PROJECT BRIEF

1. IDENTIFIERS

PROJECT NUMBER:	
PROJECT NAME:	**Global - Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries**
PROJECT DURATION:	3 Years
IMPLEMENTING AGENCY:	United Nations Development Program (UNDP)
EXECUTING AGENCY:	International Maritime Organization (IMO)
REQUESTING COUNTRIES:	Global
ELIGIBILITY:	Eligible under para. 9(b) of GEF Instrument
GEF FOCAL AREA:	International Waters
GEF PROGRAMMING FRAMEWORK:	OP#10: Contaminants-Based Operational Program/ Ship-Related Contaminants Component

2. SUMMARY

The issue of the transfer of harmful exotic organisms through ballast water discharges is a global issue requiring a concerted, coordinated, global response. The long-term objective of this project is to assist developing countries in reducing the transfer of harmful organisms from ship ballast water. The project will increase the extent to which ships calling on developing country ports adhere to the at present voluntary international Guidelines of the International Maritime Organization (IMO). Further, it will assist developing countries in the development of programs necessary to implement the expected IMO international regulatory framework most likely through a ballast water annex to the MARPOL Convention or through a separate Convention. Effective, country based Pilot Demonstration Projects at specified ports within six developing nations, representative of each global development region, will be supported. The countries include Brazil/port of Sepetiba, China/port of Dalian, India/ port of Mumbai (Bombay), Iran/Kharg Island, South Africa/port of Soldanha, and Ukraine/port of Odessa. Regional Involvement will be effected through Regional Task Forces. Barriers to be overcome, as identified in the PDF-B project phase, include those of an educational, informational, technical, institutional, financial, political, cultural, and legal nature. There are six (6) major project objectives. The objectives address the need for effective project management and coordination, stakeholder and public awareness and educational activities, barrier removal efforts in targeted countries, monitoring activities, regional involvement and identification of opportunities for self-financing and the recruitment of additional donors to ensure long-term sustainability.

3. COSTS AND FINANCING (MILLIONS US$):

GEF:	**-** Full Project	US$	6.72 million
	[of which administrative costs are	US$	0.67 million]
	PDF	US$	0.22 million
Sub-total GEF:		**US$**	**7.61 million**

Co-financing:

IMO	US$ 0.64 million
Countries:	
Brazil	US$ 0.15 million
South Africa	US$ 0.38 million
China	US$ 0.92 million
India	US$ 0.90 million
Iran	US$ 0.15 million
Ukraine	US$ 0.30 million
Private Sector	US$ 0.39 million
Total Co-financing:	**US$ 3.83 million**
Total Project Cost:	**US $11.44 million**

4. ASSOCIATED FINANCING (MILLION US$): $ 36.80

5. GEF OPERATIONAL FOCAL POINT ENDORSEMENTS:

Name: Vasil Vasilchenko
Title: Vice Minister for Environment and Nuclear Protection
Organization: Ministry for Environmental Protection and Nuclear Safety, Ukraine
Date of letter of endorsement: August 1998

Name: Pirooz Hosseini
Title: General Director, International Economic & Specialized Affairs
Organization: Ministry of Foreign Affairs, Iran
Date of letter of endorsement: 26 August 1998

Name: Dr. Francois Hanekom
Title: Acting Director-General
Organization: Department of Environmental Affairs and Tourism, South Africa
Date of letter of endorsement: 28 August 1998

Name: U.K. Choudhary
Title: Director, Ministry of Environment and Forests, India
Organization: India
Date of letter of endorsement: 15 March 1999

Name: Chen Huan
Title: Deputy Division Chief
Organization: World Bank Dept., Ministry of Finance, China
Date of letter of endorsement: 17 June 1998

Name: Antonio Gustavo Rodrigues
Title: Secretario-Adjunto de Assuntos Internacionals

Organization: Ministerio do Orcamento e Gestao, Brazil
Date of letter of endorsement: 2 March 1999

6.IA CONTACT:

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ACRONYMS

APR	Annual Project Review
APO	Associate program Officer
CPTF	Country Project Task Forces
CTA	Chief Technical Advisor
EEZ	Exclusive Economic Zone
GEF	Global Environment Facility
IC	Incremental Cost as defined by the GEF
IMO	International Maritime Organization
MARPOL	International Convention for the Prevention of Pollution by Ships
MEPC	Marine Environment Pollution Committee of IMO
NGO	Non-Governmental Organization
PDF-B	Project Development Facility of the GEF
OP	GEF Operational Program
PCU	Program Coordination Unit
PIR	Project Implementation Review
GPTF	Global Project Task Force
RPTF	Regional and Sub-Regional Project Task Forces
STAP	Science and Technical Advisory Panel of the GEF
TPR	Tri-Partite Review
UNDP	United Nations Development Programme

PROJECT DESCRIPTION

Background and Context (Baseline course of action)

Introduction

1. Global shipping moves approximately 80 % of the world's commodities. As the globalization of the economy continues, larger and faster ships make it possible for nations to keep pace with increasing demand for the rapid transportation of raw and finished products. In effect, technology is making it possible to reduce or eliminate the natural boundaries that have separated and helped maintain the integrity of natural systems for millennia.

2. While the elimination and shrinking of boundaries through technology have yielded enormous economic benefits, and while continued development of larger and faster ships may be indispensable to the growing volume of world trade, there has been a negative, and, until recently, largely unnoticed consequence. For as long as ships have transported goods between and among countries, species have been transported, both intentionally and unintentionally, into new environments. While many of these non-indigenous species introductions have been and continue to be innocuous, some have established and have led to disastrous economic and environmental consequences. Faster ships mean greater economy in the transport of goods. Unfortunately, faster ships and the consequent reduction in travel time between ports increase the likelihood of the survivability and "successful" introduction of potentially damaging non-indigenous species.

3. For many centuries ships employed solid materials (sand, rock, other terrestrial material) to ballast their ships. From about the 1880's onward, however, ships increased their use of water for ballast. The change came about due to the increasing problem of vessel instability resulting from the shifting of solid ballast during voyage, and increased reliance on steel-hulled vessels. Most vessels today carry ballast water that may be fresh, brackish or saltwater. Globally, it is estimated that about ten billion tons of ballast water is transferred each year, and that three to four thousand species are carried each day. Water taken on a vessel as ballast may contain algae, mollusks, fishes and plants. The negative consequences of introductions can take the form of negative and quite severe economic effects, disrupted ecosystems, and/or human and animal disease. An example of how a single disruption can result in a combination of economic, ecosystemic and human health consequences is offered by the introduction of toxin producing species such as certain dinoflagellates. Introductions of these dinoflagellates through ship ballast can and have had a negative effect on commercial and subsistence harvest of shellfish, have resulted in consequent negative effects on shellfish populations, and can have severe, even fatal effects on humans and animals.

4. For purposes of the remainder of this project brief, ballast is defined as any solid or liquid placed in a ship to increase the draft, to change the trim, regulate the stability, or maintain stress loads within acceptable limits. The terms ballast, ballast water, or ballast water management will include the sediment that accumulates in ballast tanks, which may be, and often is, discharged with ballast water and contains high numbers of diverse, non-indigenous organisms. It will also include chain lockers and other locations where silt is likely to accumulate and where treatment could reduce the likelihood of the transfer of non-indigenous organisms.

