

MAINE'S MARINE INVASION

What is invading Maine's coastal waters?

The Asian shore crab.¹ Dead man's fingers.² Bonamia oyster disease.³ These are just a few of the 33 non-native species that have been documented in marine waters and shorelines along the Maine coast in a preliminary count.⁴ While many non-native species are unable to survive, reproduce, and overtake native plants and animals in Maine's coastal waters, those that are successful become known as "invasive species."

Invasive species are plants, animals, and other organisms that have been introduced by human activities and develop abundant, widespread populations where they did not occur historically. In marine environments, invasive species have the potential to cause harm by displacing or preying on native organisms, impacting habitat, or introducing new parasites and diseases. With more potential invaders making their way up the East Coast and entering the U.S. from other countries, marine invasive species present a growing challenge to the state of Maine.

What are the costs?

Costs associated with preventing and controlling invasive species are not well understood, but a review of economic impacts of aquatic invasive species published in the April 2006 issue of *Agricultural and Resource Economics Review* indicates that they may be in the range of millions to billions of dollars per year for all U.S. environments.^{5,6} Few economic impact analyses specifically assess damage to marine environments, but examples suggest that the costs are significant. For example, on the Pacific Coast, monitoring and control of the Mediterranean green seaweed (*Caulerpa taxifolia*) and Chinese mitten crab (*Eriocheir sinensis*) cost the state and federal governments \$2.3 and \$1 million, respectively, between 2000 and 2001.⁷

Marine invasive species can negatively impact marine industries by fouling boat hulls, docks, fishing nets, and aquaculture pens; outcompeting commercially harvested species; and damaging wooden structures (such as piers and boats). Diseases that can be associated with certain non-native species pose human health risks. Other costs include expenses related to the research, prevention, and control of marine invasions. There are also undocumented costs of invasions to marine ecosystems.



Rocks serve as ideal hiding places for species introduced to Maine such as the Asian shore crab (*Hemigrapsus sanguineus*), above, found on the shores of Lowell Cove, Harpswell, Maine.

Photo—Tracy Hart



Known by names such as "oyster thief," "green fleece" and "dead man's fingers," this alga (*Codium fragile ssp. tomentosoides*) is believed to have been introduced to Boothbay Harbor in the 1960s through oyster aquaculture. In the Gulf of Maine, this species displaces kelp beds and has had impacts on shellfish and other marine life, aquaculture, and recreation.

Photo—Marney Pratt, Bowdoin College

How do marine invasive species get into Maine waters?

New species can arrive in Maine via several vectors, or pathways. Historically, shipping has accounted for most introductions into U.S. waters. Species can “hitchhike” from one region to the next when they attach to ship hulls or are transported in ballast water, which is pumped into empty or unfilled ship hulls to provide stability at sea. Ships may pump millions of gallons of ballast water into their hulls at foreign ports. This seawater, along with potentially more than one billion foreign organisms it carries,⁸ can be discharged into Maine harbors to make room for new cargo.⁹

Pathways unrelated to shipping have also been responsible for marine introductions. A wide variety of non-native marine species are sold at pet and aquarium stores and over the Internet. In some cases, these species have escaped or have been released into marine waters by pet owners or the aquarium industry. Marine introductions also have occurred through the mishandling of non-native marine species by research and educational facilities, such as universities and public aquariums, which buy or collect non-native marine species.¹⁰

The aquaculture and seafood industries play substantial roles in marine invasions.¹¹ The U.S. imports 2 billion metric tons of seafood each year,¹² and both the types and origins of food species are becoming more diverse, opening new avenues

for introduction. Boats, fishing gear, and any marine material that is relocated, such as barges, dry docks, and transport trailers, can transport organisms to new areas. Finally, some non-native species are introduced intentionally to control another pest species or as a food source.¹³ Currently, non-native species are introduced intentionally in the U.S. only after studies have determined that they are unlikely to become invasive and likely to serve a beneficial purpose.

In Maine, it has been estimated that nearly 400 businesses import live or frozen non-native marine species.¹⁴ One study conducted in Massachusetts found that most importers of non-native marine organisms engage in potentially risky behaviors that could increase the likelihood of non-native species introductions into the Gulf of Maine.¹⁵ Many importers reported discharging tank water used to hold non-native species directly into local bodies of water, although some treat or filter the water before disposal. The study also found that some seafood businesses in New England sell non-native species to local fishermen for bait, and others wash down trucks that carry imported species in close proximity to water.

