BENEATH THE WAVES

Environmental Protection

# The Shipboard Technology Evaluation Program

## *A U.S. Coast Guard aquatic invasive species reduction incentive.*

by LCDR Brian Moore
*U.S. Coast Guard Office of Environmental Standards*

The accelerating problem of invasive species in U.S. marine ecosystems is driven largely by changes in shipping practices and increases in traffic volume over the last few decades. In the past, most species' translocation occurred when people purposely introduced organisms they wished to establish in a new location, or when the occasional "hitchhiker" species clung to the hull of a ship to make its way to a new location. Shipworms (Teredo navalis) are an example of this.

**Stowaways**

More recently, single-purpose ships such as crude oil carriers now routinely sail to one port with cargo and return to the loading port in ballast, carrying millions of gallons of water each ballast voyage and repeatedly inoculating the waters in the loading port with water from the cargo offloading port. This can reinforce small foothold colonies of species that may have been deposited on previous voyages. Where existing environmental conditions may not have been accommodating enough for a new species to get successfully established under a less systematic presentation, the repeat depositing of millions of gallons of aquatic organism-carrying water is the perfect design for establishing viable colonies of nonindigenous species in new locations.

Whether called "nonindigenous species," "aquatic nuisance species," or "invasive exotics," no one can dispute the impact of these intruders. In some areas of the world they have been devastating:

- When the European zebra mussel (Dreissena polymorpha) was introduced in the Great Lakes between Canada and the United States, it drastically changed the ecosystem, threatening fisheries and resulting in billions of dollars in costs to clean fouled underwater structures and water intake pipes.
- When the American comb jelly (Mnemiopsis leidyi) was transported to the Black and Azov Seas, it caused the near extinction of the anchovy and sprat, drastically reducing those existing fisheries.

As shipping practices evolve and trade increases, such ship-mediated invasions put additional areas at risk for similar ecological and economic impact.

**What's Being Done?**

International, national, state, and local efforts have been initiated to address the problem of ballast water-facilitated species translocation. Currently, through the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (as amended by the National Invasive Species Act of 1996), Congress has directed the Coast Guard to develop a national ballast water management program.[1] Under these laws, ships have the option to conduct mid-ocean ballast water exchanges (discharging ballast water taken near shore and replacing it with deep ocean water). Other options include retaining all ballast water aboard while in U.S. waters or using a

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## SOME NOTABLE INVASIVE SPECIES

| *NAME:* | *NATIVE TO:* | *INTRODUCED TO:* | *IMPACT:* |
|---|---|---|---|
| **Cholera**<br>**Vibrio cholerae** | Various strains with broad ranges | South America, Gulf of Mexico, and other areas | Some cholera epidemics appear to be directly associated with ballast water. |
| **Cladoceran Water Flea**<br>**Cercopagis pengoi** | Black and Caspian Seas | Baltic Sea | Reproduces to form very large populations that dominate the zooplankton community and clog fishing nets and trawls, with associated economic impact. |
| **Mitten Crab**<br>**Eiocheir sinensis** | Northern Asia | Western Europe, Baltic Sea, and West Coast of North America | Undergoes mass migrations for reproductive purposes. Burrows into river banks and dikes, causing erosion and siltation. Preys on native fish and invertebrate species, causing local extinctions during population outbreaks. Interferes with fishing activities. |
| **Toxic Algae**<br>**(Red/Brown/Green Tides)**<br>**(various species)** | Various species with broad ranges | Several species have been transferred to new areas in ships' ballast water. | May form harmful "algae blooms." Depending on the species, can cause massive kills of marine life through oxygen depletion and release of toxins and/or mucus. Can foul beaches and impact tourism and recreation. Some species may contaminate filter-feeding shellfish and close fisheries. Human consumption of contaminated shellfish may cause severe illness or death. |
| **Round Goby**<br>**Neogobius melanostomus** | Black, Asov, and Caspian Seas | Baltic Sea and North America | Highly adaptable and invasive. Increases in numbers and spreads quickly. Competes for food and habitat with native fishes, including commercially important species, and preys on their eggs and young. Spawns multiple times per season and survives in poor water quality. |
| **North Pacific Seastar**<br>**Asterias amurensis** | Northern Pacific | Southern Australia | Reproduces in large numbers, reaching plague-like proportions rapidly. Feeds on shellfish, including commercially valuable scallop, oyster, and clam species. |
| **Asian Kelp**<br>**Undaria pinnatifida** | Northern Asia | Southern Australia, New Zealand, West Coast of the United States, Europe, and Argentina | Grows and spreads rapidly, both vegetatively and through spore dispersal. Displaces native algae and marine life. Alters habitat, ecosystem, and food web. May affect commercial shellfish stocks through space competition and alteration of habitat. |
| **European Green Crab**<br>**Carcinus maenus** | European Atlantic Coast | Southern Australia, South Africa, the United States, and Japan | Highly adaptable and invasive. Resistant to predation due to hard shell. Competes with and displaces native crabs and becomes a dominant species in invaded areas. Consumes and depletes wide range of prey species. Alters intertidal rocky shore ecosystem. |

