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BALLAST OUTREACH PROJECT
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ballast eXchange

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MITTEN CRAB ALERT

by Jodi Cassell, California Sea Grant

The Chinese mitten crab (Eriocheir sinensis) is the subject of a contentious policy debate in California, which neighboring West Coast states are following carefully.

The mitten crab, a species native to coastal rivers and estuaries of China and Korea along the Yellow Sea, was first discovered in San Francisco Bay in 1992. Since 1992, mitten crab populations expanded rapidly throughout the San Francisco Bay Delta, with over a million crabs collected at federal and state fish salvage facilities in 1998 during their fall spawning migration. It is thought that the mitten crab was introduced to San Francisco Bay either unintentionally through ballast discharge or as a deliberate release to start a fishery. (continued page 7)

Chinese mitten crabs inundating the U.S. Bureau of Reclamation's Tracy Collection Facility, which entrains and salvages fish from water diversions, in September 1998. Photo courtesy of Andy Cohen, San Francisco Estuary Institute.

GREETINGS

by Jodi Cassell, California Sea Grant

Welcome to the inaugural edition of the West Coast Ballast Outreach Project Newsletter, produced by the University of California Sea Grant Extension Program (UCSGEP). This newsletter will be produced two times yearly during the course of the project, and is intended to serve as an objective source of information on issues related to ballast and aquatic nuisance species (ANS) management issues. We welcome and encourage distribution of this newsletter. For additional copies or information about reprinting articles, call the Ballast Outreach Project at (510) 622-2398.

The West Coast Ballast Outreach Project was initiated by UCSGEP in response to the 1996 reauthorization of the National Invasive Species Act (NISA), which nationalized the issue of ballast management in the United States (see Regulating Ballast Water, page 10). The goals of the project are: 1) to improve awareness and communication about ANS and ballast management issues among the maritime industry, regulators, scientists, and the general public, and 2) to facilitate enhanced compliance with NISA 96 and the development of new approaches or technologies for ballast management.

The West Coast Ballast Outreach Project is a two-year project (February 1999 – February 2001) and will include the following outcomes:

- a project brochure and poster containing general information on ballast management and West Coast ANS, for display on ships and other venues,
- a series of ballast management forums in ports throughout the West Coast with presentations and discussion sessions on ballast technology and management developments,
- a biannual newsletter, and
- a web site with project information and a calendar, as well as linkages to other related ballast and ANS sites. *(continued back page)*

Highlights:

THE EXTENT AND IMPACTS OF BALLAST WATER INVASIONS

by Andrew N. Cohen, San Francisco Estuary Institute

Zebra mussels on native clam.
Photo courtesy of GLSGN Exotic Species Library, Wisconsin Sea Grant

In recent decades, it has become increasingly apparent that invasions by non-native organisms threaten aquatic flora and fauna in many of the world's coastal regions, as well as those human activities and economies that depend on healthy aquatic ecosystems. Invasions by non-native organism are often extensive, and data from various systems indicate that the rate of invasion has been increasing – Fig. 1. This increase is thought by many to be linked to the expansion and globalization of commerce, and the wider and faster movement of goods and people around the world. Several human activities contribute to the long-distance transport of aquatic organisms, including aquaculture, the trade in aquarium organisms, live seafood and live bait, and the accidental transport of organisms attached to the hulls of boats and ships. However, it appears that the most important mechanism currently operating, in terms of the number and diversity of organisms transported and the number of resulting invasions, is the transport of organisms in ships' ballast water – Fig. 2.

In the process of loading ballast water, vessels inevitably take aboard large numbers of small or microscopic drifting organisms known as plankton. In addition they sometimes take in significant numbers of small, bottom-dwelling organisms along with sediment stirred up from the bottom. Over the past 15-20 years, several research teams have studied water and sediments collected from the ballast tanks of commercial vessels to see what remains alive after the completion of transoceanic voyages. These studies have identified virtually all types of marine and freshwater organisms in these samples, sometimes in substantial abundance, including at least several hundred different species of marine invertebrates and over a hundred different species of phytoplankton (Table 1). However, given the difficulty of distinguishing many of these organisms at the species level, the true number of species in these samples is surely much higher. Many types of protists, bacteria and viruses are apparently also present in these samples, although there has been relatively less work done on identifying them.

Ballast water has been responsible for a number of recent invasions that have been harmful to ecosystems or human activities:

- In the early 1980s, the western Atlantic comb jelly *Mnemiopsis leidyi*, a small, floating organism similar to a jellyfish, was introduced into the Black and Azov Seas where it became phenomenally abundant. It devoured the zooplankton that had been the main food for anchovies and sprat, devastating the regional fisheries for these species.