Maine seaweed, used for packing live bait, seafood, and aquaculture products, carries hitchhikers from this state to other locations and is implicated in several marine invasions on the West Coast.¹⁶ There are many



The Chinese mitten crab (*Eriocheir sinensis*) is native to East Asia. As of January 2008, this species has not been found in the Gulf of Maine, but resource managers are concerned that it will spread to this area in the near future. It was first reported in the U.S. in San Francisco Bay in 1992, and it started appearing in Chesapeake Bay crab pots in 2005. In 2007, specimens were found in Delaware Bay and the Hudson River. The Chinese mitten crab's common name comes from the dense, fuzzy patches on its white-tipped claws. It can also be identified by its round-shaped carapace, which can grow up to 4 inches in diameter. The Chinese mitten crab reproduces in salt water, and the young migrate into brackish water and freshwater. It is an adept walker, and can leave the water to walk around dams or other obstacles. Documented impacts include: causing or accelerating shoreline erosion, due to its burrows in muddy banks and levees; disruption of native organisms through predation and competition; and, where large numbers are present, interference with fishing gear.^{23, 24}

Photo—Dr. Wolfgang Rabitsch

existing pathways by which marine invasions may occur, and additional mechanisms for introduction could become a threat as population, trade, boating, sales of species over the Internet, and shipping traffic increase in Maine.



◀ Several species of non-native colonial tunicates (“sea squirts”) are now found all along the coast of Maine. The red or orange sheath tunicate (*Botrylloides violaceus*) to the left was photographed during the 2003 Rapid Assessment Survey of floating docks in northeastern U.S. ports. Ports and harbors are potential hotspots for marine invasive species because activities that can transport and potentially introduce new species can be concentrated in these areas, including ballast water exchange, hull cleaning, bait and seafood transport, and boat travel.

Photo—Gretchen Lambert, courtesy of MIT Sea Grant

▶ In addition to being found all along the coast, the colonial tunicate (*Didemnum* sp.) to the right is spreading rapidly on Georges Bank. The area of seabed covered by this tunicate doubled at 75 percent of the Georges Bank sites surveyed by NOAA and USGS in both 2005 and 2006.¹⁷

Photo—Beth Bisson



How is Maine addressing the threat of marine invasive species?

Maine is addressing marine invasions on several fronts, including agency actions, regulations, and participation in local and regional efforts.

Maine Department of Marine Resources

The Maine Department of Marine Resources (DMR) collects sighting reports of exotic organisms such as the Asian crab (*Hemigrapsus sanguineus*); conducts annual surveys for green crabs (*Carcinus maenas*); and collects location and abundance data for *Didemnum sp.* when possible while conducting near shore surveys for other species. DMR regulates the importation of live marine organisms to minimize the entry of diseases, parasites or any organisms that may be dangerous to native marine life; and maintains a list of Maine facilities that hold live marine organisms and have the potential for accidental introductions. To help prevent the spread of species from Maine to other regions, DMR is working with other groups toward raising awareness for proper disposal of seaweed used for commercial baitworm shipping and packaging.

Maine Department of Environmental Protection

The Maine Department of Environmental Protection (DEP) has developed comprehensive survey, management, and communication programs to address the impacts of freshwater Aquatic Nuisance Species, and the agency has begun to evaluate ways this work may extend to the marine environment. The DEP's primary interests in identifying and managing marine Aquatic Nuisance Species relate to the potential and documented impacts of ANS on: estuarine and marine water quality; the structure and function of estuarine and marine communities; and individual populations of indigenous marine species.

Maine Plan for Managing Invasive Aquatic Species

Maine's Action Plan for Managing Invasive Aquatic Species, adopted in 2002, calls for understanding the ecology and impacts of species that have the greatest potential to disrupt Maine's commercial fisheries and marine infrastructure. Some of the tasks identified for managing the threat of marine invasive species include working with the U.S. Coast Guard and other entities to make sure that ballast water is controlled; identifying alternative seaweed packing materials; developing a database of companies and organizations involved in the transport and trade of non-native organisms; and establishing suspicious species reporting procedures.

