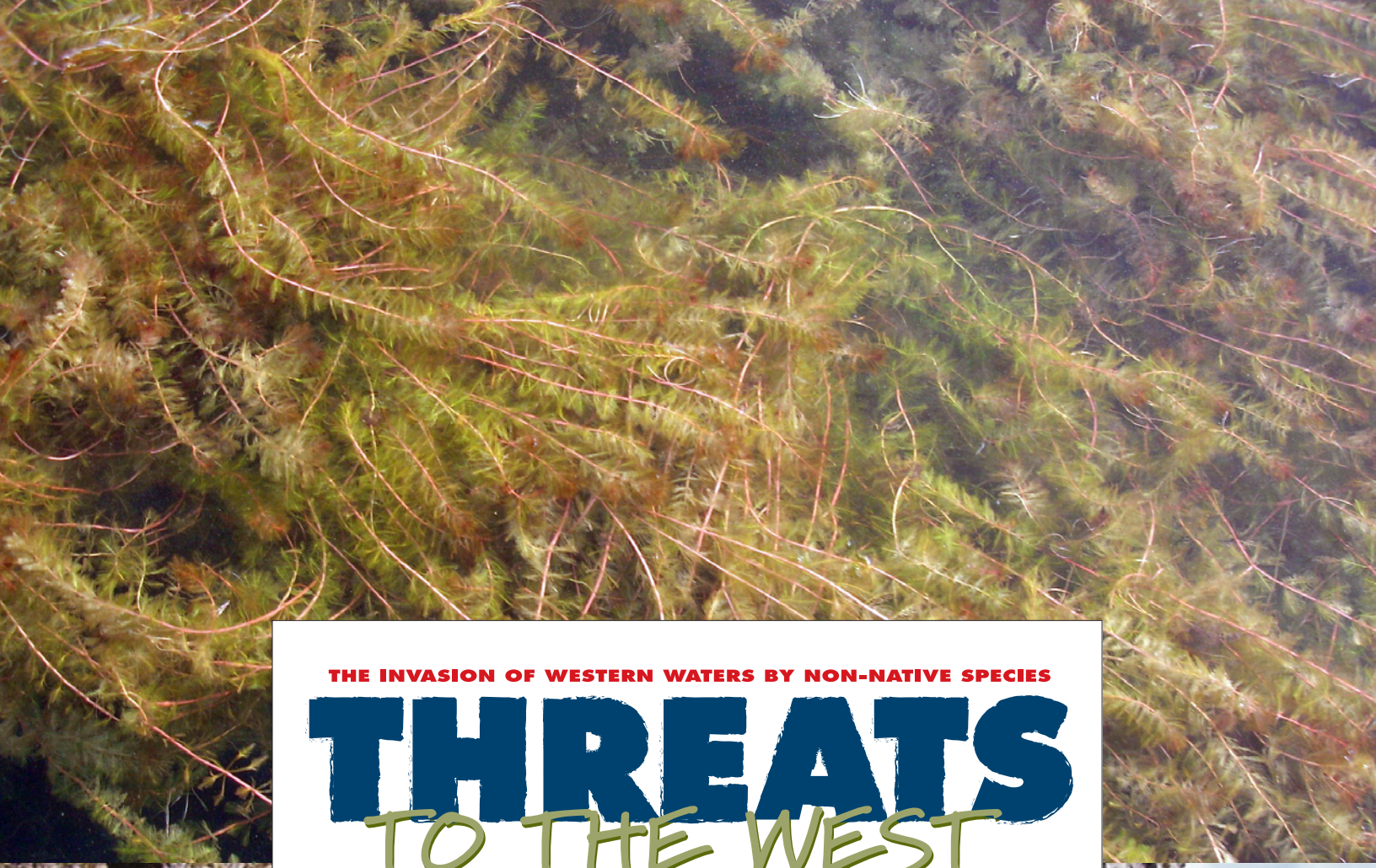
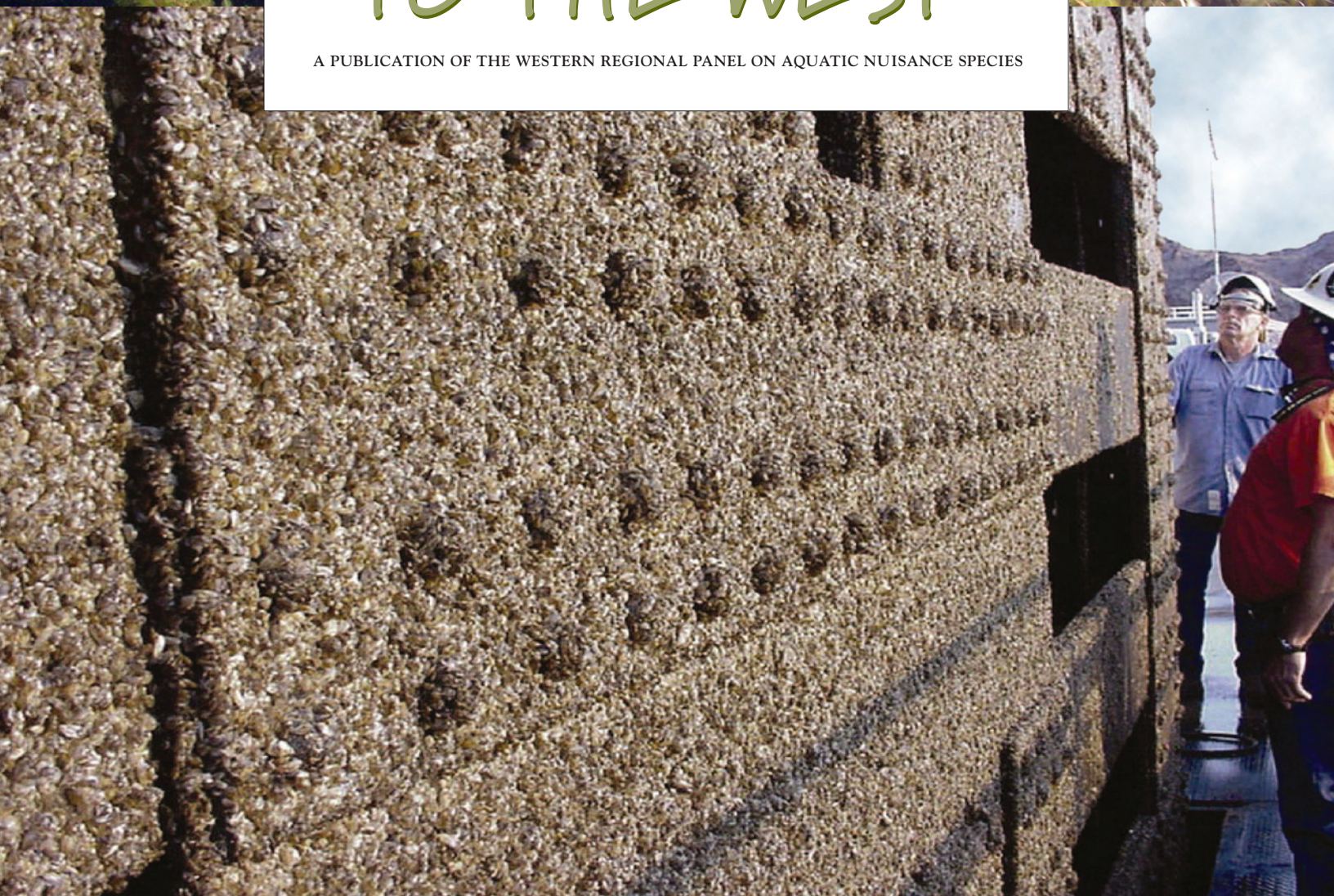
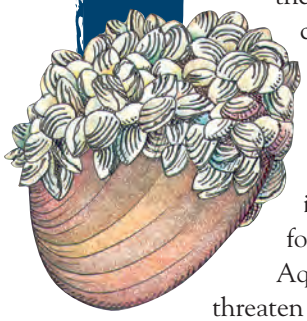


