Preventing biological invasions via the activities of ships: U.S. Coast Guard efforts to facilitate the development of effective ballast water treatment technology.

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Overview of Coast Guard Aquatic Nuisance Species Program

Federal regulations promulgated under the National Aquatic Nuisance Prevention and Control Act of 1990 (NANPACA) require vessels entering the Great Lakes and upper portions of the Hudson River, after operating outside of the U. S. exclusive economic zone (EEZ), to utilize approved ballast water management (BWM) practices prior to or while operating in these waterways (33 CFR 151C). The approved BWM practices include: holding ballast water on board, conducting a mid-ocean ballast water exchange (BWE), and utilizing an alternative ballast water treatment (BWT) method determined by the Coast Guard to be at least as effective as BWE in preventing biological invasions. During a BWE procedure, a vessel empties its ballast tanks and refills them with water that is less likely to contain potentially invasive species. This is currently defined as water from an area over 200 miles from shore and a depth of 2000 meters. BWE has many drawbacks, including vessel safety concerns, but it is considered the best solution available. The National Invasive Species Act of 1996 (NISA) expanded the scope of regulations to include all U.S. waters. Among other things, NISA required the establishment of voluntary national guidelines (comprised of the same practices as in the Great Lakes requirements) to minimize the introduction and spread of aquatic nuisance species. In 1999, the Coast Guard published regulations (64 FR 26672, May 17, 1999), which require all vessels arriving from outside the EEZ to report their ballast water management practices to the Coast Guard and request those vessels implement the guidelines. The Final Rule (USCG-1998-3423, 66 FR 58381) for these provisions was published in the Federal Register on November 21, 2001. Under the current rule, vessels entering U.S. waters outside of the Great Lakes are directed to send the ballast water management reports to the National Ballast Information Clearinghouse. Congress directed the Coast Guard to evaluate the compliance by the shipping industry with the voluntary guidelines and to determine if the voluntary program provides sufficient protection from ballast water meditated biological invasions.

This paper summarizes several of the main components of the Coast Guard's Aquatic Nuisance Species Program. These efforts include:

- The analysis of ballast water management patterns by the National Ballast Information Clearinghouse.

- The Report to Congress on the status and effectiveness of the national program
- The development of standards and testing protocols for ballast water management methods
- The development of protocols for approving experimentally-installed shipboard treatment systems
- Research and Development Projects

National Ballast Information Clearinghouse

In NISA, Congress directed the Secretary of Transportation and the Smithsonian Environmental Research Center (SERC) to collaboratively operate the National Ballast Information Clearinghouse (Clearinghouse) for the collection and analysis of information and data regarding compliance with ballast water reporting requirements, BWM practices, and ecological surveys of aquatic nuisance species in U. S. waters. The Clearinghouse is physically located at the SERC, in Edgewater, MD, and is supported via a cooperative agreement between the Coast Guard and the Smithsonian Institution. A key element of NISA involves tracking the effectiveness of voluntary guidelines, as measured by (a) the level of compliance with voluntary guidelines, (b) changes in the rate and patterns of ballast water delivery, and (c) reduction in the rate of ballast-mediated invasions. The Clearinghouse was created to provide these analyses on a national scale, and the first two are discussed in further detail below.

Assessment of industry compliance with reporting requirement and voluntary guidelines

The Clearinghouse has implemented a nationwide program, the National Ballast Survey (NABS), to measure ballast water management and delivery patterns for commercial vessels that arrive to U.S. ports from outside the nation's EEZ. The NABS was designed explicitly to create a national database on ballast water that will allow the following evaluations. (1) Measurement of rates of compliance with the ballast water reporting requirement; (2) Measurement of rates of compliance with the voluntary management guidelines for holding or exchanging ballast water; (3) Measurement of patterns of ballast water delivery and management (including exchange) according to vessel class for geographic region and season of arrival; (4) Measurement of among-year changes in ballast water management by vessel class and geographic region; (5) Assessment of accuracy of data through use of multiple, independent data sources.