5. The first description of an unwanted species introduction was given by Ostenfeld (1908) after a mass occurrence of the Asian phytoplankton algae Odontella (Bdulpphia) sinensis took place in the

North Sea. It was not until almost seventy years later, however, before the first shipping studies, including sampling of ships' ballast water, were conducted. Studies conducted from 1975 to the present day have included reviews of the state of knowledge and level of risk associated with the transplantation of non-indigenous organisms to fisheries and aquaculture, infrastructure costs to remediate severe fouling of intake pipes and other sub-surface infrastructure vulnerable to fouling by introduced organisms, and human health effects. These studies, when taken together, demonstrate that there have been numerous and costly ballast water related introductions of non-indigenous organisms, and that these introductions are likely to increase unless there is a concerted, global effort to stem them. Following is a sample of verified and damaging introductions of non-indigenous species via the ballast water route:

- the introduction of the Eurasian zebra mussel (Dreissena polynorpha) in the North American Great Lakes, resulting in expenses of billions of dollars for pollution control and the treating of fouled underwater structures and waterpipes;

- the introduction of the American comb jelly (Mnemiopsis leidyi) to the Black and Azov Seas, causing the near collapse of the commercially important anchovy and sprat fisheries, at a cost of $250 million/year;

- the introduction of the Japanese brown kelp (Udaria pinnatifida) to Tasmanian waters, having detrimental impacts on the abalone and sea urchin fisheries;

- the appearance of South-East Asian dinoflagellates of the genera Gymnodinium and Alexandrum to Australian waters, introductions which can cause paralytic shellfish poisoning; introduction of Gymnodinium algae in Hong Kong in 1998 led to harmful algae blooms resulting in claims of $40 million due to damage to fisheries.

6. In addition to the verified introductions listed above, the introduction of vibro Cholera into Latin American waters, while not demonstrably linked to ballast water discharge, has been demonstrated to be able to be transported in ballast water and is indicative of the need to take measures to ensure that the spread of pathogenic bacteria and viruses through the ballast water route is minimized.

7. The severe problems generated by each of these introductions led to specific actions to give ballast water transfer of exotic organisms higher priority and/or resulted in countries taking direct, unilateral actions to protect against future introductions. The United States, in direct response to the disastrous introduction of the zebra mussel into the Great Lakes ecosystem, has taken a legislative approach to stem the number of future introductions. Since 1993, the U.S. has required that the Masters of any vessel entering the Great Lakes choose from among three alternatives to assure that the introduction of unwanted organisms into the lakes will be minimized. These alternatives include an exchange of ballast water at sea beyond the U.S. Exclusive Economic Zone (EEZ), retention of the ballast water on board during the entire voyage, or the exercise of an environmentally acceptable alternative which must receive prior approval from the U.S. Coast Guard.

8. Other countries have also begun to take action. Israel requires that ships visiting the port of Eilat must exchange their ballast water outside the Red Sea, and ships visiting Israel's Mediterranean ports must exchange their ballast water in the Atlantic Ocean. In the early 1990's, Argentina began

requiring that ships calling at Buenos Aires chlorinate their ballast water. Argentinean officials randomly visit ships calling at Buenos Aires to ensure compliance with the chlorination requirement.

9. Australia was the first country in the world to introduce ballast water management guidelines. It did this in 1990 and the subsequent IMO Guidelines (Resolution A774 of 1993) were based to a substantial extent on these Australian guidelines. Since 1990 Australia has enhanced its initial guidelines and, specifically, has introduced mandatory reporting by all vessels, a ballast water research and development levy, compliance and monitoring arrangements, and a maritime awareness program.

10. At present there is not any single technological "fix" for problems associated with ballast water transfer. Nor is there likely to be a single technological "fix" in the near term. There is at present no system or practice in use today that will totally prevent the introduction of unwanted non-indigenous aquatic species into port or estuarine waters. Further, there is no "off-the-shelf" technologies specifically designed for treating ballast water that are suitable for use on board ship without some vessel redesign and modification. Thus the issue to be addressed in the near term is one of taking actions to minimize the potential for transfer, a need that all observers agree is achievable and an urgent priority. Attempts to take such near term actions, and prepare for additional future measures, has become a priority for the IMO, the designated Executing Agency for this project proposal.

International Action

11. Most nations agree that the most effective actions to minimize the globally significant, negative effects of ballast water transfer will come from a coordinated, cooperative global approach rather than the establishment of a patchwork of individual regional and national actions. In response to this need for uniform action, the IMO, in 1993, adopted Assembly Resolution A. 774 (18). The Resolution states, inter alia, that "(T)the discharge of ballast water and sediment has led to unplanned and unwanted introductions of non-native plants, animals and pathogens that are known to have caused injury to public health and property and to the environment." The Resolution states further that "(T)the unwanted introduction of plants, animals and pathogens through the uncontrolled discharge of ballast water and sediment has important global implications that can be effectively, equitably and responsibly addressed through coordinated and cooperative action."

12. In 1997, the IMO Assembly adopted Resolution A.868 (20), which supersedes A.774 (18) and contains guidelines intended to limit the movement of organisms by ballast water worldwide. The Guidelines assist ship masters by, among other things, providing information on areas where the uptake of ballast water should be avoided, precautionary procedures that should be employed when taking on ballast water in shallow areas, ballasting with freshwater, discharging ballast water and sediments to on-shore facilities where available, and the exchange of ballast water in open ocean.

13. Due to the direct economic, environmental and human health effects associated with this issue, and since many scientists have concluded that biological science cannot predict with certainty whether a species that is environmentally benign in its native environment will continue to be benign when introduced to a new location, many observers conclude that a precautionary approach should be taken when considering measures to mitigate the potential for damaging exotic organism transfer. Consistent with these conclusions, the IMO has included a precautionary approach as part of its Guidelines.

14. While adherence to the IMO Guidelines would result in significant reduction in the threat posed by uncontrolled ballast water releases, compliance with the voluntary guidelines has not been encouraging. Consequently, the Marine Environment Protection Committee of the IMO is presently drafting new, internationally applicable regulatory arrangements in the form of an Annex to the MARPOL Convention or separate Convention specifically for ballast water. It is planned by IMO that this will be considered for adoption.

Current Ballast Water Treatment Options

15. Given existing and potential future difficulties posed by the introduction of unwanted species, and the fact that once an exotic organism is established in the marine environment it is virtually impossible to eradicate, the goal of managing ballast water should be one that includes the prevention of the introduction of non-indigenous species including bacteria, viruses, algae, protists, invertebrates and fish. What makes this goal particularly difficult to achieve in addition to the technological difficulties, is the need to satisfy other criteria. These additional criteria include the need to take into account the safety of the ship and its crew; the need to be environmentally acceptable and practicable in application; the need to be compatible with normal ship operations; and the need to be cost-effective. While there is a need to undertake discussions with ship designers about the need for a new generation of ships that will take into account the need for on-board ballast water treatment, an activity that will be undertaken by IMO, there is an immediate need to address the ballast water related concerns deriving from the present generation of ships.

