

2006

Non-Native Invasive Marine Species in Maine, A Report to the Maine State Legislature, Marine Resources Committee and Natural Resources Committee

Peter E. Thayer

Maine Department of Marine Resources

James F. Stahlnecker

Maine Department of Environmental Protection

Follow this and additional works at: <https://digitalcommons.usm.maine.edu/cbep-publications>

Recommended Citation

Thayer, Peter E. and Stahlnecker, James F., "Non-Native Invasive Marine Species in Maine, A Report to the Maine State Legislature, Marine Resources Committee and Natural Resources Committee" (2006). *Publications*. 244.

<https://digitalcommons.usm.maine.edu/cbep-publications/244>

This Report is brought to you for free and open access by the Casco Bay Estuary Partnership (CBEP) at USM Digital Commons. It has been accepted for inclusion in Publications by an authorized administrator of USM Digital Commons. For more information, please contact jessica.c.hovey@maine.edu.

NON-NATIVE INVASIVE MARINE SPECIES IN MAINE

A Report to the Maine State Legislature,
Marine Resources Committee and Natural Resources Committee

February 1, 2006

Prepared by:
Peter E. Thayer, Maine Department of Marine Resources
and
James F. Stahlnecker, Maine Department of Environmental Protection



Non-native Invasive Marine Species in Maine – A Report to the Maine State Legislature

Background

In May 2005, LD 667 (HP 487) – “A Resolve – Regarding Non-native Invasive Marine Species”, sponsored by Rep. Herbert Adams was passed by the Maine Legislature, and signed into law. The Resolve, Chapter 43, directs the Dept. of Marine Resources, in conjunction with the Dept. of Environmental Protection, to submit this report to the Joint Standing Committee on Natural Resources and the Joint Standing Committee on Marine Resources, “concerning the nature and extent of the problem of non-native invasive marine species in Maine waters.” The report’s purpose is to provide a “summary of issues and efforts to control non-native invasive marine species in the New England area, a description of the existing legal framework for regulation of ballast discharges, any recommendations for changes to Maine law to better address ballast discharges and other issues related to non-native invasive marine species.”

The resolve further directs the State, and all appropriate agencies and governments as deemed by the Commissioners of DMR and DEP, to participate in the development of practices and procedures to prevent introduction of non-native invasive marine species into State coastal waters and the Gulf of Maine ecosystem; and to work to eliminate or mitigate the negative impacts of non-native invasive marine species where introduced by continuing to develop science-based strategies and promoting collaborative problem-solving. Appropriate state agencies are defined as those involved with managing or studying Maine’s marine environment, its harvests and its related commerce.

Invasives on a Global Scale

‘Non-native species’ are organisms that have been transported via human activities and introduced to locations in which they previously did not occur, and appropriate environmental conditions have allowed them to successfully establish populations and reproduce. When their presence and interactions with the new environment, habitat or species community are disruptive and have a negative impact, the introduction is termed ‘invasive’. The methods and mechanisms by which they are transported are called pathways, or vectors. Ocean-going shipping vessels have been primarily responsible for marine non-native introductions globally and in the U.S., largely through the dumping of ballast water. On a global scale, commercial shipping transports approximately 2/3 of world trade based on tonnage and requires the discharge of 3.5 billion tons of ballast water each year (Endresen et al., 2004). Testing of ballast water aboard cargo carriers showed that almost all were determined to have live organisms in their ballast water tanks. In addition, the organisms found in the ballast water were taxonomically diverse and had apparently come from multiple donor areas (Smith et al., 1999). These findings are exacerbated by the fact that global commerce is increasing, including more shipping and also cruising activity. Furthermore, increasingly shorter shipment transport times contribute to more risk of species being introduced alive into receiving waters (State of

Maine Action Plan for Managing Invasive Aquatic Species, 2002). Worldwide, shipping is considered the primary vector for marine invasive species transport, based on: the large number of vessels involved, the diversity and abundance of species they transport in ballast water, and the direct release of these species alive into coastal waters (Smith, 2002).

Other vectors include the exchange of “sea chest” (cooling) water, and the transport of organisms via “fouling”- attachment and growth on the hulls of vessels, dry docks, and floating marine debris. Activities such as commercial and recreational fishing, the live seafood trade, stock enhancement, aquaculture, habitat restoration, bottom drilling, research activities, recreational activities, the ornamentals trade and the aquarium pet trade all present potential pathways. (Carlton, 2001). Once an organism (or its eggs, larvae, fragments etc.) has been introduced to a region, the natural factors of the ocean environment - including coastal currents, tides and winds – can combine to spread the organism over a large range relatively quickly, making containment or eradication an especially difficult and oftentimes impossible task.

For all environments (freshwater, land, marine), the U.S. spends a combined \$130 billion per year dealing with invasive species problems (Carlton 2001). An alarming example of the impact of a freshwater invasive is the zebra mussel (*Dreissena polymorpha*), which invaded the Great Lakes in 1988 via ballast water, likely from Europe. This species now



Conducting a rapid assessment, 2003 – underside of a dock in South Freeport, ME. Courtesy of Peter Dyrinda.

costs nuclear power plants in that region an average of \$800,000 per year to control. They are now found in Quebec, New York, Connecticut and Vermont (NEANS 2001). Although less information exists on the total costs of efforts to monitor, control, and prevent marine invasive introductions, they also have significant fundamental and economic impacts on fisheries resources, ecosystem resources, human welfare, and industrial development and infrastructure (Carlton 1989). For example, the Chinese mitten

crab (*Eriocheir sinensis*) and Mediterranean green seaweed (*Caulerpa taxifolia*) together cost the federal and state governments \$3.3 million between 2000 and 2001, for monitoring and control on the U.S. Pacific coast (Hart, 2005). Hundreds of introduced organisms occur in U.S. waters (Ruiz et al., 2000); and each day at least 7,000 different species are transported around the world (Carlton 1999).