THE INVASION OF WESTERN WATERS BY NON-NATIVE SPECIES

THREATS TO THE WEST

A PUBLICATION OF THE WESTERN REGIONAL PANEL ON AQUATIC NUISANCE SPECIES



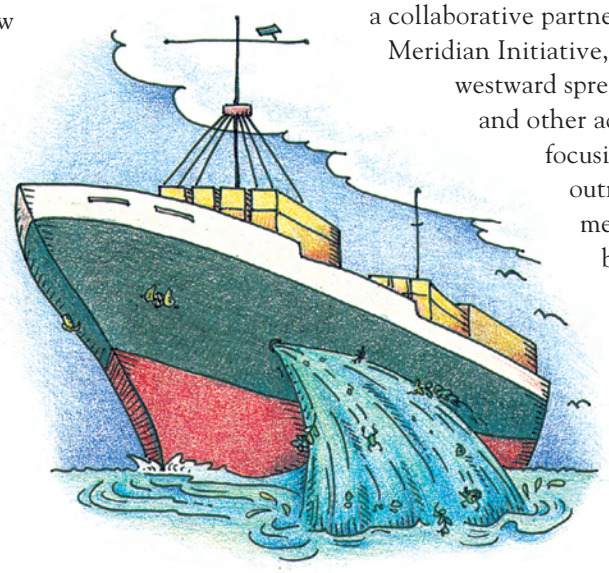


From alligatorweed to zebra mussels, aquatic invasive plants and animals from around the world are irreversibly altering our waters in western North America. Humans have introduced these unwanted species, either accidentally or intentionally. Not all non-native species cause serious problems, but some do, disrupting entire ecosystems by destroying habitat, preying on native species, introducing diseases, and altering food webs as they invade new areas. Aquatic invasive species not only threaten the natural environment, they also cause serious economic damage. Each year, the United States spends billions of dollars attempting to control or slow the spread of these plants and animals. Zebra and quagga mussels alone cause tremendous economic harm when they clog water pipes, infest hydropower facilities, and damage boat engines. Recreation suffers when aquatic weeds choke boating and swimming areas, or invasive seaweeds foul popular beaches. And aquatic invasive species carrying parasites and diseases can even affect human health. Climate change is expected to worsen these impacts.

WHAT LEADS TO AQUATIC INVASIONS?

Aquatic invasive species arrive by many pathways. They can be introduced into rivers and bays when ships empty the ballast water they carry in their hulls for stability. For example, fish larvae can be sucked into ballast tanks at one port and carried to the next destination. Additional invaders can arrive attached to ship hulls and anchors. As faster vessels enable shorter shipping times, more species now survive transit from distant shores. San Francisco Bay, one of the West Coast's busiest international ports, is now infested with well over 200 introduced species…many of which hitched a ride as ship stowaways. These invaders cause serious problems for the Bay's native flora and fauna.

Like ships, recreational boaters and anglers can also unwittingly spread aquatic invasive species. When boaters fail to notice and remove invasive plants and animals from their watercraft and recreational gear after an outing, surviving invaders may get a free ride to another water body and expand their hostile takeover. Fishing gear and bait can also introduce non-native species into a new ecosystem.



Some invasive aquatic plants get their start when people plant them for erosion control or to beautify their gardens. Many nurseries sell non-native aquatic plants and fail to warn customers of their potential for becoming pests. Exotic aquarium plants and fish are dumped into waterways by people who tire of their hobby. Aquaculture facilities can inadvertently contribute to the problem when the species being grown escape confinement or transmit non-native parasites and diseases. Even research labs and public schools sometimes introduce aquatic invaders by releasing study animals, such as crayfish, into the outdoors.

WHAT IS BEING DONE TO PREVENT FURTHER INVASIONS?

In 1990, largely in response to the zebra mussel invasion of the Great Lakes, Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA). Among other measures, the NANPCA established a national Aquatic Nuisance Species Task Force (ANSTF) and authorized the creation of several regional panels to address regional aquatic invasive species problems. In 1996, the NANPCA was reauthorized as the National Invasive Species Act (NISA) and the Western Regional Panel (WRP) was created.

The WRP is comprised of representatives from U.S. federal, tribal, state, and local agencies, Canadian federal and western provincial agencies, and private environmental and commercial interests from states west of the 100th Meridian, including Hawai'i and Alaska. The WRP is charged with taking action to prevent the spread of aquatic invasive species, and to provide information and recommendations to the ANSTF. One of the WRP's primary goals is to educate decision-makers and the public about the need to prevent further invasions in the West.

Together, the ANSTF and the WRP developed a collaborative partnership called the 100th Meridian Initiative, which aims to prevent westward spread of zebra mussels and other aquatic invasive species, focusing on education and outreach, and encouraging measures such as voluntary boat inspections and decontamination. This publication describes some of the aquatic invaders that have already arrived to the West, and suggests ways you can help prevent their spread.

WHAT CAN YOU DO TO HELP?

You can help prevent the spread of aquatic invasive species by following these guidelines:

- Report sightings of suspected invasive species to your local wildlife agency, parks department, county agricultural office or resource conservation district. You can also report your sighting to the U.S. Fish and Wildlife Service by a toll-free call to 1-877-STOP-ANS or 877-786-7267. Early detection of aquatic invaders improves the odds that we can get rid of them.

- Learn more about invasive species and invasion pathways (see Resources, back page). Share what you've learned with other people.
- Plant only native plants in your garden or pond.
- Join a community group to remove non-native invaders and restore native habitat.
- Never empty aquariums into rivers, streams, or other waterways, including storm drains—or into any type of wild area. Check with your local pet store for safe disposal options or visit www.Habitattitude.net.

