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LEGISLATIVE HEARING ON A DISCUSSION DRAFT:
BALLAST WATER MANAGEMENT ACT

BEFORE THE
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
SUBCOMMITTEE ON COAST GUARD AND MARITIME TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES

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Good morning, Chairman LoBiondo and members of the Committee. I am Timothy Keeney, Deputy Assistant Secretary for Oceans and Atmosphere and the National Oceanic and Atmospheric Administration (NOAA). Thank you for inviting me here today to testify on the draft *Ballast Water Management Act*. I am co-chair of the Aquatic Nuisance Species Task Force and am pleased to be here today to discuss this important issue. The Administration supports the goal of this legislation to provide for the management and treatment of ballast water to prevent the introduction of non-indigenous, or invasive, aquatic species. The Administration's *Ocean Action Plan* recognizes the need for ballast water management, and we remain committed to working with our Congressional partners in their efforts to address this issue in a comprehensive way.

While marine transportation is an important link in the chain of global trade, the introduction of invasive aquatic species that it can bring threatens the health and value of our coastal and inland waterways. NOAA's mission is to serve as steward of the nation's marine resources through science-based conservation, management and protection of ecosystem health.

I appreciate the opportunity to speak to you today about the spread of aquatic invasive species through ballast water, NOAA's ballast water research priorities, federal coordination and cooperation, and our comments on the *Ballast Water Management Act*.

Aquatic Invasive Species Spread Across the Nation

Ballast water is a significant pathway for the introduction of non-native species into our coastal ecosystems and waterways. Given the high level of commercial shipping traffic in U.S. waterways, it is important to strengthen our current tools for management and treatment of ballast water to prevent the introduction of invasive aquatic species. Historically, the transfer of organisms by ships has resulted in the unintentional introduction and establishment of hundreds of freshwater and marine

invasive species into the United States. Ballast water was the likely pathway for the introduction of species such as the clam *Potamocorbula amurensis* into San Francisco Bay, and the fishhook water flea and zebra mussel into the Great Lakes.

The Great Lakes basin is the aquatic gateway to the heartland of America and a hot spot for aquatic species introductions to major interior sections of the United States. Approximately 180 invasive aquatic species have become established in the Great Lakes; 36 percent of which are attributed to shipping activities. While the spread of aquatic species introduced in most U.S. coastal ecosystems is generally restricted to adjacent contiguous coastal ecosystems, the Great Lakes provide a pathway for freshwater-adapted invasive species to spread throughout the interior waters of the central and eastern United States.

One need only examine the spread of zebra mussels —the poster child for aquatic invasions — which were first discovered in Lake St. Clair in 1988 and are believed to have entered the Great Lakes through ballast water. Zebra mussels now thrive outside the Great Lakes–St. Lawrence River system as far west as the middle of Kansas, as far south as the Mississippi delta below New Orleans, Louisiana, and as far east as western Vermont and the Hudson River estuary north of New York City. Zebra mussels have fouled industrial and municipal water intakes that must now be chemically treated on a regular basis throughout the summer months to keep them flowing. Estimates of the annual cost of zebra mussel control and mitigation are in the hundreds of millions of dollars per year in the Great Lakes basin alone. The introduction of zebra mussels provided the initial impetus for coordinated federal action on aquatic nuisance species and led directly to the passage of the *Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990* (*NANPCA*).

NOAA's Research on Ballast Water

When the *NANPCA* passed, Congress recognized there was a larger issue than the problems caused by zebra mussels or any other lone invader. Recognizing the pathway that brought the zebra mussel to the United States could be a pathway for other species, the law required that we take steps to manage ballast water. By the time *NANPCA* was due for reauthorization, it was common knowledge that ballast water was, and continues to be, a significant pathway for new introductions of invasive species into coastal waters.

Ballast Water Technology Demonstration Program

The National Research Council's (NRC) July 1996 report, *Stemming the Tide – Controlling Introductions of Nonindigenous Species by Ships' Ballast Water*, recommended that "U.S. authorities should sponsor and encourage further research and development efforts," addressing filtration and other ballast water treatment technologies, the level of treatment needed to reduce invasion risk, and appropriate monitoring systems.

In 1996, Congress passed the *National Invasive Species Act* (*NISA*) to amend *NANPCA*.