16. Based on the difficulty of meeting all of the criteria mentioned above, the mid-ocean exchange of ballast water is at present the most reliable method of reducing the risk of harmful exotic organism transfers, and is likely to remain the most effective method at least over the short term. Compared with coastal waters, deep ocean waters contain fewer organisms, and many of those organisms that may be taken in with ballast water during open ocean exchange are often not able to survive in the coastal environment, and vice versa. There is ongoing research in several countries aimed at determining the array of treatment options that could elevate the level of certainty that unwanted organisms are not being transferred via ship ballast. The treatment options include, but are not limited to, the mechanical treatment of species in ballast (filtration, separation, sedimentation and flotation, pump velocity); physical treatment of species in ballast water (heat treatment, cooling treatment, radiation, ultrasonics, microwave, rapid pressure changes, electrical treatment, magnetic fields); chemical treatment of species in ballast water (chlorination, metal ions, ozone, hydrogen peroxide, oxygen deprivation, coagulants, pH adjustment, salinity adjustment, anti-fouling paints as ballast tank coating, organic biocides); and biological treatment of species in ballast water via bio-control.

Importance of the GEF Intervention

17. There is consensus that unless all regions and countries act together, competition among ports, countries and regions will result in growing acrimony. Worse yet, a patchwork quilt of regulations could result in drift toward adoption of the lowest common-denominator approach to mitigate the growing number of serious economic, environmental and public health effects deriving form uncoordinated ballast water management. In addition, work undertaken during the PDF-B phase of this project demonstrated clearly that most developing countries are ill prepared to act on the issue of ballast water transfer. The barriers to action included, among others, poor awareness on the part of all segments of society including government officials. There was also poor or no information about ballast water discharges taking place in national waters, poor or no integration of effort

between and among government agencies and potentially affected constituencies, few or no existing regulations or presence of a legal framework that could incorporate necessary and appropriate regulations, low priority given to the issue because of competing demands, and, a consequence of the low priority given to the issue, few if any national resources committed to the effort.

18. The proposed GEF intervention, through the establishment of the envisioned pilot demonstration projects, would show how six developing nations can marshal limited resources and take the necessary actions to protect their resources and people from the negative consequences of unwanted organisms deriving from unregulated ballast water discharges and to act as lead country in the regions. Country and port specific actions, based upon case-by-case analyses of most sensitive values at risk, would include selected options from a Decision Support System (DSS) and the means to ensure monitoring and compliance of it, a set of "Good Practice" Measures, and a project "tool kit" of ballast water treatment options. The DSS is a management system that provides a mechanism for assessing all available information relating to individual vessels and their individual management of ballast water so that, based upon assessed risk, the appropriate course of action can be taken. There are a number of "Good Practice" measures, which will be essential to the Project as a whole and, in particular, at each of the demonstration sites. These criteria will be used as the benchmarks against which the implementation of the project can be evaluated. "Good Practice" measures will include options at each of the three phases in the continuum of ballast water management. These measures, part of a generic "tool kit", would be implemented when indicated by the DSS that some action is necessary. Further descriptions of DSS, "Good Practice" Measures, and the "tool kit" are included in this Brief as Annex 5.

19. It is also expected that elements of the DSS, relying as it will on tracking of ships through various ports to determine level of risk, will complement work that will likely be the subject of another GEF intervention to develop a demonstration marine electronic highway in some of the world's busiest shipping lanes.

20. Physical descriptions of the specific port sites in each country, their geographic location, an initial description of port specific issues, reasons for their selection, some expected port-specific activities, and the focal point institutions for each, appear as Annex 6 of this Brief. It should be noted that each port has been selected for reasons of their willingness to participate in the project. This requires not only agreement by the national government, but agreement as well by a range of other governmental and quasi-governmental agencies that include port administrations. The level of agreement required to ensure the participation of a port is thus no small feat. Other criteria for selection include the presence of natural resources placed at risk, such as aquaculture, as a result of unmanaged ballast water transfer, and also human health. The list of participating ports was reviewed during the experts meeting held in Cape Town, South Africa and confirmed as being representative of the issues to be addressed. It should be noted that the participating countries and ports that have been selected are committed to addressing the ballast water issue as a priority national concern and will include, as part of the Decision Support System developed for each country and port, the option of testing pragmatic approaches to resolving issues connected to ballast water discharge.

21. The GEF intervention would also serve to inform other coastal nations to the existence of the problem, resources that are at risk, and measures which, when applied globally and strategically, will reduce the serious global, economic environmental and public health effects of unmanaged ballast water discharge. This activity would be continued by IMO after the project. An important

additional contribution of the proposed project would be to enable participating countries, and countries engaged at the regional level, to both form and inform ongoing deliberations aimed at developing a legally binding agreement related to the ballast water issue. At present, limited information concerning the issue and the consequent lack of focus on its importance are detrimental to such developing country involvement in current negotiations. The absence of the proposed GEF intervention would with little doubt lead to not only a continuing inability of developing countries to protect themselves but also to a growing tendency for other nations to take unilateral steps that will make a global approach ever more difficult to achieve. The mechanism, objective, principles, and strategy that would lead to the creation of a regional approach are described in Annex 7.

Rationale and Objectives (Alternative course of action)

Long-term objective
22. The long-term objective of this project is to assist developing countries, encompassing a wide variety of environmental, geographic, and socioeconomic conditions, in reducing the transfer of harmful organisms and pathogens in ship ballast water. This will be accomplished by increasing the extent to which ships calling on developing country ports adhere to the voluntary Guidelines of the IMO, and to an anticipated ballast water annex to MARPOL 73/78, enabling them to ratify and implement legally binding provisions that are being prepared. Effective, country-driven and country-based Pilot Demonstration Projects at specified ports within six developing nations, representative of each global development region, will be supported.

Specific Project Objectives

Objective 1: Ensure effective project coordination and support (information, communications, expert assistance, program implementation capacity and evaluation and assessment) through establishment of an IMO based Program Coordination Unit (PCU) and the identification of, and provision of resources for, the establishment of a Lead Agency in each of the six participating countries

Objective 2: Increase knowledge of, and potential solutions for, the generic, port-specific, and country-specific dangers associated with the ballast water related transfer of non-indigenous organisms in port and country-specific receiving waters.

Objective 3: Develop and implement generic and, to the extent possible, country and port specific programs defining the measures necessary to increase compliance with IMO provisions, with special attention to achieving protection of identified, country-specific most sensitive values at risk.

Objective 4: Develop and implement generic and, to the extent possible, country and port specific compliance and monitoring programs to ensure maximum practicable compliance with IMO provisions, with special attention to achieving protection of identified, country-specific most-sensitive values at risk.

Objective 5: Make provision, as appropriate, for the creation and operation of Regional or Sub-Regional Task Forces to increase regional level awareness, cooperation and eventual replication of project results across the region.

Objective 6: Identify opportunities for increased project self-financing during the project, financing after the three year project timeframe, and the initiation of a Donor Conference to secure the necessary additional financing to sustain implementation of IMO, participating country and global efforts to implement IMO provisions.