IF YOU ARE A BOATER OR ANGLER:

- Always follow federal, state, and local laws and regulations.
- Always cooperate with federal, state and local law enforcement officers or other officials managing the water bodies where you use a boat.
- Never move live bait or other organisms from one body of water into another, and also don't dip your bait bucket into one lake if it contains water from somewhere else.
- Carefully check and clean fishing gear, looking closely at the soles and laces of wading boots.
- Always at the conclusion of a boating excursion, "Clean, Drain & Dry" all wet equipment, including the boat, trailer, water toys and associated equipment, and angling equipment, including footwear. In particular:
  - Clean all plants, unwanted fish, shellfish and debris off the outside and inside of your equipment, and place in a local garbage bin.
  - Drain all raw water from containers, ballast tanks, bilge, live wells, transom wells, and the motor.
  - Thoroughly dry all equipment, recognizing that in cool moist environments, it can take up to 30 days to kill hitchhikers like zebra mussels. Alternatively, expose properly winterized equipment to 72 hours of consistently sub-freezing temperatures.
  - If you can't dry for a sufficient length of time, use a professional to flush scalding hot water (140^{0}F) through your boat and motor raw water circulation systems, and wash other parts of your boat that normally get wet with the same scalding water.

WATCH OUT!

Prevention is the best bet to keep new invaders out of the West, but if they do arrive, early detection improves our chances to halt their spread. Removing established invasions is difficult and expensive. Here are a few "least wanted" that have yet to get a significant grasp in the West. If you suspect finding a new introduced species, please report it (see the previous section).

"KILLER ALGAE" (*Caulerpa taxifolia*)—although a native form of this green marine seaweed occurs in Hawai'i, the invasive strain has caused extensive damage in the Mediterranean Sea.

BLACK CARP (*Mylopharyngodon piceus*)—this Asian carp species occurs in the lower Mississippi, can grow to more than 3 feet, and preys upon mussels and snails.

WATER CHESTNUT (*Trapa natans*)—Like many freshwater weeds, this triangular-leafed plant forms thick floating mats that impede fishing, boating, swimming, and blocks sunlight.

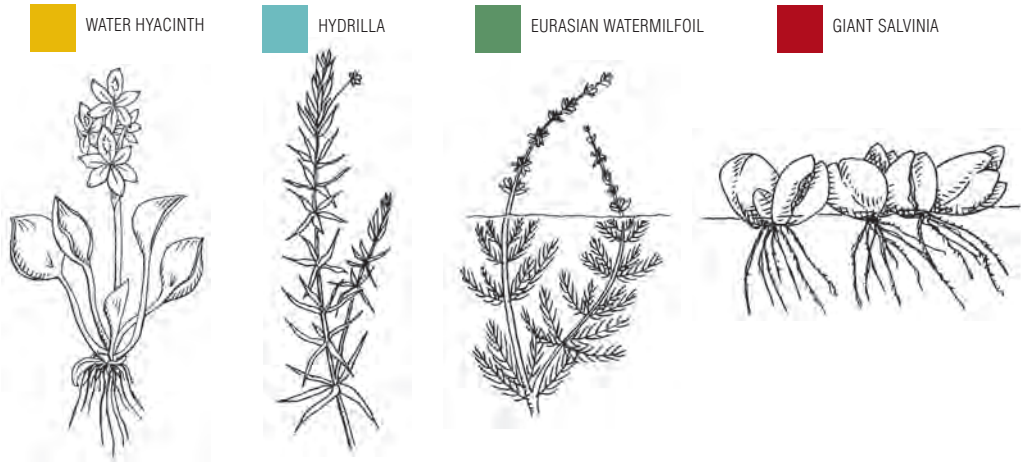
ROUND GOBY (*Neogobius melanostomus*)—presumably introduced to the Great Lakes via ballast water, these small bottom-dwelling freshwater fish with a unique set of suction-cup fins resemble native sculpin and are aggressive feeders.

SPINY WATERFLEA (*Bythotrephes cederstroemi*)—these planktonic crustaceans are barely half an inch in length, but their long barbed tail spine deters predators. Abundant in the Great Lakes, where they compete for food with native species.

INVASIVE AQUATIC PLANTS

THE WORST

Here are a few of the most troublesome species in the West. See "Resources" list on back page for links to more complete listings.



WATER HYACINTH
(Eichhornia crassipes)

With purple flowers, this floating South American plant is considered beautiful, but it quickly grows out of control. Populations can double in 12 days. Water hyacinth forms mats on the water surface that can block boat traffic, limit recreational access, and displace native plants.

HYDRILLA
(Hydrilla verticillata)

Individual hydrilla plants can grow up to an inch per day, invading deep, dark waters where other plants cannot grow. Native to India and Korea, various strains of hydrilla were intentionally imported into the United States for aquarium use. It has established in California, Idaho, and other western states. Hydrilla can make waterways impassable, causing problems for boaters, swimmers, and anglers. It also can block power plants and irrigation systems

EURASIAN WATERMILFOIL
(Myriophyllum spicatum)

Introduced accidentally from Europe, this perennial plant was discovered in the eastern U.S. in the 1940s. Milfoil has since invaded lakes, ponds, and irrigation canals in nearly all 50 states. As with other aquatic weeds, propellers and other boat or trailer parts transport Eurasian watermilfoil between water bodies.