The NABS currently relies on two primary sources of data:

1. Ballast water information reported directly to the Clearinghouse by arriving vessels;
2. Foreign Waterborne Transportation Statistics collected by the U.S. Customs Service and the U.S. Army Corps. of Engineers. These data on vessel arrivals to U.S. ports are compiled by the Department of Transportation's Maritime Administration (MARAD);

Eventually, the U.S. Coast Guard will provide a third source of data through verification surveys conducted nationwide. Data are submitted to the Clearinghouse from these multiple sources and entered into a relational database. The database is then queried and the results are statistically tested to describe arrival and ballasting patterns. Following two years of data collection, the Clearinghouse prepared a final report of these patterns in October 2001. Analysis of the submitted BWM reports indicated that industry compliance with both the reporting requirement and the voluntary guidelines were quite low. The main findings of the Report follow, while the entire report is available on line at http://www.invasions.serc.si

Compliance with Ballast Water Reporting Requirement

1. Nationwide compliance with reporting was low over the first 24 months (1 July 1999 – 30 June 2001) that mandatory reporting was in effect. Only 30.4% of the vessels that entered U. S. waters from outside the EEZ filed reports with the Clearinghouse, as required by the U.S. Coast Guard.

2. Compliance with reporting varied greatly among geographic regions, during the first 24 months. Compliance rates by region were as follows: Alaska – 20.8%; Caribbean – 16.6%; East Coast –29.0%; Gulf Coast – 17.1%; West Coast – 66.5%; and Pacific Islands – 50.4% (calculated for Hawaiian ports only, as MARAD data do not include Guam).

3. Among individual Captain of the Port Zones (COTPZs) of the U.S. Coast Guard, compliance with reporting ranged from 87.9% in San Francisco, California to 10.1% in Providence, Rhode Island.

4. For the entire U.S., compliance with reporting did not improve substantially from the first year to the second (28.3% and 32.4%, respectively).

5. Among the three continental U.S. coastal regions, the Gulf Coast showed the least improvement in reporting compliance between years (0.5%) followed by the East Coast (5.2%).

6. On the West Coast (of the contiguous U. S.), compliance with the reporting requirement increased markedly (15.3%) between years, resulting primarily from an increase in California (which receives most ship arrivals). This increase was coincident with implementation of California state law, requiring submission of copies of the federal ballast water management reports to the State Lands Commission and authorizing monetary and criminal penalties for noncompliance.

Compliance with Voluntary Ballast Water Management Guidelines

1. Due to the poor nationwide reporting rate (30.4%), it remains difficult to estimate reliably the temporal and geographic patterns for (a) ballast water delivery and (b) use of the voluntary ballast water management practices.

2. Despite current low nationwide reporting, the National Ballast Survey and the Clearinghouse database were designed explicitly to provide fine-grained information on patterns of ballast water management and delivery by geographic location (port, coast, traffic pattern), time (month, year, and across years) and vessel type. Thus, the system is in place to evaluate and track management patterns across the country.

3. The limited reports to date permit documentation of only coarse patterns of ballast water management. However, as reporting rates rise and concomitant uncertainty diminishes, the NABS database will better describe the behavior of commercial vessels arriving to the U.S.

4. Of the 28,988 foreign arrivals that submitted reports from 1 July 1999 to 30 June 2001, 73.6% indicated no intention to discharge ballast water within U. S. territory, 12.9% declared no exchange of ballast water prior to discharge, and 13.0% of the reporting vessels declared some degree of ballast water exchange prior to discharge.

5. Thus, of the 7,652 vessels that reported discharge of ballast water in U.S. waters, about half (51.2%) indicated some degree of mid-ocean exchange and 48.8% indicated discharge with no prior exchange. The reasons for not performing ballast water exchange were varied and included constraints posed by the vessel's itinerary, as well as ship and crew safety concerns.

6. Nationwide, approximately 29.7% (11.1 million metric tons, or mt) of the ballast water from foreign arrivals was reported as discharged into the U. S. without undergoing any exchange.

7. Of the vessels that reported no intent to discharge ballast water upon arrival, most carried ballast water. Only 12.8% (3,712 of 21,336 vessels) was reported as No Ballast on Board, or NOBOB.

8. Compliance with the voluntary guidelines varied greatly among regions. For the West Coast, most ships that discharged ballast reported it had undergone exchange (72.3% of ships), and most ballast water discharged was reported to have undergone some exchange (85.2% of the total volume). In contrast, on the East Coast, most ships (70.4%) that discharged ballast water reported they had not undertaken exchange,

although most of the discharged ballast water had reportedly undergone some exchange (53.3% of total volume).