23. It should be noted that Objectives 1 and 6 relate to the institutional component while Objectives 2, 3, 4, and 5 essentially cover the knowledge, guidelines and monitoring programs which are the subjects of the Decision Support System and represent the operational components of the project.

Rationale for GEF Intervention

24. The GEF has directly acknowledged the importance of the ballast water issue, and its intent to support activities related to mitigation of ballast water related transfer of organisms, in its Operational Strategy. The Strategy states that "(A)activities related to abatement of pollution from ship-based chemical washings and interventions against the transfer of noxious, non-indigenous species in ballast water are priorities for the GEF because they are virtually unaddressed problems." The proposed project represents an important step in realizing this stated GEF programmatic intent.

25. The proposed project is also consistent with Operational Program #10 of the GEF, the Contaminants-Based Operational program. The long term objective of OP #10 is to "…develop and implement international waters projects that demonstrate ways of overcoming barriers to the use of best practices for limiting releases of contaminants causing priority concern", and to "involve the private sector in utilizing technological advances for the resolving of these transboundary priority concerns." OP #10 further states that "(I) in the near term of the GEF, special emphasis is being placed on interventions to prevent the transfer of non-indigenous species in ballast water." The creation of demonstration sites, representative of each of the world's development regions, is an explicit objective of the project. Further, the IMO, whose 154 member states closely cooperate with ship owners associations, port and harbor authorities, shipbuilding industries, classification societies and environmental groups, constitute the best link for the active involvement of the shipping industry as a whole.

26. A key assumption of OP #10 is that, over time, successful demonstration projects will be replicated, successful approaches to identified problems will be repeatedly used, and that barriers to the successful adoption of pollution prevention measures will be removed. Linkages with the UNDP/GEF initiative IW:LEARN will provide for sharing of project results and replication of successful practices in other developing countries. In addition, the UNDP-GEF TRAIN-SEA-COAST or similar program will provide the capacity for preparing and adopting high quality training materials to support country based efforts.

Project Activities/Components and Expected Results

GEF project objectives and activities

Objective 1: Ensure effective project coordination and support (information, communications, expert assistance, program implementation capacity and evaluation and assessment) through establishment of an IMO based Program Coordination Unit (PCU) and the identification of, and provision of resources for, the establishment of a Lead Agency in each of the six participating countries

Rationale

27. There is general agreement on the need for a globally consistent approach to address the ballast water issue. Even in those countries that have begun implementing nationally based approaches for ballast water control, there is recognition that a globally consistent approach has to be pursued. There is also agreement that the IMO is the appropriate international organization to assume the continuing task of developing the necessary international, legally binding provisions that are likely to occur via an annex to MARPOL 73/78. IMO's Marine Environment Protection Committee and Ballast Water Working Group have made the ballast water issue a priority in their work and will also be of invaluable assistance to the work of the project. This objective would, among other things, create within the IMO in London, UK a PCU comprised of two (2) professionals, an Associate Program Officer, requisite administrative and technical support, and support from the permanent staff of the IMO. The work of the PCU would be supported by the GEF over the three years of the GEF sponsored project. After the three-year period, the IMO would undertake to establish and sustain, in its London headquarters, the necessary mechanism to assist all member states as they strive to meet their obligations under the expected mandatory IMO regulations. IMO's Marine Environment Division acts as a Secretariat for, among others, the MARPOL Convention. This Secretariat consists of 12 permanent professionals. When IMO approves a legally binding annex to MARPOL on ballast water management, this Secretariat will include the new annex in its work and will ensure that there is expertise on this issue within the Secretariat. It is particularly important that IMO be centrally involved in the project as they create for the project, as noted by the STAP review, access to officials and programs in countries where many ships are registered, such as Panama, Liberia, Monrovia and Norway, whose regulations, along with classification societies, will be crucial for the development of future regulations.

28. In addition, the IMO Technical Cooperation Programme, of US$11 million per year plus extrabudgetary resources, will assist developing countries to implement the ballast water annex to MARPOL. A case in point is the US $ 60,000 allocated for an IMO-financed Workshop on Ballast Water Control and Management for participants from the 10 countries bordering the Black Sea and the Caspian Sea scheduled for July 1999. An assumption of this project is that the approval by IMO of a legally binding MARPOL annex on ballast water managememt will provide a framework for the sustainability of project activities-both at IMO Headquarters and in the participating countries. At the same time it is likely that the increased awareness and capabilities provided through this GEF intervention will themselves increase the liklihood of such approval and enhance the relevance of the eventual annex to developing countries.

29. While the IMO is committed to assisting in co-financing the creation of an effective project PCU in its London offices, and committed to an endeavor to sustain that presence after project completion, provision of information and development of pilot programs at the country and port level, the subject of this proposal, are *not* part of IMO's mandate. Without the GEF intervention, the needs outlined in this project proposal will not be met. The relationship between IMO regular activities and the GEF project appears as Annex 1.

30. Work undertaken during the PDF-B phase of the project resulted in a finding that information about the dangers of ballast water transfer of non-indigenous organisms was poor to non-existent in many developing countries, and constituted a major barrier to action. Further, it was found that where information did exist, no single agency had been given or had assumed lead responsibility for work related to the ballast water issue. This combination of poor information and

no delegation or assumption of leadership on the part of any specific agency makes it impossible to address the issue effectively or at all, and is seen as the single most important, early priority of the project to develop. One of the priority recommended barrier removal activities was the creation of a lead agency that would be given the overall responsibility for development of the port-specific and country-specific strategies that are the principal objective of this project. The lead agency, through a senior lead agency official, would be responsible for the creation and convening of the necessary Country Project Task Force (interministerial in nature) and would also be responsible for the development and implementation of the necessary informational, educational and participation activities that are key to project success. Provision of GEF resources would enable recruitment of a Special Assistant to assist in the coordination and implementation of project activities.

31. Finally, it is important that this project set the stage for broader regional cooperation on the issue of ballast water transfer. Lack of action on the regional level could become a serious barrier to progress if single country actions were to lead to other nations using the lack of adequate ballast water management provisions to attract greater interest in their ports. Also, there will eventually be the need to bring about broader sectoral changes than are likely to be brought about in this series of pilot projects. Nonetheless, the project will have built in provision for the establishment of regional or sub-regional task forces, as deemed appropriate, to advise, learn from, and hopefully cooperate with work undertaken in each of the participating countries.

Activity 1.1 Recruit and hire the Chief Technical Advisor (CTA), Communications Specialist[1] (CS), Associate Program Officer, and requisite administrative and technical support.

Activity 1.2 Create and organize the PCU to facilitate and coordinate the work program of the participating countries, and serve as the communication vehicle between the participating countries, regional and sub-regional task forces, and other nations and entities engaged in work related to ballast water management.

Activity 1.3 Review existing and, as necessary, prepare new case studies demonstrating the economic, environmental and public health dangers associated with the transfer of non-indigenous species and pathogens via ballast water and distribute same to participating countries and other nations as part of the necessary program of education for government officials and the full range of affected interests.