GIANT SALVINIA
(Salvinia molesta)

A free-floating aquatic fern native to southeastern Brazil, this plant is an aggressive invader. In parts of Texas, Louisiana, and Hawai'i, giant salvinia forms mats so extensive that birds can no longer nest or forage in their usual areas, and anglers find it difficult to cast into infested waters. Although prohibited in many states, this plant is still being cultivated and sold.

BRAZILIAN ELODEA
(Egeria densa)

Probably introduced decades ago from an unwanted aquarium, this South American plant roots at the bottom of waterways. Brazilian elodea can grow to 12 feet tall and forms a dense canopy that chokes the water column. It cannot be easily eradicated with herbicides and is difficult to remove mechanically because broken-off clumps can grow into new plants.

GIANT REED
(Arundo donax)

Originally from India, giant reed likely was introduced into California by the Spanish in the 1800s for erosion control along drainage canals. The reed spread and invaded riparian ecosystems throughout the state. Today, gardeners can purchase and plant this species along backyard streams. When pieces of stalk or root break off and wash downstream, they can establish new plants. Giant reed's towering stalks guzzle groundwater, reducing streamside habitat for songbirds.

GORILLA OGO
(Gracilaria salicornia)

This red seaweed was introduced intentionally in Hawai'i in the early 1970s for aquaculture research. Native to the Indian Ocean and South Pacific, it reproduces both sexually and through fragmentation, so even a tiny piece can spread to another location. This seaweed has dispersed via snorkel gear, ships, and other pathways. It now harms coral reef habitat within the Hawai'ian Islands by forming thick smothering mats. When large amounts of gorilla ogo wash ashore, the smelly debris affects beach use and tourism.

Brazilian elodea

Eurasion watermilfoil

TINY INVADERS

Though often invisible to the naked eye, aquatic non-native viruses, bacteria, protists, fungi and other microbes share similar pathways of spread with more obvious aquatic invasive species. However, their impacts are typically disease-related, and therefore often are addressed from the standpoint of animal and public health programs. High-profile examples include:

VIRAL HEMORRHAGIC SEPTICEMIA VIRUS (VHSV): already infects coastal fish in the West, but a particularly deadly strain in the Great Lakes looms on the horizon.

CHYTRID FUNGUS: spores of this fungus affect frogs by harming their skin's ability to breathe and absorb water, and also causing nervous system damage. Likely introduced to the U.S. from commercial trade of exotic frogs.

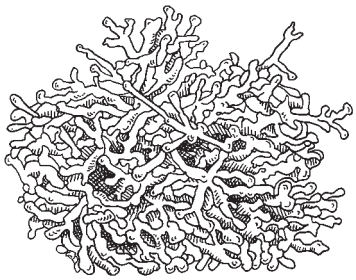
WHIRLING DISEASE: trout are particularly vulnerable to *Myxobolus cerebralis*, the parasite that causes infected fish to swim erratically in circles.

OF THE WEST

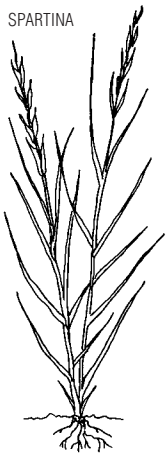
BRAZILIAN ELODEA

GIANT REED

GORILLA OGO

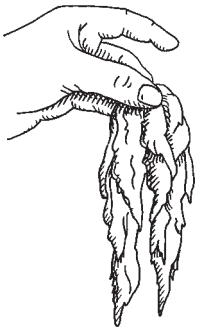


SPARTINA



PURPLE LOOSESTRIFE

DIDYMO



Water hyacinth clogs a creek entering the San Francisco Bay Delta. Photo by Lisa Owens Viani.

MAP KEY:

Boxes indicate presence of species in the state or province but do NOT depict exact location. Box colors represent species as identified at top of this page.

Giant reed clogs streams and rivers, sometimes threatening structures like this bridge. Photo courtesy of Tom Dudley.

SPARTINA
(Spartina sp.)

Commonly called cordgrasses, several species of Spartina have established in the West. *Spartina alterniflora,* native to the eastern United States, was intentionally introduced to San Francisco Bay. Hybridization has since reduced the presence of California's native cordgrass, *Spartina foliosa,* perhaps to local extinction. *Spartina alterniflora* has also been a problem in Washington. At one time it transformed mudflats into vast expanses of cordgrass, eliminating habitat for fish, shellfish, and shorebirds. Successful control efforts have since drastically reduced its abundance in Washington.

PURPLE LOOSESTRIFE
(Lythrum salicaria)

A wetlands plant accidentally introduced into the northeastern U.S. from Europe in the 1800s, purple loosestrife has spread to 48 states. Because of its showy purple flowers, loosestrife is popular in gardens. Each plant can produce over 2 million seeds per year. As the wind carries the seeds— each the size of a pepper grain—the plant spreads far and wide. Loosestrife crowds out native plants, destroys marshes and wet prairies, and chokes waterways.