A 2001 report to the Pew Oceans Commission on introduced marine species stresses the need for ballast and fouling management programs, rapid response and early warning systems, expanded bioinvasions research and monitoring surveys, and expanded public education and outreach (Carlton 2001). Development of science-based strategies for the prevention of introductions, regular monitoring of both native and non-native species present, and rapid response to introductions are of great importance for stemming

invasives in Maine. Prevention in particular is the most effective course of action for avoiding the establishment and reproduction of unwanted marine species. Eradicating invasives after they are established is extremely costly and in most cases impossible (Hart, 2005).

Non-natives in Maine

Maine's most destructive and costly invader has been the green crab, *Carcinus maenus*. This crab arrived in the eastern U.S. in the mid-1800's via ballast from the Baltic and North Seas, moving northward and establishing itself in Maine in the early-mid 1900's. The crab has since significantly diminished the soft-shelled clam (*Mya arenaria*) resource, despite extensive efforts by the DMR in the 1950's and 1960's to eradicate it by methods such as fencing, trapping, and applying DDT to mudflats. Population numbers do show decline during periods of exceedingly cold winters (Glude, 1955). This resiliency by the green crab to prolonged and various eradication efforts underscores the extreme difficulty in dealing with marine invasives once they have become established, and the importance of attempting to prevent introductions by being aware of potential vectors and addressing them.



Green crab (*Carcinus maenus*). Photo: Marney Pratt

Two recent events occurred in Maine that increased awareness of the potential problems and issues due to the arrival of marine non-native species:

In early 2001 a new dry dock facility constructed in China entered the lower Kennebec River, having traveled through a variety of seas, both tropical and temperate, on its voyage. The potential for accumulating non-native species and introducing them to Maine waters prompted a rapid biological assessment of the hull by its owner, Bath Iron Works. The study was conducted by DMR and Normandeau Associates, with guidance from several invasives experts. Some living non-native species were found during the initial February survey, however, all non-native species were dead by the May follow-up survey, presumably due to cold temperatures and low salinities. While the highly publicized dry dock drew much attention, the more frequent visits of vessels with less notoriety may pose the greater risk of invasions.



Asian shore crab (*H. sanguineus*). Photo: Marney Pratt

Also in July 2001, the Portland Press Herald reported that the invasive Asian shore crab *Hemigrapsus sanguineus* had been sighted for the first time in Maine, at South Portland and Scarborough locations. Since then monitoring surveys and reports indicate that they have continued to spread easterly along the coast and have been detected as far as Schoodic Peninsula

in 2005. This crab displays an aggressive nature and along with displacing other crab species from invaded areas, it may be out-competing and eating other occupants of the intertidal zone for food.

Some other examples of nonnative species introduced to Maine waters are:

- Tunicates, or “sea squirts”, such as *Didemnum sp.* and *Botrylloides violaceus*, grow in colonies and spread on bottom areas, competing with indigenous



The tunicate *B. violaceus*. Photo: Marney Pratt

organisms such as juvenile fish and scallops for settling habitat and food. They foul man-made structures such as pilings, fishing and aquaculture gear, and moorings, requiring extensive and costly time to remove them.

Didemnum sp., native to the North Sea, has been reported to grow heavily on oyster cages, smothering and killing oysters in

the Weskeag River (F. Pierce, pers. comm.). Recently it has been detected on Georges Bank and appears to be spreading rapidly. *B. violaceus*, introduced from the Pacific Ocean, now ranges from Virginia to Maine (MIT/Sea Grant 2003). The clubbed tunicate *Styela clava*, a native of the western Pacific and reported in the Prince Edward Island region in 1998, has also made its way to Maine waters. *Styela* is a major problem for aquaculture in Canada, fouling gear, docks and bouys; also it competes with young mussels and oysters for food and space (Fisheries and Oceans Canada 2002).

- *Codium fragile* – a spongy green algae coined as ‘oyster thief’ – was first reported in 1957 from Long Is. NY, and has since established populations in Boothbay Harbor and other Maine locations. It is believed to have been introduced from Asia. Shellfish beds such as oysters can become completely covered with, and smothered by, heavy *Codium* growth; the larger plants can become buoyant and physically remove oysters from beds (Hillson, 1982), especially in storm surges.



Codium, the “oyster thief”. Photo: Marney Pratt

- MSX (oyster disease) is caused by the invasive parasite *Haplosporidium nelsoni*, introduced from Asia to the Chesapeake Bay area in the late 1950’s, where it has contributed in part (along with the protozoan to the decimation of that region’s oyster resource. MSX-associated mortalities have occurred in Maine locations such as the Piscataqua River since 1995 (Barber et al., 1997).

- ISA (infectious salmon anemia) is a virus (*Orthomyxovirus*) that causes mortalities in both farmed and wild Atlantic salmon. This disease was first reported in Norway in 1984, and was subsequently detected in New Brunswick and Scotland (Anderson, 2000). The virus was first diagnosed in Maine in 2001 at salmon pens in Cobscook Bay, causing large mortalities of farmed salmon and requiring slaughter of all fish in the affected cages (J. Lewis, pers. comm., 2002).
- The invasive bryozoan *Membranipora membranacea* (present in the Gulf of Maine since 1987) can increase the likelihood of kelp breakage by making the kelp blades more brittle and susceptible to wave damage (Dixon et al. 1981; Lambert et al. 1992; Scheibling et al. 1999). Kelp forests serve as food for important animals such as sea urchins and also provide habitat for many organisms including lobsters. Outbreaks of *Membranipora* can cause substantial losses in the kelp canopy, allowing *Codium* to recruit and prevent the kelps from recovering (Scheibling 2000; Levin et al. 2002; Sumi and Scheibling 2005).



M. membranacea growing on kelp; Photo: M. Pratt

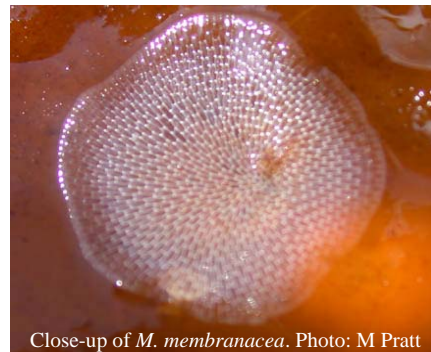
Species that have not yet been reported in Maine but are considered to be possible future threats include the Chinese mitten crab (*Eriocheir sinensis*); the Pacific oyster (*Crassostrea gigas*); and the Veined Rapa whelk (*Rapana venosa*), among others. The invasive mitten crab in particular has caused numerous and extensive ecological and fishing problems on the U.S. west coast, where it was introduced from the Yellow Sea in Asia. It is illegal to import eggs or live specimens of the mitten crab, which is a delicacy, to the United States under the Federal Lacey Act. A recent alert from the Nonindigenous Aquatic Species database indicates that the mitten crab has now been found in Thunder Bay Harbour, Ontario (M. Tyrrell, pers. comm., 2006).

