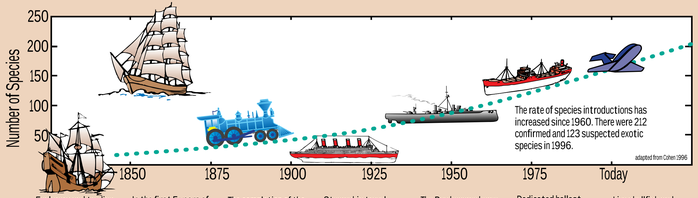
The History and Effects of Exotic Species in San Francisco Bay

San Francisco Bay Project, Water Resources Division*

USGS science for a changing world

How did they get into San Francisco Bay?



Explorers and trading ships began visiting northern California in the 1500's.

In the first 5 years of the gold rush more than 4500 ships sailed into the Bay. Organisms had to survive transport from the Atlantic ports by way of Cape Horn which required 3-4 months.

The completion of the transcontinental railroad in 1869 reduced the transit time coast to coast to about 20 days.

Steamship travel with steel-hulled ships in the 1920-1930's resulted in the conversion to liquid ballast.

The Bay became home to many merchant and military ships arriving from all over the world during and after World War II.

Dedicated ballast tanks, supertankers, and short (2 week) transoceanic transit times have resulted in a higher survival rate of organisms in ballast water.

Live shellfish and other organisms can be shipped by air from all over the world in less than a day.

People sometimes dump aquarium animals and potential food resources into local waters.

Meet some of the critters who stayed.

Early ships had organisms on their hulls and in dry ballast. It is unknown if any organisms were introduced.

The barnacle, ***Balanus improvisus***, living on the ships hull, was first recorded in 1853.

The Atlantic Oyster was farmed in the bay from 1869 to 1930 and brought in as juveniles from the east coast. Organisms living with or on the oysters were accidentally introduced.

135 Striped Bass were shipped by railcar from the Atlantic Coast in 1879.

The Japanese Oyster was transplanted in 1932-39 and in the late 1950's along with at least two "hitchhiking" species.

Exotic species arrived in 1940-50 from an increasing number of countries as shipping expanded.

Exotic species can be large (Atlantic Green crab and Asian clam) or small (amphipods).

Seaweed used to pack the Atlantic Lobster and bait worms harbored at least one species of snail.

None of the history of introduced species in San Francisco Bay could be presented here without the pioneering research of Jim Carlton and the more recent work of Andrew Cohen.

Who?

An Exotic Species is:

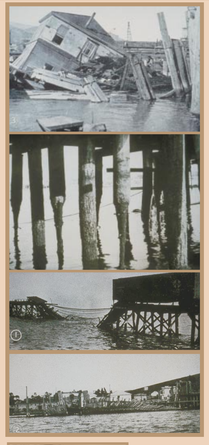
A reproducing population of an organism which is established in a new region.

How are exotic species introduced?

By accident, in ships ballast, on hulls of ships, and intentionally as prey , predators , or as a food resource.

What have they done?

The Atlantic Shipworm (***Teredo navalis***), introduced in 1913, resulted in $3.1 billion (in today's dollars) in damage to wooden structures on the bay between 1919 and 1921.



Striped Bass was first introduced in 1879 and commercially harvested from 1889 until 1935. It is estimated to bring the Bay Area economies about $45 million annually.

The isopod, Sphaeroma quoyanum, introduced in 1893, burrows into the mud banks increasing the erosion rate of the salt marsh.

The Eastern Mudsnail, introduced in 1901-07, forced the native Horn Snail from the mudflats and into the hypersaline salt marsh ponds.

What are they doing now?

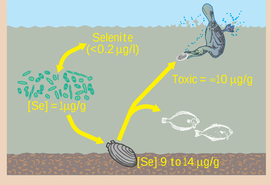
The Chinese Mitten Crab may have been illegally introduced in 1992-94 as a food resource. It burrows into, and weakens dikes and levees. It is also a host to the oriental lung fluke, a human parasite.

The Atlantic Green Crab, first seen in the bay 1989-90, preys on juvenile Dungeness Crab which use the bay as a nursery ground.

Smooth cordgrass was first planted in the bay to mitigate a destroyed marsh in the 1970's. It replaces the native species, advances onto and reduces the mudflat area.

Unexpected effects...

Any introduced species may create a new pathway for contaminants into the higher trophic levels. New species may accumulate contaminants more efficiently and be more productive than native species and thus may increase the contaminants passed up the food web.



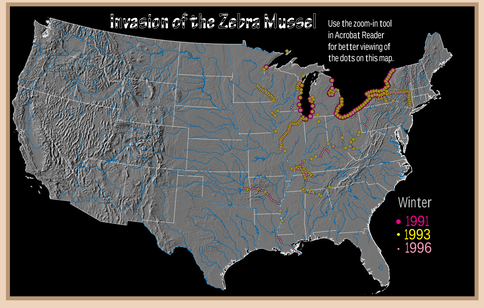
California may be next!

Boats, with Zebra Mussels, have been stopped at the California border. If it invades San Francisco Bay, it will survive in the north bay and the rivers. The potential range is wide-spread.

Maintenance costs to remove Zebra Mussels from structures (like the gear pictured here) exceeded $17 million in 1995.

Planktonic larvae allow Zebra Mussels to spread quickly and to settle in small places. They have clogged a three foot diameter pipe in less than three months.

The Zebra Mussel attaches to any hard surface and native fauna such as crayfish and clams and many die.



The Zebra Mussel was introduced into the Great Lakes in 1986 by ballast water. It has spread rapidly throughout the midwest, but not west of the Continental Divide or east of the Appalachian Mountains.

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