9. Compliance with voluntary guidelines also varied considerably by port system, or COPTZ. For example: Portland, Oregon received the highest volume of ballast water, (6.60 million mt) of which 91.5% underwent some degree of mid-ocean exchange prior to discharge; Juneau, Alaska had the highest percent of reported discharged ballast water that had undergone some exchange (98.1% of 113,050 mt); and Portland, Maine had the lowest percent of reported discharge that had undergone any exchange (0% of 17,559 mt).

10. Analysis of the locations reported for completion of ballast exchange, using a geographic information system, indicates a significant proportion of the reported exchange occurred in coastal areas (< 200 mi offshore), rather than mid-ocean as requested.

Report to Congress

As required by NISA, the Coast Guard submitted a report to Congress in June, 2002, assessing the adequacy and effectiveness of the voluntary guidelines in preventing the introduction and spread of non-indigenous species in U.S. waters (http://www.uscg.mil/hq/g-m/mso/mso4/programupdate.doc). Based on the Clearinghouse analysis that found compliance with the reporting requirement too low to assess compliance with the guidelines, and as directed by Congress, the Secretary announced the intention to make the voluntary program mandatory and enforce it with civil and criminal penalties. The Secretary further announced to Congress the following schedule of rule makings by which this will be accomplished (Note – dates reflect when the Coast Guard anticipates having regulatory documents ready for DOT and interdepartmental review, and not actual publication dates):

- Develop a protocol for Coast Guard approval of installations of experimental technologies on board vessels (Interim Rule Winter 2002)
- Incorporate penalties for a vessel's failure to submit BWM reports (Final Rule Fall 2003)
- Transition from a voluntary national BWM program to a mandatory program (Final Rule Summer 2004)
- Establish a standard to serve as the benchmark for all BWM options (Final Rule Fall 2004)

Development of Standards and Testing Protocols For Ballast Water Treatment Methods

An often-cited hurdle to the development of acceptable ballast water treatment technologies is the absence of a standard. While a standard is not a necessary precursor to the development of technology designed to reduce as much as

possible the number of organisms discharged with ballast water, it is required to inform ship owners of the level of treatment necessary. The Coast Guard has begun a coordinated effort, involving a wide range of stakeholders, to develop such a standard. The following are the key components of this effort to date.

Development of Standards
Ballast Water and Shipping Committee
The Aquatic Nuisance Species Task Force's Ballast Water and Shipping Committee (BWSC, chaired by the Coast Guard) formed a workgroup to develop possible options on which to base a standard for ballast water discharge and treatment. Several options for approaches to setting standards were identified, and the Coast Guard published a notice in the Federal Register on *Potential Approaches to Setting Ballast Water Treatment Standards* (USCG-2001-8737) on May 1, 2001, requesting public comment on these and accompanying issues related to setting, implementing, and enforcing such standards.

In brief, the approaches and issues identified by the Committee and published in the Federal Record are:

- Approaches based on ballast water exchange (BWE) as currently specified by Congress under NISA.
    - Standard based on the theoretical effectiveness of BWE in replacing water [100 percent for empty-refill exchange (ERE) and 95 percent for flow-through exchange (FTE)].
    - Standard set as equivalent to the measured effectiveness of BWE. This effectiveness could be expressed as an average across all vessel types and all taxa, as a specific profile across taxonomic groups within vessel types, or as some intermediate combination of these.
- Approaches not related to BWE but used in other standard-setting efforts:
    - Standard based on the measured capabilities of the best available technology. As in b), this level of treatment could be determined as an overall average, or within discrete groupings of vessels and taxa.
    - Standard based on the biological requirements, as empirically estimated or modeled, of receiving systems.

The range of potential options developed by the BWSC indicated a significant need for further discussion about the basis upon which to formulate a standard or set of standards for use in evaluating ballast water treatment (BWT) technologies. In response, the Coast Guard not only published the Federal Register notice, but also sought input from experts in technical areas related to ballast water treatment and biological invasions of aquatic ecosystems.