In addition to species being introduced into Maine, there are species that have been transported from Maine and invaded other regions. In particular, the packing seaweed used for the shipping of marine baitworms - called 'wormweed' (*Ascophyllum nodosum* ecad *scorpioides*) - has been implicated as the source for costly invasions of the green crab *Carcinus* and the Atlantic rough periwinkle *Littorina saxatilis*, at west coast locations including San Francisco Bay. The seaweed may be laden with numerous small invertebrates which can be introduced to new locations upon discarding of the seaweed (Carlton 2001). Although the State of Maine currently has no law or regulation to legally ban the usage of this seaweed for exportation, it is possible that the U.S. Dept. of Agriculture has the authority to do so. In addition, receiving states have legal precedence for banning the importation of the seaweed, as it functions as an instrument for transporting non-natives.

Pathways - Vectors into Maine

While ballast water from commercial shipping represents the major vector for marine invasive species world-wide, Maine's special circumstances and features probably reduce the level of risk of invasive species introduction via ballast water in Maine. Maine's near shore marine waters are relatively cold. Potential invaders originating from temperate or tropical regions introduced in Maine coastal waters would be less likely to survive, reproduce, and become problematic as nuisance species. The incoming ships that recently have visited ports with a similar, cold water environment containing cold water species suited to survival and reproduction in Maine waters would certainly be a subset of the total number of ships.

The State of Maine Action Plan for Managing Invasive Aquatic Species states that "Except for foreign fishing vessels that do the opposite, ships coming to Maine generally unload cargo and take on rather than release ballast water here." In areas that receive little ballast water discharge, discharge of ballast may be supplanted as the primary vector in marine invasive species transfers by other vectors (Smith, 2002). Ballast water discharge does occur in Maine waters, albeit on a smaller scale than in some other areas. With the documented regular presence of marine organisms in ballast water aboard cargo ships (Smith et al., 1999), the ballast water vector warrants concern and attention to promote the protection of Maine's waters from invasive marine organisms.



There are several additional mechanisms and activities that may or do provide pathways into Maine marine waters:

- Transport of organisms by coastal commercial and recreational fishing vessels; trailers; fishing gear such as traps and nets; dry docks; barges etc.
- Hull fouling, and cleaning, of recreational boats at marinas and boat yards. According to a marina manager in mid-coast Maine, the presence of organisms on the hulls of recreational boats is prevalent (E. Stephenson, pers. comm., 2005).
- Seafood importation – although relatively little seafood is imported into Maine (E. Stephenson, pers. comm., 2005), some shellfish such as molluscan bivalves are imported live into Maine and may carry live non-indigenous species on or within their shells.
- The live bait trade also provides a potential vector for introductions into Maine (although Maine is one of the world's largest exporters of marine baitworms for recreational fishing).
- Aquaculture practices such as seed acquisition, cultching, and transport of salmon fry/young; along with accidental escape of farmed salmon; can cause the release and spread of non-native organisms such as the ISA virus (State of Maine Action Plan for Managing Invasive Aquatic Species, 2002).

- Aquarium industry, both commercial and home – non-native fish and invertebrates, and plants such as algae and seagrasses, may be accidentally or intentionally released, or transported along with target species (termed “hitchhiking”).
- Wet labs at research facilities, lobster pounds, depuration plants and other facilities with flow-thru seawater systems that may intentionally or unintentionally hold non-native species, which could become discharged into the immediate marine environment.
- Illegal (‘black market’, etc.) introductions of non-natives, providing for example banned species for seafood, home aquariums, or non-permitted species for lab research. The Chinese mitten crab is an example of an extremely ecologically and economically damaging species that is believed to be an intentional introduction for the seafood industry.
- Biological supply houses that collect and supply organisms for distribution, for education and research.
- Wetlands restoration – non-native genotypes of grasses etc., which can be ordered from wetlands restoration supply businesses, may be used in plantings.

Existing Ballast Water Regulations

Because of the recognition of the magnitude of the problem of marine invasives transported in ballast water world-wide, the issue has attracted a large amount of attention internationally, nationally, regionally, and here in Maine.

International

The United Nations International Maritime Organization (IMO) Marine Environmental Protection Committee began dealing with the issue of marine invasives in ballast water since the issue came to their attention in 1988. They have provided funding and expertise to address ballast water issues in developing countries via the Global Ballast Water Management Program (IMO website). They developed voluntary guidelines for ballast water management in 1998. The guidelines:

- Require mandatory open ocean exchange of ballast water.
- Allow for alternative ballast water treatment, and outline how those measures might be approved.
- Offer incentive for alternative treatment.
- Require a ballast management plan.
- Do not include any fees to support the program. Individual nations would provide infrastructure.

These guidelines have some drawbacks including:

- Exemptions are allowed.
- Domestic coastal voyages are not covered.

- Reporting is not required at each port of call and there is no electronic submission of data.
- There is no boarding of vessels to monitor compliance, nor are there penalties for non-reporting or non-compliance.
- Enforcement is left to individual states to enforce on their own nation's ships.
- They are not in force as only 6 of the required 30 nations have adopted the convention.

United States

U.S. Coast Guard:

The Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANCPA 90) required management of ballast water for ships entering the Great Lakes. The Act, upon its reauthorization in 1996 (and subsequently known as the National Invasive Species Act of 1996 or NISA 96), required development of ballast water management for all other ships entering US waters. The Act also required US Coast Guard to evaluate voluntary ballast water management three years after it was adopted to determine its effectiveness. USCG evaluated the voluntary program, determined that it was ineffective, and instituted mandatory ballast water management for all ships entering US waters starting in 2004.