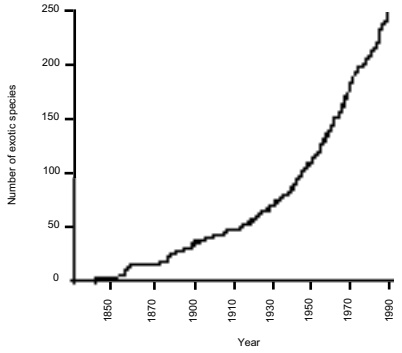


Fig. 1. Increasing Rate of Invasions.
Cumulative number of exotic species established in San Francisco Bay/Delta Estuary.
Adapted from Cohen and Carlton, 1998, Science 279:555-58.

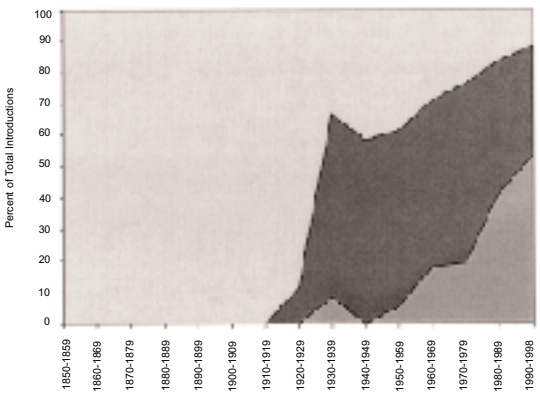


Fig. 2. Ballast Water Introductions
Lower and upper bound estimates of the number of ballast water introductions per decade. Based on the date of the first Pacific Coast record for exotic organisms established in the S.F. Bay/Delta Estuary.
From Cohen, in press, in Proc. 1st Nat'l Conf. Marine Bioinvasions.

In the late 1980s, the zebra mussel, Dreissena polymorpha, was discovered in the Great Lakes, apparently introduced in ballast water from northern European ports. This mussel has been an expensive nuisance, clogging the pipes that deliver water to cities, factories and power plants; attaching in enormous numbers to ship and boat hulls, marine structures and navigational buoys; covering recreational beaches with accumulations of rotting mussels and sharp-edged shells; and disrupting food webs, promoting blooms of nuisance algae and threatening native shellfish. Individual factories, water treatment plants and power plants have suffered millions of dollars of damage, and the overall costs for the region have been estimated at over hundreds of millions of dollars per year. The mussel has now spread across much of North America, from Canada to New Orleans and from the Hudson River to Oklahoma.

In October 1986, three clams, belonging to the Asian species Potamocorbula amurensis, were collected in San Francisco Bay. By the summer of 1987, Potamocorbula was the most abundant clam in the northern part of the Bay and soon spread throughout the rest of the Bay, attaining average concentrations of over 2,000 clams per square meter. It is a highly efficient filter-feeder and severely depleted phytoplankton populations, reducing or altering the food available to organisms higher in the food chain. It may also have reduced native zooplankton populations and made the ecosystem more vulnerable to invasion by Asian species of zooplankton. In addition, the clam accumulates selenium—a contaminant of concern in the ecosystem—in its tissues at concentrations that are apparently high enough to impair the reproductive activities of the fish and birds that feed on it.

Dinoflagellates are microscopic drifting organisms that can become phenomenally abundant, producing discolorations of the sea known as red tides. These red tides can kill fish and shellfish, and some of the dinoflagellates produce human neurotoxins that accumulate in toxic levels in mussels and clams. In recent decades, red tides have been reported in many parts of the world where they were previously unknown, closing shellfisheries and in some cases sickening or killing people. At least some of these red tide outbreaks resulted from dinoflagellates introduced in ballast water or in ballast tank sediments.

Ballast water discharges may pose an even more serious public health threat. During the 1991 South American cholera epidemic, the bacterium that causes cholera was discovered in oysters and fish in Mobile Bay, Alabama. The U.S. Food and Drug Administration then sampled the ballast water of 19 ships arriving in Gulf of Mexico ports from Latin America and found the South American epidemic strain of cholera in five of them. Some medical researchers believe that the epidemic strain was originally transported from Asia to South America in ballast water. The South American epidemic resulted in over a million reported cases of cholera and over 10,000 deaths.