Drawing upon the recommendations of the NRC report, *NISA* instructed the Secretaries of the Interior and Commerce to work in cooperation with the Secretary of Transportation to "conduct a ballast water management demonstration program to demonstrate technologies and practices to prevent aquatic nonindigenous species from being introduced into and spread through ballast water in the Great Lakes and other waters of the United States." In response, the Department of the Interior through the U.S. Fish and Wildlife Service, and the Department of Commerce through NOAA, created the Ballast Water Technology Demonstration Program (Program).

In 1998 at the Program's onset, few ballast water treatment technologies were sufficiently advanced to be demonstrated on ships undertaking actual voyages. Further development of technologies was needed in order to achieve the statutory goal of demonstrating the effectiveness of ballast water treatment technologies at preventing the introduction and spread of aquatic nonindigenous species via ballast water. Therefore, the Program focused on ballast water treatment technology research and development, providing opportunities for researchers to advance promising technologies from the laboratory to full-scale shipboard demonstration. The Program has also contributed to the development of improved methods and technologies required for testing ballast water treatment systems. Testing full-scale systems in a credible and economically efficient manner is requiring the development of new tools and methods. The Program is ideally situated to facilitate this key research and development effort.

Because much of the expertise in the development and demonstration of ballast water technologies is found outside the federal government in a number of academic, commercial, and entrepreneurial centers, the Program has been administered through a system of competitive grants. Federal applicants, if statutorily authorized, have been allowed to compete on an equal basis with non-Federal applicants. Each year, except 2003, the Program has called for grant proposals to support Ballast Water Technology development at any stage from laboratory research to full-scale shipboard demonstration. Proposals are evaluated by an independent technical review panel of government, academic, and private sector experts.

The NOAA National Sea Grant College Program is authorized to award grants for "research on biology and control of zebra mussels and other important non-native species" (33 USC 1131). The priorities of the Sea Grant Aquatic Invasive Species Research and Outreach Grants Program include research and development into ballast water management methods, and the Sea Grant Program works closely with the Ballast Water Technology Demonstration Program to maximize coverage and prevent duplication of ballast water related efforts.

Since the inception of the Ballast Water Technology Demonstration Program, including spending estimates for 2006, NOAA has expended over $13.2 million in support of 63 ballast water technology research and development projects. The U.S. Fish and Wildlife Service has contributed $1.9 million towards these awards, and the Program's third Federal partner, the U.S. Maritime Administration, has contributed the use of seven ships from its fleet to ballast water technology researchers to facilitate the demonstration of

technology projects. In addition, the Sea Grant program has spent $3.6 million in support of 25 ballast water technology projects.

Twenty-four different technologies have been studied, often in multiple projects spanning several years that started as bench-scale proofs of concept and matured to pilot-scale or full-scale demonstrations. The appendix shows the ballast water technology studies supported by the Program or by the NOAA National Sea Grant Program. In 2004, two ballast water treatment technologies supported by the Program received "Global Technology Innovation Awards" from the Wall Street Journal, and a third project won an "Environmental Challenge" award from the International Association of Independent Tanker Owners (INTERTANKO). In addition, the Program has directly benefited the U.S. Coast Guard's efforts to develop ballast water discharge standards and procedures and methods for testimony and evaluating ballast water treatment systems.

In 2005, the Program enhanced its capacity to support ballast water treatment technology development and demonstration. In addition to seeking proposals for individual technology development and demonstration grants, the Program sought proposals for projects to establish and maintain a research, development, testing and evaluation (RDTE) facility in the Great Lakes in 2006. This and future RDTE facilities are intended to further support the ballast water technology development efforts by increasing:

- Long-term continuity in projects;
- Standardization and quality control in experiments;
- Independence between treatment technology vendors and investigators evaluating their technologies;
- Greater engagement of ship and port interests, including at the local and regional level;
- Ease of access to necessary physical infrastructure not otherwise available for ballast water technology demonstration; and
- Coordinated regional participation in the development and use of consensus standard ballast water test methods and protocols.

RDTE facilities are also likely to play an important role in testing ballast water treatment systems for purposes of approval by the U.S. Coast Guard. As such, this component of the Program is critical to the timely availability of market-ready technology. The Great Lakes was chosen as the venue for the RDTE facility because the public and private sector interest, technical expertise and available infrastructure in this region are more advanced than elsewhere.

