Ballast Water News

Global **Ballast Water** Management Programme

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From the Editor

Welcome to the first quarter of 2002, and the commencement of our third year of operation. In this 8th issue of Ballast Water News, we offer a mixed-bag of articles covering a range of subjects. We are honoured to welcome Mr Klaus Töpfer, Executive Director of United Nations Environment Programme (UNEP), as Guest Speaker. UNEP has a vital interest in the issue of invasive species, and IMO and GloBallast are working to form strategic alliances with UNEP and others in our quest for marine environmental protection.

A significant event in March was the 47th meeting of IMO's Marine Environment Protection Committee (MEPC), and we report on the substantial progress made towards finalising the new international ballast water Convention.

The potential for pathogens to be transferred in ballast and the resulting public health concerns remain a hot topic. Dr Gloria Casale of the US Health Resources and Services Administration provides a timely review and the scenario presented is somewhat sobering. When you consider that more than 10,000 people were reported to have died in South America in the early 1990's from an apparently ballast-mediated cholera epidemic, one must ask if the current investments being made by governments and industry to address the transfer of pathogens in ballast water are adequate.

A major achievement this quarter was the commencement of the long-awaited ballast water risk assessments at the six GloBallast Demonstration Sites. These will significantly enhance the ability of countries to manage ballast water transfers more effectively, and we feature an article on our risk assessment approach.

An important source of data for the risk assessments is the Ballast Water Reporting Forms collected from arriving ships. Concerns have been expressed about the completeness and validity of data on these forms. We describe an innovative proposal to use electronic sensors and satellite communications to overcome this problem, by automatically transmitting data on ship-board ballast water practices to shore-based authorities. We also feature a proposed new design for an alternative ballast water exchange method, from Teakay Shipping.

Under the original GloBallast workplan, this was to be our final year. In January, our 3rd Global Task Force meeting considered a case to extend activities by 12 months. We are pleased to announce that this was unanimously approved, and we report on the meeting on page 10.

We complete this issue with a review of a new book published by the Turkish Marine Research Foundation, on exotic species in the Aegean, Marmara, Black, Azov and Caspian Seas.

It is clear from the first three months that 2002 is shaping up to be another exciting and active year in the world of marine bio-invasions, bringing us slowly but ever closer to a solution to this major marine malady.

Steve Raaymakers
Contributing Editor

From the Programme

In January 2002 we held our 3rd Global Task Force meeting in Goa, India. This offered an opportunity to assess the achievements of the six Pilot Countries, to identify shortcomings and to plan future activities.

The meeting benefited from the participation of high ranking officials from the Government of India, the Chairman of the IMO Marine Environment Protection Committee and experts from the shipping industry and international environmental NGOs. The meeting prompted extensive media coverage that proved the efficiency of the successful awareness campaign conducted by India.

In 1997, when the GloBallast Programme began to be designed, the international community was planning to adopt a regulatory regime for ballast water transfers by 2001. Under this assumption the activities of GloBallast were structured to achieve two main development objectives: to increase adherence to the existing IMO Guidelines and to assist Pilot Countries in implementing the anticipated Convention. Due to the complexity of the issue, the negotiations between IMO Member States have taken longer than expected and the adoption of the Convention is now scheduled for 2003.

This change in the initial assumptions and the absence of a Convention, made it premature to embark on the Compliance Monitoring and Enforcement component of the Programme and some other activities such as the Legislative Review and Training have been limited to the requirements of the existing IMO Guidelines.

The time gap created between the scheduled end of GloBallast in March 2003 and the possible adoption of the new Convention also threatened losing the unprecedented momentum of concerted international action that has been precipitated by the Programme. In order to address all these aspects the Task Force decided to extend the Programme by 12 months, to March 2004.

In addition to this extension, as reported previously the PCU is also developing plans for the continuation of GloBallast beyond the nominal end of the current phase. This is driven by the shift in the likely timing of the new Convention combined with an increasing demand for programmatic support and technical assistance in the ballast water area. The Task Force asked the PCU to prepare a project document in this respect and to explore possibilities of enhancing co-operation with existing regional marine programmes, such as 'sister' GEF International Waters projects and the UNEP Regional Seas Programme. The next phase will focus on regional replication of what has been achieved in the six Pilot Countries.

The warm hospitality of the Indian Government and the dedication of the CFP and his team made the 3rd Global Task Force meeting a major success. The next meeting is scheduled for the end of October 2002 in Dalian, China.

Dandu Pughiuc
Chief Technical Adviser

Ballast Water News is the quarterly newsletter of the Global Ballast Water Management Programme (GloBallast). GloBallast is a cooperative initiative of GEF, UNDP and IMO to assist developing countries to reduce the transfer of harmful organisms in ships' ballast water, through the implementation of IMO ballast water management guidelines.

For further information please contact:

Programme Coordination Unit, Global Ballast Water Management Programme
International Maritime Organization, 4 Albert Embankment, London SE1 7SR, UK
Tel +44 (0)20 7587 3247 or 3251. *Fax* +44 (0)20 7587 3261
Email dpughiuc@imo.org or sraaymak@imo.org *Web* http://globallast.imo.org

Guest Speaker

Mr Klaus Töpfer
Executive Director - UNEP

Klaus Töpfer became Executive Director of the United Nations Environment Programme and Director-General of the United Nations Office at Nairobi in February 1998. He is also Under-Secretary General of the United Nations.

Before joining the UN, he held several posts in the Government of Germany, including Minister of Regional Planning, Building & Urban Development and Minister of the Environment, Nature Conservation & Nuclear Safety. Prior to joining the Federal Government, he was State Minister of Environment & Health and formerly Secretary of Social Affairs, Health & Environment for Rhineland-Palatine.

Before his political career, Mr Töpfer was Full Professor at the University of Hannover (1978-1979), Head of the Department of Planning and Information in the State of Saarland (1971-1978) and Head of Economics at the University of Münster (1970-1971). He holds a doctorate in Philosophy and a degree in Economics.

Thousands of marine species are carried daily in ships' ballast water, on voyages that may transport them hundreds or thousands of kilometres to new environments. While the majority of these species do not survive, shipping has nevertheless become an important dispersal vector for marine species. Should a newly introduced species establish and multiply into pest proportions, impacts can be severe. UNEP considers invasive species to be one of the major threats to global biodiversity.