Number of Species Collected	Maximum Concentrations of Organisms per Gallon	No. Ships Sampled	Ballast Water Port of Origin	Ballast Water Port of Release	Sample Type
174 phytoplankton, protist and invertebrate species	Up to 3,000 organisms	46	Outside NW Atlantic	St. Lawrence River, Montreal	Water
210 species collected	Up to 1,500 copepods, 12 million diatoms, 60 million microflagellates, or 10 billion picoplankton (bacteria and/or autotrophic picoplankton	86	Japan	Great Lakes/Upper St. Lawrence River	Water
56 phytoplankton species	Up to 57 million toxic dinoflagellate cysts	12	Japan	Tasmania	Sediment
402 species in 24 animal, plant and protist phyla		159	Foreign Ports	Oregon	Water
275 plant, protist and animal species		70		Chesapeake Bay	Water
At least 198 protist plus several diatom and invertebrate species		17		Israel	Water and Sediment
Over 350 species		189		Germany	

References:

1. Bio-Environmental Services, 1981, Report to Environment Canada, Ottawa

2. Locke et al,. 1991 Can Tech. Rep. Fish. Aquat. Sci. 1822; Locke et al., 1993, Can. J. Fish. Aquat. Sci. 50: 2086-93; Subba Rao et al., 1994, Can. Data Rep. Fish Aquat. Sci. 937

3. Hallegraeff et al., 1990, pp. 475-80 in Toxic Marine Phytoplankton, Elsevier, New York; Hallegraeff & Bolch, 1992, J. Plankton Res. 14(8):1067-84

4. Carlton and Geller, 1993, Science 261:78-82; Pierce et al., 1997, Mar. Ecol. Prog. Ser. 149: 295-97

5. Smith et al., 1996, Shipping Study II, US Coast Guard Rep No. CG-D-02-97

6. Galil and Hilsmann, 1997, Europ. J. Protistol, 33:244-53

7. Gallasch et al., in press, in Ballast Water: Ecological and Fisheries Implications, ICES, Copenhagen

Different Tricks - Different Ships

by Annette Dehalt, West Coast Ballast Outreach Project

As most mariners would know – and some landlubbers may come to appreciate – not all ships are created equal when it comes to ballast water management. Structural, mechanical and procedural circumstances not only vary with vessel category (tanker, container ship, bulk-carrier, to name just the most common), but often on a ship-by-ship basis. Even sister ships, which are designed identically, will very likely have different cargo and operation demands. Each vessel faces different challenges with regard to ballast management, one aspect of which is Open Ocean Exchange (OOE).

While tankers, container ships and bulk-carriers ("bulkers") come in various sizes, shapes, cargoes and ballast tank configurations, a few generalities may nonetheless apply. All ships are designed to withstand a certain weight range of loading, and ballast is needed to compensate for unloaded cargo. Bulkers and tankers typically transport goods one-way on their "cargo leg" and make the return trip "in ballast." Container ships frequently do repetitive circle routes, loading and unloading along the way, so that they usually are both "with cargo" and "with ballast" on most legs. Global economies and trade patterns determine what goods (bulk, containerized cargo, oil, etc.) are transported along which routes, the ship types responsible for transport, and indirectly the source and amount of water transported in return.

Tankers and bulkers represent some of the largest vessels in the fleet, with bulkers having the largest average ballast capacity, followed by tankers and container ships. However, there are wide size ranges, and categories overlap broadly. On the other hand, the heavily ballasted bulkers are often underway for the longest time periods, so some potential introduced species perish on-route, while the much lighter container ships often have a number of shorter legs, which is more conducive to species survival. Also, ballast needs are not always directly correlated to ship size. For example, a line of very large "post-Panamax" container ships has been designed with reduced ballast capacity per unit cargo compared to their smaller, narrower predecessors.

The size and number of ballast compartments can affect a ship's ability to conduct safe and effective ballast exchange. To simplify, most container ships and recent double-hull tankers have a large number of small ballast tanks, while most bulkers and old-style tankers have a small number of large tanks. They often need to carry a significant portion of their ballast water in huge, empty cargo holds. Inflow and outflow is more easily regulated if tanks can be individually controlled, and operations are safer with decreased width and length over which ballast water can shift. This makes Open Ocean Exchange more difficult for those ships with only a few large ballast compartments.

Tank shapes, locations, and pumping systems also vary between ship categories and individual ships, and may affect ballast exchange options and efficiencies under different circumstances. Common configurations for holding a majority of ballast are: "hoppers" (corner ballast tanks) and empty cargo holds for bulkers; dedicated (clean) ballast holds and sometimes additional cargo holds for old-style tankers; double-hull compartments (lining bottom and sides) for new tankers; and double-bottom compartments for most container ships.

There are basically two methods of Open Ocean Exchange, Empty-Refill and Flow-Through, available to the U.S. shipping industry today*. Ship-specific challenges are associated with both. Empty-Refill (sequential unloading and reloading of ballast tanks) can lead to excessive hull stresses due to differential weight distribution, especially in heavy weather and/or if the ballasting sequence is not carefully planned out. This is of particular concern to very large vessels with large ballast compartments, including most bulkers and many old-style tankers. Temporarily discharging more ballast than appropriate for existing sea conditions, as well as the sloshing effect in incompletely filled tanks, can also have negative impacts on ship stability, which can be even more critical for ships of relatively smaller size or for those with large ballast compartments

On the other hand, Flow-Through (pumping ocean water into full ballast tanks to overflow via deck vents – three times the tank volume to approximate the exchange efficiency of Empty-Refill) poses concerns about tank over-pressurization, since deck vents were not designed for this type of continuous use, and could malfunction or clog up. Having tons of water of dubious origin flooding your deck for hours likely requires additional safety precautions and weighs in as a nuisance factor.