Activity 1.4 Establish a global resource information center for international ballast water activities including collection and print and on-line distribution of current and future ballast water management research occurring globally as well as regionally, and assure wide distribution.

Activity 1.5 In consultation with the respective GEF country focal points, UNDP Resident Representatives, and government officials as necessary, determine a Lead Agency for each participating country and a senior official within those lead agencies to assume leadership of project activities and represent the participating country in meetings of the Global Project Task Force (GPTF).

Activity 1.6 Create and operate a GPTF comprised of senior representatives from each

[1] As previously mentioned, the IMO would underwrite the full cost of the Communications Specialist over the three years of the project.

participating country lead agency, the IMO, and UNDP. The GPTF , building on the results of an initial ad-hoc meeting held in Cape Town, South Africa in July of 1998, would meet at the direction of the CTA and assist in the formulation and ongoing review of the project and project results. It would also provide strategic and policy guidance and assist in mobilizing additional project resources. Finally, it would also work closely with the PCU to determine appropriate education and training programs for government officials.

Activity 1.7 With the assistance of the GPTF and senior representatives from participating countries, plan and hold six country-based Communications Workshops to develop communications approaches, including education and awareness activities. Also the workshops will identify the level of communications activities and hardware and software, newsletters, email and internet services necessary to successful project implementation. This work would be coordinated with work undertaken in Activity 2.3.

Activity 1.8 Make provision for evaluation and assessment of project results.

Objective 2: Increase knowledge of, and potential solutions for, the generic, port-specific, and country-specific threats and impacts associated with the ballast water related transfer of non-indigenous organisms in port and country-specific receiving waters.

Rationale

32. The most significant barrier to action on ballast water transfer has been identified within the PDF-B process, and by other observers, is the lack of information about the existence and potentially catastrophic consequences of the ballast water transfer of unwanted organisms. Without adequate information on the potentially serious and destructive non-indigenous introductions that may already have occurred, actions to remediate the problem will not be taken. The competition for scarce resources in developing economies is fierce. In this competition for limited resources, those issues that have overt, short-term consequences on populations receive priority. While the potential consequences of the unchecked transfer of unwanted organisms through ballast water transfer are fairly seen as a time bomb, it is not at this time perceived as such by many developing countries and by likely negatively affected constituencies within those countries. There seems to be little doubt that a massive outbreak of cholera would be devastating to the limited public health resources of developing countries. Further, ballast water related transfer of unwanted organisms could have, and already has had, disastrous consequences for the growing reliance of developing countries on aquaculture for export purposes and for helping ensure national food security. Seen in this context, it is not difficult to understand why information and education for government officials and all potentially affected stakeholders is a pre-requisite for project success.

33. The STAP reviewer states that he questions that this objective should take a port as well as country approach, and that the "key cases are still those in enclosed areas, the Great Lakes and the Black Sea." While this is true to an extent, there is clear evidence that open coasts are also at risk and thus abiding by the precautionary principle, a tenet of existing IMO based provisions and of the GEF Operational Strategy, would suggest the need to take open coasts into account. The STAP review states further that "A better approach may be to erect scenarios of relevant local issues one of which could be public health, one on a coastal sea-food related issue, and one say on coastal erosion which is an important function provided by natural ecosystems." While most of these are issues that are indeed likely to emerge as key issues to be addressed by the participating countries and ports, it is country officials and an array of stakeholders at the local level that should attempt to

undertake the necessary analysis. Lastly, the STAP reviewer observes that "Non-experts cannot do the assessment and making predictions of the impact of potentially thousands of species is almost impossible. Scenarios made by natural and social scientists may be an option." It is now explicit in Activity 2.1 that the best available natural and social scientists will participate. It is seen as important, however, to take full advantage of the knowledge base of local, affected interests who are likely to have been experiencing the adverse results of ballast water introductions, even though there reports may at first be anecdotal.

34. The PCU must assume an important role in the activities related to this objective through the provision of international linkages. It must also begin to build capacity within the IMO to make possible replication at the global level of the successful experiences at these pilot demonstration sites. The participating countries are likely to have few if any materials to address or describe problems associated with unchecked ballast water releases. Increasingly, however, there is a growing body of case studies, research, control programs, and public education and information programs that have been and continue to be developed in countries such as Argentina, Australia, Canada, Israel, New Zealand, and the United States. Elements of this growing body of information will be incorporated into the project as appropriate and useful. The IMO serves as a resource center for much of the ballast water related work that is occurring worldwide. The PCU, housed within the London based IMO, would be well positioned to make existing case studies, research, control programs, short workshop packages, and public information and education programs available to project participants and other nations, and will be able to "tailor" materials to meet participating country-specific needs.

Activity 2.1 The PCU, working with each CPTF, will provide resources to identify existing relevant, and potential additional, community assessment, education and information activities. These activities must involve the best available expertise from both the natural and social sciences and the full range of affected interests, including NGOs and the private sector.

Activity 2.2 PCU provision of support for a workshop in each of the participating countries, under the direction of Country Project Task Forces CPTF s, to define, implement, and evaluate appropriate community assessment, information, participation and education strategies and comment upon the project generally and the desired shape of the country action plan specifically.

Activity 2.3 Based upon the results of the workshop in Activity 2.2, and reviews of activities undertaken in Activity 1.8, CPTFs will devise workplans for the community assessment, information, participation, and education activities of the project.

Activity 2.4 Provide the resources necessary for participating country implementation of the Workplans referenced in Activity 3.6, including resources for the creation and implementation of educational programs for port and government officials and identified stakeholders.

Activity 2.5 Create a targeted education program, under direction of the CPTFs, and create a training program for ship masters, owners and operators or their agents, and port and harbor authorities to make them fully aware of the ballast water issue generally and more specifically their likely obligations under current and emerging International Guidelines. Project experience would be used to devise a global education program for shipmasters, owners and operators. Use of UNDP TRAIN-X, to ensure communication of results to other countries in the region and globally, will be fostered.

Objective 3: Develop generic and, to the extent possible, country and port specific programs defining the measures necessary to increase the rate of compliance with IMO Guidelines, with attention to achieving enhanced protection of identified, country-specific most sensitive values at risk.

Rationale

35. The essence of this project is twofold. First, it is intended to result in the development of a generic, developing country based, ballast water management strategy, which can be adapted to the needs of other countries. Second, and to the extent possible, the project will facilitate initial work toward the development of country and port specific programs, including national legislation, to achieve effective ballast water management consistent with IMO provisions. Work undertaken in the PDF-B phase of the project and a review of existing ballast water control programs is indicative of the overall strategy that should form the basis for program development. The strategy should be one that seeks to avoid the adverse economic, environmental, and human health impacts of unwanted, ballast water transported non-indigenous organisms. The strategy should make provision to avoid unwanted introductions by minimizing their risk of entry, establishment, and spread in country receiving waters while simultaneously minimizing impediments to trade.