While vectors for invasive marine species extend well beyond shipping, in order to effectively address this problem, the shipping industry must do all it can to decrease, if not eliminate, the amount of living material that it disperses around the globe, however difficult this may be. This is a task that must be tackled with diligence and urgency, as marine bio-invasions continue to increase at an exponential rate.

Considering the variety of pathways for marine bio-invasions, including non-shipping vectors, one important issue for the Regional Seas Programme of UNEP is the implementation of guidelines and action plans to curb the dispersal of invasive species. The Regional Seas Programme was established in 1974 to bring coastal nations together in a common commitment to prevent degradation of marine ecosystems and their resources. Since invasive species have become a major threat, the issue is becoming a central part of this programme.

Within the UN system, IMO has the mandate and responsibility for addressing ship-sourced marine pollution. IMO is now taking the lead to develop an international legal instrument on ballast water management. It is gratifying that IMO recognizes marine bio-invasions as a priority and in 1997 adopted guidelines that recommend, among other things, that ships undertake ballast exchange at sea. Currently, this might well be the best practical option to reduce the risk of transfer of harmful organisms to coastal areas. However, the shortcomings of this method must be acknowledged and addressed, namely that (a) it is not fully effective in removing organisms from ballast water and (b) it might also in many cases be subject to ship-safety limits.

It is my understanding that various R&D groups around the world are seriously exploring alternative methods for treating ballast water. These groups should be commended and supported in their endeavours in order to expedite implementation of a more effective solution.

The goal of UNEP is to promote initiatives that would properly control all marine bio-invasions, in an integrated and holistic manner. Towards this end, UNEP supports collaboration and cooperation with various organizations, including the GEF/UNDP/IMO Global Ballast Water Management Programme (GloBallast), and its efforts to assist developing countries.

It is further gratifying that the Convention on Biological Diversity (CBD) has a thematic Work Programme that deals with marine and coastal biodiversity, including marine bio-invasions. CBD is also managing the Global Invasive Species Programme (GISP). GISP is reviewing the current knowledge base and developing new tools and approaches to deal with invasive species both, terrestrial and aquatic. The role of CBD through its various processes is particularly crucial in this regard.

The issue of marine bio-invasions is also included in the Global International Waters Assessment (GIWA), an initiative led by UNEP. The aim of GIWA is to produce a comprehensive and integrated global assessment of the ecological status and the causes of environmental problems in international waters. Because of their impact on ecosystems, the assessment of marine bio-invasions through ballast water and other vectors is an inevitable indirect task for GIWA.

In order to achieve proper control of invasive marine species, UNEP will continue to support and cooperate with other organizations and programmes. It is hoped that through the efforts of IMO and the GloBallast Programme, the ballast water aspect of this broader problem will be effectively addressed, including rapid adoption and entry-into-force of the new international ballast water Convention.