Mandated to choose, many bulkers and large, old-style tankers would likely prefer the Flow-Through method based on hull stress considerations, while a lot of container ships and double-hull tankers with the greater flexibility of a large number of smaller tanks may prefer the Empty-Refill method in order to avoid potential tank over pressurization. Masters' individual choices will depend on weather, ship design and condition, crew experience and other considerations.

Operational ballast management plans, as well as new designs and retro-fittings, can go a long way to make ballast management simpler, safer, and more effective – and can be adapted to individual ships, ship types, and circumstances. In many situations, ballast can be topped up off-shore, or certain ballast tanks left full or discharged again into the port of origin. Structurally improved deck vents or installation of outflowing pipes to the side of the vessel can greatly improve application of the Flow-through method. Pumping capability between individual tanks would reduce the need to unload on one side of the ship and reload on another in order to adjust heel and trim. New vessel designs may incorporate reduced ballast needs, strategic placement of ballast and fuel tanks, improved pumping systems, etc.

> Operational ballast management plans ...can go a long way to make ballast management simpler, safer and more effective.

Obviously, options are within reach, but there is not one easy solution that uniformly applies to all vessels needing to perform Open Ocean Exchange and other forms of ballast management. The latter will undoubtedly include potential water treatments (such as filtration, UV light, or biocides) which are now in the testing phase. Appreciating the complexities of vessel design and operation will hopefully lead to greater understanding of the challenges facing the maritime industry and technology developers, as well as to increased cooperation in the search for innovative and flexible solutions to this urgent problem.

** Recently, Australia has developed an improved Flow-Through method (Geoff Rigby) and Brazil has promising results with a new Dilution Method (Claudio Land, see also: "Solution" page 9).*

IN PRINT

Stemming the Tide:
Controlling Introductions of Nonindigenous Species by Ships' Ballast Water.
National Research Council, 1996
National Academy Press

Ships' Ballast Water and the Introduction of Exotic Organisms into the San Francisco Estuary: Current Status of the Problem and Options for Management.
Andrew N. Cohen, 1998
San Francisco Estuary Institute

ON LINE

West Coast Ballast Outreach Project
http://ballast-outreach-ucsgep.ucdavis.edu

Pacific Ballast Water Group
http://web.pdx.edu/~sytsmam/pbwg/pbwg.html

U.S. Coast Guard Ballast Water Program
http://www.uscg.mil/hq/g-m/mso4/contents.htm

Sea Grant Nonindigenous Species Site
http://www.ansc.purdue.edu/sgnis

National Ballast Water Information Clearinghouse - SERC
http://www.serc.edu/invasions/ballast.htm

Nonindigenous Aquatic Species Site
http://www.nas.er.usgs.gov/

Great Lakes Panel on Aquatic Nuisance Species
http://www.glc.org/ans/anspanel.html

CALENDAR

COMING EVENTS

October 12–14, 1999 - Southeast Regional Aquatic Nuisance Species Conference, Charleston, South Carolina. *Contact: Marilyn Barrett O'Leary, Louisiana Sea Grant Program, moleary@lsu.edu*

December 10, 1999 - Educational Forum on Ballast Water Management, Vancouver, British Columbia. The forum will focus on port ballast water management activities, including a review of the Port of Vancouver's mandatory ballast water exchange program and presentations on techniques for verifying which ships have conducted proper open ocean exchange. *Contact: Karen Hart, West Coast Ballast Outreach Project, California Sea Grant, kdhart@ucdavis.edu*

February 14–18, 2000 - 10th International Aquatic Nuisance Species and Zebra Mussel Conference, Toronto, Ontario, Canada. *Contact: Elizabeth Muckle-Jeffs, profedge@renc.igs.net*

PAST EVENTS

April 26–30, 1999 - 9th International Zebra Mussel and Aquatic Nuisance Species Conference, Duluth, Minnesota. The Conference was highlighted by a ballast water workshop on April 28th, and a symposium "Ballast Water Management and Aquatic Nuisance Species: Setting a Research Agenda for the Great Lakes." *Contact: Elizabeth Muckle-Jeffs, profedge@renc.igs.net*

