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## Delta Invasions

The Sacramento-San Joaquin Delta is critically important not only to the wildlife and wildlands of California, but also to our economy. Together with Suisun Marsh and San Francisco Bay, the Delta is part of the largest estuary on the west coast of the Americas and provides habitat to over 750 species of plants and animals, including species listed under the state and federal endangered species acts.

The Delta has undergone substantial ecological changes due to the introduction and establishment of invasive species. These species have modified Delta habitats by displacing native plants, degrading water quality, and altering water flows. They have disrupted the Delta food web by reducing primary productivity and altering nutrient cycling. Additionally, these species have impacted native and desirable species through competition for food and space, predation, disease introduction, parasitism, and interbreeding. One species that had a significant, albeit brief, impact on the Delta is the Chinese mitten crab. In this issue of Eye on Invasives you'll learn what became of the once abundant species that invaded the Delta in the early 1990s.

The Delta is also of vital importance to the state's economy. Water from the Delta serves 25 million people and irrigates over 3 million acres of farmland statewide. It provides recreational opportunities such as boating, swimming, fishing, and hunting for tourists and local residents. The Delta has ports, shipping channels, and includes many miles of railroads and highways that enable the transport of goods in and out of the state. Invasive species obstruct navigation, impair

recreational activities, clog water delivery infrastructure, damage dikes and levees and other flood control infrastructure, and encroachment into agricultural fields. These impacts result in increased maintenance and repair, as well as lost revenue when land and infrastructure cannot be fully utilized. To counter such impacts, the California Department of Parks and Recreation, Division of Boating and Waterways, spends over \$6 million annually to control aquatic plants.



California Department of Water Resources File Photo

When the cost of controlling an invasive species is compared to the cost of preventing its introduction and establishment, prevention is usually a fraction of the cost of control. While hundreds of invasive species already occur in the Delta, work continues to keep others out. One such example is nutria, large rodents that once inhabited the Delta. In this issue you will learn more about nutria and the threat they pose to the Delta, as well as how early intervention prevented significant impacts to the Delta, and by extension, to the wildlife and economy of California.

## Research Spotlight: Salinity on the Rise: Make Way for Native Pondweeds

Evyan Borgnis and Katharyn Boyer, Romberg Tiburon Center for Environmental Studies, San Francisco State University

Submerged aquatic vegetation (SAV) is vital to estuarine ecosystems, providing foundational habitat for algae and invertebrates and supporting the diets of invertebrates, fish, and waterfowl. SAV is also valued by humans for stabilizing sediments and contributing to long-term storage of carbon, an increasingly important service during a time of changing climate. In the low salinity zone of the San Francisco Estuary (Estuary), native SAV assemblages consist of sago pondweed (*Stuckenia pectinata*), fineleaf pondweed (*S. filiformis*), coontail (*Ceratophyllum demersum*), common waterweed (*Elodea canadensis*), and American pondweed (*Potamogeton nodosus*). All of these native species are currently facing competition with a variety of non-native, or invasive, SAV. One of the most problematic invasive SAV for the Estuary is Brazilian waterweed (*Egeria densa*).

Although invasive SAV are capable of providing similar ecosystem benefits as native SAV, many invasive SAV can outcompete and eradicate native species using biochemicals, fast growth, or aggressive reproduction. Once an invasive species has outperformed the natives, it can establish and quickly transform subtidal areas into dense, single-species zones. In the freshwater reaches of the Estuary in the Sacramento-San Joaquin River Delta (Delta), Brazilian waterweed has achieved this level of establishment. Its single-species mats are currently choking channels, which limits area for fishing and recreation. Brazilian waterweed's large mats also trap so much sediment that channel topographies are changing. Further, Brazilian waterweed's dense mats provide shadowy hiding places for large fish. Other researchers have found that many of these large fish are nonnative species, such as largemouth bass.



The native fineleaf pondweed (*Stuckenia filiformis*) along Chipps Island in Suisun Bay. Katharyn Boyer, SFSU

Native and invasive SAV distributions are likely to shift due to water management practices and global climate change. In the past century, California's agriculture and domestic water demands have increased salinities throughout the Estuary. Further, salinities are projected to increase due to climate change by sea-level rise pushing saline

waters up the Estuary and warmer temperatures altering the timing of necessary (fresh) snowmelt pulses.