Klaus Töpfer

~~~ NEWSFLASH ~~~

BW Treatment Goals & Standards

US Coast Guard Calls for Comments

The US Coast Guard has placed a Notice in the US Federal Register *(Vol. 67, No. 42, 4 March 2002)* requesting comments on three options for 'Goals' and four options for 'Standards' for ballast water treatment.

Submissions must follow a prescribed procedure and close on 3rd June 2002.

The Notice can be viewed and downloaded from ***http://dms.dot.gov***

Select 'Search' and enter "USCG", "2001", and "10486" for the Agency, CY and Document ID, respectively.

Further Information:
Dr Richard Everett, USCG, reverett@comdt.uscg.mil

Convention Update

From 4 to 8 March 2002 the IMO Marine Environment Protection Committee (MEPC) held its 48th meeting in London, and through its Ballast Water Working Group, continued to make progress on finalising the text of the new *International Convention for the Control and Management of Ships' Ballast Water and Sediments.*

Under the Chairmanship of Mr Mike Hunter of the UK, the Working Group was well attended with some 112 participants representing 39 Member States, one Associate Member and observers from 13 Inter-Governmental and Non-Governmental Organizations.

As instructed by the MEPC Plenary, the Working Group addressed the development of ballast water treatment standards as a first priority, and following extensive consideration a number of points of principle emerged.

The Group agreed that ballast water exchange would be one of the tools within the Convention, alongside one or more treatment standards. There will be provision for the review of both ballast water exchange and treatment standards based upon submissions to IMO in view of developing technology. The Group considered that it was essential to signal the treatment standard that would be the ultimate target, though opinion was divided as to whether this should form part of the Convention or be part of a supporting resolution.

It was clear that only a 100% removal or inactivation standard can be guaranteed to be effective in eliminating the transfer of unwanted organisms and pathogens, but that best currently available technology is unlikely to be able to achieve this. A large proportion of the Group was of the opinion that a 95% reduction would achieve a worthwhile reduction of risk and would be a practicable and achievable solution in the medium term.

The Group was also divided over the need for a more stringent Tier 2 standard; some expressing the view that a robust Tier 1 standard would avoid the need for additional measures in defined areas. Depending on the choice of standards, there may be a need for a single global standard, or alternatively for a range of standards.

For this reason the Group identified a range of standards for further evaluation and MEPC established an inter-sessional Correspondence Group to:

- carry out a detailed comparative assessment of each of the proposed standards, taking into account the various technologies that might be used to achieve these standards and all other relevant factors and considerations; and
- prepare a report to MEPC 48 with recommendations that will enable MEPC to decide on the standards that should be included in the text of the Convention.

The Correspondence Group is being coordinated by Mr Fred Kenney of the United States.

Significantly, a proposal of the Oil Companies International Marine Forum (OCIMF) that interim ballast water treatment standards should be recommended, prior to the entry into force of the Convention, gained support from many countries.

The Group then turned to the further development of the text of the Convention. The major element, which had not previously been addressed, was the section on Special Requirements in Certain Areas, or Tier 2. The Group developed criteria for establishing ballast water discharge control areas, and requirements for ships discharging ballast water within such areas. This text is necessarily provisional until decisions have been taken regarding the choice of one or more ballast water treatment standards. Japan reserved its position on the text that was prepared. In line with the recommendations of the IMO Legal Office, the text is based on the principle that areas are either designated within the Convention or are approved by IMO. A number of delegations expressed concern about the use of this principle and the United States in particular, reserved its position, saying that it may not support IMO approval as a pre-condition for the designation of areas under US jurisdiction which it may consider to be in need of special protection.

The Working Group also had an extensive discussion on proposals put forward by Brazil regarding the concept of acceptable ballast water. The Group agreed that the concept of acceptable ballast water was linked to the development of treatment standards and the use of risk assessment techniques, particularly in relation to exemption provisions. Brazil expressed the intention of presenting a document to MEPC 48 on the use of Scientific Multicriteria Decision Aid Methodologies in establishing the ranking of ballast water treatment techniques.

It was agreed that the text of the Convention should be further refined before consideration by MEPC 48 in October 2002. With the aim of maintaining the objective of holding a Diplomatic Conference to consider adoption of the Convention in 2003, it was agreed to hold an inter-sessional meeting of the Ballast Water Working Group in advance of MEPC 48.

During the final Plenary several countries once again highlighted the urgent need for this Convention to be finalised, adopted and to enter-into-force as soon as possible, or the shipping industry will continue to face the spectre of proliferating unilateral regulation.

(adapted from the Ballast Water Working Group Chairman's oral report to MEPC Plenary)

SR

Ballast Water - a Public Health Issue?

For six hundred years leaders in the health and maritime industries have recognized the international transport of disease as a public health threat. As early as the fourteenth century it was understood that plague epidemics moved along maritime trade routes. The concept of quarantine originated in Venice. Ships were required to stay at anchor off shore for forty days (a quaresma) and were not allowed to enter the port until there was reasonable assurance the ship was disease free.

Although there was no understanding of the germ theory in the 1300s, the effects of disease transmission were well known. In 1347 several ships returned to Venice from Constantinople and the Black Sea bringing Bubonic Plague, the Black Death, to a population that was immunologically vulnerable. By 1348 the disease had spread to Paris and was transmitted to London within a few months. All aspects of society were thrown into turmoil; including religion, government, trade and agriculture. During the course of this epidemic the population of Europe was decimated, with the mortality rate reaching over sixty five percent in many cities. Historians report that it had significant effects on the economy of Europe for two hundred years.[1]

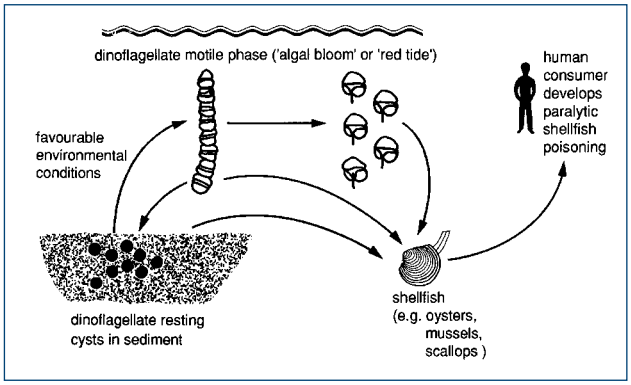