36. A review of previous work is also suggestive of a number of key principles that should be adopted if a program of control is to be successful. First, emerging country strategies should be just that, i.e. country strategies should take a single national strategy approach to the ballast water transfer issue, taking into account the legitimate requirements of all stakeholders. Second, the emerging strategy must be generally consistent with IMO provisions. Third, the strategy must take into account the need to give special consideration to the protection of a country's most sensitive values at risk. For example, in some nations there are significant and highly valuable aquaculture ventures, which directly abut or are in close proximity to shipping lanes. Further, there are occasions when ballast water discharges in zones of high shellfish productivity can place entire local populations at risk from such as unintentional introductions as the Dinoflagellate Gymnodinium catenatum, which are known to cause paralytic shellfish poisoning, other toxin producing algae which may result in harmful algal blooms, and Vibro cholerae, which affects vulnerable populations through consumption of infected seafood. It thus becomes necessary to have, as part of a country program of action, a process that will identify on an ongoing basis high risk species and organisms that would have particularly deleterious effects on the economy, environment or on human health. Fourth, it must recognize the importance for the dissemination and sharing of results nationally, regionally, and globally. Fifth, each country must act to name a Lead Agency for development of the GEF program and assure that the formation of CPTFs (interministerial in nature), which will maximize the likelihood of eventual, successful program implementation. Sixth, it must make provision for the necessary, increased levels of information, education and training commensurate with the seriousness of the problem. Seventh, and finally, the program of action must make provision to identify and secure the necessary financial resources to complement GEF funding and sustain the ballast water program after the life of the GEF intervention. Each Activity would be implemented under the general direction of respective participating country CPTFs.

Activity 3.1 Create and provide resources for CPTFs in each country. CPTFs would be interministerial in nature, would meet at the call of the Lead Ministry or Agency and be chaired by a senior representative of it, and be responsible for project development, implementation, and general project oversight within each participating country.

Activity 3.2 Review existing information regarding the quantity and quality of current ballast water discharges in domestic waterways and determine the existing and potential threats posed by uncontrolled ballast water transfer on the economy, environment, and on human health.

Activity 3.3 Ascertain existing information gaps and define the activities needed to fill those gaps.

Activity 3.4 Based upon a review of results from Activities 3.2, 3.3, 2.1, 2.2, 2.3, and other sources as deemed necessary, prepare, through the use of workshops and other mechanisms, a Workplan to devise the generic and, where appropriate, country and port specific programs of action (see Annex 6 for some of the activities planned for each port/demonstration site).

Activity 3.5 Provide support for the review of existing, pertinent domestic legislation and regulatory authorities and make recommendations to bring about the necessary changes to effect the country program of action in accord with IMO measures and/or a new MARPOL ballast water annex.

Activity 3.6 Provide the resources necessary to implement the Workplan referenced in Activity 3.4, including resources for specific assessment and participation initiatives for the selected Pilot Demonstration Sites and for the creation of a public participation program aimed at key stakeholders at each site.

Objective 4: Develop generic and, to the extent possible, country and port specific compliance and monitoring programs to ensure maximum practicable adherence with IMO provisions, with special attention to achieving protection of identified, country-specific, most sensitive values at risk.

Rationale

37. There is at present no single treatment or procedure that can obviate the risk of the introduction of harmful non-native organisms via ship ballast water. Thus it is essential that, as each country experiments with what it deems to be the most appropriate array of control options, effective participating country monitoring be established to accomplish two objectives. First, monitoring will be important for each country to measure the extent of compliance with IMO provisions generally and country-specific guidelines. Without monitoring to inform of successful compliance, replication of project results may not be warranted. Second, country-specific monitoring of compliance can serve as an important research tool that can be used to assess the relative efficacy of ballast water treatment options in a variety of climates, ecosystems, multiple use zones, and development regions. Thus effective monitoring can both inform and form the ongoing effort to minimize the global risks associated with the ballast water transfer of non-native organisms.

38. At the very least, project related compliance and monitoring should and will involve, first, an examination of the ship's logs and records to ascertain the location and the amount of ballast water that has been loaded and where and how much of the ballast was changed. Second, project related compliance and monitoring should include provision for the continuous recording of basic physical/chemical water quality parameters such as turbidity, salinity, temperature, concentration of dissolved oxygen, and pH. Each of these parameters can be monitored by automatic, online

equipment that provides continuous readouts for subsequent data storage or for direct transmission to shore. Alternatively, these parameters can be measured concurrently by handheld equipment at regular intervals. According to an estimate made by the U.S. NRC, the cost of these systems would be US$500 to US$2500 per unit, not including installation costs.

39. Each participating country, given particular, important values they determine to be at risk, may choose to build in additional compliance and monitoring considerations.

40. Regardless of the monitoring system devised for use by each participating country, compliance can only be effective if ship masters know what is required of them and carry out the requirements. Thus there will be a need to develop manuals and other communications that will fully apprise ship masters and appropriate port authorities of Guidelines and other requirements. Activities under Objective 4 would be under the general direction of respective participating country CPTF s.

Activity 4.1 Support for the CPTF s to develop a generic, and, to the extent possible, tailored compliance and monitoring program.

Activity 4.2 Support to create country-specific manuals and appropriate reporting forms for ship masters and all other relevant persons or entities detailing in clear fashion expectations with regard to ballast water management

Activity 4.3 Support to recruit and train lead agency compliance and monitoring officials for placement at the designated pilot project ports.

Activity 4.4 Support to purchase, test, and assist in bringing about refinements in analytical equipment capable of monitoring basic physical/chemical water quality parameters.

Objective 5: Make provision, as appropriate, to create Regional or Sub-Regional Project Task Forces (RPTFs) to increase regional level awareness, cooperation, and eventual replication of project results, including replication of final results.

Rationale

41. The countries and ports that have chosen to participate in the project do so at some risk. Ports are competitive and it is possible that a port participating in the project will enact certain requirements that will make other regional ports more attractive to shippers. Regional or Sub-Regional initiatives will be necessary to minimize the possibility that participating ports will be, in effect, penalized for their project participation. Further, the programs that will be developed in each of the six participating countries and ports should to the extent possible be replicated across the region and discussion would include the necessary sectoral changes required to bring about a regional approach to action. The formation of the RPTF s is intended to facilitate this process. As appropriate RPTF s would be chaired by the participating country project focal point.

Activity 5.1 Create, as appropriate and in cooperation with participating countries, six regional or sub-regional Task Forces to support and learn from the experience of the participating countries and ports.

Activity 5.2 Provide for RPTF meetings on an as needed basis, and ensure ongoing communication between and among RPTF members in each of the six project regions.

Objective 6: Identify opportunities for increased self-financing during the project, after the three-year project timeframe, and initiate a Donor Conference to secure the necessary additional financing to sustain implementation of IMO, participating country and global efforts to implement IMO provisions.

Activity 6.1 Review the opportunities for self-financing of project components at the global, national and regional levels, pinpointing potential economic sources and mechanisms.

Activity 6.2 Sponsor a Donor Conference using the on-going GEF project as leverage for the creation of necessary additional donors, and confirm with IMO their support for the continuation of post-project activities from their regular budget.

