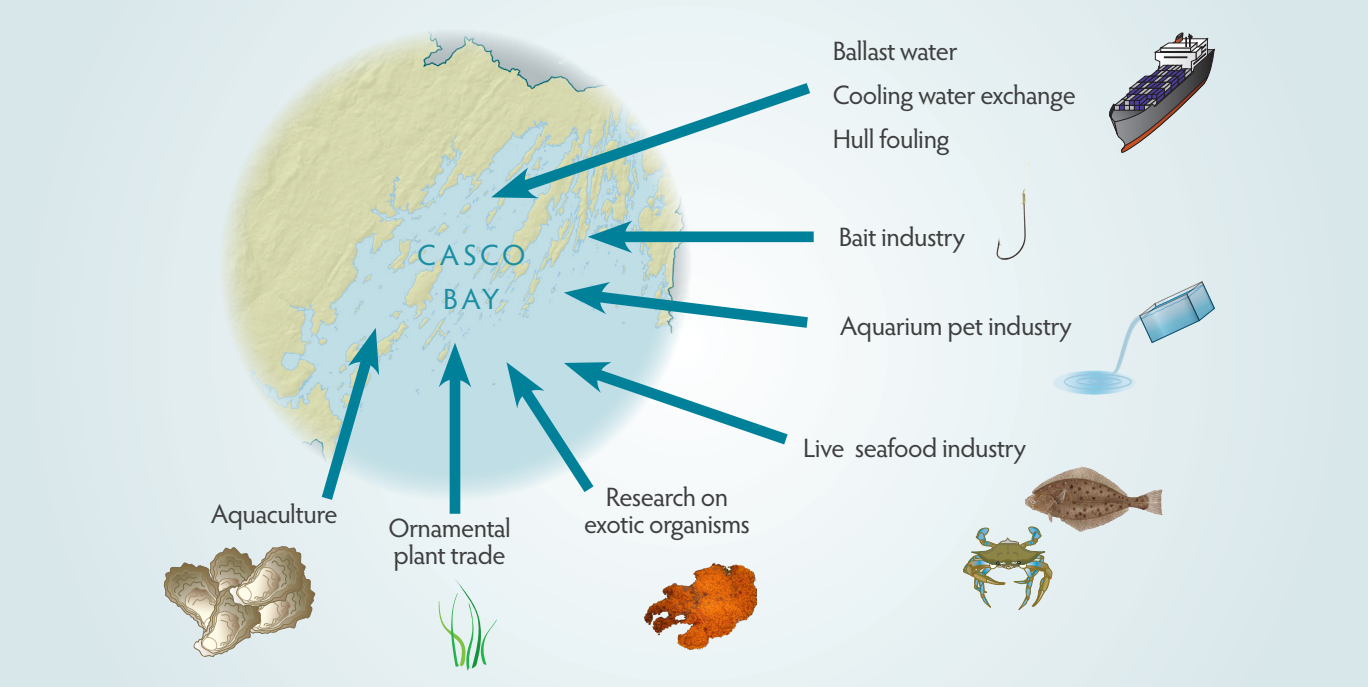
INDICATOR 16

Are marine invasive species present in Casco Bay, and are they increasing?

CBEP Goal: Minimize adverse environmental impacts to ecological communities from the use and development of land and marine resources.



Invasive species enter Casco Bay's waters through multiple vectors – methods and mechanisms of transport. Shipping is considered the most significant source of invasive species, through ballast water exchange, exchange of cooling water, and transport of fouling organisms on the hulls of ships. Other vectors include accidental release of research organisms, release of exotic aquatic plants and animals, aquaculture of non-native species and related introduction of non-native fouling organisms, and release of non-native bait organisms.

Why Is It Important to Monitor Marine Invasive Species?

The bottom-dwelling (benthic) communities of the Gulf of Maine have been going through major shifts in species composition since the 1970s (Harris 2009). The factors influencing those shifts include the introduction of non-native species (see the vector diagram above). When a non-native species succeeds in establishing a reproducing population – and has a negative impact on the native plant and animal community or habitat – it is called "invasive."