Scientific research has established that human pathogens are transported in ballast water of ships.[2] Public Health professionals were astonished to discover that *Vibrio cholerae* could invade some species of algae, then enter a dormant state awaiting favorable conditions that facilitate its re-emergence as an infectious agent.[3]

The first call for research that would define the extent to which ballast water was a potential vector for the dissemination of disease came at IMO in 1973. Since then, research has confirmed that ballast water can carry *V. cholerae,* multiple viruses, *Escherichia coli* and other pathogenic forms from port to port around the world.[4] The load of bacteria and viruses in the ballast water of ships, as well as the biofilm that lines the ballast tanks, is substantial. Further, credible scientific evidence exists inferring that ballast water exchange at sea does little to decrease the content and concentration of these pathogens and may actually stimulate and increase the bacterial and viral load.[5] A recently published article confirms that pathogens that have been identified in ballast water include *Clostridium perfringins, Salmonella species, Escherichia coli, Vibrio cholerae,* and enteroviruses.[6]

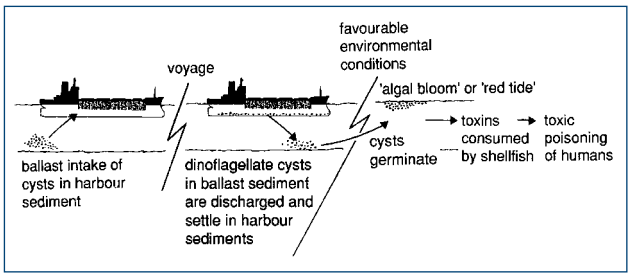
The water in many international ports is highly contaminated with sewage and agricultural run-off. High concentrations of pathogens can be taken up in the millions of gallons of ballast water needed to stabilize a ship and subsequently can be transported throughout the world.

In addition to bacteria and viruses, ballast water can also transfer a range of species of micro-algae, including toxic species that may form harmful algae blooms or 'red tides'. The public health impacts of such outbreaks are well documented and include paralytic shellfish poisoning, which can cause severe illness and death in humans.

Satellite Image of Harmful Algae Blooms in The Gulf



Life cycle of toxic algae (dinoflagellates)



Transfer of dinoflagellate cysts in ballast water

Three factors combine to prevent the elimination of microorganisms from ballast tanks by exchange at sea.

First, currently there is no mechanism for totally emptying the ballast tanks on the high seas.[7] A residual amount of ballast water and sediment always remains in the tanks.[8]

Second, the greatest source of continuing contamination of the ballast water is the biofilm produced by the microorganisms and macro organisms in the ballast tanks. The biofilm is a tough impermeable polymeric matrix that adheres to the inner surfaces of ballast tanks. The biofilm is largely unaffected by exchange at sea and resistant to most proposed methods of removal.[9] In fact, the biocide concentrations necessary to inactivate pathogens imbedded in the biofilm matrix are orders of magnitude higher than that necessary to kill pathogens that are suspended in water.[10] Accumulating research demonstrates that biofilm provides a protective environment for pathogenic bacteria. This is consistent with the conclusion that the biofilm is causally related to pathogen transmission.[11]

Third, following exchange at sea the environmental conditions in the ballast tanks may favour a population expansion. In fact, when conditions are favourable the

numbers of disease producing organisms can reach levels considerably higher than were recorded before the exchange.[12] Although the salinity of the exchanged water in the ballast tanks can be higher and the water temperature can be lower, the conditions for expanded growth are more favourable because the flushed sea water will likely contain more oxygen and less nitrogen.

When a ship arrives at a port and discharges its ballast water the possibility of contaminating the local waters with foreign bacteria, viruses, plankton, crustacea, copepods, etc. is initiated. This begins a cycle of pathogen transport that continues as ships enter and leave the port taking on and discharging their ballast water. Even ships that are only involved in coastal trade and never leave the territorial waters of their homeland can transport foreign organisms to each of their ports of call. The ballast water of all ships is a potential source for the dissemination of pathogens as well as macro organisms.

The threat of human disease dissemination via ballast water is greatly increased in developing countries. Any lack of sanitation and inadequate treatment of domestic drinking water supplies leave populations highly susceptible to epidemic diseases that are carried to their harbours and estuaries in ballast water. However, it is important to realize that drinking water that is derived from a fresh water source proximate to a port is also at risk. Any break in the water purification system leaves the population served by that source of water susceptible to disease. The Milwaukee Experience, a massive *Cryptosporidium parvum* outbreak in April 1993, provides an important lesson.

It should be noted that this epidemic was not caused by ballast water. Nevertheless it underlines the important potential for the spread of waterborne diseases everywhere, including in highly developed countries. In essence, this epidemic affected 400,000 people, hospitalized more than 4,000 and caused the deaths of 110, due to a fault in the water purification facility that drew water directly from Lake Michigan to distribute to the citizens of Milwaukee.[13] The economic impact of this outbreak was estimated at more than $54 million.[14]

Another public health danger is that shellfish beds that provide a food source for human consumption can be contaminated by *V. cholerae* and many of the Hepatitis viruses carried in the ballast water. An event of this type would negatively impact the local economy as well as the health of the public. An incident involving the discharge of ballast water in Mobile Bay, Alabama provides an example of this mode of dissemination. In addition to finding *V. cholerae* in the ballast water of ships entering Mobile Bay it was detected in local oysters and finfish.[15] During routine monitoring, the US Food and Drug Administration isolated toxigenic *Vibrio cholerae* O1, serotype Inaba, biotype El Tor from oysters and intestinal contents of an oyster-eating fish taken from closed oyster beds in Mobile Bay.[16] This isolate was indistinguishable from the Latin American epidemic strain and differed from the strain of *V. cholerae* O1 that is endemic to the Gulf Coast.

Vibrio Cholerae

There have been cholera epidemics directly associated with the international carriage and discharge of ballast water. An epidemic that began simultaneously at three separate port cities in Peru in 1991 swept across South America affecting more than a million people and killing eight thousand.[17] By 1994 ten thousand people were reported to have died from the cholera epidemic, but most experts agree that this number underestimates the actual mortality because of underreporting. Of interest, this strain had previously been reported only in Bangladesh.[18]