June 16, 1999 - Invasive Species: Developing Solutions for the Pacific Coast Maritime Industry, Vallejo, California. Attended by more than 170 individuals, this conference covered a variety of topics including science, the legal framework, a port's approach, technical options, and ways to develop partnerships. *Contact: Karen Hart, West Coast Ballast Outreach Project, California Sea Grant, kdhart@ucdavis.edu*

August 19, 1999 - Educational Forum on Ballast Water, Olympia, Washington. The first half of the forum covered the Pacific Ballast Water Group's effort to define the scope of the problem on the Pacific Coast of North America and to coordinate ballast water activities along the coast. The second half of the forum concentrated on hydrocyclonic treatment of ballast water. *Contact: Karen Hart, West Coast Ballast Outreach Project, California Sea Grant, kdhart@ucdavis.edu*

VESSELS AND INVASIVE SPECIES *by Kenny Levin, Pacific Merchant Shipping Assn.*

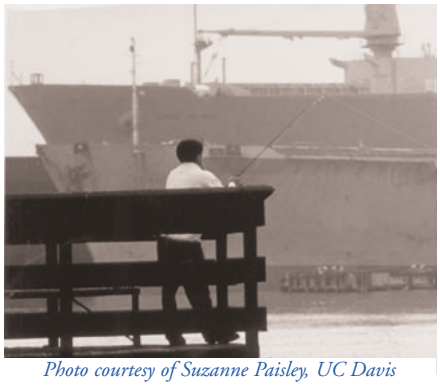


Photo courtesy of Suzanne Paisley, UC Davis Division of Agriculture and Natural Resources

The marine industry, that is the vessels involved in international trade and commerce on the oceans of the world, has found itself facing a problem for which it has no easy solution. What was previously the most benign of substances, the seawater that makes up the highways of marine transportation, is now being labeled a dangerous waste, a point source of pollution and the medium for the inoculation of non-indigenous species into the harbors and bays of the world. In a few short years, the industry has come to the realization that its ballast water can be causing problems – expensive and serious problems.

Ballast water and ballasting are intrinsic to safe vessel operations. With vessels having long lives as capital investments, the state of vessel design and engineering will change slowly over time. According to Dr. Bob Hiltebrand, head of the U.S. Coast Guard's Ballast Water Research and Development program, technological solutions to this ballast water problem are ten to fifteen years off. There is one method currently available to reduce the ballast water problem: exchange of ballast water from coastal origins for ballast water from the deep seas. While far from perfect, this method has already been used by some of the merchant fleets of the world. As of July 1, 1999, the U. S.Coast Guard's rule 33 CFR 151 requires voluntary ballast water exchange and mandatory reporting.

Of real concern to groups like the Pacific Merchant Shipping Association is that an industry that has long thought of itself as "green" or environmentally concerned, may now be portrayed as foot dragging, negative and reluctant to solve a problem. But the solutions are not available yet. This situation is exacerbated by, for instance, an equipment manufacturer in Scandinavia that states on its web site that their equipment meets the requirements of a State of California bill that is still in the legislature. No test data has been provided when representatives of the marine industry requested it. But for the uninitiated, they see a web site proclaiming an easy solution at hand to a problem that the marine industry claims is not easily solved.

Groups like the Pacific Merchant Shipping Association and similar organizations in Southern California, Columbia River area, Puget Sound, the Great Lakes and Washington DC are all working with ports, regulators, legislators, academics and environmental advocates to reduce the inoculation of invasive species via ballast water. But finding the solution is a tough search, both from a biological and engineering perspective.

MITTEN CRAB ALERT

(continued from page 1)

The Facts

Although prized as a culinary delicacy in its homeland, the mitten crab is listed as an injurious species in the United States, which prohibits import under the Lacey Act.

Proven or Potential Impacts of the Mitten Crab

- Water Facility Operation Impacts -

In California (1998), nearly 1 million adult crabs were entrained during their fall migration at both federal and state fish salvage facilities at Tracy, causing major problems with removal and disposal.

- Levee Stability -

The crab is a burrowing species with the potential to significantly impact levee stability.

- Human Health -

Mitten crabs may host the Oriental lung fluke, which causes tuberculosis or influenza-like symptoms in humans.

The Debate

Should fishing and/or farming (aquaculture) for mitten crabs be allowed in California or other areas of the United States?

The California Fish & Game Commission has been approached by several groups interested in fishing for and/or farming the crabs at aquaculture facilities. Groups have promoted commercial fishing as a means to both control the mitten crab and develop new opportunities for Bay Area fishermen. In their most recent action on this issue, August 1999, the Commission voted to continue their ban on permits to fish or farm the mitten crab. However, several firms have recently approached other states to inquire about importing mitten crabs for aquaculture purposes (Georgia, Florida, Alabama, Mississippi, Arkansas, Texas, Oklahoma, Tennessee, and Kentucky have been, or will likely be approached).