The Ballast Water Management Act of 2005, further amending NISA, is before Congress. Provisions of the act would require ballast water management for vessels traveling within the Exclusive Economic Zone (EEZ). It also provides for ongoing work with EPA to create ballast water discharge standards and assess ballast water (BW) treatment options. Current bill language suggests compliance by some vessels built before 2009 would be delayed until as late as 2014 or 2016.

Management of ballast water at present is limited to exchange of ballast water while at sea, an attempt to significantly dilute the concentration of coastal marine organisms in the ballast tanks. This is accomplished by unloading and replacing ballast water with open ocean water or through pumping open ocean water through full ballast tanks, essentially replacing their holding capacity several times while in the open sea. Neither practice completely removes all organisms from the tanks, but merely dilutes their concentration and thus reduces risk of introduction by reducing the number of animals potentially released. Since organisms remain in the ballast water on board, exchanged water still poses a threat to coastal waters receiving "exchanged" ballast water.

Since ballast water exchange does not remove all organisms and merely reduces risk of new invasive species introduction, interest in alternate technologies such as treatment of ballast water is high. Funding for research has come from federal, state, and non-governmental sources. Systems under investigation include: onshore treatment, thermal treatment, UV or ozone treatment, chemical treatment, or filtration. No ballast water treatment systems are currently approved by Federal or state ballast water management

programs. The proposed Ballast Water Management Act of 2005 includes alternative options for ballast water management other than exchange, but recognizes that ballast water exchange (BWE) is likely to be the common choice.

In addition to the IMO features summarized above, USCG ballast water management includes:

- Electronic reporting
- A requirement that reporting be conducted at each port of call
- Provision for boarding of vessels to determine compliance with ballast management requirements
- Penalties for not reporting and for non-compliance

The USCG ballast water management also has some drawbacks:

- Not currently required for coastal shipping traffic operating within the 200 mile Exclusive Economic Zone (EEZ). (Shipping coming from other ports on the US east coast to Maine waters would remain unregulated, at least until the 2005 Act is approved and vessels are required to comply (as late as 2014-16)).
- Little enforcement.

USCG personnel do not typically board vessels in Portland harbor solely to check ballast water management. Typically ballast issues are only actively addressed when another primary security or safety issue prompts USCG to board the vessel. USCG personnel do share the view that most ships pick up rather than release ballast water in Maine (Maine Marine Invasives Species Working Group).

EPA:

EPA regulations have not required NPDES permits for ballast water discharge from vessels. In 1999, Northwest Environmental Advocates (NWEA) petitioned EPA to repeal those regulations and include ballast discharge in NPDES permitting. EPA denied the petition and was subsequently sued in federal court by NWEA and other environmental groups in 2003. The court found that invasives could be considered pollutants under the Clean Water Act (CWA) and held that EPA exceeded its authority in exempting an entire category of discharges (BW) from the NPDES permit program. Subsequent to the ruling, EPA, the environmental groups, and some states have asked the court to take a variety of different approaches in crafting the remedy order, which the court will release in February, 2006, to implement the ruling. While the environmental groups and some Great Lakes states (through their AGs) have asked the court to require EPA to issue regulation on a schedule set by court or within 18 months of the final remedy order, the Shipping Industry Ballast Water Coalition asked that EPA be given time to consider and implement what it would consider to be the best method to regulate BW discharges. EPA requested that the court not set a schedule or timing requirements but that the court remand the issue to EPA for its reconsideration. As noted above, the final remedy order is expected in February 2006, but EPA will then have 90 days to

consider whether it will appeal the ruling and final remedy order. If an aggressive schedule is included in the remedy order, NPDES regulation of BW could be required within a few years. If EPA appeals the decision or if the court remedy order allows EPA a longer time frame for consideration and promulgation of BW regulations, BW regulations may be delayed for a number of years. If EPA appealed and won regulation through EPA/NPDES would not occur.

The ballast water committee of the Northeast Aquatic Nuisance Species Panel (NEANS) has been working on a regional plan that would address the issue of ballast water exchange for ships engaged in coastwise travel (traveling within the 200 mile Exclusive Economic Zone (EEZ)). Currently these ships are exempt from the Coast Guard regulations on ballast exchange (pending adoption of BWM Act of 2005). The regional plan would encourage the use of alternative ballast water exchange zones (ABWEZ) within the EEZ for ships conducting coastwise travel. The oceanographic conditions in these alternative zones would make it less likely that organisms released in ballast water would survive to reach the coast.

The regional plan would likely take the form of a memorandum of understanding (MOU) between the northeast states and Canadian provinces. The committee may seek to include the shipping companies in the MOU as well.

A regional plan has some advantages:

- It would provide a less fragmented approach than would be achieved by individual states adopting separate regulations, thus providing a higher level of protection. In this fashion, no state/province would opt out or adopt unreasonably low BWM standards that would undermine adjacent state or province efforts.
- The uniformity of regulation across the region would likely be more palatable to the shipping industry, whose members have complained about the need for a uniform regulatory structure across states.
- It would avoid competition between ports and advantages enjoyed by ports with weaker BW regulation.

A regional plan might lack the power of enforcement at inception. Determination of industry compliance to a cooperative approach over an initial period of participation might be a starting point. Participation may be expected to be strong from an industry that perceives this more consistent, regional approach to be more desirable than the more complex and fractured approach of individual state regulation of EEZ ballast water. Subsequently, states could incorporate the regional standards into individual state law, allowing greater enforcement while still maintaining a uniform, regional approach to ballast management. Currently there is no document or language available which Maine can sign (Judith Pederson, personal communication). This effort should be investigated as a possible vehicle for addressing invasive species in ballast water in Maine, as part of a regional approach.

New England States

- No New England state currently regulates ballast water. Rhode Island's legislature required a white paper be produced outlining issue surrounding ballast water and invasive species and implications for state waters including Narragansett Bay. The white paper supported the development of a national ballast water management program applicable to all U.S. waters and enforced by the federal government. It suggested development of state regulations only in the absence of federal legislation that effectively protects RI state waters from the introduction of non-native species. It also recommended coordination and cooperation with neighboring states on ballast water management. Subsequent to the white paper, Rhode Island has not adopted any BW management requirements into state law.