Risks and Sustainability

Issues, Actions and Risks

42. The long-term success of the global effort to reduce the risks of the introduction of non-native organisms, through the establishment and support of pilot demonstration projects as envisioned in this proposal, depend, inter alia, on the political willingness of the participating countries to follow through on commitments undertaken to successfully implement the project. The latter in turn depends on changing economic, political and social conditions at the individual country level. For this project, the political factor appears to introduce a moderate risk at this time. While each of the countries has made a specific commitment to the project during the PDF-B phase, it is clear that the issue of ballast water transfer does not at present command the level of attention and concern that would enable it to compete successfully with other developing country priorities. One assumption of the project is that as each participating country becomes increasingly aware of the economic, environmental and human health threats that are presented by the unchecked transfer of ballast water, their commitment will grow and lead to a sustainable effort. Another project assumption is that the pilot projects will lend themselves to replication at the regional and global level. This assumption rests on the willingness and capacity of the IMO to use its global standing to help create and maintain at the global level the envisioned regional task forces and take a strong lead in bringing about replication of project results. Notwithstanding the fact that the IMO has indicated its willingness to do so, and as the IMO appears to be the international entity best suited to the task, this risk is seen as moderate. This moderate level of risk is due to significant project communications and coordination challenges, rivalries that may exist between and among countries in the region, and the temptation to abide by a lower standard for ballast water exchange to gain economic advantage. The successful adoption and implementation of legally binding IMO provisions would reduce the risk considerably, and successful implementation of the project would create in each development region models to learn from and the beginning of a regional approach to the ballast water discharge issue.

Sustainability

43. The project is designed to create conditions for the development and implementation of generic, country and port-specific ballast water management that can in turn be used to contribute to the ballast water control strategies that will need to be developed within neighboring countries, the

region as a whole, and globally. Sustainability in this context will be a function of two interactive forces. First, the high likelihood of legally binding ballast water related provisions in the near future would force country, regional and global actions through IMO. Second, the existence of the pilot project results that are the focus of this project brief will make it possible for countries and regions to have identified, prior to the implementation of mandatory standards, the elements of sustainability for country level ballast water control programs. This experience can be used effectively to help inform discussions regarding the mandatory provisions that are now being discussed and actually help form the content of that expected agreement. And third, the project will result in the creation of documented and tested strategies and practical materials that will assist countries to remove barriers to effective ballast water management.

44. At the country level the project will focus on building institutional capacities to sustain the country specific ballast water control action. As stated by the STAP reviewer economic benefits are generated by natural, undisturbed marine ecosystems and these ecosystems are at risk from certain species introduced by ballast water. Project capacity will be created through effective educational, informational, and participatory programs at the country level, programs that will involve all affected constituencies including the shipping industry itself. The inclusion of country specific compliance and monitoring programs will enable the development of feedback loops to measure inform project decisions during the course of activities and will serve to shape future work in the ballast water control area. The monitoring efforts will, in total, make possible successful replication of successful practices both within and outside of the region.

Government Commitment

45. This proposal has the long-term commitment of the six participating countries and the full support of the IMO Secretariat, the MEPC, and the Ballast Water Management Group of the MEPC. Participating governments are prepared to take the lead within their respective regions and serve as the catalyst for the formulation of a regional approach to this issue.

Stakeholder Participation and Implementation Arrangements

Stakeholder Commitment and Participation

46. Stakeholder Commitment and Participation are key to the success of this project. If governments are to sustain action to cope with the problems associated with ballast water transfer, there must be the creation and provision for the sustenance of community level education, information, participation and involvement. At present, there is little information concerning the already occurring and potentially debilitating effects that the transfer of non-native organisms have on the economies, environment and on the human health of developing countries. The project, by committing the substantial resources that it has on the need for education, information, participation and involvement will begin to obviate this problem and create models for others to follow. The project will also facilitate the effective participation of developing countries in the process of developing the proposed ballast water related annex to MARPOL. As developing countries participate in the project either directly or through RPTF s, they will become increasingly familiar with the importance of the issue, the potential consequences of inaction, formulation of specific actions tailored to developing country needs and resource availability, and, ultimately, will be able to more effectively inform and form the process leading to and content of the proposed MARPOL annex.

Project Implementation and Institutional Framework

47. Direct and ongoing oversight of project activities will be the responsibility of the Project Coordination Unit (PCU). The PCU will be comprised of a Chief Technical Advisor (CTA), Communications Specialist, Associate Program Officer, and requisite administrative and technical support.

48. There will be the establishment of a Regional Task Force (RPTF), a Global Project Task Force (GPTF), and Country Project Task Forces (CPTFs). The RPTF will, among other things, advise and comment upon work undertaken during the life of the project and will be encouraged to adopt measures in their respective countries consistent with those of the project. The GPTF will be comprised of senior representatives from each country lead ministry or agency, IMO, and UNDP and have general project oversight responsibility. CPTF s will have overall responsibility for the development of country-specific ballast water control action plans. CPTF s will play a crucial role of securing the active participation of all affected country interests.

Project Implementation

49. The International Maritime Organization, which coordinated work done under the PDF-B, will act as Executing Agency for UNDP. As previously mentioned the IMO, through its direct linkages to 154 member states, close cooperation with shipowners associations, port and harbor authorities, shipbuilders, classification societies, and environmental groups is ideally situated to execute the project.

VI. Incremental Costs and Project Financing

50. The creation of pilot projects, which demonstrate developing country strategies for the control of ballast water discharges, will yield important global and regional benefits. Each ship carries in its ballast water several thousand organisms, many of which, depending upon conditions in receiving waters, could become established as non-native species with the capacity to disrupt ecosystems, damage local economies, and undermine human health. Healthy regional marine ecosystems and constituent biodiversity provide robust local and national economic activity, are sources of protein and thus important to the creation of food security, and their continued health is directly tied to human health. The GEF has recognized these important linkages, and their vulnerability to uncontrolled releases of ballast water by targeting ballast water discharges "…..as virtually unaddressed problems" and constituting a "priority for the GEF."

51. Coastal waters that already have been and are at risk of being compromised by ballast water related invasions of non-indigenous organisms clearly have future use values (e.g. recreation potential, scientific research, and concentrated biodiversity), and existence values, both of which accrue at the global level. The costs of inaction are the loss of these benefits. The full project will demonstrate how country driven control programs can and will yield global and regional management objectives that will reduce negative externalities. The incremental costs (IC) associated with the project, and which are the subject of the following table, are those which are deemed necessary to bring about the global and regional benefits consistent with the GEF Operational Strategy and OP #10 of the GEF Operational Programs document.

52. The STAP review mentioned that an "important justification for not introducing non-native species is that natural coastal systems have an intrinsic value, but this is not appreciated." The point is well taken and the intrinsic value of coastal systems have quite substantial socio-economic importance and offer justification as to why such systems should be conserved in each participating

country.

53. The participating countries will provide US $2.8 million in project Co-finance. This figure includes contributions from Brazil, South Africa, China, Ukraine, Iran and India. Contributions are in-kind, direct, and additional expenditures to existing programs to assist in project implementation. In addition to the direct IMO contribution of US $639,000, IMO will provide resources for the Communications Specialist valued at US $400,000 over the three-year life of the project. The private sector contribution is initially US $392,000 and is expected to grow over the life of the project.