As a graduate student (Borgnis) and professor (Boyer) at the Romberg Tiburon Center for Environmental Studies (San Francisco State University), we have been investigating how native and invasive SAV may be affected by rising salinity. We have monitored salinity levels and SAV assemblages within the native pondweed beds in Suisun Bay and the invasive Brazilian waterweed beds in



Invasive Brazilian waterweed (*Egeria densa*) near Decker Island in the Delta. Katharyn Boyer, SFSU

the Delta for the past two years. In addition, we have performed greenhouse experiments examining the competitive abilities of fineleaf pondweed and Brazilian waterweed at elevated salinities. These results have demonstrated that fineleaf pondweed is currently limited to the brackish waters (salinity up to about 10 ppt) of Suisun Bay and the confluence of the Sacramento and San Joaquin rivers due to Brazilian waterweed's strong competitive abilities in less saline water. However, with rising salinities (up to at least 15 ppt, the highest salinity we tested), fineleaf pondweed will be able to survive and thrive, while Brazilian waterweed will become increasingly stressed.

In a future, more saline Estuary, it is likely that invasive species with low salinity tolerances in the Delta will be replaced by the more tolerant native SAV species. An estuary dominated by native SAV will provide a more diverse habitat that is likely to benefit more native estuarine organisms.

This research is supported by the CALFED Ecosystem Restoration Program and the California Department of Fish and Wildlife. For more information, contact Evyan Borgnis ([elborgnis@gmail.com](mailto:elborgnis@gmail.com)) or Katharyn Boyer ([katboyer@sfsu.edu](mailto:katboyer@sfsu.edu)).

# Boom And Bust of the Chinese Mitten Crab

CDFW STAFF

When a non-native species arrives in a new ecosystem, it may establish, reproduce and spread, and thus be considered invasive. However, the long-term outlook for the new population cannot immediately be predicted. It is common for a species to establish and experience temporary exponential population growth, followed by a precipitous decline or extirpation. This boom-and-bust pattern occurred with the Chinese mitten crab (*Eriocheir sinensis*) invasion of the San Francisco Estuary and its watershed.

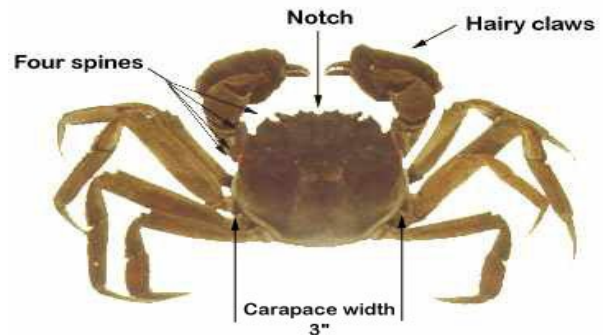
The mitten crab is a catadromous species (adults reproduce in salt water and their offspring migrate to fresh water to rear) that burrows into banks and levees, and is well-known for long distance upstream migrations in both its native and introduced locations. It is native to the Pacific coasts of China and Korea, and has been found outside of its native range in Europe and the Great Lakes, Mississippi River delta and the Saint Lawrence River in Canada.

Like many other nonindigenous crustaceans, the mitten crab has life history traits that make it a successful invader, including a high rate of reproduction, short generation time, and broad environmental tolerances and diet. Mitten crabs were first collected in the South San Francisco Bay in the early 1990s. After several years of rapid population growth and expanding distribution, the mitten crab population peaked in 1998. The large year classes of 1998 and 1999 were likely due to a combination of warm ocean temperatures and high winter outflows that transported larvae from the estuary to warmer ocean water, where larval development occurs.



Chinese mitten crab burrows near Alviso Slough. DWR File Photo

The extensive banks and levees found in the Delta provide ideal burrowing substrate for juvenile mitten crabs. Burrows are generally located between the low and high tide marks, and provide protection from desiccation and predators, particularly during the low tides. Given the economic and ecological impacts observed in both its native range and Europe, a large established population in the San Francisco Estuary Delta posed several threats. The primary



Identifying an adult Chinese mitten crab (*Eriocheir sinensis*).  
CDFW File Photo

concern was the likelihood that mitten crab burrows could lead or contribute to levee instability and accelerated bank erosion, threatening the many islands with agricultural fields and communities in the Delta. Additional threats to the state arise from the mitten crabs diet as opportunistic omnivores, eating any available food source. A large population could pose greater risks for threatened and endangered species in the system, interfere with commercial fishing operations, and cause loss of rice field productivity due to consumption of rice shoots.