Other States

California, Oregon, Washington, and Maryland all have ballast water management law in place.

Existing Maine laws applicable to marine invasives

Maine law prohibits the discharge of pollutants to Maine waters without first obtaining a permit from DEP through Title 38. Maine has also enacted regulations prohibiting the discharge of black water and gray water from large commercial passenger vessels, and required reporting of unauthorized discharges for these vessels. Currently, Maine does not have specific laws regulating discharge of ballast water into coastal waters. The Commissioner of the Department of Marine Resources has broad authority to prevent the introduction and spread of unwanted marine organisms into Maine waters, but it is not explicitly targeted toward invasive organisms. The DMR has laws to regulate the importation of marine organisms into the state, including Chapter 24, Regulations: Importation of Live Marine Organisms; and Title 12, Section 6071, Statutes: Importing of Certain Marine Organisms. The intent of Chapter 24 is to prevent the entry via live marine organisms, regardless of size or age, of any infectious or contagious diseases or parasites, predators or other organisms that may be dangerous to indigenous marine life or its environment. Under Title 12, Section 6071 it is unlawful to import for introduction, possess for purposes of introduction or introduce into coastal waters a live marine organism (except for Atlantic salmon imported by the Atlantic Salmon Authority under Part 12) without a permit issued by the commissioner. Dumping of marine animal waste material into marine waters is controlled by statute in Title 12, Section 6251. The department regulates shellfish sanitation and depuration under Chapter 15 of the regulations. This law gives the Commissioner the power to embargo shellfish for any reason set forth in Title 12, section 6856(6), including shellfish that are deemed "otherwise unsafe". Shipment and handling of shellfish are governed by the federal National Shellfish Sanitation Program, which is adhered to by the DMR Shellfish Sanitation Program.

Recent and current efforts to control invasive marine species in Maine and the Gulf Of Maine region

As mandated by the Legislature, the Interagency Task Force On Invasive Aquatic Plants and Nuisance Species for the Land and Water Resources Council developed the State of Maine Action Plan For Managing Invasive Aquatic Species (October, 2002). This plan explains that marine interests were not included in the development of the legislation since the impetus for the establishment of the task force was the threat to lakes.

However, the Action Plan identified the need to include more marine representation on the Task Force as one of its tasks (Task 1A1). Discussion about this task took place and the Task Force concluded that including one or two marine representatives would not sufficiently meet the needs of marine invasives requirements and adequately address the scope of the problem. Separate work on a large scale on marine invasives issues was apparently justified in the view of the Task Force (J. McPhedran, pers. comm.)

The Northeast Aquatic Nuisance Species Panel (NEANS) was established in 2001 under the auspices of the Federal Aquatic Nuisance Species Task Force (ANSTF). Comprised of representatives from government, academia, industry, recreational, utility,



Rapid assessment team, 2003. Photo: G. Lambert

environmental and other organizations, it addresses freshwater and marine non-native species issues for the Atlantic coast states from New York to Maine, and also Quebec, New Brunswick, and Nova Scotia. The mission of the panel is to "protect the marine and freshwater resources of the Northeast from invasive aquatic nuisance species through commitment and cohesive coordinated action". The panel has working committees for ballast water, policy and legislation, science and technology, and

communications, education and outreach. In addition to maintaining a marine invasive species database and list of priority species, it coordinates efforts to develop rapid assessment and rapid response protocols, and develops educational outreach materials. The State of Maine has both marine and freshwater representation on the panel.

In May 2004, Casco Bay Estuary Partnership (CBEP) and Maine Sea Grant co-hosted a forum in Portland, "Maine's Marine Invasion", on non-native and invasive species in Maine, which brought together scientists and managers from throughout New England. At the forum a survey was administered to determine the number of participants that were actively involved in some manner of research, monitoring and/or outreach relative to non-natives, and to characterize the areas of effort. The results of the forum showed that out of 53 respondents, 29 indicated having research and education/outreach efforts directed towards non-natives.

Currently, an ad hoc Maine Marine Invasive Species Working Group (MMIWG), formed as an outgrowth of the 2004 Forum, has been meeting regularly to identify and discuss issues related to invasive species in Maine's coastal waters. This group is comprised of DMR, DEP, SPO, DOT, University of Maine, Sea Grant, Ocean Conservancy, Friends of

Casco Bay, and other members. The working group has been attempting to address issues of relevance to Maine and make connections to other regional and national efforts on marine invasives. It has partially fulfilled the need identified in the Task Force's Action Plan for a marine body to address invasives here in Maine. The group's efforts have included advising and recommending an approach to deal with invasives in ballast water and via other vectors in Maine.

Currently DMR staff participate in the activities of several invasives-focused working groups, including: The Northeast Aquatic Nuisance Species Panel; The Maine Marine Invasives Working Group; the Maine Interagency Task Force On Invasive Aquatic Plants and Nuisance Species; the MIT/Sea Grant Pilot Diving study and Marine Baitworm Industry Survey project; the Regional Ballast Water Management Plan initiative; and the Gulf of Maine Research Institute's Vital Signs project.

DMR is compiling a list of facilities having overboard discharges into marine waters, such as from flow-through seawater systems (aquariums, wet laboratories, lobster holding tanks, shellfish depuration plants etc.), from which non-native species introduced into, or held in, the system could become discharged into the immediate marine environment. The facilities will be surveyed, and the risk of introductions will be assessed.

The DMR maintains an invasives webpage including an electronic reporting form for reporting Asian crab sightings. Information from confirmed sightings is compiled in a database; and is shared with other Asian crab researchers who are tracking the geographic spread of this crab. DMR also collects reports for other non-native species.