Maine Marine Invasive Species Working Group

The Maine Marine Invasive Species Working Group has formed to collaborate on marine invasive species issues and identify priorities for education, research, monitoring, and management. The working group is comprised of representatives from: Casco Bay Estuary Project, Census of Marine Life, Cornell University, U.S. Environmental Protection Agency, Friends of Casco Bay, Friendship International, Gulf of Maine Research Institute, Maine Coastal Program/Maine State Planning Office, Maine Department of Environmental Protection, Maine Department of Marine Resources, Maine Department of Transportation, Maine Sea Grant College Program, MIT Sea Grant College Program, The Nature Conservancy, The Ocean Conservancy, University of Maine, University of New Hampshire, and Wells National Estuarine Research Reserve.

What actions are still needed in Maine?

Addressing marine invasive species issues is difficult due to the large number of pathways by which species can be introduced into marine waters and the presence of environmental factors, such as water currents, that make it difficult to halt the spread of introduced species. Yet, more actions are needed in Maine to minimize the impacts of established invasions and prevent new ones. These actions include developing a rapid detection and response system for new invasions, funding marine invasive species research, monitoring and management, inventorying activities that can lead to new species introductions, and educating citizens and business owners about the risks of various behaviors.

For more information on marine invasive species, check out the following Web sites:

Sea Grant National Aquatic Nuisance Species Clearinghouse
www.aquaticinvaders.org

MIT Sea Grant Center for Coastal Resources
<http://massbay.mit.edu/exoticspecies>

Northeast Aquatic Nuisance Species Panel
www.northeastans.org

Maine Department of Marine Resources Asian Shore Crab Site:
www.state.me.us/dmr/rm/asian_shore_crab.htm

Smithsonian Institution Marine Invasions Research Lab
www.serc.si.edu/labs/marine_invasions

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

Sea Grant Nonindigenous Species
www.sgnis.org

Massachusetts Bays Program
www.massbays.org

The Global Invasive Species Database
www.issg.org/database/welcome

Massachusetts Office of Coastal Zone Management,
Aquatic Invasive Species Program
<http://www.mass.gov/czm/invasives/index.htm>

Northeast Aquatic Nuisance Species Panel

Through several representatives on the federal Northeast Aquatic Nuisance Species (NEANS) Panel, Maine works with other states to address the spread of marine invasive species within the region. NEANS was established in 2001 as a regional, coordinated effort to address the spread and threat of Aquatic Nuisance Species in the Gulf of Maine and in freshwater systems of the northeastern U.S. and Atlantic Canada.

Maine Marine Invasive Species Legislation

In May 2005, a state bill sponsored by Rep. Herbert Adams (LD 667/HP 487) was signed into law requiring state agencies and governments to develop practices and procedures to prevent introduction of non-native invasive species into state coastal waters and the Gulf of Maine ecosystem under the direction of the Commissioners of the Maine Department of Marine Resources (DMR) and the Maine Department of Environmental Protection (DEP). The bill also requires collaborative inter-agency efforts to eliminate or mitigate the negative impacts of non-native marine invasive species where they have already been introduced. In addition, the bill directed DMR and DEP to write and submit a report to the State Legislature on marine invasive species in Maine (see right for more details).

Glossary of Terms

Introduced species are those that have been transported by human activities—intentionally or unintentionally—into a region in which they did not occur in historical time and are now reproducing in the wild.¹⁹ Introduced species are also known as non-native, exotic, or alien species.

An **invasive species** is an organism that is introduced to an area where it is not native, and where it successfully invades and disturbs natural ecosystems, displacing indigenous and endemic (native) species.²⁰ An invasive species can also be defined as an introduced species that outcompetes native species for space and resources.²¹ According to some definitions, these organisms also must have the potential to cause harm. U.S. Executive Order 13112 (1999), for example, defines an invasive species as an alien species whose introduction does, or is likely to, cause economic or environmental harm or harm to human health.

Aquatic nuisance species are non-native aquatic plants or animals that threaten the diversity or abundance of native species, the ecological stability of infested waters, or the commercial, agricultural or recreational activities that depend on such waters.²²

2006 Report to the Maine State Legislature

LD 667 required the Maine DMR and the Maine DEP to write and submit a report on marine invasive species to the Joint Standing Committee on Natural Resources and the Joint Standing Committee on Marine Resources. The two agencies worked with the Maine Marine Invasive Species Working Group to compile information on the nature and extent of marine invasive species-related problems in Maine waters, the legal framework for regulation of these problems, and a summary of efforts to control marine invasive species in New England. The report was submitted to the Maine State Legislature on February 1, 2006. A copy of the report can be obtained at the following Web site: http://www.maine.gov/dep/blwq/report/marine_invasive2006.pdf