DIDYMO
(Didymosphenia geminata)

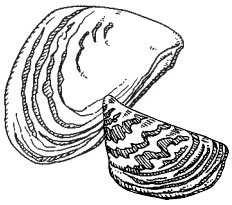
Also known as "rock snot", this microscopic plant smothers stream beds with thick mats that resemble wet toilet paper. Extensive blooms often occur during summer months, leading to decreased oxygen and other water quality problems. Although potentially native to some western streams, didymo can hitchhike to new waters via boats and fishing gear.

INVASIVE AQUATIC ANIMALS

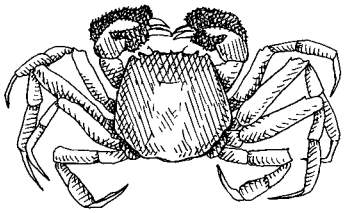
THE WORST

Here are a few of the most troublesome species in the West. See "Resources" list on back page for links to more complete listings.

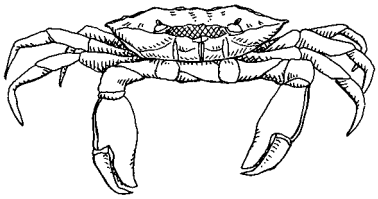
ZEBRA AND QUAGGA MUSSELS



MITTEN CRABS

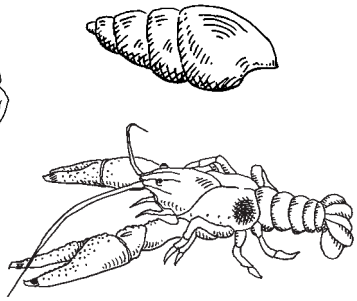


EUROPEAN GREEN CRAB



NEW ZEALAND MUDSNAIL

AMERICAN



INVASIVE CRAYFISH

ZEBRA AND QUAGGA MUSSELS
(Dreissena polymorpha and *Dreissena rostriformis bugensis)*

These freshwater shellfish are among the most destructive aquatic invaders. Native to eastern Europe, zebra and quagga mussels showed up first near the Great Lakes in the 1980s, likely via ballast water. They soon spread throughout much of the eastern U.S., and have arrived in the West largely through movement on trailered boats…most dramatically seen with the 2007 discovery of quagga mussels in Lake Mead. Zebra and quagga mussels cause substantial ecological and economic damage by disrupting food webs and clogging water pipes. Billions of dollars have been spent fighting these invaders, and they continue to appear on boats traveling to uninfested states.

MITTEN CRABS
(Eriocheir sp.)

The Chinese mitten crab (*Eriocheir sinensis*) likely arrived to the U.S. as a food source or accidentally via ballast water. It was first discovered in San Francisco Bay in 1992 and soon spread within surrounding watersheds through the crab's migratory habits. Populations in California fluctuate, but in peak years have constrained water facility operations and recreational fishing. Live smuggled mitten crabs are periodically intercepted by law enforcement agents. The related Japanese mitten crab (*Eriocheir japonicus*) was found in the lower Columbia River in 1997.

Zebra mussels can quickly clog pipes. Photo by Don Schloesser.

EUROPEAN GREEN CRAB
(Carcinus maenas)

Native to the North and Baltic Seas, this crab was introduced to the U.S. east coast in the mid-1800s. By 1990, it reached San Francisco Bay, probably via ballast water or in live bait shipments. The crab rapidly spread and is now found along the Pacific Coast from Morro Bay, California to British Columbia, not far from the Alaska border. In Bodega Bay, north of San Francisco, the green crab has reduced some native clam and shore crab populations by 90 percent.

They may be small, but New Zealand mudsnails can be big trouble. Photo by Robyn Draheim.

NEW ZEALAND MUDSNAIL
(Potamopyrgus antipodarum)

This tiny snail was likely introduced to North America by accident in shipments of trout eggs. It was discovered in Idaho's Snake River in 1987 and has since been found in many western streams and lakes. In some cases, densities exceed 100,000 snails per square meter, displacing native aquatic life. New Zealand mudsnails are effective invaders based on their ability to reproduce by cloning and to seal their shell closed.

INVASIVE CRAYFISH
(Orconectes sp. and Procambarus sp.)

The rusty, red swamp, ringed, and virile crayfish all have arrived to western waters from the Midwest and eastern U.S. as discarded bait, released classroom science specimens, and via other pathways. These non-native crayfish are adaptable to many environments, can be aggressive predators, outcompete native crayfish for resources, and have the potential to introduce new diseases and parasites.