Some examples of **research and monitoring efforts** in Maine and the Gulf of Maine include:

- Surveys and monitoring of the locations and spread of the Asian crab *Hemigrapsus* along the New England coastline (UMO, Cornell, DMR and others)
- Development of approaches for predicting the spread of marine invasive species, specifically green and Asian crabs (McGill U.)
- Predator/prey interactions of the Asian crab with juvenile lobsters in a lab setting (UMO)
- Genetic studies of the snail *L. saxatilis* to help confirm a Maine-to-California vector (Smithsonian Environmental Research Center)
- An assessment of the risks of exotic species introductions via the live marine species trade in Massachusetts (MA Bays Program/CZM)
- Effects of substrate type on the settlement and growth of native and invasive fouling organisms (Wells National Estuarine Research Reserve)
- Interactions of invasive bryozoans with native nudibranchs, and other bryozoans (Bowdoin College)
- Rapid Assessments for non-native species, conducted in 2003 (New York to Maine) and 2005 (Cobscook Bay). (MIT/Sea Grant; Nature Conservancy)
- Massachusetts state-funded program to train volunteers in the identification of invasive marine species (Salem Sound Coastwatch)

- The Maine Coastal Program has devoted a limited amount of federal funding for a small portion of a temporary staff person's time to analyze vectors in Maine and to establish an informational website. This work will be completed by June 2006.
- Sea Grant is in the initial stages of a volunteer pilot diver study project to assess offshore occurrence of non-natives
- In addition many research activities are taking place at academic institutions and not all have been included on this list for the sake of brevity.

Examples of **outreach and education**:

- Action Plan of the Maine Interagency Task Force, 2002 —identification of marine invasives issues
- Rapid Response workshop hosted by NEANS in Bar Harbor, 2003
- Maine's Marine Invasion: 2004 Forum in Portland hosted CBEP and Sea Grant
- Formation of the Maine Marine Invasives Working Group (MMIWG) as an outgrowth of the 2004 Forum - a collaborative of agency personnel, university researchers, and non-profit organizations
- Invasive sea squirt meeting held in Woods Hole, MA 2004 – information sharing re: status and impacts in the GOM and around the world
- “Maine's Marine Invasion” – an informational handout produced by Sea Grant and the MMIWG, having several thousand copies distributed
- Regional Ballast Water Management Plan effort – workshops toward development of a unified MOU for the northeast states and Canadian provinces
- Northeast Aquatic Nuisance Species Panel – web-based informational database and educational materials
- ‘Vital Signs’ – a Gulf of Maine Research Institute program for middle school teacher/student invasives education, and hands-on field data collection
- Bowdoin College Summer Institute in coastal and marine science for secondary school educators, focusing in 2006 on ID'ing and monitoring of invasive species
- Sea Grant offices in New England are developing education and outreach campaigns for recreational boaters
- As part of the limited vector analysis discussed above, temporary project staff at the Maine Coastal Program will use existing information to track marina boat traffic, for the purposes of characterizing the risk posed to Maine by hull fouling of recreational boats; and to help with Sea Grant education efforts. The Maine Marine Trade Association and Clean Marinas group are essential cooperators in this effort.

Some **prevention/reduction/eradication** efforts:

- In 2001 the Maine Aquaculture Association announced the adoption of an industry-wide Infectious Salmon Anemia Action Plan. This plan has been implemented and is designed to ensure a consistent response across the industry in actions to contain and control ISA

- In December 2005, Maine DEP released *Brightwork -- A Best Management Practices Manual for Maine's Boatyards and Marinas*, which details environmental standards for boatyards and marinas and identifies management practices and strategies to meet or exceed those standards. Of particular interest to the topic of marine invasives is the BMP section on boat bottom washing which is not completed yet due to particular waste management challenges. The DEP is proceeding with the development of a general permit to address boat bottom washwater discharges and expects the permit to be complete in summer 2006. Control of invasive species transmission will be addressed in the boat bottom washing segment of the BMP manual, which will be published as soon as the general permit is completed.
- Sea Grant is conducting a baitworm industry survey to collect information on shipping practices, and destinations of the packing material 'wormweed', in an effort to eventually eliminate invasives transported by this vector. The U.S. Dept of Agriculture may have a law prohibiting transfer of invasive species. If correct and applicable to wormweed, this law could eliminate this vector.

RECOMMENDED STEPS FORWARD by DMR and DEP

The Departments of Marine Resources and Environmental Protection believe that both outreach and research to minimize risk from invasive species have merit and support efforts by the private sector to fund these initiatives. However, given the shortage of resources to address existing natural resource problems, neither the DMR nor DEP recommend that any new General Fund appropriations be specifically prioritized for marine invasives absent a comprehensive evaluation of competing resource management needs. No statutory changes are proposed at this time. The following actions may be accomplished through existing laws and programs.

1. Agencies will clarify respective roles and responsibilities related to marine invasive species in Maine and identify agency points of contact for the public.
2. Agencies will collaborate with state, federal, regional, research and non-governmental organizations to identify the highest priority vectors and determine priorities for regulators and for ongoing research, utilizing the results of vector risk assessments.
 - a. Seafood importation, distribution and handling (DMR)
 - b. Commercial and recreational boating (DEP and DMR)
 - c. Aquarium trade (DMR)
 - d. Marine research and education facilities (DMR)

(Recommendations continued on next page)

3. Agencies will, to the extent possible, encourage and collaborate in research and monitoring to develop science-based strategies, initiatives and efforts, to prevent, reduce, and manage marine invasive species.
 - a. integrate invasive species monitoring into existing environmental programs including citizen volunteer training and monitoring efforts (DMR)
 - b. participate in research and rapid assessments of invasive species (DMR)
 - c. collaborate with the Northeast Aquatic Nuisance Species Panel (NEANS) to develop a Rapid Response protocol (DMR and DEP)
4. The Department of Marine Resources will review existing rules (e.g. DMR Chapter 24) regarding the importation of live marine organisms.
5. Agencies will, to the extent possible, work with existing government and non-governmental programs to expand educational outreach efforts that target highest risk vectors through
 - a. production of informational flyers (NEANS, MMIWG w/ DMR as distributor)
 - b. educational seminars (NEANS with DMR as point)
 - c. BMPs (NEANS w/ DMR and DEP as local promoter, depending on issue)
 - d. provide internet links to resources and databases on marine invasive species in the northeast region (DMR)
6. DEP will work to develop a regional ballast water management plan through participation in the NEANS ballast water committee, and recommend that Maine become a signatory to the plan. Once protective, consistent standards are in place, incorporate those standards into regulations.
7. DEP will track the progress of The Ballast Water Management Act of 2005 to determine what is enacted by Congress. DEP will track the outcome of the EPA court case regarding BW regulation through NPDES.
8. DEP will track the continuing ballast water treatment options being investigated at all jurisdictional levels to determine their suitability for use in Maine.
9. Support development of a uniform, concentration-based discharge standard for BW for use by the USCG to implement their existing authority. DEP will assess this standard to determine suitability for the protection of Maine waters. This recommendation is not meant to supplant #8 above, but is meant to reduce risk of introduction of invasives via BW through assuring compliance to valid, uniform discharge standard in the interim. Once workable on a practical scale, BW treatment is the preferred option.