Standards Development Workshops
To further the discussion of treatment standards for ballast water, the Coast Guard organized two workshops in the spring of 2001. The Coast Guard organized events brought together experts in general water treatment, ballast water treatment, and ballast water biota, and were intended to be a next step in the process of developing standards for the treatment of ballast water. The workshops were intended to result in recommendations for a first quantitative standard and a consensus opinion on the necessary research needed in order to propose and implement specific standards. Technical experts at the Coast

Guard workshops, and comments to the notice (USCG-2001-8737) by the National Oceanic and Atmospheric Administration, agreed that standards for ballast water treatment should not be based on the effectiveness of ballast water exchange. The Coast Guard believes that Congress, in singling out BWE, viewed the practice as an immediately practical, but recognizably imperfect tool for treating ballast water, and wanted to ensure that approved alternatives would not be less effective than BWE is known to be. As currently practiced, BWE produces varying results, with estimates ranging from 39% to 99.9% removal of original organisms, depending on the taxonomic groups measured and the ships studied. Further eroding the value of BWE as a standard for treatment is the fact that the procedure cannot be used to treat ballast water of ships engaged in coastal voyages, and often cannot be used by vessels on transoceanic voyages due to safety concerns.

Advanced Notice of Proposed Rulemaking

The recommendations of the Coast Guard workshops, and of a coincidental IMO workshop, were incorporated in a Coast Guard advance notice of proposed rulemaking (ANPRM) on *Standards for Living Organisms in Ship's Ballast Water Discharged in U. S. Waters* (USCG-2001-10486), published in the Federal Register on March 4, 2002. In this notice, the Coast Guard announced that, instead of basing a ballast water treatment standard on a narrow determination of the quantitative effectiveness of ballast water exchange, it would instead be considering an approach in which alternative BWTs were judged to be at least as effective as BWE if they a) produced predictive results, b) removed or inactivated a high proportion of organisms, c) functioned effectively under most operating conditions, and moved toward a goal consistent with the congressional intent to eliminate ballast water discharge as a source of harmful NIS

The following three long-term goals and four short-term interim standards were drawn from the IMO and Coast Guard workshops, and published for comment in USCG-2001-10486:

Goals

1. No discharge of zooplankton and photosynthetic organisms (including holoplanktonic, meroplanktonic, and demersal zooplankton, phytoplankton, and propagules of macroalgae and aquatic angiosperms), inclusive of all life-stages. For bacteria, Enterococci and Escherichia coli will not exceed 35 per 100 ml and 126 per 100 ml of treated water, respectively.
2. Treat for living organisms at least to the same extent as drinking water
3. Ballast water treatment technologies will demonstrate, through direct comparison with ballast water exchange, that they are at least as effective as ballast water exchange in preventing and controlling infestations of aquatic nuisance species for the vessel's design and route.

Standards

1. Achieve at least 95% removal, kill, or inactivation of a representative species from each of six representative taxonomic groups: vertebrates, invertebrates (hard-shelled, soft-shelled, soft-bodied), phytoplankton, and macroalgae. This level would be measured against ballast water intake for a defined set of standard biological, physical, and chemical intake conditions. For each representative species, those conditions are:
    - The highest expected natural concentration of organisms in the world as derived from available literature, and
    - A range of values for salinity, turbidity, temperature, pH, dissolved oxygen, particulate organic matter, and dissolved organic matter.
2. Remove, kill, or inactivate all organisms larger than 100 microns in size.
3. Remove 99% of all coastal holoplanktonic, meroplanktonic, and demersal zooplankton, inclusive of all life stages (eggs, larvae, juveniles, and adults). Remove 95% of all photosynthetic organisms, including phytoplankton and propagules of macroalgae and aquatic angiosperms, inclusive of all life-stages. Enterococci and Escherichia coli will not exceed 35 per 100 ml and 126 per 100 ml of treated water, respectively.
4. Discharge no organisms greater than 50 microns in size, and treat to meet federal criteria for contact recreation (35 Enterococci per 100 ml for marine waters and 126 Escherichia coli per 100 ml for freshwaters).