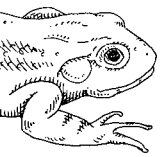
AMERICAN BULLFROG
(Lithobates [=Rana] catesbianus)

Native to the eastern United States, the bullfrog was introduced to western states in the late 1800s where it was cultivated in streams and ponds and sold to restaurants. Bullfrogs now thrive in many parts of the West. In addition to being substantial predators upon native fish, frogs, and turtles, bullfrogs worsen the spread of amphibian diseases like chytrid fungus.

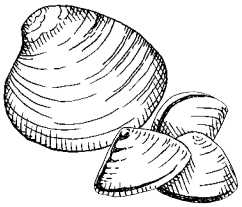
A green crab devours *Hemigrapsus oregonensis*, a small shore crab native to the West Coast. Photo by Ted Grosholz.

OF THE WEST

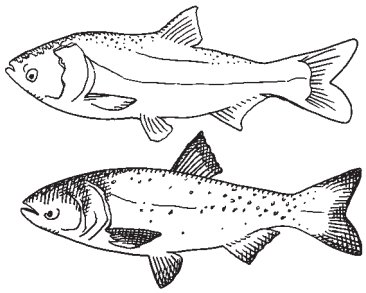
BULLFROG



ASIAN CLAMS

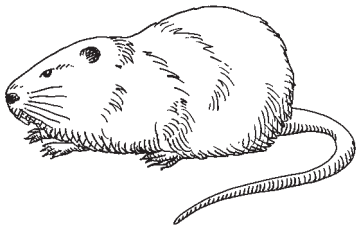


SILVER CARP

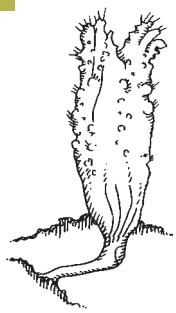


BIGHEAD CARP

NUTRIA



INVASIVE TUNICATES



ASIAN CLAMS

(Corbicula fluminea [freshwater] and *Potamocorbula amurensis* [estuarine])

Corbicula clams live in freshwater and were introduced in the 1800s by Chinese immigrants as a food item. First discovered along the Columbia River in Washington, they have spread into 38 states. *P. amurensis* is also native to Asia but inhabits estuaries. It arrived in California in the mid-1980s and now averages 2,000 clams per square meter in some areas of San Francisco Bay.

SILVER AND BIGHEAD CARP

(Hypophthalmichthys molitrix and *H. nobilis)*

Infamous for their ability to jump up to ten feet out of water when disturbed by boats, silver carp are a human safety concern in addition to a threat to native species. Both silver and bighead carp are voracious consumers. They were intentionally imported into U.S. aquaculture facilities from Asia in the 1970s. Subsequent flooding allowed them to escape into the Mississippi River. Their populations have doubled annually, with the fastest expansions occurring in the Missouri and Illinois Rivers.

NUTRIA

(Myocastor coypus)