Collaborators – the following agencies and governments are considered appropriate partners for working with DMR and DEP towards the prevention of introduction of marine invasives, and the elimination or mitigation of their negative impacts:

Maine State Planning Office	Native American Tribes
Maine Dept. of Inland Fish & Wildlife	U.S. Fish & Wildlife
Maine Dept. Of Conservation	U.S. Environmental Protection Agency
Maine Dept. of Transportation	U.S. Coast Guard
Maine Dept. of Agriculture	U.S. Dept. of Agriculture
Maine Dept. of Health and Human Services	
National Oceanic and Atmospheric Administration - National Marine Fisheries Service, National Sea Grant Program	

Acknowledgements

Sincere thanks to the following who have contributed to the preparation of this report:

The Maine Marine Invasives Working Group, who have provided invaluable input, information and review throughout the development of the report.

Elizabeth Stephenson, Maine Coastal Program, for research into the identification of vectors in Maine; for information provided on ballast water management, and for providing helpful assistance and content toward the report preparation.

Hetty Richardson, DEP, for assistance in research into ballast water regulation and draft revisions.

Pam Parker, DEP, for comments and review of the DEP *Brightwork* BMP segment.

John Sowles, Linda Mercer, David Etnier, DMR, and Andrew Fisk, DEP, for contributing content and providing guiding comments and review.

Connie Devenger, DMR, for assistance in assembling the reports for the Committees.

Marney Pratt, Bowdoin College; Megan Tyrrell, Wells National Estuarine Reserve; Judy Pederson, MIT/Sea Grant; Gretchen Lambert, U. of Washington; and Fisheries and Oceans Canada; for graciously providing and allowing usage of photos.

Cover photos, clockwise: Rapid assessment Eastport 8/05, courtesy of Judith Pederson; Green crab (*Carcinus maenus*), courtesy of Marney Pratt; Clubbed tunicate (*Styela clava*) fouling mussel lines in P.E.I., courtesy of Fisheries and Oceans Canada. Last page photo: fouling plates with various invertebrates including two introduced tunicate species, courtesy of Megan Tyrrell.

Addendum: Maine Marine Invasives Working Group: recommendations to state agencies and legislature

Throughout the process of writing this report, ME DMR and DEP have worked closely with members of the Maine Marine Invasives Species Working Group. This group includes scientists, and representatives from organizations who are familiar with the issues surrounding marine invasions. The following list of recommendations, developed and supported by members of the Working Group, is not being forwarded to the committees by DMR and DEP for legislative consideration. However, the Working Group's list is included here to provide additional information and suggestions discussed by the Working Group on ways to address these issues, and to exemplify the Working Group's high degree of interest and concern about these issues. DMR and DEP considered the Working Group's list in formulating the agencies' recommended steps forward.

General

- 1) Identify a lead agency responsible for addressing the problem of marine invasive species in Maine.
- 2) Appropriate funds to conduct research into the biology and ecology of marine invasive species and the risk they pose to Maine's environment and economy.

Prevention and Risk Assessment

- 3) Although many seafood distribution facilities are on sewer systems, there are some companies that may still dump their untreated fish processing water directly into the nearest waterway, providing a potential pathway for introduction of non-natives. Seafood distribution facilities in Maine should be assessed for processing water disposal practices, presence of treatment or filtering, and the level of risk for introductions.
- 4) Appropriate funds to conduct research to assess the risk posed by commercial and recreational boat traffic as vectors of marine invasive species and to inform potential hull and propeller cleaning regulations.
- 5) Further assess the risk posed by imported live and fresh seafood as a vector of marine invasive species in Maine.
- 6) Appropriate funds to conduct a formal study to identify the highest priority vectors, utilizing the results of the aforementioned vector risk assessments.
- 7) Ban the importation of certain species for any use, private, commercial, wetlands restoration, or otherwise (except with a permit). Maine could begin this effort by using lists of banned species previously created by Massachusetts and New Hampshire.

Research

- 8) Appropriate funds to conduct research to develop science-based strategies, initiatives and efforts, for the prevention, reduction, eradication and management of marine invasive species.
- 9) Appropriate funds to conduct marine invasive species research and rapid assessments of invasive species. Funding is also needed to monitor environmental conditions that may facilitate invasions and the potential impacts of invasive species on native marine species and communities.

Enforcement

- 10) Establish a centralized system, housed within an identified lead agency, to address marine invasive species issues in Maine. The State of Maine needs centralized leadership on the marine invasive species issue to provide more cohesiveness, improved management of information and better delivery of that information to managers, scientists, and the public.

Rapid Response

- 11) Collaborate with the Northeast Aquatic Nuisance Species Panel (NEANS) in their efforts to develop a Rapid Response protocol, with a central coordinator(s), and an operating structure and equipment in place.

Outreach and Education

- 12) Expand outreach efforts, such as production of informational flyers and educational seminars, to target the highest priority vectors as identified by the aforementioned risk assessments. Example targets include: marinas, recreational fishermen, bait shops, shellfish dealers, aquarium shops, and biological supply houses.
- 13) Establish and maintain a State of Maine marine invasive species website to create a central location for Maine marine invasive species resources as well as to provide links to other marine invasives resources in the northeast region.
- 14) Establish and integrate citizen volunteer training and monitoring efforts to supplement professional monitoring of marine invasive species.