Disturbance of the natural community can lead to successful invasion by non-native species. For example, overfishing of predatory groundfish in the Gulf of Maine led to a boom in green sea urchins around 1980, replacing many of the kelp beds that had dominated hard bottom habitats with urchin barrens (areas grazed bare by the urchins). When the urchins were intensively fished starting in 1987, a shift occurred in the bottom community towards previously rare species. The new community was dominated by introduced species such as the green alga *Codium fragile*, colonial tunicates like *Didemnum vexillum* and *Botrylloides violaceous,* and the encrusting bryozoan *Membranipora membranacea* (Harris 2009). Those organisms are now considered to be invasive in Maine (Maine DMR 2006).

Marine communities face multiple stressors. Already affected by overfishing and introduced species, they now also experience warming waters due to climate change (see Section 7). Those elements may act together to allow non-native organisms to spread into new habitats (Harris and Tyrell 2001; Harris 2009). Once introduced species become well established, containment or eradication can become difficult or impossible because wind and currents and other vectors can quickly transport larvae and organisms over a wide range. Programs that regularly monitor the abundance and geographic extent of introduced and invasive species are key to successful management (Maine DMR 2006).

Status of Invasive Species in Casco Bay

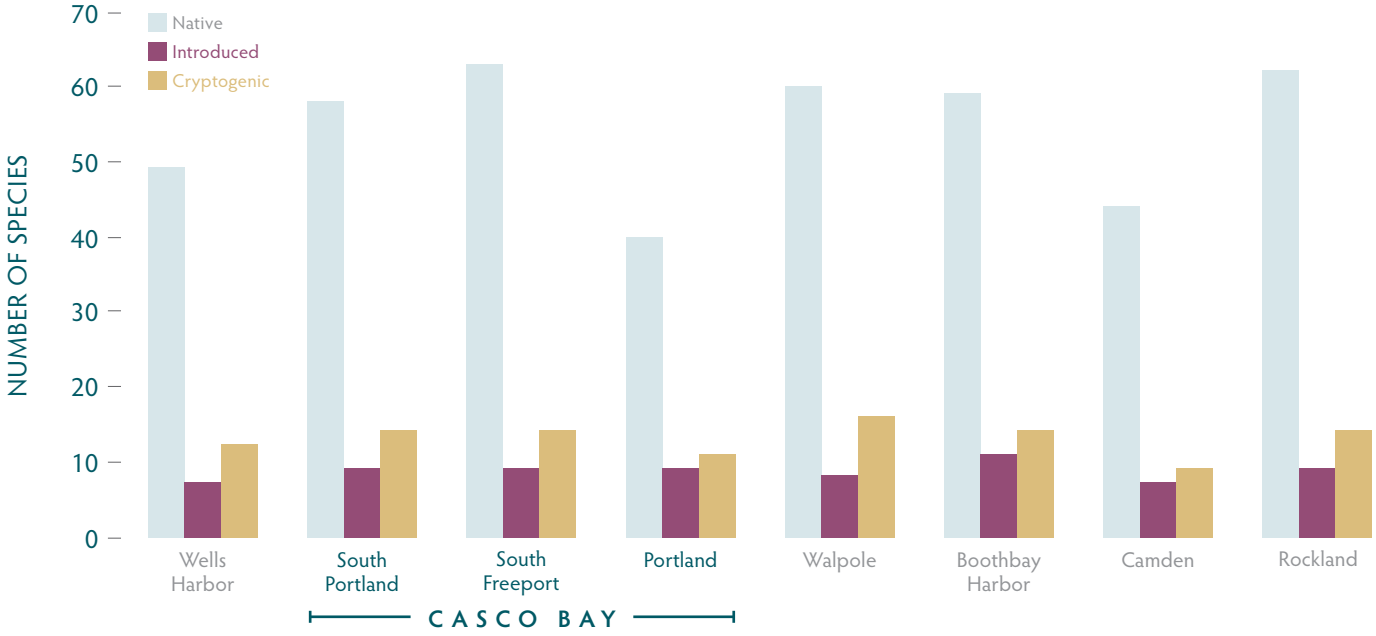
Invasive species can have significant economic and environmental impacts on fishery resources, ecosystem functions and human welfare in Casco Bay. The European green crab (*Carcinus maenus*), for example, is perhaps the most destructive established invader, responsible for reducing populations of soft-shell clams. The crab arrived in the 1800s in ballast water from the Baltic and North Seas and has become well-established in Casco Bay and throughout Maine. The invasive Asian shore crab (*Hemigrapsus sanguineus*), first reported in Casco Bay in 2001, is slowly spreading through Maine waters, and replacing native species (Maine DMR 2006). Tunicates like *D. vexillum* are spreading on bottom areas, and competing with juvenile fish and scallops for habitat and food. *Styela clava*, a clubbed tunicate from the western Pacific, fouls gear and moorings, and smothers shellfish. The spongy alga *Codium fragile* or deadman's fingers, likely introduced from Asia, is another invader that can smother shellfish beds. The bryozoan *M. membranacea* can damage kelp beds, which provide a valuable source of food and habitat, allowing *Codium* to recruit and replace the kelp (Maine DMR 2006).