Connection to Ballast Water

As proposals to fish for and/or farm mitten crabs are being brought forward throughout the country, the California legislature has been finalizing work on a bill (AB 703) that would regulate ballast water discharges in order to prevent further introductions of aquatic nuisance species, such as the mitten crab, via ballast (see Regulating Ballast Water, page 10). Many have pointed out potential problems and/or inequities associated with regulating the maritime industry, while allowing the fishing industry to profit from an introducedspecies. It has also been pointed out that permitting commercial harvest of mitten crabs might create an incentive for further introductions of the crab and other species. On the other hand, fishing and aquaculture for non-native species (including crayfish and striped bass) has been allowed, and encouraged, for many years in California and other states.

A Solution

The mitten crab issue provides an example of some of the dilemmas posed by ANS, and why management via isolated case-by-case decisions may not provide a rational approach. Effectively dealing with ANS issues, will require taking a holistic approach and answering (at least) the following questions:

- What are the overall goals of management and how will these goals will be reconciled with historic policies on species introduction and management?

- Who should pay and/or profit from management strategies?

All interested parties (the maritime industry and potential mitten crab fishermen, for example) should be at the table as management strategies are being developed.

The development of the draft National Mitten Crab Management Plan, led by the United States Fish & Wildlife Service, provides one example of an attempt at such integrated management. The USFWS involved and solicited input from over 100 individuals and interest groups from around the globe in this planning process. We encourage those interested in the ballast water issue to participate in further work on the mitten crab management plan and other similar efforts to ensure effective integration as ANS management continues to evolve.

For further information on the draft Mitten Crab Management Plan or mitten crab issues, contact Kim Webb, (209) 946-6400, ext. 311, or Jodi Cassell (650) 871-7559.

PORT TAKES ACTION

by Jody Zaitlin, Port of Oakland

The Port of Oakland is committed to supporting and participating in regional, statewide and national efforts to reduce the risk of introduction of nonindigenous species into San Francisco Bay. Towards this end, the Port implemented an ordinance effective August 1, 1999 requiring vessels calling at Port facilities to conduct ballast water exchange at sea. The ordinance (modeled after an order adopted by the Port of Vancouver, Canada) was developed as mitigation for development of new Port terminals.

The Oakland ordinance requires that vessels calling at Oakland facilities that plan to discharge ballast water in San Francisco Bay, or the Marine Sanctuary immediately outside San Francisco Bay, exchange that ballast water at sea prior to port entry. The Ordinance allows exemptions from this requirement when conditions exist that would make such an exchange hazardous to the vessel or its crew, or when the water to be discharged originated from locations along the Pacific coast of North America. The ordinance requires reporting of ballast water practices consistent with the reporting requirements of the U.S. Coast Guard. The data collected will be public information, and will be made available to the scientific community for further research in this area. The new ballast water ordinance applies to all vessels calling at existing and future Port terminal facilities, not just the new terminals. Thus the mitigation measure will reduce the probability of nonindigenous species introductions for all Port operations.

Port of Oakland. Photo courtesy of Doris Sloan, U.C. Berkeley

The Port is also looking into other long-term solutions to the nonindigenous species issue. In cooperation with the California Association of Port Authorities (CAPA), Pacific Merchant Shipping Association (PMSA) and the Southern California Steamship Association, the Port sponsored a study which reviewed existing information regarding the effectiveness and costs of ocean exchange. The study also identified technological approaches to ballast water management that are in development. The same group is currently looking for funding to investigate the feasibility of on-shore treatment of ballast water.

INDUSTRY ON

The Brazilian Dilution Method

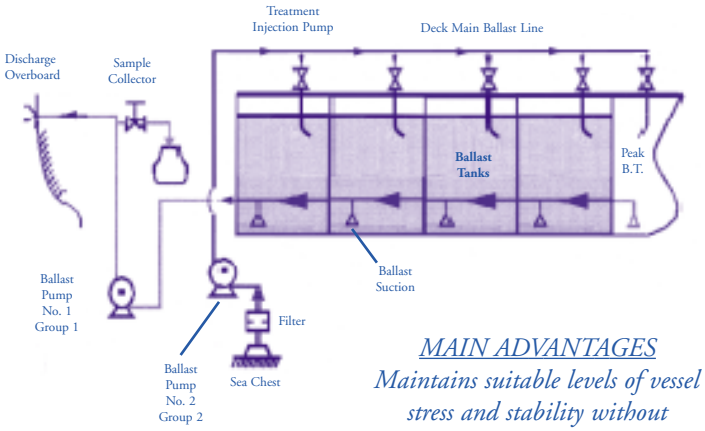
by Annette Dehalt, West Coast Ballast Outreach Project

A new method of Open Ocean Exchange for tankers has been developed by naval engineers of the Brazilian state oil company PETROBRAS. By avoiding potential safety problems of the Empty-Refill method (hull stress, stability) as well as the Flow-through method (tank pressure, water on deck), the "Brazilian Dilution Method" may prove to be a viable and safe alternative for tankers and other types of ships.

