CDFW's Marine Invasive Species Program
Frequently Asked Questions

What Are Marine Invasive Species?

- Marine Invasive Species are animals or algae that have been moved from their native region to California marine and estuarine waters.

Why are Marine Invasive Species a problem?

- The introduction of Non-Indigenous Species (NIS) can cause harm to the ecosystem by displacing native species,
- NIS can introduce new diseases, resulting in risks to human health.
- NIS can cause economic havoc on commercial, agricultural, or recreational activities by clogging waterways and impacting navigation and recreation.

What are other terms for invasive species?

- Introduced
- Non-native
- Non-Indigenous
- Exotic
- Aquatic Nuisance
- Alien

What are the most common vectors for invasive species?

- Ballast water from commercial shipping
- Hull fouling on ships and recreational boats
- Discarded bait
- Aquarium dumping
- Commercial oyster culture

Which habitats does the Marine Invasive Species Program (MISP) sample for invasive species?

- Most sampling takes place in estuaries, but we also sample some outer coast sites.
- We sample fouling organisms on hard underwater surfaces (settlement plates, scraping): the fouling organisms can cover large areas, buildup on surfaces and can therefore smother native species, damage or clog man-made structures in the oceans such as docks or power plant pipes.
- Plankton

- Sediment

What are settlement plates?

- Settlement plates are PVC panels suspended from piers and floating docks.
- The panels provide a bare substrate for species to colonize.
- After 3 months, the panels are retrieved and sent to taxonomic specialists and the genetics lab for species identification.
- Our research shows that these artificial surfaces are good indicators of which species are colonizing natural surfaces in estuaries and are effective in detecting newly introduced species.

What is genetic testing?

- Moss Landing Marine Laboratories (MLML) provides genetic analysis, including next-generation DNA sequencing of samples collected from planktonic, hard-substrate, and soft-substrate communities.
- Next-generation sequencing allows us to identify the individual species collected in multiple, unsorted, whole community samples. Each unique species has a DNA barcode that is added to the DNA Reference Library, reducing turn-around time and sampling cost.
- This project was the first monitoring program to use next-generation sequencing for routine, high volume DNA barcoding.

How does MISP use genetics to find invasive species?

- Dr. Jon Geller from MLML conducts the molecular genetic analysis, specifically next-generation sequencing.
- Next-generation sequencing corroborates individual specimen identification and detects possible cryptic species among vouchers from plate samples.
- Next-generation sequencing also allows us to sample multiple, unsorted, whole communities, and then identify the individual species collected in the samples.
- Millions of individual DNA sequences can be analyzed during a single sample event.
- Each unique species that is genetically identified has a DNA barcode that is added to the DNA Reference Library, eventually reducing turn-around time and sampling cost.

What are the overall goals of the MISP Monitoring Program?

- Measure status and trends of biological invasions in coastal marine ecosystems of California.
- Understand geographic distribution, habitat distribution, and patterns of spread for non-native marine and estuarine species in California.
- Evaluate the vectors of introduction and spread of NIS in California.

- Detect changes in the patterns (rate, spread, prevalence) of NIS in response to shipping management regulations.

How many invasive species are in California waters?

- As of 2017, we recognize over 350 nonindigenous aquatic species with established populations in California coastal waters.

How many invasive species are in San Francisco Bay?

- San Francisco Bay is one of the most invaded waterbodies in the world, with over 215 identified NIS.
- It is a hotspot for new invasions because it has high recreational and commercial shipping traffic, a history of oyster culture, and is adjacent to a highly urbanized area, making it a hub for the rest of the West Coast.

How does climate change affect invasive species?

- Changing environmental conditions may have contributed to the timing of the northward expansion of three non-native ascidians (sea squirts), including *Microcosmus squamiger, Molgula ficus,* and *Styela canopus.*
- The northward expansion generated northward shifts of marine species as a response to the warm-water anomaly, including marine invertebrates.
- With the combination of projected climate change-induced ocean warming and increased frequency of warm weather events, future introductions and northward range expansions of northern and southern species are predicted.
- Continued monitoring will help with early detection of new non-native species introductions and increase our understanding of these expansions and their implications.

Examples of California invasive species spreading because of climate change:

- *Didemnum vexillum* is an example of an invasive fouling species that has shown growth with an increase in water temperature. When ambient temperatures raised 3.5 and 4.5°C in Bodega Harbor (13.5°C), the percentage of growth coverage increased while the native *Distaplia occidentalis* showed a reduction.
- *Microcosmus squamiger, Styela canopus, Molgula ficus* are 3 sea squirts (also known as ascidians or tunicates) which traveled over 500 kilometers north from Southern California, to San Francisco Bay with the help of a multiyear marine heat wave called “The Blob”.
- Pyrosomes are tunicates, tubular colonies of hundreds or thousands of tiny individual zooids, enmeshed together in a gelatinous tunic roughly the consistency of gummy bear candy and glow in the dark due to a bioluminescent characteristic. Pyrosomes have gradually spread north,

before exploding in numbers during spring 2017, according to scientists with the National Oceanic and Atmospheric Administration (NOAA). NOAA believes the pyrosome phenomenon is related to elevated sea temperatures along the Pacific Coast that have brought other changes to marine life during the past few years.