In 2003 and 2007, MIT Sea Grant and the northeastern National Estuary Programs organized a weeklong "rapid assessment survey" (RAS) to examine the fouling organisms on floating docks and piers in areas with likely exposure to invaders, such as those near shipping ports. The August 2003 Casco Bay sites were Port Harbor Marine in South Portland, Portland Yacht Services, and Brewer South Freeport Marine. Of 29 introduced species identified in 2003 from across the region, 14 were present at the Casco Bay sampling sites (Pederson *et al.* 2005). In July 2007, the RAS revisited Port Harbor Marine and Brewer South Freeport Marine and added the Maine Yacht Center in Portland. The results of the 2007 RAS in coastal Maine are summarized in the following table. There was another RAS at Casco Bay sites in summer 2010, but the data are not yet available.

Gretchen Lambert

Botrylloides violaceus, an invasive colonial tunicate or "sea squirt" found in Casco Bay.

Results of the 2007 Rapid Assessment Survey in Maine. Scientists with expertise in native, introduced, and cryptogenic (not demonstrably native or introduced) species monitored the abundance of all three types of organisms at several sites (Pederson 2010). The most common non-native species in 2007 were two colonial tunicates, *Botryllus schlosseri* and *Botrylloides violaceus* and the bryozoan, *M. membranacea* , which appeared in all the stations. Other common non-native species included the club tunicate, *Styela clava*, and the European green crab. A total of 200 species were identified in the eight Maine sites, with an average of two fewer non-native species in Maine than in Massachusetts and New Hampshire sites (Pederson 2010).



The Vital Signs Program

Students and the Public Collect and Share Data on Invasive Species and Vulnerable Habitats

In partnership with scientists, resource managers and classroom educators, the Gulf of Maine Research Institute (GMRI) developed Vital Signs, a science learning environment investigating invasive species. Vital Signs challenges middle school students to ask questions about their local habitats, find and document both native and non-native species, and share their findings with one another and with professional scientists on the program website, www.vitalsignsme.org. Vital Signs focuses on contributing to statewide efforts to document invasive species and vulnerable native species and habitats, including lakes, forests, trout streams, wetlands, fields, salt marshes, and rocky intertidal zones. Program outcomes include increased research capacity for scientists and an opportunity for students and the public to learn and to participate in scientific research.

More than 2,000 students, 15 scientists, 47 educators, and many local citizens have taken part: downloading data sheets and taxonomic resources from the website; collecting written observations and water quality measurements; documenting species with digital cameras; and referencing their data with GPS positions. Scientists, educators, and others provide feedback on their findings, and experts check the species identifications (Thus far, the participants have an 84 percent accuracy rate.) All data and resources, scientific and educational, are publicly available online. The Maine DEP and the Invasive Plant Atlas of New England, based at the University of Connecticut, are two of Vital Signs' early partners, recognizing the program's potential to focus efforts of motivated citizens and ultimately to help scientists address the diverse challenges of invasive species monitoring and research.