The state of ballast water technology has advanced since the passage of *NISA* and inception of the Program, as evidenced by the fewer laboratory-scale projects and the increased number of full-scale demonstration projects funded by the Program. In 2004, the Program adopted the programmatic priority that applications for grants to generate data needed to meet the criteria for acceptance into the U.S. Coast Guard's Shipboard

Technology Evaluation Program (STEP) would be given preference. In 2005 and 2006, the Program included a programmatic priority giving preference to grants for projects from applicants accepted into the STEP program. (Because no applicants were accepted into the STEP program in time to qualify for grants in these years, this preference has so far gone unrealized.)

The Program will continue to work closely with the STEP program, but the work of developing technologies to the point where they are eligible to be accepted into STEP is not complete. Support is still necessary to foster the development of ballast water treatment technologies, and to increase the national capability to prevent ballast water-mediated introductions of invasive species.

Great Lakes Environmental Research Laboratory

Ongoing research throughout NOAA and the federal government on ballast water, and the threats and effects aquatic invasive species can bring, is needed to improve the scientific basis for our decision-making. The Great Lakes Environmental Research Laboratory (GLERL) is NOAA's leading institution for aquatic invasive species research and for ballast water research related to the Great Lakes. GLERL has been actively engaged in research on aquatic invasive species since shortly after zebra mussels were initially discovered in our waterways. GLERL's mission is to conduct high-quality research and provide scientific leadership on important issues in both the Great Lakes and marine coastal environments, leading to new knowledge, tools, approaches, and awareness.

GLERL achieves its mission through applied research, monitoring, technology development, information synthesis and assessment, multi-institutional partnerships, scientific leadership and education. GLERL houses a unique combination of scientific expertise in biogeochemical, hydrological, ecological, physical limnology, fish ecology, and oceanographic sciences. This broad range of disciplines is needed to adequately understand and address the important and complex issues that confront the effective management of aquatic environments. Of particular relevance to ballast water management, GLERL led the first extensive biological characterization and assessment of risk associated with residual ballast water and sediment in ships declaring "No-Ballast-on-Board" (NOBOB). The U.S. Coast Guard, along with the Environmental Protection Agency, provided start-up funds for this project in FY 2000 in order to provide information upon which the Coast Guard could base an informed management position. GLERL is currently determining the effectiveness of biocide treatments, such as chemicals, heat, UV light and oxygen deprivation on the viability of resting eggs, often found in ballast water and NOBOB vessel sediments. GLERL is also working with several private companies and the U.S. Naval Surface Warfare Center to use computational modeling water flow in ballast tanks to improve understanding and maximize effectiveness of management practices and treatment mechanisms.

Ballast Water Exchange Research

The concentration of organisms in open-ocean water is much lower than in coastal areas where ships are likely to have taken on their original ballast water. Ballast water exchange consists of flushing coastal water from ballast tanks, replacing it with oceanic water. This is intended to reduce the concentration of coastal organisms, which are more likely to become established in subsequent coastal ports upon ballast discharge; in contrast, most oceanic organisms are considered unlikely to colonize coastal habitats. In addition, it is believed that most (but not all) organisms likely to survive in the Great Lakes and upper Hudson River – freshwater ecosystems - would die in saltwater because of "salinity shock," thus increasing the efficacy of ballast water exchange.

For ships bound to marine U.S. coastal waters, the effect of ballast water exchange is primarily dilution, which results in a reduction in the concentration of organisms in the ballast water. For ships entering the Great Lakes, the effect is both dilution and salinity shock.

There is not a large volume of high quality data available to assess the effectiveness of ballast water exchange. However, over the past 6 years, the Smithsonian Environmental Research Center (SERC) has conducted more than two dozen shipboard ballast water exchange experiments across four main vessel types: commercial oil tankers, container ships, bulk carriers, and Navy refuelers. The SERC research constitutes the largest body of data available on the efficacy of ballast water exchange for ships transiting U.S. waters, and the results are being compiled and documented for a report to be published jointly by NOAA and SERC later this year. The report will conclude that while there are recognized limits to the effectiveness of ballast water exchange, when the exchange is conducted according to current requirements it can be a highly effective preventive approach. Due to the difficulty of conducting on-board experiments, SERC's data are still very limited and do not completely address all aspects of the issue. However, the available evidence suggests that until something better is developed, ballast water exchange is an appropriate and useful preventive practice.