The most noticeable effect of the boom in the mitten crab population was seen at salvage operations of the state and federal water facilities in Tracy. In 1998 the combined daily crab count for the facilities peaked at over 50,000 crabs per day. It is estimated that the presence of the mitten crab at these facilities cost over \$1 million in facility operation and control costs that year. Additionally, mitten crabs had become a nuisance to commercial shrimp trawlers and sport anglers by consuming bait and damaging catch and gear.

According to Kathy Hieb, CDFW Senior Environmental Scientist, all data sources indicate that the population has steadily declined since 2001. In 2013, it is very difficult to find mitten crabs anywhere in the San Francisco Bay or Delta. Scientists studying the issue have yet to conclusively determine the cause(s) of the mitten crab bust, but winter and spring water temperatures and outflow that control larval survival and growth, as well as juvenile settlement appear to be important factors. While the population decline is good news in the short term, it is important to maintain monitoring, reporting, and outreach programs for the species. If conditions again become favorable for the mitten crab, another boom could occur and mitten crab control could once again be a major issue facing the San Francisco Estuary and its watershed.

For more information on the Chinese mitten crab please see the Aquatic Nuisance Species Task Force [Management Plan](#). The California Department of Fish and Wildlife continues to track mitten crabs. Please report sightings, including date and location, to [Invasives@wildlife.ca.gov](mailto:Invasives@wildlife.ca.gov).

## Partner Spotlight:

# Invasive Aquatic Plant Control in the Delta

CDFW STAFF

Invasive aquatic plants are found throughout the Sacramento-San Joaquin Delta, its tributaries, and Suisun Marsh. Floating and submerged aquatic plants in particular are a concern in the Delta due to the harm they pose to the environment, economy, and human health. Floating invasive aquatic plants such as water hyacinth (*Eichhornia crassipes*) and South American spongeplant (*Limnobium laevigatum*) form thick, extensive mats that sit on the water surface. Submerged invasive aquatic plants such as Brazilian waterweed (*Egeria densa*), Eurasian watermilfoil (*Myriophyllum spicatum*), and Carolina fanwort (*Cabomba caroliniana*), produce long, dense stands of vegetation below the water surface. Both mats and stands of invasive aquatic plants impact the Delta by creating navigational obstructions and hazards for boats and other watercraft; impairing recreational activities, such as swimming, fishing, and hunting; clogging and damaging water utility and flood control infrastructure; altering water quality; and modifying the physical and chemical characteristics of fish and wildlife habitat. The impacts caused by invasive aquatic plants may ultimately reduce recreational use and tourism, create public safety hazards, interfere with the delivery of water, and reduce the quality and quantity of habitat for native and desirable plant, fish, and wildlife species.



Rake samples were taken in the Delta to determine the dominant species of underwater vegetation. Shown here is the Brazilian waterweed (*Egeria densa*). Parks-DBW File Photo

Invasive aquatic plants can reproduce by vegetative fragmentation in addition to seed production and thus can multiply and spread very rapidly, especially with the help of boats and other watercraft traveling between waterbodies. Many of the invasive aquatic plants species in the Delta have become so widespread that eradication of these species is no longer an option because they would likely be reintroduced. The only reasonable method to reduce the impacts of invasive aquatic plants in the Delta is to implement long-term control to reduce existing populations of these species and prevent their spread to new areas. The California Department of Parks and Recreation, Division of Boating and Waterways (Parks-DBW) implements the Aquatic Weed Control Program in the Delta, its tributaries, and Suisun Marsh. This program is



Water hyacinth (*Eichhornia crassipes*) in the Delta. Parks-DBW File Photo

a result of legislation signed in 1982 aimed to control the extensive infestation of water hyacinth in the Delta. Brazilian waterweed was added to the program in 1997 and South American spongeplant was added in 2013.