Trends/Indicator Development

Maine Marine Invasive Species Working Group (MMISWG), a stakeholder committee comprising government, non-profit and academic members, has been exploring development of an indicator for the invasive tunicate *Didemnum vexillum*. As part of the state's annual May/June sea urchin dive surveys along the Maine coast, Maine Department of Marine Resources (DMR) has been collecting spring data on invasive *Didemnum* abundance since 2007. *Didemnum* typically reaches its maximum density in the fall and dies out over the winter. CBEP and Maine Department of Environmental Protection (DEP) provided funding to test the capacity of the spring data to predict fall abundance and distribution of *Didemnum* by repeating the survey in September, 2009 at twelve sites in Casco Bay and Boothbay Harbor. The data suggest that while there is a significant correlation between spring and fall abundance, there were many sampling sites where *Didemnum* was absent in the spring, but had appeared by September. In Casco Bay, *Didemnum* was not as abundant as some other areas of the coast. Additional studies will be required to establish local spring/fall abundance relationships to determine whether spring data can serve as an indicator for the extent and biomass of *Didemnum*.

Woods Hole Science Center, USGS

Didemnum vexillum, a harmful colonial tunicate that has invaded Casco Bay waters.

Solution and Actions

The most effective ways to minimize problems with invasive species rely on source prevention strategies such as ballast water and fouling organism management programs. Ballast water management is now addressed in US Coast Guard (USCG) regulations requiring mid-ocean ballast water exchange and in the Vessel General Permit (VGP) issued to commercial vessels under the federal Clean Water Act. The VGP requires, for example, that vessels avoid discharging into sensitive areas (such as shellfish beds); clean tanks in mid-ocean or in dry dock; and discharge the minimum amount required for operation. The permit also requires disposal of fouling organisms from anchor chains and seawater

The US Coast Guard has proposed strict regulation of ballast water discharges based on treatment to meet numeric standards.

piping, and management of hull-cleaning away from sensitive areas (VGP 2009). USCG (2009) has proposed new national regulations requiring treatment of ballast water to reach strict numeric standards for organisms discharged and is currently working on both treatment and testing protocols. (While the majority of ships coming into Casco Bay do not discharge ballast water in port, there are some discharges every year.)

The Northeast Aquatic Nuisance Species Panel (NEANS), consisting of state and federal representatives from throughout the northeast region, is addressing non-shipping vectors through educational programs and materials for industries that import non-local marine organisms such as the hatchery, fish-farming, and bait industries; the exotic pet industry; and aquatic pet owners (Weigle 2007). Public education programs in Casco Bay include the Gulf of Maine Research Institute's Vital Signs program (see sidebar). Maine Sea Grant, working with the MMISWG and others, has distributed a brochure (2008) and a poster (2009) encouraging fishermen and others to report invasive species, including two that have not yet made it to New England: the Chinese mitten crab (see photo) and the Rapa whelk (*Rapana venosa*), which preys voraciously on several commercially important shellfish species. Early detection and reporting may make control of those invaders possible.

Actions under the State of Maine 2002 *Action Plan for Managing Aquatic Invasive Species* (DEP 2002) have been focused on managing the introduction of freshwater plants. To address marine species, the state is participating in the regional NEANS panel as well as the MMISWG. The members of MMISWG, including CBEP, are continuing to work together on invasive species indicators, as well as on the tools and strategies needed for early detection and rapid response.

Christian Fischer

The Chinese mitten crab, *Eriocheir sinensis*, is found in both estuarine and fresh waters (but not yet in Maine!). This dinner-plate sized crab burrows into muddy banks and can accelerate shoreline erosion. To report sightings, call Maine DMR 207-633-9539.

Educational poster from Maine Sea Grant.

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