Its basic concept involves ballast loading through a special deck pipeline into the top of the tanks, and simultaneous unloading through the bottom of the tanks (by pump or gravity), while keeping a constant flow rate and ballast tank level (see diagram). Company-funded sea trials in June 1998 on the product carrier M/V Lavras indicate 90% of ballast water renewal after three tank volumes dilution, even with provisional piping – an effectiveness comparable to currently used exchange methods. The Dilution Method was considered safe, practical and economical (up to 1% of new tanker cost mainly for installation of the deck pipeline, and up to 3% of old tanker value for retro-fitting). Advantages include: unchanged ballast loading condition, easier sediment removal, and set-up for the adoption of alternative water treatment methods, as well as for future system automation.

PETROBRAS has a record of technological, environmental, and marine safety initiatives, including collaboration with Brazilian universities, state authorities, and international organizations. It is the first company/fleet in the world to have earned Certification ISO 14000, a recognition for environmental management by the International Organization for Standardization. The Brazilian Dilution Method was presented as a technical contribution to the International Maritime Organization (IMO), and has been included as an alternative method in IMO's Draft Code on Ballast Water Management.

For additional information, please contact naval engineers Claudio G. Land or Jose M. Pimenta (dtv6@petrobras.com.br).



MAIN ADVANTAGES

Maintains suitable levels of vessel stress and stability without unloading the ballast tanks completely.

THE MOVE

REGULATING BALLAST WATER

by Linda Sheehan, Center for Marine Conservation

Invasions of local ecosystems by nonindigenous species have caused significant environmental, economic and human health problems. Nonindigenous species are now reported to be the number two threat to endangered and threatened species nationwide, just after habitat destruction.1

Those areas hardest hit by invasions, such as the Great Lakes, are engaged in enormously expensive efforts to mitigate the growing impacts from the introduced species. New estimates indicate that the zebra mussel alone causes at least $3 billion in damage each year nationwide; the Asian clam, a significant threat to the health of San Francisco Bay, accounts for $1 billion in costs nationwide each year.2

The discharge of ballast water is a major pathway for introduction of such species.3 The rising impacts associated with these discharges have resulted in increasing international, national, state and local regulatory activity to stem the tide of the invasions.

The discharge of ballast water is a major pathway for the introduction of nonindigenious species.

INTERNATIONAL RESPONSE

The Marine Environment Protection Committee (MEPC) of the United Nations International Maritime Organization (IMO) has developed voluntary guidelines for ballast water management. These guidelines, adopted by the IMO in 1993 and revised in 1997, recommended ballast exchange while recognizing its limitations. Because the guidelines are voluntary, and not part of a legal convention, there is some move to propose a new Annex to the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). If a new Annex were adopted, it would come into force only after nations representing 50% or more of the gross tonnage of the world's merchant shipping fleet have ratified it by drafting domestic legislation to implement the Annex in their jurisdictions.

NATIONAL RESPONSE

Currently, the principal U.S. legislation controlling the discharge of ballast water is the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA)4 and the National Invasive Species Act of 1996 (NISA).5 NANPCA and NISA were passed in the wake of major impacts on Great Lakes ecosystems and economies from nonindigenous species, particularly the zebra mussel. Under NANPCA and the U.S. Coast Guard regulations drafted to implement it, vessels entering the Great Lakes ecosystem with ballast from outside the 200-mile EEZ must conduct open ocean ballast water exchange in waters at least 2,000 meters deep before entering the EEZ and discharging ballast water. NISA amends NANPCA and directs the U.S. Coast Guard to develop a nationwide program pro,oting voluntary ballast water exchange and requiring mandatory reporting of vessels' handling of their ballast water. The voluntary ballast handling guidelines may become mandatory at a later date if the Secretary of Commerce determines they are ineffective. Interim final regulations to implement NISA were issued by the Coast Guard in May 1999. Effective July 1, 1999, all vessels entering U.S. waters with ballast on board must report their ballast management procedures.

Dissatisfied with the pace of NISA and concerned about growing impacts from nonindigenous species, a coalition of business, fishing and environmental groups filed a petition to the U.S. Environmental Protection Agency in January 1999 to regulate ballast water discharges under Clean Water Act Section 402.6 The petition argues that EPA exceeded its authority when it exempted ballast water discharges from the permitting requirements in the Clean Water Act, which does not provide for such an exemption. In response to the petition, EPA will be issuing a draft report in October 1999 outlining responses and potential regulatory strategies.