Coast Guard-approved alternative ballast water management method.

Ballast water exchange has some functional limitations. For example, ships transiting less than 200 miles from shore are not required to deviate from their course to reach sufficiently deep waters to conduct an exchange and are exempted from ballast water management requirements. Even when conducted, ballast water exchange is considered to be only 95 percent effective (at best) at removing near-coastal organisms from ships' ballast, thus leaving some threat of successful species translocation.

**More information on STEP can be found at: http://www.uscg.mil/hq/cg5/cg522/cg5224/step.asp**

To facilitate the invention of new systems to address organisms in ships' ballast water, the U.S. Coast Guard developed the shipboard technology evaluation program (STEP) to provide an incentive for ship owners to participate in experimental evaluations of promising technologies on operational cargo vessels.

**The STEP Process**

Under STEP, successful applicants receive an "equivalency," whereby the Coast Guard deems that use of the experimental system satisfies ballast water management requirements. Enrollment includes a rigorous evaluation of the prototype's likelihood of success based on a thorough review of the science and engineering behind the technology.

Following this efficacy review, the applicant's study plan is peer-reviewed for scientific rigor and validity. Finally, the Coast Guard completes a thorough evaluation of the potential environmental impact associated with the use of the system in the specific marine areas the ship operates in. This includes review under the Endangered Species Act, National Marine Sanctuaries Act, Marine Mammal Protection Act, and National Environmental Policy Act. Only upon completion of these screening measures are systems accepted and allowed to begin in U.S. waters.

Currently, four ships have applied to participate in the program. The ships are widely varied in route and service, including:

- a North Atlantic container freight,
- Caribbean and Pacific Ocean passenger cruising,
- a Pacific Ocean bulk dry cargo integrated tug and barge,
- a Gulf of Mexico bulk liquid tank ship.

Having this breadth of routes and service types is crucial to getting a comprehensive data set. However, each enrolled vessel will only represent one data set for the particular impacted waters and service type. Therefore, the U.S. Coast Guard is very interested in exploring the possibility of enrolling additional vessels and their associated technologies in new locations. This will allow for a geographically broader view of a particular technology's capability, and review it on different types of ships within overlapping service areas to determine if there are potential volume or flow rate capacity limits.

Such expansion is necessary to more fully characterize these new state-of-the-art ballast water management technologies. Once such detail is obtained, we can make realistic conclusions about how robust treatment levels need to be to meet the desired results.

**Technologies Under Evaluation**

Current applicants have proposed mechanical filtration systems that further expose remaining organisms to ultraviolet energy, use of in situ-generated chlorine ions, and dosing ballast water with chlorine dioxide for sterilization.

Additional technologies that are being advanced include using ultrasonic energy to disrupt cellular structures, heat to sterilize the water, various chemicals as biocides, and de-oxygenation to suffocate any organisms.

As these ballast water treatment efforts mature, a future focus will include dealing with organisms that attach themselves to ships' hulls, shafts, and anchors, a process that also transports species outside their native range.

***About the author:***
*LCDR Brian Moore is a marine safety officer with experience in the offshore oil and gas exploration and development fields (port facilities and liquefied natural gas, petroleum, and chemical shipping). Prior to joining the U.S. Coast Guard he was a chemistry teacher and an Army National Guard air cavalry aeroscout. He has master's degrees in quality systems management and environmental earth sciences and environmental policy.*

**Endnote:**

1. 33 CFR 151 Subparts C&D.