Importantly, workshop participants were careful to stress that the capability of current technology to achieve the percent or size-specific reductions expressed in the optional standards, under the operational flow and volume conditions characteristic of most commercial ocean-going vessels, is not well established. Nevertheless, the participants felt these efficiencies were practical and realistic initial targets, and that BWT to these levels would provide increased protection compared to no BWT at all, or to BWE carried out only when vessel design and operating circumstances permit.

Development of Testing Protocols

Technology Verification Program

The Coast Guard and the U. S. Environmental Protection Agency (EPA) have signed a Memorandum of Agreement to utilize the expertise residing in each organization to cooperatively and collaboratively assess the capabilities of ballast water treatment technologies. In particular, the Coast Guard and the EPA are adding ballast water treatment technology to the EPA's Environmental Technology Verification (ETV) Program. Through leveraging the technological and scientific strengths of the two agencies and by integrating complementary activities, the agencies expect to maximize the use of existing capacity and improve the efficiency of environmental technology evaluation and verification.

The goal of ETV is to verify the performance characteristics of commercial-ready environmental technologies through the generation and evaluation of objective

and quality-assured data so that potential purchasers and regulators are provided with an independent and credible assessment of the technology that they are buying or permitting. ETV is intended to to accelerate the development and commercialization of improved environmental technology and expand the environmental technology choices of public and private decision makers, both in our country and abroad. Importantly, while the ETV program is not regulatory in nature, it is anticipated that many of the test protocols developed within the Program will be similar or identical to the protocols used in regulatory certification tests.

The ETV program relies heavily on the ongoing participation of stakeholders to assure that the most important questions concerning a technology's performance are addressed. Test plans and protocols to acquire these data for ballast water treatment technologies are being developed by an expert Technical Advisory Panel, and will be released by the ETV Program shortly. Further information on the ETV program is available on the internet at http://www.epa.gov/etv.

Approval for Experimental Treatment Systems

The Coast Guard is developing an Interim Rule for a program that will provide an incentive for ship owners and operators to actively participate in projects testing ballast water treatment technologies. As on-board installation and testing costs are likely to be significant, many vessel owners are understandably reluctant to participate in such projects without assurances that installed systems will be acceptable to regulatory agencies for some period of time should requirements come into effect during the testing period. the basic concept includes the advance, but conditional, approval of experimentally installed systems. To prevent misuse of this approval, the program will contain safeguards to insure that the systems tested have a reasonable chance of being as effective as ballast water exchange, and that tests are conducted according to well-established principles of experimental design and analysis. A Notice requesting public comment on *"Approval for experimental shipboard installations of ballast water treatment systems"* (USCG-2001-9267) was published in the Federal Register on May 22, 2001, with a 60-day period for receipt of comments.

Broadly, the program would involve review of test plans by a panel of biologists and engineers with relevant expertise, verification inspections of installed systems by the Coast Guard, and a requirement that systems would meet all other applicable regulations. Following the period of approval, experimental systems would be subject to all ballast water treatment standards and requirements. The Coast Guard is currently drafting language for an Interim Rule on the experimental approval program, with a target date for distribution for review in winter, 2002

Research and Development

In NISA, the Congress gave primary responsibility for supporting the development of ballast water treatment systems to the Departments of Commerce and Interior, through the National Ballast Water Treatment Demonstration Program. The Coast Guard was directed to develop regulations governing the use of such practices on ships operating in U. S. waters. Consequently, the research priorities of the Coast Guard's ANS Program are directed at supporting the development of regulations and standards, and the technical procedures necessary for their implementation. The principal current efforts are:

Evaluation of treatment system R&D efforts

The *Scientific Audit Project* evaluates the testing methods and results of public and private entities engaged in developing ballast water treatment systems for use onboard ships. These projects represent a range of scales and waypoints in the development process, from dockside tests to small-scale, shipboard installations. To date, an interdisciplinary team assembled by the U. S. Department of Transportation's John A. Volpe National Transportation Systems Center has conducted evaluations of five testing efforts.

The first set of audits revealed several issues that require further examination. The observations summarized below apply generally to all testing program phases.

Experimental Design - Experimental design issues can lead to serious problems in the interpretation of results, particularly in regards to the application of the treatment system as a whole or its component parts elsewhere (i.e., in a different environment at a different scale of treatment). Problems were identified in some instances in the areas of management and articulation of program goals, establishment of a firm basis in biological science, quality assurance planning resulting in poor execution of protocols, and a general lack of method validation. Improper selection of experimental hardware for the creation of the desired environmental models, lack of monitoring of key chemical and biological indicators, and inadequate sampling schema resulted in a poor understanding of the systems' performance.