Since 1973, 91 cases of cholera have occurred in the United States that were unrelated to international travel. Most of these followed consumption of raw or undercooked seafood harvested from the US Gulf Coast contaminated with the Gulf Coast strain of *V. cholerae* O1.[19] *V. cholerae* is a common component of freshwater and marine habitats. When a novel genotype arrives via ballast water, local conditions may favor its establishment.[20] It is these foreign strains of *V. cholerae* that pose a significant heath risk for coastal populations.

In view of the available evidence it is reasonable to conclude that pathogens are carried in the ballast water of ships. Further, the links between these pathogens and human disease is well documented. However, the degree to which disease develops in coastal populations as a result of the transmission of foreign pathogens has not been fully evaluated. Regrettably, there are no studies that determine the incidence of gastrointestinal or diarrheal disease in port cities during the summer season. This fundamental public health inquiry has not been adequately explored.

Recently, nations have expressed an understandable concern regarding the possible exposure of their populations to foreign human pathogens. Still, the importance of ballast water as a source for the transportation and introduction of disease is largely ignored. Available data support the conclusion that ballast water is a potential mode of international dissemination of disease. Ballast water is a biological time bomb liable to engender significant disease in vulnerable populations anywhere in the world.

Gloria A. Casale, MD, MSPH
ATPM Fellow in Healthcare Policy Development
US Health Resources and Services Administration
Gloria_Casale@msn.com; Gcasale@hrsa.gov

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Risk Assessments Underway

The development objectives of the GloBallast Programme are to assist developing countries to implement the existing IMO ballast water guidelines (A.868(20)) and to prepare for the introduction of the forthcoming ballast water Convention.

The IMO guidelines offer port States flexibility in determining the nature and extent of their national ballast water management regimes. This flexibility is warranted given that nations are still experimenting with approaches. A port State may wish to apply its regime uniformly to all vessels that call at its ports, or it may wish to assess the relative risk of particular trading routes/and or vessels to valuable resources and apply the regime selectively.

Uniform application or the 'blanket' approach offers the advantages of simplified administration and no requirement for 'judgement calls' to be made. In addition, this approach demands substantially less information management effort. Finally, it offers greater protection from unanticipated invaders, as overall protection is not dependent upon the quality of a decision support system that may not be complete. The primary disadvantage of the blanket approach is additional cost to vessels which otherwise might not need to take action.

Some nations are experimenting with systems to allow more selective applicability of ballast water management requirements, based upon voyage-specific risk assessments. This 'selective' approach offers to reduce the numbers of vessels subject to ballast water controls and monitoring. This is especially attractive to nations that wish to reduce introductions of target species only. More rigorous measures can be justified on ships deemed to be of high risk if fewer restrictions are placed on low risk vessels. However, this approach places commensurate information technology and management burdens on the port State and its effectiveness depends on the quality of the information supporting it. This approach may also leave the country/port vulnerable to unknown risks from non-target species.

For countries/ports which choose the selective approach, it is essential to establish an organized means of evaluating the potential risk posed by each arriving vessel, through a Decision Support System.

Before a port State decides on whether to adopt the blanket or the selective approach, some form of general risk assessment needs to be carried out for each port under consideration. Ballast water risk assessments can be classified into three categories:

- Qualitative risk identification – this is the simplest approach, and is based on subjective parameters drawn from previous experience and expert opinion, resulting in simple allocation of 'low', 'medium' and 'high' risk.
- Semi-Quantitative Ranking of Risk – this 'middle' approach seeks to increases certainty and minimise subjectivity by introducing quantitative data wherever possible.
- Quantitative Risk Assessment – a full, mathematical analysis of the risk of ballast water introductions, requiring significant inputs of a large variety of data, including on target species, environmental conditions, individual ship and voyage characteristics, management measures applied and evaluation and input of all uncertainties. Such an approach requires a high level of resourcing and sophisticated techniques that are still under development.

GloBallast is undertaking initial, first-pass risk assessments for each of the six Demonstration Sites of Sepetiba, Dalian, Mumbai, Kharg Island, Saldanha and Odessa. To maximise certainty while seeking cost-effectiveness and a simple, widely applicable system, we have selected the 'middle' approach.

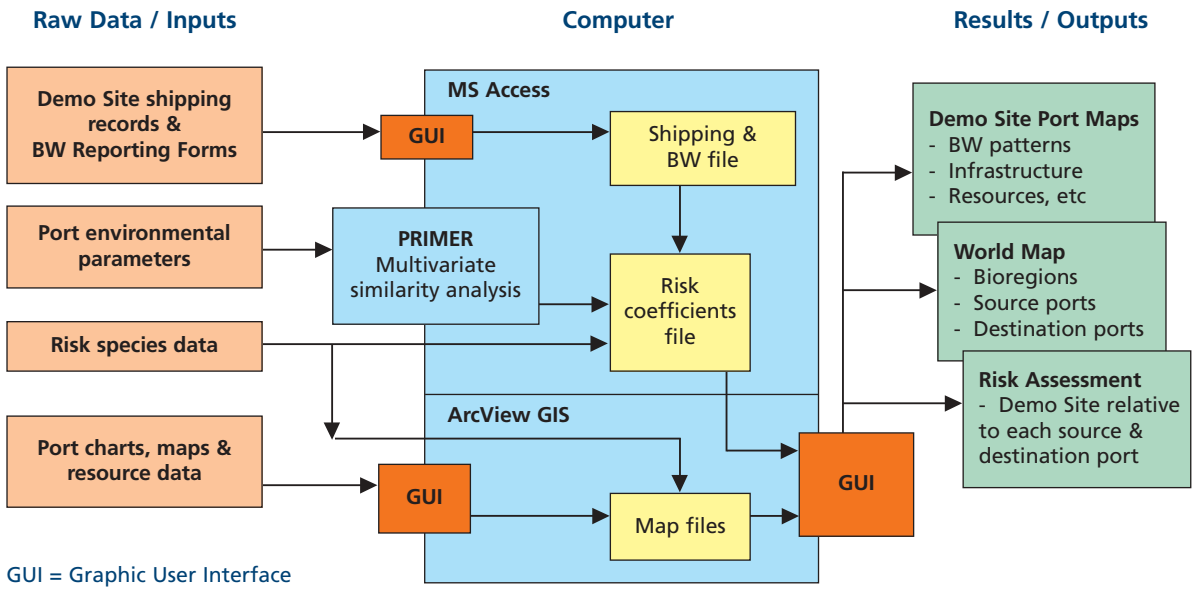
The GloBallast risk assessments are looking at shipping arrival patterns and identifying the source ports from which ballast water is imported. Once these are identified, source port/discharge port environmental comparisons are carried out to give a preliminary indication of overall risk. This will help determine the types of management responses that are required, and provide the foundation blocks for developing more sophisticated ballast water Decision Support Systems.

The risk assessments are being undertaken by international consultancy companies URS and Meridian Pty Ltd, led by Dr Rob Hilliard and Mr Rob Healy respectively, on contract to the GloBallast PCU. The first country visits commenced with Ukraine in February 2002 and are now well underway. The consultants are working with and training country counterparts at each Demonstration Site, as part of the capacity building objectives of the programme. The aim is to establish a fully trained risk assessment team in each country, equipped with the necessary skills, hardware and software to undertake further ballast water risk assessments, both at additional ports within their countries and in their surrounding regions in future.

The Ukraine Risk Assessment Team

In responding to the GloBallast brief for this project, the consultants at URS and Meridian have developed an innovative, modular approach that integrates three computer packages, as shown in Figure 1.

Fig 1: Schematic of Ballast Water Risk Assessment being trialled by GloBallast



GUI = Graphic User Interface

(Adapted from URS)