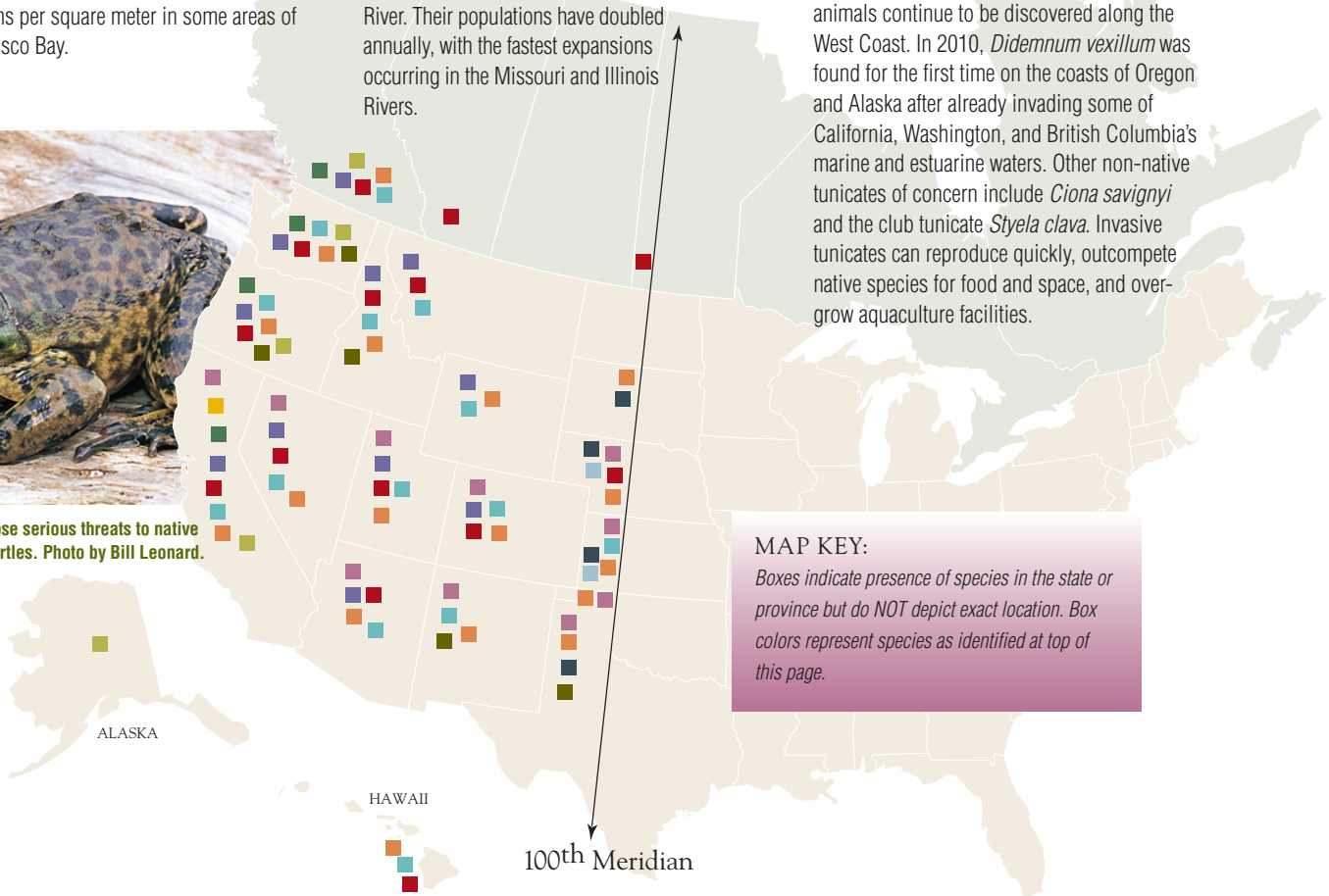
Native to South America, these semi-aquatic rodents were first introduced to the U.S. for fur farming. Numerous escapes and introductions to the wild ensued. Nutria now occur in a number of western states, where they eat wetland vegetation and cause erosion. They are highly prolific; females are ready to breed within forty-eight hours after giving birth!

INVASIVE TUNICATES

(Ascideacea)

Also known as sea squirts, these fouling animals continue to be discovered along the West Coast. In 2010, *Didemnum vexillum* was found for the first time on the coasts of Oregon and Alaska after already invading some of California, Washington, and British Columbia's marine and estuarine waters. Other non-native tunicates of concern include *Ciona savignyi* and the club tunicate *Styela clava*. Invasive tunicates can reproduce quickly, outcompete native species for food and space, and overgrow aquaculture facilities.

Bullfrogs pose serious threats to native frogs and turtles. Photo by Bill Leonard.



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WEB RESOURCES

100th Meridian Initiative
www.100thmeridian.org

Aquatic Nuisance Species Task Force
www.anstaskforce.gov

Center for Aquatic and Invasive Plants
http://plants.ifas.ufl.edu

Clean Angling Coalition
www.cleanangling.org

Habitattitude
www.habitattitude.net

National Invasive Species Information Center
www.invasivespeciesinfo.gov
(see www.invasivespeciesinfo.gov/unitedstates/state.shtml for a list of state invasive species councils)

National Ballast Information Clearinghouse
http://invasions.si.edu/nbic/

Pacific Ballast Water Group
www.psmfc.org/ballast

Stop Aquatic Hitchhikers
www.protectyourwaters.net

U.S. Coast Guard Ballast Water Management Program
http://www.uscg.mil/hq/cg5/cg522/cg5224/bwm.asp

U.S. Fish and Wildlife Service Aquatic Invasive Species Program
http://www.fws.gov/fisheries/ANS/ANS.html

U.S. Geological Survey Nonindigenous Aquatic Species Database
http://nas.er.usgs.gov

Western Regional Panel
http://answest.fws.gov

The Western Regional Panel On Aquatic Nuisance Species

Produced by the Western Regional Panel on Aquatic Nuisance Species, with project coordination by the San Francisco Estuary Partnership and funding by the U.S. Fish and Wildlife Service.

Writing/Editing: Lisa Owens Viani, Cynthia Tait, and Paul Heimowitz
Design: Bobbi Sloan
Illustration: Lisa Krieshok

FRONT COVER, TOP: *Eurasian watermilfoil invasion in the Pend Oreille River, Idaho. Photo by Thomas Moorhouse, Clean Lakes, Inc.*

FRONT COVER, BOTTOM: *Quagga mussels coat the stop log gate at Davis Dam on the Colorado River. Photo by David Arend, U.S. Bureau of Reclamation.*

BACK COVER: *Giant reed towers over a worker. Photo courtesy of Tom Dudley.*

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