Protocol and Sampling Issues - Problems were noted among the observed test programs in inadequate replication, use of non-standard marine biological protocols, validation of live/dead metrics, potential for contamination, and verification of the assay methods as applied and in the environment being tested.

Evaluation of treatment processes

The *Process Evaluation Project* tested the capabilities of three general processes currently being applied to ballast water treatment (filtration, hydrocyclonic separation, and ultraviolet light) under controlled and similar

conditions of flow rate, water quality, and test organisms. The project, located at the University of Miami, involved an interdisciplinary team of engineers and biologists affiliated with the University's Department of Engineering and the Rosenstiel School of Marine and Atmospheric Chemistry, under the direction of Dr. Thomas Waite. The test facility was capable of processing approximately 1,500 gallons per minute, and included a mixing system with a high pressure injection pump capable of adding suspended solids (clay slurry) and other augmented substances to the ambient water collected from Biscayne Bay.

The first phase of the project examined the efficacy of the treatment processes as a function of turbidity. Treatment efficacy was monitored by evaluating a broad spectrum of biological and biochemical effects. Planktonic organisms, including bacteria, algae, and zooplankton were monitored to determine any effects due to treatment combinations. In addition, biochemical analyses (chlorophyll and ATP) were conducted to determine their utility for measurements of biomass and viability, respectively.

The results of the analyses showed clearly that hydrocyclonic separation was not effective for treatment of ballast water at any level of turbidity. There was no statistically detectable effect of turbidity on the efficacy of any of the unit processes, including the UV radiation unit, over the range of 5-90 NTU (range of natural highly turbid systems: 10-15 NTU). The 50-micrometer screen filter was fairly effective at removing zooplankton. Although numbers of macro-organisms were too low for statistical analyses, the results also suggested that UV would not be effective at meaningful treatment of large zooplankton. UV was effective at initially reducing bacterial abundances, but subsequent regrowth resulted in an increase in abundances to orders of magnitude above pretreatment numbers.

Verification of mid-ocean exchange

The *Exchange Verification Project* is developing improved methods for verifying that ballast water has been exchanged in the mid-ocean. The Coast Guard currently uses salinity measurements to verify that ballast water has been exchanged. When the original ballast water is fresh, or low salinity, the presence of water with less than 30 parts per thousand, or ppt, of salt upon arrival in the destination port is sufficient to show that the water was not exchanged in mid-ocean, where salinities are typically above 32 ppt. However, this technique fails when the source of the ballast water is a high-salinity coastal area. Thus, more refined techniques are required to determine whether water in ballast tanks is from coastal or mid-ocean locations. The Exchange Verification Project is investigating whether a suite of characteristics can be used to discriminate between coastal and oceanic water, regardless of the salinity of the coastal source water. The scope of the Project is divided into two parallel efforts:

Development and validation of parameters for BWE Verification

At a two-day workshop on potential techniques for verification of ballast water exchange, held in August, 2000, invited chemical and biological oceanographers discussed a diverse range of potential verification techniques. The highest priority was to consider all techniques capable of discriminating oceanic and coastal water samples in order to have a comprehensive scientific basis from which selections based on non-scientific factors (e.g. cost, practicality) could be made. The goal was to test the capacity of currently available analytical methods, individually or in combination, to discriminate exchanged from unexchanged coastal water. A preliminary, and largely qualitative, comparison of the anticipated strengths and weaknesses of the presented techniques was used to reduce the list of potential techniques to six: metals, turbidity, fluorescence of dissolved organic matter, radium, phytoplankton salinity tolerance, and lignin.