Parks-DBW is the only agency authorized to control invasive aquatic plants in the Delta and this authorization is currently limited to three species: water hyacinth, Brazilian waterweed, and South American spongeplant. Assembly Bill 763, signed by Governor Brown on September 23, 2013, will allow Parks-DBW to add additional species to the list of authorized invasive aquatic plants to be controlled in the Delta. New invasive aquatic plant species will be added to the list using a process outlined in Section 64.5 of the Harbors and Navigation Code. This process consists of Parks-DBW consulting with state and federal agencies, academia, and the scientific and research communities to identify and prioritize species. Parks-DBW will then request the California Department of Fish and Wildlife (CDFW), in coordination with other appropriate state agencies, conduct a risk assessment to determine if identified species are invasive and present a threat to the environment, economy, or human health of the state. If CDFW determines the assessed aquatic plant species to be invasive, then Parks-DBW will add the species to the list and initiate necessary and appropriate control actions.

Authorizing Parks-DBW to manage additional invasive aquatic plants will help to reduce the economic, environmental, and human health impacts of existing and newly introduced invasive aquatic plants, as well as prevent the spread of all invasive aquatic plants to new areas within and beyond the Delta.

To read the full language of Assembly Bill 763 please visit the State of California Legislative Counsel [website](#).

# Keep Nutria Out of California: Prevention Protects our Wetlands

CDFW STAFF

The nutria (*Myocastor coypus*), also known as coypu, is a large, semi-aquatic rodent that is native to South America, but has been introduced to every continent except Australia and Antarctica, primarily for their fur. Nutria strongly resemble the North American beaver, but are much smaller, with long, round, sparsely haired tails. Adults typically reach a body size of two feet long, with tails over one foot long; large adults can weigh 15 to 20 lbs. Nutria are identifiable by their prominent, bright orange teeth, white muzzles and whiskers, and rounded tails. Nutria can produce two to three litters each year, each litter consisting of two to nine young, which are capable of breeding as early as three months of age. Conservative estimates predict that one breeding pair can result in a population of 16,000 nutria in as few as three years, making their introduction inherently threatening.

In 1899, nutria were first introduced in the United States at Elizabeth Lake, California, for the purpose of fur farming. Though this population failed to establish, multiple other introductions throughout the U.S. were later successful. By the late 1930s, nutria ranches had been developed in several states, but when the fur market crashed in the 1940s, many nutria were released into the wild. However, because of their hearty appetites, during the 1940s many agencies and entrepreneurs began promoting nutria for aquatic weed control, and subsequently introduced nutria into many new areas, where feral populations flourished. To date, nutria have been found in 22 states, though currently established in 16, as well as Mexico and Canada. Feral populations were present in the Central Valley and South Coast of California in the 1940s and 1950s, but a successful campaign led to their eradication from the state by 1978.



Nutria (*Myocastor coypus*). Trevor Sheffels, Portland State University

Our neighbors to the north, however, haven't been as lucky; both Oregon and Washington are battling increasing populations and expanding ranges of nutria, as well as the extensive damage they cause. Nutria are infamous for their devastating herbivory and burrowing. Consuming up to

25% of their body weight in above- and below-ground vegetation each day, and damaging 10 times as much in the process. Nutria are capable of destroying aquatic plant communities and the habitat they provide for riparian, wetland, and aquatic animals. Their feeding habits can also result in extensive erosion of soils and permanent loss of wetland structure, turning marshes into open water.



Nutria marsh damage in Louisiana. Louisiana Department of Wildlife and Fisheries File Photo

Soil erosion is furthered by their burrowing and tunneling, causing water control structures, banks, and road beds to weaken or collapse. Destruction of water control structures and erosion caused by burrowing are particularly problematic in the Pacific Northwest, where high densities of nutria populations are present in urban areas, and have been expanding toward the southern border of Oregon.