How can I help prevent NIS from coming to California?

- Learn to recognize common invaders and keep an eye out for signs of new ones. Early detection is crucial to stopping the spread of invasive species. Visit the California Non-native Estuarine and Marine Organisms (Cal-NEMO) database. *http://invasions.si.edu/nemesis/calnemo/intro.html* Report any suspect invasive species sighting online. *https://www.wildlife.ca.gov/Conservation/Invasives/Report*
- If you have acquired an undesirable pet or fish species for your aquarium or water garden, it is important not to release these plants or animals into the environment. *www.habitattitude.net*
- Write a letter to your local state representative or get involved with an activist group. Let your lawmakers know your opinions about the impact of invasive species on our natural heritage. *http://www.legislature.ca.gov/legislators_and_districts/legislators/your_legislator.html* Volunteer at your local park, refuge or other wildlife area to help remove invasive species. Help educate others about the threat. Join us during California Invasive Species Action Week. https://www.wildlife.ca.gov/Conservation/Invasives/Action-Week

What types of NIS organisms are in California?

Tunicates:

- *Ciona savignyi* is native to Japan. It is abundant in the fouling community, but very little is known about its impacts.
- The Clubbed tunicate (*Styela clava*) is native to Eastern Asia. It was most likely introduced on the hulls of ships or with imported oysters. It has established a widespread distribution because it has the ability to withstand salinity and temperature fluctuations. It out-competes native organisms for food in the water column and feeds on the larvae of native species causing population declines.
- *Didemnum vexillum* (Rock Vomit) is a rapidly spreading colonial tunicate that overgrows rocks, shellfish, and other organisms.

Bryozoans

- *Watersipora subtorquata* is often the only species able to settle on hulls of ships and surfaces treated with antifouling paints because they are tolerant to copper and mercury in antifouling paint.
- *Watersipora* spp. also have hard encrusting colonies that are tolerant of moving water.

- Other fouling organisms are able to attach on to the W. spp. colonies because they are non-toxic points of attachment, allowing a diverse fouling community to develop, which can adversely affect the speed and efficiency of ships.

Crustaceans (Shrimp, crabs)

- Green Crab is native to Europe and now established on the coast of North America. It devours large quantities of prey, including native clams, oysters, mussels and crabs. The greatest economic concern is the Green Crabs impact to the commercial shellfish industry.

Mollusks (snails, mussels, shipworms)

- *Corbula amurensis* (Asian Clam) - The invasion of *C. amurensis* has had dramatic effects on San Francisco Bay. Within a year of its first detection, huge biomasses of this clam established, out competing native dry-season benthic communities. San Francisco Bay's food web has dramatically altered because of the development of the huge biomass of filter-feeding bivalves.

Seaweeds (macroalgae)

- *Undaria* (Asian Kelp) is an invasive alga that is native to Japan, northern China, and Korea. Undaria, which was first found in Southern California and has since spread to San Francisco and Half Moon Bay, most likely came to the California coast by means of hull fouling. It forms dense underwater forests resulting in competition for space and light with native plants and animals.
- *Sargassum horneri* (Devil Weed) was first noted in Los Angeles Harbor in October 2003, and was found to have spread from the inner harbor to the channel by October 2005. By 2009, *S. horneri* had reached Anacapa and Santa Cruz Islands, in the northern Channel Islands and Isla Natividad, Baja California, Mexico. Many of the harbors of coastal southern California, from Port Hueneme to San Diego Bay were colonized by 2013.

What can be done after a marine invasive species has become established?

- For "pest" or "nuisance" NIS that have demonstrable negative ecological and economic impacts, removal strategies may be considered.
- Removal strategies may include eradication or control.
- Success of removal efforts depends on multiple factors: early discovery, occurrence within confined habitats, limited spatial spread, and a rapid response from management with sufficient funding.

Are there examples of successful control efforts?

- While removal of several NIS from terrestrial and inland water habitats has proven effective, most attempts to remove marine NIS have failed. Some examples of failed attempts include:
    - The veined whelk *Rapana venosa* along the Brittany coast, France;
    - The Japanese kelp, *Undaria pinnatifida,* in Italy, the United Kingdom, the Netherlands, New Zealand, Australia, and California;

- The sea squirt, *Didemnum vexillum,* in New Zealand and the United Kingdom;
- The fanworm polychaete, *Sabella spallanzanii,* in New Zealand.
- The European green crab *Carcinus maenas* in Seadrift Lagoon, Marin County, CA

- The few successful removals of marine NIS include:
  - The black-striped mussel *Mytilopsis sallei* in three lock-gated marinas in Darwin, Australia;
  - The South African sabellid polychaete *Terebrasabella heterouncinata*) in the vicinity of abalone farms in California;
  - An isolated incursion of *U. pinnatifida* in the Chatham Islands, New Zealand;
  - *Caulerpa taxifolia* in Agua Hedionda Lagoon and Huntington Harbor, California and in sheltered emnbayments in New South Wales, Australia.