Rapid Assessment Surveys of the New England Coast

In the summers of 2000, 2003, 2005, and 2007, a team of taxonomic experts from across the country conducted rapid assessment surveys to identify native and non-native species on floating docks and piers on the New England Coast. The surveys included sites in Maine in 2003, 2005, and 2007. The goal of the surveys is to track location, abundance, distribution, and changes over time in non-native species populations throughout the region. The MIT Sea Grant College Program and three northeastern U.S. EPA National Estuary Programs coordinated the surveys, with assistance in Maine from members of the Marine Invasive Species Working Group. The NOAA National Sea Grant Program, the U.S. EPA National Estuary Program, and the Maine Marine Invasive Species Working Group have provided funding. For more information on these surveys, please visit: <http://massbay.mit.edu/exoticspecies/exoticmaps/>











Green crabs (*Carcinus maenus*) have been touted as an example of the need for prevention when dealing with marine invasive species. Despite ongoing eradication attempts, the green crab has become a dominant species in Maine's intertidal zones and has had significant effects on Maine's soft-shell clam industry.

Photo—Doug Snow

Green crab illustration by Kathy Villarreal

How can Maine citizens help stem the invasion?

Eradicating marine invaders once they are established has proven to be extremely costly and usually impossible, making prevention the best tool. The key to preventing new marine introductions is identifying and minimizing the pathways by which marine invasive species arrive and spread in Maine. Through actions such as proper disposal of food, trash, and waste water and proper handling of non-native species, Maine citizens and businesses can minimize the risks of introducing new marine species:

-  Discard bait and seafood products and containers in the trash or compost only. Dispose of shellfish and shellfish waste (e.g. lobster and clam shells) in trash receptacles or composting facilities.
-  Clean boat hulls thoroughly before launching in a new area (even within the state) and do so away from shore to prevent runoff into the water.
-  Avoid buying organisms that are potential invaders through pet or aquarium shops or the Internet.
-  Never release a non-native aquatic pet, or the water in which it is held, into a waterway, storm drain, sewer system, or near the shore. The release of some species is illegal.
-  Support efforts to strengthen state and federal laws on the import and export of marine organisms.
-  Support legislation to provide funding for invasive species research, monitoring, management, education and prevention.
-  Learn more about marine invasive species and participate in public education programs on the topic.
-  Join a citizen monitoring group, such as the Maine Shore Stewards (<http://www.umaine.edu/umext/ssteward/>), or the Volunteer Diver Monitoring Program organized by Northeastern Sea Grant Programs and Salem Sound Coastwatch (<http://chartis.mit.edu/mitis/contributors/divers/default.aspx>).



Jan Smith, Executive Director of the Massachusetts Bays Program, surveys species found on floating docks and piers during the 2007 Rapid Assessment Survey. For more information about these surveys, visit <http://massbay.mit.edu/exoticspecies/exoticmaps/>

Photo—Karen Young



Dr. Judith Pederson, a marine invasive species expert from MIT Sea Grant, gives Maine teachers an overview of Rapid Assessment Survey techniques at the Aquatic Invaders in Maine (AIM) teachers' institute in June 2007, a program coordinated by UMaine Cooperative Extension, Maine Sea Grant, and the Gulf of Maine Research Institute.

Photo—Doug Snow



Volunteer science divers from the University of Maine and the Maine Department of Marine Resources working with Maine Sea Grant in 2006 to develop a protocol for underwater invasive species transect surveys.

Photo—Beth Bisson



Maine teachers conducting intertidal transect surveys, June 2007. Transects are one method used to track marine invasive species in intertidal areas.

Photo—Doug Snow

If you find any unusual organisms, check the MIT Sea Grant Web site <http://massbay.mit.edu/exoticspecies/exoticmaps/index.html> and Hitchhiker's Guide to Exotic Species <http://massbay.mit.edu/images/HHall.pdf> to identify the organism.

If your suspect matches one of the species listed, please call Pete Thayer, Maine Department of Marine Resources, (207) 633-9539, so that state officials may better track the appearance and spread of invasive species in Maine.

Endnotes

1. Asian shore crab (*Hemigrapsus sanguineus*).
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3. Bonamia oyster disease (*Bonamia ostrea*), a pathogen.
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