Due to the detrimental impacts they cause on ecosystems, nutria are a restricted species in California and may only be imported, transported, or possessed under a permit issued by California Department of Fish and Wildlife (CDFW). Should Oregon nutria populations expand into California, or if nutria were illegally imported, immediate reporting and eradication efforts would be critical in preventing establishment and protecting our invaluable wetland habitats, particularly the Suisun Marsh and Sacramento-San Joaquin Delta. If nutria were to establish in the Bay-Delta, we would likely see expansive losses of habitat critical to many endangered, threatened, or rare wetland species, as well as many migratory birds that rely on the Delta reed marshes for stop-overs in the Pacific Flyway. Additionally, the agriculture industry surrounding the Delta would likely face economic losses due to herbivory on nearby crops, as well as from destruction of levees and drainage systems. To protect our resources, it is essential that we prevent nutria from entering and establishing in California. Any suspected sightings should be immediately reported, including date and location, to CDFW at [Invasives@wildlife.ca.gov](mailto:Invasives@wildlife.ca.gov).

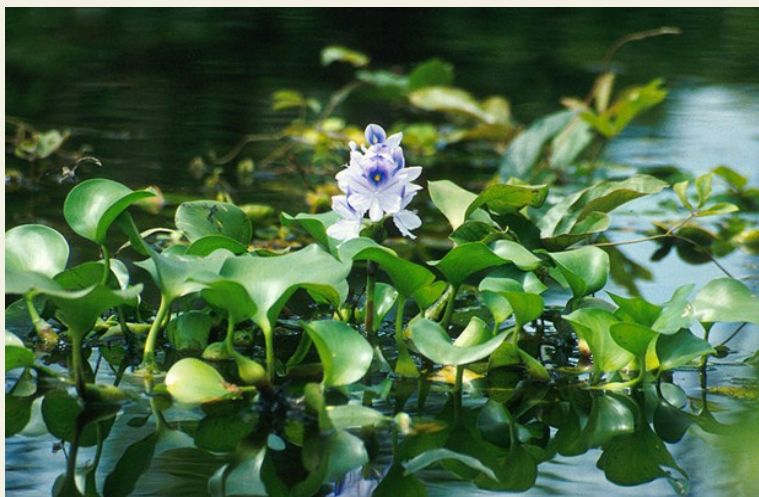
## Do You Know This Is Invasive? Water Hyacinth—*Eichhornia crassipes*

Attractive and showy lavender flowers make water hyacinth a popular aquatic garden plant that is known for providing shade, shelter, and spawning habitat for pond fish while reducing algae by absorbing excess nutrients. What you may not know is that water hyacinth is prolific and if left unchecked can double its population within weeks. Although beautiful, this free-floating perennial plant can be invasive to natural ecosystems where it is introduced.

Native to the Amazon River basin, water hyacinth has spread to all tropical and subtropical countries. According to the Global Invasive Species Database, water hyacinth is regarded as one of the world's worst invasive weeds. It was introduced in New Orleans as an ornamental plant in 1884 and was documented in California as early as 1904. Water hyacinth is now found in ponds, irrigation canals and ditches, rivers, and sloughs generally below 600 feet in elevation in the South Coast, Colorado Desert, Central Coast, Central Valley, and Bay-Delta ecoregions.

Many individual water hyacinth plants form dense mats that prevent sunlight from penetrating and deplete oxygen from the surrounding water, making conditions inhospitable for other aquatic plants and animals. These large mats can span the width of waterways, making fishing, boating, and all water recreation activities difficult, if not impossible.

The California Department of Parks and Recreation, Division of Boating and Waterways implements a control program for water hyacinth in the Delta, and California Department of Food and Agriculture is currently working to develop a biological control agent as an alternative to herbicides.



Water hyacinth (*Eichhornia crassipes*). Ted Center, USDA

Visit the CDFW Booth at the upcoming  
2014 International Sportsmen's Expo  
and Fred Hall Fishing Tackle, Boat and



Travel Shows



January 9-12: Sacramento (Sportsmen's Expo)

March 5-9: Long Beach (Fred Hall Show)

March 27-30: Del Mar (Fred Hall Show)

### Aquatic Invasive Species Vector Risk Assessment Forum

January 13, 2014, 1:00 pm – 5:00 pm

Natural Resources Building, 1416 Ninth Street,  
Sacramento, First Floor Auditorium

The California Department of Fish and Wildlife's Invasive Species Program is hosting a forum with researchers to discuss their recent work characterizing the risk from marine invasive species vectors and to explore the possibility of applying their methodologies to freshwater invasive species vectors and ecosystems.

### Subscribe

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A Sneak Peek into  
the next issue of  
**Eye On Invasives:**  
Freshwater Invasives