Testing of these potential verification techniques is being performed in two stages. In the first, proof of concept, stage, experiments were conducted by SERC during the Fall of 2000 on three voyages from California (San Francisco and Los Angles) and Washington (Puget Sound) to Valdez, Alaska, and on a trans-Atlantic voyage, selected to cover a range of conditions, including low salinity. On three of the voyages, source water salinity was close enough to full oceanic salinities to render the current salinity-based verification approach unreliable. In short, results from the stage 1 tests indicated that the most promising options, in addition to salinity, are fluorescence, concentrations of metals (Ba, P, Mn, Mo, U, and V), and concentration of a short-lived isotope of radium, ^{223}Ra. While some parameters were useful singly, multivariate analysis provides the best resolution and confidence in distinguishing exchanged and unexchanged water.

In the second stage, in planning now, additional experiments and samplings will be conducted to validate the discriminatory approach. This work will include exchange experiments during commercial voyages and transect sampling along coastal-oceanic gradients in different geographic regions and during different seasons. An initial set of experiments will focus on vessels arriving to Columbia River ports, and preliminary discussions concerning collaborative projects are currently underway with several foreign government agencies.

Development of verification technologies

In addition to developing basic analytical procedures for verifying mid-ocean exchange, the Coast Guard is also working with private sector R&D companies to develop technological approaches to verifying and monitoring mid-ocean exchange. Funding for this element of the verification project comes primarily through the Small Business Innovative Research (SBIR) Program. Current efforts seek to develop hand-held water-testing technologies based on one or more of the core verification parameters described above, and ship-mounted technologies, such as tank-level monitors and flow meters, for monitoring the physical exchange of water.

Characterizing the No Ballast On Board Problem

The *"No Ballast On Board" Project* addresses the specific issue of vessels which declare "No Ballast on Board" (NOBOB), but which can contain thousands of tons of residual water and accumulated sediments that contain non-indigenous organisms. The Coast Guard, through a Cooperative Agreement with the NOAA Great Lakes Environmental Research Laboratory (GLERL), is collaborating with academic and government researchers, and the shipping industry, on studies that characterize the temporal and spatial patterns of NOBOB vessels, the amount and distribution of water and sediment carried in their ballast tanks, the composition of the biological communities they carry, the effect of added Great Lakes water on resident foreign biota in the tanks, and the efficiency and effectiveness of mid-ocean exchange in flushing coastal water and organisms from tanks. It is anticipated that this work will lay the groundwork for evaluating the effectiveness of operational and technological ballast water management practices aimed at minimizing sediment load and possible ANS movements. The Project started in 2000, and has attracted significant non-federal funding. Results to date indicate that:

- Live organisms are found in all water and sediments examined.
- Large numbers of resting stages (eggs, cysts, and spores) occur in sediments
- Many resting stages readily hatched in the lab under Great lakes conditions, and produced second-generation populations.

Additional information about the NOBOB project is available at the GLERL web page: http://www.glerl.noaa.gov/res/Task_rpts/nsreid10-1.html.

International Ballast Water Management Treaty

NISA calls for the U.S. government to engage in foreign negotiations to address ANS and ballast water issues. These are taking place at the International Maritime Organization (IMO) Marine Environment Protection Committee (MEPC). The Ballast Water Working Group at MEPC 47 (4-8 March 2002) continued its review of the articles and regulations of a draft instrument. These discussions remain based on the principle that the final instrument should be based on a ballast water treatment performance standard; however it is recognized that ballast water exchange will be used as a starting point within the framework of the finalization of ballast water standards. The major obstacle to concluding an international agreement remains the absence of a ballast water treatment standard.

Continuing its leadership role in this issue at IMO, the U.S. coordinated an intersessional correspondence group to continue discussions on developing a ballast water treatment standard. U.S. input to this group is coordinated by the Coast Guard and represents the current state of domestic thinking within the federal government on an environmentally protective ballast water treatment

standard. U.S. views have been generally well received to date and incorporate agency positions of the USCG, NOAA, EPA, DOD, MARAD, DOJ and DOS.