Ballast water is already being regulated under Clean Water Act Section 303(d),7 which requires states to limit pollutant loads into impaired water bodies. Because the San Francisco Bay Area is impaired by the discharge of nonindigenous species, the regional water quality agency for the Bay Area is preparing a plan to limit the introduction of such species to a load the Bay can safely handle. The agency's draft workplan8 proposes to set this load at zero, with exceptions.

STATE RESPONSE

California water quality laws, which are broader than the federal Clean Water Act, are viewed by the state water quality agencies as including the discharge of ballast water.9 The California Legislature passed a bill, AB 703, by Assembly Member Ted Lempert that would require open-ocean ballast exchange or equivalent treatment for vessels proposing to discharge ballast into state waters. Enforcement would be conducted by the State Lands Commission, and the program would be paid for by fees on vessels. Fees would also help pay for further research on the problem and potential solutions. Governor Davis is expected to sign the bill, which has broad based support.

LOCAL RESPONSE

The ports of Vancouver, Canada and the Humboldt Bay Harbor District in California have imposed mandatory open-ocean exchange of ballast water. The Port of Oakland recently imposed similar requirements, using the Port of Vancouver as a model. In January 1999, the Secretary of the Department of the Interior, Bruce Babbitt, announced his support for making such programs mandatory throughout the United States.

REFERENCES

[1] *Wilcove, David et al., "Quantifying Threats to Imperiled Species in the United States," Bioscience, vol. 48, no. 8 (Aug. 1998).*

[2] *Pimentel, David, "Environmental and Economic Costs Associated with Non-Indigenous Species in the United States" (presented to the American Assoc. for the Advancement of Science, Anaheim, CA: January 24, 1999).*

[3] *For example, from 53% to 88% of the nonindigenous species introduced into San Francisco Bay in the last decade came in via ballast water. Cohen, Dr. Andrew, San Francisco Estuary Institute, "Invasions Status and Policy on the U.S. West Coast" (May 1999).*

[4] *16 U.S.C. Secs. 4701 et seq.*

[5] *Id.*

[6] *33 U.S.C. Sec. 1342.*

[7] *33 U.S.C. Sec. 1313(d).*

[8] *Regional Water Quality Control Board, Region 2, "Draft Exotic Species TMDL Workplan–Workload" (May 7, 1999).*

[9] *See, e.g., id., p. 2 ("ballast water and hull fouling discharges cause pollution as defined under the Porter-Cologne Water Quality Control Act").*

CONTACTS

West Coast Ballast Outreach Project
Jodi Cassell, Marine Advisor
California Sea Grant
300 Piedmont Ave, Rm 305A
San Bruno, CA 94066
jlcassell@ucdavis.edu
(650)871-7559 phone (650)871-7399 fax

Karen Hart, Project Coordinator
SFEP/ California Sea Grant
1515 Clay St., Suite 1400
Oakland, CA 94612
Kdhart@ucdavis.edu
(510)622-2398 phone (510)622-2501 fax

Local Ballast Water Contacts:

Alaska
Ray RaLonde, Alaska Sea Grant
(907)274-9691
afrlr@uaf.edu

California
West Coast Ballast Outreach Representatives (see above)

Hawaii
Bruce Miller, Hawaii Sea Grant
(808)956-8645
bmiller@hawaii.edu

Oregon
Mark Systma, Portland State University
(503)725-3833
sytsmam@pdx.edu

Washington
Scott Smith, Washington Dept. of Fish & Wildlife
(360)902-2724
smithsss@dfw.wa.gov

Western Regional Panel
Linda Drees, U.S. Fish & Wildlife Service
(913)538-3473 x20
Linda_Drees@fws.gov

Regional Fish & Wildlife A.N.S Representative
Denny Lassuy, U.S. Fish & Wildlife Service
(503)872-2763
denny_lassuy@fws.gov

Sea Grant MIST Program Coordinator
Paul Heimowitz, Oregon Sea Grant
(503)722-6718
paul.heimowitz@orst.edu

Nancy Lerner, Washington State Sea Grant
(206)616-8403
njlerner@u.washington.edu

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In closing, we sincerely welcome and appreciate your interest in the West Coast Ballast Outreach Project and look forward to working with you as the project continues.

Your comments and input on this newsletter and other project components are vital to the success of this outreach effort, and we welcome any input via phone, email, fax, or post.

Jodi Cassell,
UC Sea Grant Marine Advisor

Karen Hart,
Ballast Outreach Project Coordinator

http://ballast-outreach-ucsgep.ucdavis.edu

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California Sea Grant
University of California, One Shields Avenue
Davis, California 95616-8751