As noted above, GLERL is working with the U.S. Naval Surface Warfare Center to develop a high resolution computer model to predict and visualize the mixing and flow of water in a ballast tank, with application to the ballast water exchange process.

NOBOB Research

The issue of ships with "No-Ballast-on-Board" (NOBOB) was raised in the Great Lakes region in the mid-1990s. Technically these ships are carrying no ballast, but most have some amount of residual water in the tanks which includes sediment that can be resuspended when new ballast water is added. This resuspended sediment can therefore be discharged during ballasting operations while in the Great Lakes. When we realized that NOBOB ships could be a source for new introductions, NOAA began a research program to investigate this pathway for invasion.

Although circumstances vary from ship to ship, some water and entrained sediment usually remain in ballast tanks even after complete pump-out. The residual water and sediment can contain a wide assortment of plants, animals, and microorganisms, including so-called "resting stages" such as cysts or resting eggs. The life cycles of many invertebrates, algae (including toxic dinoflagellates), protozoa, and bacterial species include the capability of producing resting stages. Production of resting stages ensures long-term viability of the population because they are extremely resistant to adverse conditions including anoxia, noxious chemicals, freezing, and passage through digestive tracts of fish and waterfowl. Resting eggs of invertebrates and cysts of dinoflagellates usually sink when released. Resting stages may remain viable in sediments for decades or even centuries, and can germinate or come to life under a combination of favorable light, temperature, and other environmental conditions.

NOAA is particularly concerned about ballast water and sediment residuals in ballast tanks in the Great Lakes region, where over 90% of the foreign vessels entering are declared NOBOB. Consider a single ballast tank holding 1,500 metric tons of water when full. If only 0.5% of that volume is not able to be pumped, then up to 7.5 metric tons (7.5 cubic meters, or about 2,000 gallons) of water would remain. Across a ship's numerous tanks, a significant volume of ballast water and mud can remain onboard. As ballast water treatment technologies are developed and tested, their effectiveness in dealing with the NOBOB residuals should also be evaluated. NOAA (GLERL) initiated a NOBOB assessment research program in 2001 that was completed in 2005. The final report for that project is the most detailed characterization and risk assessment of NOBOB ballast residuals to date and was followed almost immediately by the U.S. Coast Guard issuing new policies, in part based on findings from the NOAA study, for ballast management of NOBOB vessels entering the Great Lakes.

In the absence of effective treatment technologies, a "best management practices" approach has been initiated, especially for the Great Lakes. The effects of different management practices on reducing the biological invasion risk associated with NOBOB tanks is an important area for research. NOAA (GLERL) initiated and is in the final year of a study to assess the practicality and effectiveness of best ballast management practices that were adopted by the shipping industry in 2000, the St. Lawrence Seaway management corporations in 2001, and more recently, the U.S. Coast Guard and Transport Canada. Additional research is needed to verify some of these practices, to develop remote measurement capabilities that allow better measurements of the amount of sediment accumulated across the entire ballast tank, and for determination of the salinity of residual ballast water.

Patterns, Corridors, and Vectors of Invasion

Preventing the movement of non-native organisms from one location to another via ballast water or other means is the only effective strategy to prevent invasions. A major barrier to planning for and preempting future invasions is trying to identify where future species invasions may originate, and which species may pose the highest potential risk of successfully invading that ecosystem. Comprehensive analyses of recent and past

patterns of species invasions by coastline, region, or coastal ecosystem may help to identify the most significant invasion corridors or pathways by which invasive species arrive in our coastal ecosystems. Monitoring and analyzing global trade and shipping patterns may be able to help identify future shifts in likely invasion corridors leading to the United States. These analyses may help determine which species are capable of invading U.S. coastal ecosystems.