Firstly, a customised and standardised MS Access database is established at the nominated in-country agency for the ongoing entry, management and analysis of the IMO Ballast Water Reporting Forms collected from arriving ships. This database, combined with other shipping records held by the port, is used to identify source and destination ports. The GloBallast Pilot Countries started collecting the Ballast Water Reporting Forms some 12 to 18 months ago. This is a fundamental and essential first basic step for any port State wishing to commence a ballast water management programme.

All coastal and marine resources (biological, social/cultural and commercial) in and around the port that might be impacted by marine bio-invasions are mapped onto ArcView Geographic Information System (GIS), along with map layers of port infrastructure and interactive depictions of the port's de-ballasting/ballasting patterns, including locations, times, frequencies and volumes of discharges and uptakes.

Any high risk species present at the source ports that might pose a threat of introduction to the Demonstration Site, and any high risk species present at the Demonstration Site that might be exported to a destination port, are identified, using all available data sources. These include the biological baseline surveys completed recently at each site under the GloBallast Programme, and various databases such as those under development by the Smithsonian Environmental Research Center (SERC), the Australian Centre for Research on Introduced Marine Pests (CRIMP) and the Global Invasive Species Programme (GISP).

Environmental data, including sea temperature, air temperature, salinity, rainfall and tidal regimes, is collected from available sources for both the Demonstration Site and all source and destination ports.

The environmental data is analysed by PRIMER, a versatile multivariate analysis package, to generate similarity coefficients comparing the Demonstration Site with each of its source ports and destination ports. This environmental matching combined with the risk species analyses, provides the underlying basis of the risk assessment, allowing highest and lowest risk ports to be identified. Where port data is lacking, bioregions are used to support the environmental matching.

The overall package is topped-off through the presentation of results on interactive port and world map layers, using the ArcView GIS. Raw data and inputs are entered and results and outputs are viewed graphically through the Graphic User Interface (GUI), enhancing the user-friendliness and management utility of the system.

The risk assessments are scheduled for completion by the end of 2002, and will mark another major achievement of the GloBallast Programme. The approach adopted is not the only one available, but we believe that it combines the best elements of a semi-quantitative approach to provide an optimum result within the limited available budget (US$250,000 across six countries).

The outputs will include published reports, trained risk assessment teams and operational risk assessment systems for use as demonstration tools in each of the six main developing regions of the world. The geographical spread and broad representativeness of the regions mean that the final results will help plug a very large gap in the existing global knowledge base. This will place governments, scientists, the shipping industry and the general public in a stronger position to deal with the ballast water 'problem'.

Further Information:
sraaymak@imo.org

Modelling Ballast Water Discharges

The fate of pollutants in the marine environment, including organisms discharged in ballast water, is largely dependent on hydrodynamics, including currents, tides and waves and also winds. The prediction and modelling of hydrodynamics is a proven tool in studying the fate of pollutants in the sea. Computational fluid mechanics and hydrodynamic modelling allow the study and prediction of the behaviour of fluids in response to environmental forcing, through the numerical solution of the equations that rule the hydrodynamic processes.

An example of this type of simulation was performed at the GloBallast Demonstration Site at the Port of Sepetiba in Brasil. The Princeton Ocean Model - POM [1] was used to model the general hydrodynamic circulation of Sepetiba Bay in response to tidal elevation and winds. To study the fate of the ballast water discharged from a fixed point (ship at berth), a two-dimensional model developed by the Oceanic and Atmospheric Processes Modelling Laboratory (LAMMA) of Federal University of Rio de Janeiro was used. This simulates the sea surface fate of substances and the governing equation of the model is that for advection and diffusion of passive constituents.

A scenario was tested for a ship releasing 21,000t of ballast water next to a berth, using a pump with capacity of 3 t/h (7h to complete the discharge). The total time of simulation was 120 hours, in a spring tide period, considering a 5m/s north-east wind. Model results indicated that the discharged ballast water reached Jaguanum Island in 45 hours and the opposite side of the bay (Marambaia sandbank) in 68 hours (Figures 1 to 3).

Such studies are extremely useful for developing and assisting port-based ballast water management plans. Once the ballast water discharge patterns are known for a port (locations, times, frequencies and volumes), the likely dispersal of the ballast water and the times taken to reach different areas can be modelled for a variety of conditions.

The model outputs can in turn be used to identify likely settling points for any introduced marines species contained in the ballast water. This is extremely useful for risk assessment, identifying potential impact areas and resources at risk, and for designing port biological surveys and monitoring programmes. It can also be used to identify more suitable ballasting and deballasting zones, if applicable.

It should be noted that ballast water discharge and dispersal are not simply surface phenomena - a three dimensional model will provide more accurate predictions. Also, many of the organisms within ballast water are not passive constituents, and may possess considerable motile capabilities which should be considered in the model.

All such models are dependent on the availability and quality of physical data, and need to be verified through field observations. However, while the initial modelling work carried out for Sepetiba is simplistic and based on several assumptions, it demonstrates the potential benefits of this tool for ballast water management purposes and could be developed further.

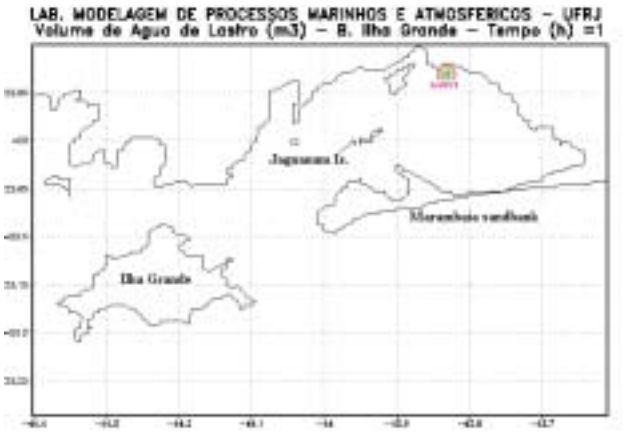


Figure 1 - 1 hour of simulation.

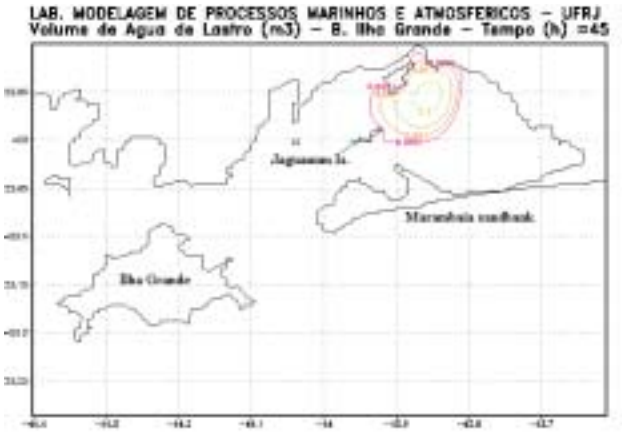


Figure 2 - 45 hours of simulation.

Figure 3 - 68 hours of simulation.

Alexandre de C. Leal Neto
GloBallast - Brazil
aneto@dpc.mar.mil.br

Maurício da Rocha Fragoso & Audalio Rebelo Torres
Federal University of Rio de Janeiro
fragoso@acd.ufrj.br & audalio@acd.ufrj.br

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Satellite Monitoring of BW Ops?

