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Ballast water is a major source for introducing invasive species into aquatic ecosystems where they would not otherwise be present. (Photo credit: Smithsonian Environmental Research Center Marine Invasive Laboratory).

Ballast Water – A Pathway for Aquatic Invasive Species

In port or during travel, water used as ballast is pumped into a vessel's holding tanks using pumps, flooding, or gravity feed lines. This is necessary to allow vessels to fit safely under bridges and cranes, reduce stress on the hull of the ship, increase stability, aid propulsion and maneuverability, and compensate for weight loss from fuel and water consumption or cargo load changes.

Ballast water usually contains a variety of biological organisms, including animals, plants and pathogens. After ballast water is taken on board, the ship moves on to the next port. As it takes on new cargo, it must release ballast water to decrease the weight of the ship. As the untreated ballast water is released, so are the organisms. The result is the introduction of these species into a new environment. If the organisms survive, they can cause major ecological and economic damage to the ecosystem. The likelihood that a vessel will release live organisms from ballast water is high – especially given the large volumes of ballast water discharged annually into U.S. waters. Domestically, approximately 200 million metric tons of ballast water are discharged into U.S. waters annually. Of this approximately 30 percent is of foreign origin, outside the U.S. Exclusive Economic Zone.

Examples of aquatic invasive species introduced to new environments via ballast water:

- **Zebra Mussel** (*Dreissena polymorpha*) - Since their introduction into the Great Lakes in the mid-1980s, zebra mussels have drastically altered ecosystems by removing suspended material from the habitat, including planktonic algae that are the primary base of the food web. Further, the fouling behavior of the mussels has resulted in billions of dollars in costs to clean underwater structures and water intake pipes.
- **American Comb Jelly** (*Mnemiopsis leidyi*) – During the 1990s, excessive feeding on zooplankton by the comb jelly contributed significantly to the collapse of the anchovy and sprat fisheries in the Black and Asov Sea.
- **Cholera** – In 1991, ballast water containing the microbe *Vibrio cholera* was released and infected the drinking water in Peru - one million people were infected with cholera and more than 10,000 died. Later that year, a South American strain of human cholera bacteria was found in ballast tanks in the port of Mobile, Alabama.
- **Toxic Algae** – Once introduced into a new area, algae may form harmful algae blooms. Depending on the species, these blooms can cause massive kills of aquatic life through oxygen depletion and release of toxins. Algal blooms may foul beaches, significantly impacting tourism and recreation. Additionally, some species may contaminate filter-feeding shellfish, resulting in the closing of fisheries as consumption of contaminated shellfish may cause severe illness or death.



Failure to properly maintain ballast water can have catastrophic results. Ships have broken in two and/or capsized at sea when ballasting has been conducted improperly for the operational circumstances (Photo credit: Mid Atlantic Panel on Aquatic Invasive Species).

Of all goods imported into the United States, 78 percent move through ports. With the expansion of international trade, including the resurrection of the Arctic trade route, the potential for new species introductions increases. In the United States, the U.S. Coast Guard and the U.S. Environmental Protection Agency are authorized under the Aquatic Nuisance Species Prevention Act and Clean Water Act to enforce mandatory ballast water regulations in U.S. waters. Management practices include open-ocean ballast water exchange (discharging ballast water taken near shore and replacing it with deep ocean water), ship-board treatment of ballast water using chemical or physical methods, and on-shore water treatment facilities. The National Ballast Information Clearinghouse gathers information on the quantity and origin of ship ballast water discharged into U.S. waters, and whether open-ocean exchange or water treatment occurred prior to release.

Key Facts:

- More than **21 billion gallons** of ballast water are discharged into U.S. waters from international ports every year.
- An estimated **10,000** marine species are transported around the world in ballast water every day.

Ballast Water Discharge Management Regulation

Ballast water discharged from ships is one of the largest pathways for the introduction and spread of aquatic invasive species. One way that this risk is reduced is ballast water exchange. The effectiveness of ballast water exchange varies among vessels; however, ballast water exchange is considered to be only ninety-five percent effective (at best) at removing near-coastal organisms from ships' ballast, thus leaving some threat of successful species translocation. The U.S. Coast Guard believes that setting a performance standard would be the most effective way for approving Ballast Water Management Systems (BWMS) that are both environmentally protective and scientifically sound. Ultimately, the approval of BWMS would require procedures to ensure that the BWMS works not only in the laboratory but also under shipboard conditions. These would include: pre-approval requirements, application requirements, land-based/shipboard testing requirements, design and construction requirements, electrical requirements, engineering requirements, and piping requirements. As a necessary first step in approving BWMS, the Coast Guard proposes defining a ballast water discharge standard that would enable it to assess a BWMS's ability to be environmentally protective. To support this rulemaking, the U.S. Coast Guard has prepared a Draft Programmatic Environmental Impact Statement and draft Regulatory Analysis.



Research & Development

The Shipboard Technology Evaluation Program (STEP) is intended to facilitate the development of effective ballast water management system technologies, in order to create more options for vessel owners seeking alternatives to ballast water exchange. 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. Only upon completion of these screening measures are systems accepted and allowed to begin in U.S. waters.

As of November 2010, six ships have applied to participate in the STEP program. Current applicants have proposed mechanical filtration systems that expose organisms to ultraviolet energy, use in situ-generated chlorine ions, and treat 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.

IMO Ballast Water Management Convention

In September 1995, the International Maritime Organization (IMO) identified invasive species as a major issue confronting the international maritime community. In February 2004, the IMO adopted the “International Convention for the Control and Management of Ships’ Ballast Water and Sediments” (Convention), which established ballast water management procedures and included an international standard for ballast water discharge. There are 15 implementing guidelines within the Convention. The last two were finalized in 2008 at the 58th session of the Marine Environment Protection Committee of IMO. The Convention will enter into force one year after ratification by 30 countries representing not less than 35 percent of the gross tonnage of the world’s merchant shipping. As of October 2009, Eighteen countries, representing 15.36 percent of the gross tonnage, had signed the Convention. The U.S. Coast Guard leads the U.S. government’s delegation to the IMO for the Convention; however, to date the U.S. has not ratified the BWM Convention.

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