Federal Coordination and Cooperation

The efforts of NOAA, and other federal agencies and organizations, have demonstrated how coordination and cooperation can improve our effectiveness in addressing the environmental and economic damage caused by aquatic invasive species that enter our waterways, including through a ship's ballast. The interagency Aquatic Nuisance Species Task Force set up under *NANPCA* has fostered much of this activity. The Task Force is chaired by NOAA and the U.S. Fish and Wildlife Service, and has eight other federal members and thirteen *ex officio* members representing other levels of government. In addition, two invited observers from Canada's Federal Government participate. This pattern is repeated with even stronger state government and other stakeholder involvement on each of the Task Force's six Regional Panels. For example, similar coordination is occurring at a regional level around the Great Lakes where the Regional Working Group, representing 11 federal agencies, was established by Presidential Executive Order in May 2004.

The Aquatic Nuisance Species Task Force is not the only entity working on such coordination. Executive Order 13112 created a National Invasive Species Council (NISC) to help coordinate invasive species actions more broadly. NISC currently has representatives from thirteen federal departments and agencies, and is a policy and coordinating body. In order to give structure to the federal government's efforts in addressing invasive species issues, NISC prepared a comprehensive *National Management Plan*, which specifically addresses ballast water. Similarly, a number of executive agencies are working together on the Security and Prosperity Partnership that was set up with Mexico and Canada in which ballast water has been identified as an area of cooperation related to the movement of invasive species.

Ballast water research is an excellent example of federal interagency collaboration and cooperation. It is not an exaggeration to state that we often are in contact with other federal agencies on ballast water issues several times a week. Regular meetings take place among the federal partners to address specific aspects of the ballast water issue. Our federal partners include the U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Maritime Administration, the U.S. Geological Survey, and the Department of Defense.

At an international level, an interagency working group under the leadership of the U.S. Coast Guard has been responsible for the development of United States' position on ballast water management at the United Nations' International Maritime Organization. The United States' contribution to this process has been significant. The U.S. delegation

greatly influenced the overall framework of the Convention, and led the effort that resulted in several key provisions including: more stringent measures, sampling for port state control, concentration based standard, and phase out of ballast water exchange. The U.S. has also been heavily involved in the development of fourteen sets of technical guidelines.

Comments on the *Ballast Water Management Act*

At this time, the Administration has not formed official views on the discussion draft. The Departments of Commerce, Defense, Homeland Security, Justice, State and Transportation, the Environmental Protection Agency, and others are currently reviewing the document. The comments that follow represent the Administration's preliminary, informal views on the discussion draft. The Administration appreciates the Subcommittee's efforts to address the ballast water issue and stands ready to work with the Subcommittee to ensure the bill's progress. The Administration will provide detailed official views in the near future.

While preferring full reauthorization of the *NANPCA*, the Administration is willing to work with drafters to focus on ballast water, given that it is an immediate, pervasive, and well-known vector for introduction of invasive aquatic species. However, there are major concerns with the discussion draft. The International Maritime Organization (IMO) has agreed to the text for an International Convention for the Control and Management of Ships' Ballast Water and Sediment (Convention), and because of the international nature of shipping, the Administration believes it is important that the approach taken in domestic legislation must be compatible with the structure and framework of the international provisions. S. 363 closely tracks the approach in the Convention, and the Administration is willing to support the approach taken in S. 363 if modifications are made. We strongly recommend the Subcommittee consider this approach as well.

At this time, the Administration would like to highlight some, but not all, concerns with the discussion draft:

A number of provisions in the discussion draft are problematic and could actually delay reaching the goal of effective ballast water management. Proposed section 1102(h) requires surveys on the number of organisms in untreated ballast water and in exchanged ballast water. Several surveys have already been conducted in both of these areas, and results are available in published literature. Under the Convention, discharge standards are applicable to some vessels on which construction is initiated after January 1, 2009. With a 36-month deadline for review of alternative ballast water management methods before domestic standards would be proposed, proposed section 1105 makes it unlikely that the shipbuilding industry will have adequate lead time to meet that date.

Even though the U.S. Government proposed a more stringent discharge standard at the diplomatic conference that drafted the Convention, the standard specified in the discussion draft is weaker than the IMO standard. The discussion draft only explicitly requires regulation setting the upper standard of 10 viable organisms greater than or equal

to 50 micrometers per cubic meter of water ((Sec. 6 of the draft bill setting forth a new Sec. 1104(a)(4)), while the Convention has a standard that includes organisms between 10 and 50 micrometers and standards for pathogens (Regulation D-2). Organisms in the smaller size category include dinoflagellates that cause harmful algal blooms. In both Australia and France, harmful algal blooms have been caused by organisms introduced in ballast water. The Department of Commerce previously testified that it had concerns with even the IMO standard since it allowed so many organisms that technically constitute a "harmful algal bloom" by the definition used to shut down shellfish beds. In general terms, the Administration prefers to see a standard that would encourage development of new technologies rather than being based on currently available technology – i.e., fewer organisms per cubic meter of water.