As long as ballast water exchange remains as a management measure, effective and objective compliance monitoring and enforcement techniques are required. Currently, the main method for assessing a ship's compliance with ballast water exchange is inspection of the Ballast Water Reporting Form filled in by the ship's officers. Some port States are trialing various ballast water sampling techniques to assess compliance, and others propose using audits of both bridge and engine room logs. All such approaches currently suffer from limitations. Enter the concept of automatic, electronic, fraud-proof monitoring systems.

The 73rd session of IMO's Maritime Safety Committee in 2000 adopted amendments to the *International Convention on Safety of Life at Sea* (SOLAS) making it mandatory for all passenger ships and all other ships of 3000 GT and larger, that are built on or after 1 July 2002, to carry a Voyage Data Recorder (VDR). VDR's are similar in concept to the 'Black Boxes' carried on aircraft, and will record data about the nature of the voyage (course changes, procedures, orders given etc). They could also be designed to record data on mechanical activities, including operation of ballast pumps.

The same amendments to SOLAS also make it mandatory for new ships built on or after 1 July 2002 to carry Automatic Identification Systems (AIS), with a phase in period for existing ships. The terrorist attacks in the USA last September have led to calls for an earlier introduction of AIS, to enhance maritime security.

AIS will enable the ships' identity and other characteristics (Name, Flag, IMO No. etc) to be automatically transmitted by satellite or radio to shore-based authorities. The system could also be adapted to transmit operational data, such as ballast pump operation.

One of the GloBallast Pilot Countries, Ukraine, is proposing a research project to trial such a system. A Ballast Water Exchange Electronic Monitoring System (BWEEMS) might work as follows:

- Signals from a set of electronic sensors placed throughout the ships' ballast water tanks and piping/pumping system feed into a central controller/data processor. This could include automatic recording into the ships' VDR.
- This data could be displayed on shipboard PC monitors for officers' information, and automatically printed onto the Ballast Water Reporting Form/Handling Log.
- The data could also be transmitted to the shipping companies shore-based office and/or Port State Control authorities, via the AIS.
- Data read-out and transmission could be done periodically at any time, upon request from the shipping company and/or Port State Control authorities, or automatically at pre-set times.

There would be full data protection for preventing human intervention. The following data could be collected:

- temperature and salinity of ballast water
- ship's position (GPS)
- date and time
- starting/stopping of ballast pumps
- ship's list and trim
- rolling period
- quantity of water in each tank
- pressure in each tank
- opening/closing of ballast valves
- longitudinal strength of ship's hull
- hull vibration

The system would use different types of sensors. For example quantity of water in the tank could be measured by pressure gauges on the tank bottom or with the ullage detectors (as used on tankers), with flow-meters or even calculated from a pressure gauge fitted on the inlet pipe. It is also possible to fit ultrasonic water speed sensors on ballast pipes, which measure flow velocity using the Doppler-effect. These options provide the possibility to find the best solutions for various vessels.

How would this information be delivered from sensors fitted somewhere deep in the ship to the data processor? On modern tankers it could be done through existing wire cables for cargo system sensors, and for other existing ships, via any cables passing throw compartments (e.g. for lighting in cargo holds). In this case, signals would be coded by special units. New built ships could of-course have the systems purpose designed.

The system would also have significant safety benefits. Basic recommendations and limitations which should be observed during ballast exchange, in accordance with the ship's ballast water management plan (sequence of emptying and refilling, maximum pressure, minimum meta-centric height etc) would be included in the programme. This would generate alarm signals in case of danger or deviation from prescribed parameters. BWEEMS would also offer a much welcome decrease in the volume of paperwork connected with shipboard ballast water management, with all information stored electronically on-board and backed-up at shore stations.

While decisions would be supported by the system, full responsibility would still lie with the captain and officers. According to the International Safety Management Code, double control is useful, especially for preventing human errors while fulfilling such a difficult and unsafe procedure as ballast exchange at sea.

Partners are now being sought to develop and test a trial system.

Further Information:

Captain Alexander Sagaydak, Alpha Navigation Co
capt.alex@paco.net, as@alpha.odessa.ua

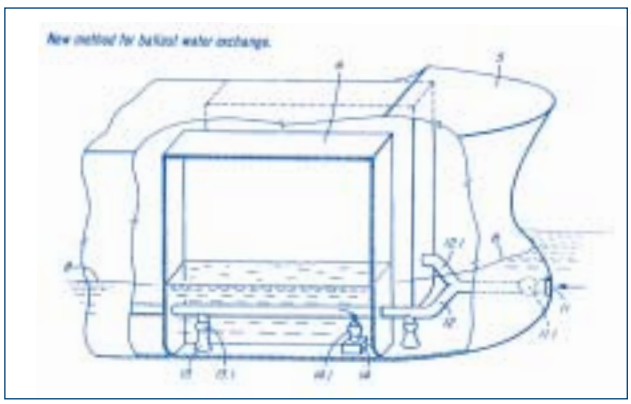
Steve Raaymakers, GloBallast PCU
sraaymak@imo.org

Alternative Exchange Design Proposed

Despite significant safety and operational constraints and serious questions about its biological effectiveness, ballast water exchange at sea remains the main, albeit far from satisfactory, management measure aimed at reducing the transfer of aquatic organisms in ships' ballast water. Generally, IMO and various National jurisdictions have identified two main methods for ballast water exchange: the sequential and flow-through methods. Both methods come with limitations and require considerable amounts of fuel and staff time.

When the sequential method is used, water is pumped out of the ballast tank until suction is lost and new ballast water is pumped in. The flow-through method involves pumping ballast water into the tank until the original water overflows through the openings on top of the tank. Both methods require electric or steam-driven ballast pumps and a diesel generator or boiler. Careful monitoring of deballasting and ballasting operations is essential, and extra work is generated for the crew.

Hisashi Numata, Senior Naval Architect with Teekay Shipping and Dr. Masahiro Tamashima of Fluid Tech Co. Ltd., began working on an alternative design employing natural forces and limited amounts of fuel and manpower in 1997. Many months were spent conducting model tests of the idea for Aframax tankers.



The Teekay design (Int. Patent Application PCT/CA98/01167)

Numata-san's proposed method relies on natural forces of pressure and gravity to achieve ballast water exchange. Unlike the sequential and flow-through methods, the new method would not require operation of auxiliary machinery. Instead, new water enters the ballast tank main line through a water inlet at the ship's bow. The pressure from the water flowing into the tank forces the original water out through an opening located at the forward bottom end of the ballast tank. To complete the operation, a limited power is required to pump in enough new ballast water to meet the initial water level.

A patent has been obtained in Japan and the US, and a worldwide patent application filed. The proposed design is yet to be tested at real-life scale and most importantly, its biological effectiveness is yet to be demonstrated.