References

- Anderson, E. 2000. Infectious Salmon Anemia Virus (ISAV): An Emerging Viral Pathogen of Atlantic Salmon.
<<http://www.umaine.edu/mainesci/Archives/MolecularBiology/salmon-virus.htm>>
Accessed January, 2006.
- Barber, B.J., Langan R., Howell T.L. 1997. Haplosporidium nelsoni (MSX) epizootic in the Piscataqua River Estuary (Maine/New Hampshire, USA.). J. Parasitol 83(1):148-50.
- Carlton, J.T. 1989. Man's role in changing the face of the ocean: biological invasions and implications for conservation of nearshore environments. *Conservation Biology* 3:265-273
- Carlton, J.T. 1999. The scale and ecological consequences of biological invasions in the world's oceans. *In: Invasive Species and Biodiversity Management*. Sandlund, Schei, and Viken, eds. Kluwer Academic Publishers, Dordrecht, Netherlands. 195-212.
- Carlton, J.T. 2001. Introduced Species in U.S. Coastal Waters: Environmental Impacts and Management Priorities. Pew Oceans Commission, Arlington, Virginia.
- Dixon J., Schroeter S.C., Kastendiek J. (1981) Effects of the encrusting bryozoan, *Membranipora membranacea*, on the loss of blades and fronds by the giant kelp, *Macrocystis pyrifera* (Laminariales). *Journal of Phycology* 17: 341-345
- Endresen, O., Behrens, H.L., Brynstad, S., Andersen, A.B., and Skjong, R. Challenges in global ballast water management. *Marine Pollution Bulletin* 48(7-8): 615-623, 2004.
- Fisheries and Oceans Canada. 2002. Aquatic Invaders in the southern Gulf of St. Lawrence.
<http://www.glf.dfo-mpo.gc.ca/sci-sci/inva-enva/index-e.html#clubbed_tunicate>
Accessed January, 2006.
- Glude, J.B. 1955. The Effects of temperature and predators on the abundance of the soft-shell clam, *Mya arenaria*, in New England. *Trans. Amer. Fish. Soc.* 84:13-26.
- Hart, Tracey. 2005. Maine's Marine Invasion. U of Maine: Maine Sea Grant . MSG-E-05-01. 6 pp.
- Hillson, C.J. Seaweeds. 2nd ed. Pennsylvania State UP: Keystone Books, 1982.
- Interagency Task Force on Invasive Aquatic Plants and Nuisance Species. 2002. *State of Maine Action Plan for Managing Invasive Aquatic Species*.

International Marine Organization. 2002. IMO homepage. International Convention for the Control and Management of Ships' Ballast Water and Sediments adopted in 2004.

<<http://www.imo.org/home.asp>>

<http://www.imo.org/Conventions/mainframe.asp?topic_id=867>

Accessed January, 2006.

MIT/Sea Grant Center for Coastal Resources. 2003. Introduced Species – Descriptions.

<http://massbay.mit.edu/exoticspecies/exoticmaps/descriptions_intro.html>

Accessed January, 2006.

Lambert W.J., Levin P.S., Berman J. (1992) Changes in the structure of a New England (USA) kelp bed: The effects of an introduced species? *Marine Ecology Progress Series* 88: 303-307

Levin P.S., Coyer J.A., Petrik R., Good T.P. (2002) Community-wide effects of nonindigenous species on temperate rocky reefs. *Ecology* 83: 3182-3193

NEANS - Northeast Aquatic Nuisance Species Panel. 2001. Aquatic Species Harm Northeast Region. <<http://www.northeastans.org/neanspanelfactsheet.pdf>>

Accessed January, 2006.

NEANS - Northeast Aquatic Nuisance Species Panel. 2002. Ballast Water Committee Work Plan. <http://www.northeastans.org/bw_workplan_through_9.30.03.pdf>

Accessed January, 2006.

Ricciardi A., Fitzgerald G. and Cameron B. (2001) Marine Biological Invasions.

<www.fundyforum.com/profile_archives/profile2.html> Accessed January, 2006.

Ruiz, G.M., T.K. Rawlings, F.C. Dobbs, L.A. Drake, T. Mullady, A. Huq, and R.R. Colwell. 2000. Global spread by microorganisms by ship. *Nature* 408:49-50

Scheibling R.E. (2000) Species invasions and community change threaten the sea urchin fishery in Nova Scotia: workshop on the coordination of green sea urchin research in Atlantic Canada. Fishery. Session V. Moncton, NB.

<<http://crdpm.umcs.ca/oursin/sesv.htm>> (note: website cited in published papers; currently offline)

Scheibling R.E., Hennigar A.W., Balch T. (1999) Destructive grazing, epiphytism, and disease: The dynamics of sea urchin - kelp interactions in Nova Scotia. *Canadian Journal of Fisheries and Aquatic Sciences* 56: 2300-2314

Smith, L.D., M.J. Wonham, L.D. McCann, G.M. Ruiz, A.H. Hines, and J.T. Carlton. 1999. Invasion pressure to a ballast-flooded estuary and an assessment of inoculant survival. *Biological Invasions* 1: 67-87.

Smith, Dr. L. David, 2002. June 20, 2002. Written Testimony of Dr. L. David Smith, Assistant Professor, Department of Biological Sciences and Environmental Science and Policy Program, Smith College, Northampton, MA 01063. Presented to U.S. House of Representatives, Subcommittee on Environment, Technology & Standards, Washington, D.C., June 20, 2002.

<<http://www.house.gov/science/hearings/ets02/jun20/smith.htm>>

Accessed January, 2006.

Sumi CBT, Scheibling R.E. (2005) Role of grazing by sea urchins *Strongylocentrotus droebachiensis* in regulating the invasive alga *Codium fragile* ssp *tomentosoides* in Nova Scotia. *Marine Ecology Progress Series* 292: 203-212

Weigle, S.M., L.D. Smith, J.T. Carlton, and J. Pederson. 2005. Assessing the risk of exotic species introductions via the live marine species trade. *Conservation Biology* 19 (1), 213-223.