Also of concern is the exemption from regulations provided to participants of STEP (Sec. 6 of the draft bill setting forth a new Sec. 1104(a)(4)). In particular, the Administration is concerned with the scope and timing of how exemptions for STEP systems would operate. S. 363 includes a more targeted exemption for STEP participants with a defined time limit, which the Administration supports.

The Administration is concerned that the discussion draft would change the nature of our Ballast Water Management Demonstration program. Most of the projects funded to date have involved controlled experiments at laboratory or pilot scale so that basic research could be conducted leading to development of alternative technologies that would be effective and practicable when used on board ships. One of the objectives of the demonstration program has been to facilitate the availability of shipboard systems eligible for inclusion in the U.S. Coast Guard Shipboard Technology Evaluation Program (STEP). Although NOAA already has indicated that it would give priority to projects approved for the STEP program, the discussion draft would restrict projects only to the STEP program when one of the priorities should be development and testing of new technologies at the research and development stages prior to that which could be used in the STEP program. The current program has the flexibility to focus resources on shipboard tests, either within or separate from STEP, as circumstances warrant. The Administration also is concerned that the interagency cooperative nature of the current program would be changed. *NANPCA* currently provides that the Ballast Water Management Demonstration program is to be a joint effort of both the Department of Commerce and the Department of the Interior. The U.S. Fish and Wildlife Service (FWS) has made a significant contribution to the program. In addition, even though there is no statutory mandate to do so, the Maritime Administration (MARAD) of the Department of Transportation has become a key partner in this program. NOAA, FWS, and MARAD currently put out a joint request for proposals and conduct a joint peer review of the proposals received. NOAA believes that the program is a good example of how different agencies can work together to reach a common goal.

The discussion draft would exempt vessels engaged in coastwise trade (within the EEZ) from the requirement to meet the discharge standard. This would greatly compromise the protectiveness of the resulting regulatory regime, as coastwise vessels would then facilitate the dispersal of harmful aquatic organisms introduced by other pathways.

Additional technical concerns have been raised which will be included in the Administration's detailed views.

Conclusions

We only have to look at the spread of zebra mussels, and the continuing efforts to manage them and other invasive species that have come to our shores through ballast water, to realize that we will be living with the consequences of past introductions for a long time to come. While we may have made progress towards reducing the risks associated with ballast water — the most significant pathway for introductions into coastal areas and waterways — much more remains to be done. We are also optimistic that ongoing research will lead to a number of promising technologies that will enhance our ability to address ballast water transfer of aquatic invasive species.

We appreciate the opportunity to provide testimony on the draft Ballast Water Management Act, and we appreciate the Committee's efforts to address this important issue.

This concludes my testimony and I would be happy to respond to any questions that members of the Committee may have.

APPENDIX

Ballast Water Technologies studied under the Ballast Water Technology Demonstration Program and National Sea Grant College Program (# of projects)

Chemical Biocides:

- Carbon Dioxide (1)
- Chlorine / Chlorine Dioxide (1)
- Ferrate Ion (1)
- Gluteraldehyde (2)
- Halogens (1)
- Hydrogen Peroxide (2)
- Juglone (1)
- Menadione (2)
- Ozone (8)
- Peracetic acid (2)
- Sodium Hypochlorite (1)

Separation:

- Filtration (including Media & Screen) (10)
- Vortex/Hydrocyclone (4)
- Centrifugation (1)

Energy:

- Acoustic (6)
- Microwave (1)
- Thermal (4)
- Ultraviolet (6)

Practices/Other:

- Coagulation (1)
- Depressurization (1)
- Deoxygenation (5)
- Exchange (7)
- Onshore Treatment (3)
- Design of Ships or Tanks (4)

Related Research:

- Assessment (1)
- Microorganisms (6)
- Monitoring / Standards (5)
- No-ballast-on-board (NOBOB) ships (2)
- Outreach (2)
- Toxicity Analysis (1)