An intersessional meeting of the Working Group the week prior to MEPC 48 should allow the Committee to take a decision as to whether the instrument is sufficiently developed to recommend the holding of a diplomatic conference in late 2003. Because of the critical nature of the ballast water treatment standard question to the Committee's recommendation to Council, Ballast Water Management deliberations will likely focus on the standard. Copies of the MEPC 48 documents may be obtained via the Internet at: http://www.CoastGuard.mil/hq/g-m/mso/mso4/mepc48ag.html

The United States believes it is possible to establish a true environmentally protective BWM regime with sufficient structural flexibility to minimize impacts on vessel owners and operators, address the concerns of States regarding aquatic invasions, and spur the development and adoption of more effective treatment technologies. By taking a long-range view on this issue, the MEPC can establish a framework that will allow the global community to address this serious issue in an orderly and scientific manner. This framework should include ways to encourage the development of technology without being limited by what is available in the near term, and remain a viable framework for the future. To help develop a globally protective and scientifically sound instrument, the United States has proposed the following concepts be considered for incorporation into the text of the instrument. The U.S. believes that these concepts will help form the basis from which the remaining details can be resolved.

The performance standard that is established in the instrument must be viewed by the International scientific community as likely to significantly reduce, while bringing the shipping community substantially closer to the goal of eliminating, the threat of ballast water mediated aquatic invasions. While 100% removal or inactivation of organisms would be such a standard, it is widely viewed as unachievable in the near term. However, the standard must be based on more than an intuitive determination that a volumetric exchange of a ship's ballast water provides substantive environmental benefits, and compliance with the standard must be verifiable. The United States does not believe that it is possible to quantify the reduction in risk attained through anything less than a 100% reduction in the number of organisms discharged from a ship's ballast tank. Reducing the total number of organisms discharged at any one time will probably have some effect on the invasion probability, but it is not possible to state anything about the magnitude of the risk reduction.

For discussion at the intersessional meeting of the MEPC Ballast Water Working Group, the United States has suggested that a standard such as *"Discharge no detectable quantities of viable aquatic organisms larger than X microns in size"* would meet these criteria. Such a standard's efficacy from a biological standpoint would be clear, and monitoring/enforcement would be feasible. As

further background to discussion of this proposal, the United States submitted an informational paper to MEPC on the results of a preliminary review of easily accessible existing literature on the sizes of organisms found in ballast water, taking into account their various life stages, and proposed that this be considered as an aid to understanding what a size-based treatment standard would achieve in biological terms.

Recognizing that a significant BWM technology gap remains, and that the shipping community will need time to test, verify, and install treatment technologies as they become commercially available and proven aboard ship, the date by which identified ships must meet the performance standard should be set sufficiently far into the future to allow for the development of technology and an orderly transition into shipboard service. Ten years from the adoption of the treaty at the international conference (e.g. 2013) is suggested as the effective date. With the adoption of the treaty at the international conference, a great amount of work will still remain to develop the supporting protocols, test methods and approval processes for treatment technologies. Importantly, elements of these protocols, methods and processes sufficient to verify compliance with the standard will be needed in the treaty itself.

The developing instrument recognizes the ability of a port State to adopt additional measures when it has a particular problem with the transfer of harmful aquatic organisms and pathogens. However, the current text also presents economic, technical, and international law problems. A few of the more critical problems, from the U.S. perspective, are discussed below.

The existing draft assumes that additional measures necessary to address the transfer of harmful aquatic nuisance organisms and pathogens will be shore-based. As such, the structure is prescriptive and inflexible since it does not recognize that other measures may be more practical and cost-effective. Tying the success of the Instrument to shore-based facilities also fails to recognize the substantial difficulties encountered by Parties in implementing rules and standards that are dependent upon the provision of expensive shore-based facilities in numerous ports. Shore-based facilities may require a substantial infrastructure to address the needs of all ships entering port; which may be beyond the capacity of many, if not most, ports. Thus, the current draft, while seemingly allowing a Party or Parties to adopt additional measures, creates such practical hurdles as to render the taking of additional measures difficult or even impossible. The uncertainty about what organisms and pathogens may be problematic as well as the uncertainty of what may be necessary for addressing specific threats of invasion, warrant development of the instrument in a manner that allows flexibility in addressing specific threats of invasion where the standard may be inadequate.

Additionally, the current draft requires IMO approval even for port State measures that States may currently take without such approval, consistent with their sovereignty under general principles of international law and reflected in the UN Convention on the Law of the Sea. This presents controversial questions concerning the appropriateness of IMO approval in such circumstances. The United States has proposed language that would avoid the controversy surrounding IMO approval for port State measures, and should facilitate the ability of the Ballast Water Working Group to reach agreement on the pertinent sections of the Instrument in a timely manner.