Further information:

Howard Seto, Teekay Shipping
howard.seto@teekay.com

3rd Global Task Force Meets

In carrying out its workplan, the GloBallast Programme is guided by a Global Task Force, which meets annually and acts as an overall steering and advisory committee. The Task Force comprises high level respresentatives from GEF UNDP, IMO, the six Pilot Countries, the international shipping industry and international environmental NGOs (Friends of the Earth International and IUCN), plus the GloBallast team itself.

As outlined by Dandu Pughiuc on page 1, the Task Force held its 3rd meeting in Goa, India, from 16 to 18 January this year. The meeting was hosted by the Government of India, and held at the National Institute of Oceanography, a major player in the programme.

The 3rd Global Task Force Meeting, Goa, India.

Reports presented by the six Pilot Countries and the PCU showed that significant progress has been made in implementing the GloBallast Programme to date. A major outcome of the meeting was approval to extend the programme by one year to March 2004.

An interesting point of discussion at the meeting was how the success of the Programme could be evaluated. Given the Programme's broadest objective of reducing the transfer of harmful organisms in ships' ballast water, success would ultimately have to equate to a measurable reduction in marine bio-invasions. This requires comprehensive, long-term marine monitoring programmes.

While the biological port surveys initiated by the Programme provide a foundation for such monitoring, the time that it will take for risk reduction measures to take effect means that it will be years, if not decades, before the success or otherwise of such measures will be begin to manifest. The delegate from Friends of the Earth somewhat eloquently stated that the fruits of GloBallast would only ripen for future generations, and for the current team, it is the voyage rather than the final port of call, that is so exciting and important.

The Global Task Force is seen as being an important contribution to the success of GloBallast. Its broad-based membership ensures that the proper range of interests is represented and that inter-sectoral exchanges are enhanced. In the course of the programme we have seen Task Force members move beyond mere sectoral representation to constructive partnering. The PCU is now seeking to strengthen these partnerships towards manifestation of practical projects, particularly with the shipping and NGO sectors.

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Book Review

Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas (AMBACS) is perhaps the most comprehensive treatment of invasive marine species ever written for a given geographical area, and provides a model for authors considering similar works in other areas.

Edited by internationally acclaimed marine scientists Yuvenaly Zaitzev and Bayram Öztürk and published by the Turkish Marine Research Foundation, this well structured and clearly presented study includes contributions from 12 leading experts in the AMBACS region.

The study reports that 146 exotic species are known in the region to date and the majority are associated with shipping, including ballast water. The AMBACS region has suffered some of the worst known marine bio-invasions, including the famous north American Comb Jelly *Mnemiopsis leidyi.* The study reports that *Mnemiopsis* reduced fisheries production by more than US$200 million a year in the Black Sea and by more than US$40 million a year in the Sea of Azov in the late 1980's. These figures were for certain fish species only and did not include the flow-on effects of inactive fishing fleets, ports and factories, which are considered to have been much worse. Of great concern, *Mnemiopsis* has recently been transferred in ballast water to the Caspian Sea as well.

The book's chapters are divided according to each of the five seas and include information on physical geography, biology and ecology followed by details of each known introduction. For each species, information is given on its latin name, synonyms, common names, distinctive characteristics, probable origin, likely introduction pathway, distribution and impacts in the invaded area, plus a photograph or illustration showing its morphology and a distribution map.

The study concludes that the overwhelming majority of marine bio-invasions in the AMBACS region have had drastic negative impacts, with only one introduction, the Asian snail *Rapana thomasiana*, being sited as having some benefit (in the 1990's Turkey exported more than 1,000 tonnes of edible *Rapana* meat a year).

The study identifies critical information gaps and prospects for the future and recommends management actions required, including urgent implementation of the IMO ballast water management guidelines in the region.

This book is an essential resource for any scientist, manager or official involved in the issue of marine bio-invasions. It can be purchased from the Turkish Marine Research Foundation, www.tudav.org.

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Progress Report

Activities Undertaken January – March 2002

- ✓ 3rd Global Task Force meeting held in Goa, India, 16-18 Jan.
- ✓ Ballast Water Risk Assessments for 6 Demonstration Sites commenced.
- ✓ Review of Global Information Clearing House function completed.
- ✓ Legislative Review Project completed.
- ✓ Lecture given at World Maritime University, Malmö, Sweden.
- ✓ Attended and presented at Nordic Ballast Water Summit, Oslo, Norway 28-29 Jan.
- ✓ Attended and presented at 11th International Conference on Aquatic Invasive Species, Alexandria, USA 25-28 Feb.
- ✓ Attended/assisted 47th meeting of MEPC 4-8 March.
- ✓ Lectured at Netherlands Institute for Sea Research, 12 March.
- ✓ Attended and presented at 8th PEMSEA Programme Steering Committee meeting, Korea, 19-22 March.
- ✓ Treatment and workplan developed for TV documentary.
- ✓ 8th issue of Ballast Water News produced.

Activities Planned April – June 2002

- Implement recommendations from Review of Information Clearing House function, including:
  - Additional, part time staff resources.
  - Revamp web-site, directories and databases.
  - Interactive chat-room/e-forum.
  - Options for on-line peer-reviewed R&D journal.
- Hold Train-X Workshop in Montevideo, Uruguay, 15-23 April.
- Attend/present at IUCN/GISP Invasive Species Workshop, Gland, Switzerland, 1-3 May.
- Attend/present at Offshore Arabia – Clean Seas Conference, Muscat, Oman 13 – 14 May.
- Hold 1st Regional Conference on Ballast Water Control and Management in Tehran, Iran, 17-19 June.
- Produce new set of awareness materials.
- Secure partners for production of TV documentary.
- Produce 9th issue of Ballast Water News.

More Information?

Programme Coordination Unit
Global Ballast Water Management Programme
International Maritime Organization
4 Albert Embankment
London SE1 7SR United Kingdom

Telephone : +44 (0)20 7587 3247 or 3251
Fax : +44 (0)20 7587 3261
Email : dpughiuc@imo.org *or* **sraaymak@imo.org**
Web : http://globallast.imo.org

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