	PROJECT BUDGET	
Objective 1	**Program coordination and support**	**Incremental Cost**
Activities		
1.1	Recruit and hire the Chief Technical Advisor (CTA), Communications Specialist, Associate Program Officer, requisite administrative and technical support, and short term consultants.	900,000[2]
1.2	Create and organize the PCU to facilitate and coordinate the work program of the participating countries, and serve as the communication vehicle between the participating countries, regional and sub-regional task forces, and other nations and entities engaged in work related to ballast water transfer.	55,000
1.3	Review existing and, as necessary, prepare new case studies demonstrating the economic, environmental and public health dangers associated with the transfer of non-indigenous species via ballast water and distribute same to participating countries as part of the necessary program of education for government officials and the full range of affected interests.	100,000
1.4	Establish a global resource information center for international ballast water activities including collection and distribution of current and future ballast water research occurring globally and assure distribution to participating countries.	50,000
1.5	In consultation with the respective GEF country focal points and other government officials as necessary, determine a lead agency for each participating country and a senior official within those lead agencies to assume leadership of project activities and represent the participating country in meetings of the Global Project Task Force.	0
1.6	Create a Global Project Task Force (GPTF) comprised of senior representatives from IMO, UNDP, and each participating country lead agency. The GPTF would meet at the direction of the CTA and assist in the formulation and ongoing review of the project and project results. It would also work closely with the PCU to determine appropriate education and training programs for government officials.	50,000

[2] Costs associated with the Communications Specialist will be assumed by IMO. The value of this contribution is US $400,000 over the three years of the project.

1.7	With the assistance of the GPTF and senior representatives from participating countries, plan and hold six country-based Communications Workshops to develop communications approaches, including education and awareness activities. Also the workshops will identify the level of communications activities and hardware and software, newsletters, email and internet services necessary to successful project implementation.	120,000
1.8	Make provision for evaluation and assessment of project results.	80,000
	OBJECTIVE 1 INCREMENTAL COST TOTAL	**1,355,000**
Objective 2	**Increased Knowledge and Potential Solutions**	
2.1	The PCU, working with each CPTF, will provide resources to identify existing relevant, and define potential additional, community assessment, education and information activities. These activities must involve the best available expertise from both the natural and social sciences and the full range of affected interests, including NGOs and the private sector.	150,000
2.2	PCU provision of support for a workshop in each of the participating countries, under the direction of the CPTFs, to define appropriate community assessment, information, participation and education strategies.	150,000
2.3	Based upon the results of the workshop in Activity 2.2, and reviews of activities undertaken in Activity 1.7, devise workplans for the community assessment, information, participation, and education activities of the project.	60,000
2.4	Provide the resources necessary to implement the Workplans referenced in Activity 2.3, including resources for the creation and implementation of educational programs for government officials and identified stakeholders.	665,000
2.5	Create a targeted education program for ship masters, owners and operators or their agents, and port and harbor authorities to make them fully aware of the ballast water issue generally and more specifically their obligations under current and emerging International Guidelines.	300,000

	OBJECTIVE 2 INCREMENTAL COST TOTAL	**1,325,000**
Objective 3	**Barrier Removal Efforts**	
3.1	Create and provide resources for Country Project Task Force s (CPTF s) in each country. CPTF s would be interministerial in nature, would meet at the call of the Lead Ministry or Agency and chaired by a senior representative of it, and be responsible for project development, implementation, and general project oversight within each participating country.	600,000
3.2	Review existing information regarding the quantity and quality of current ballast water discharges in domestic waterways and determine the existing and potential threats posed by unchecked ballast water transfer on the economy, environment, and on human health.	150,000
3.3	Ascertain existing information gaps and define the activities needed to fill those gaps.	150,000
3.4	Based upon a review of results from Activities 3.2, 3.3, 2.3, 2.4, and other sources as deemed necessary, prepare and implement a Workplan to devise the port-specific and country-specific programs of action.	300,000
3.5	Provide support for the review of existing, pertinent domestic legislation and regulatory authorities and make recommendations to bring about the necessary changes to effect the country program of action.	300,000
3.6	Provide the resources necessary to implement the Workplan referenced in Activity 3.4, including resources for specific assessment and participation initiatives for the selected Pilot Demonstration Sites and for the creation of a public participation program aimed at key stakeholders at each site.	600,000

	OBJECTIVE 3 INCREMENTAL COST TOTAL	**2,100,000**
Objective 4	**Building Monitoring Capacity**	
4.1	Support for the CPTFs to develop generic and, as appropriate, country and port specific compliance and monitoring programs.	240,000
4.2	Support to create generic, port and country-specific manuals and appropriate reporting forms for ship masters and all other relevant persons or entities detailing in clear fashion expectations with regard to ballast water management	150,000
4.3	Support to recruit and train lead agency compliance and monitoring officials for placement at the designated pilot project ports.	450,000
4.4	Support to purchase, test and bring about refinements in analytical equipment capable of monitoring basic physical/chemical water quality parameters, and to train personnel in their use.	270,000
	OBJECTIVE 4 INCREMENTAL COST TOTAL	**1,110,000**
Objective 5	**Regional and Sub-Regional Task Forces**	
5.1	Create, as appropriate and in cooperation with participating countries, six regional or sub-regional task forces to support and learn from the experience of the participating countries and ports	
		0
5.2	Provide for RPTF Meetings on an as needed basis, and for ongoing communication between and among RPTF	
		700,000
	OBJECTIVE 5 INCREMENTAL COST TOTAL	**700,000**
Objective 6	**Self Financing and Donor Conference**	
6.1	Review the opportunities for self-financing of project components at regional and national levels, pinpointing the potential economic sources and mechanisms.	50,000
6.2	Sponsor a donor conference using the on-going GEF project as leverage for the creation of necessary additional donors and the securing of loans and confirm with IMO their support for the continuation of	50,000

	post-project activity from their regular budget.	
	OBJECTIVE 6 INCREMENTAL COST TOTAL	**100,000**
	SUB-TOTAL PROJECT BUDGET	**6,720,000**
	Executing Agency Support Cost @10%	**672,000**
	TOTAL PROJECT BUDGET	**7,392,000**

III. Monitoring, Evaluation and Dissemination

Monitoring and Evaluation

54. Project objectives, outputs and emerging issues will be regularly reviewed and evaluated at annual meetings of the Regional Task Force. The project will be subject to the various evaluation and review mechanisms of UNDP, including APR (Annual Project Review), TPR (Tri-partite Review) and an external Evaluation and Final Report prior to the termination of the project. The project will also participate in annual PIR (Project Implementation Review) exercise of the GEF. The project will also develop and utilize M&E indicators following the GEF's recommended process, stress reduction, and environmental status framework.

Lessons Learned and Technical Reviews

55. This project will be involved from the start in the new GEF International Waters LEARN (Learning Exchange and Resource Network) program and the Train-Sea-Coast program. IW:LEARN is a distance education program whose purpose is to improve global management of transboundary water systems. IW:LEARN will provide structured interactive conferencing capacity across and within the portfolio of GEF International Waters projects which will allow participants to share learning related to oceans, river basins, and coastal zone management. For environmental professionals working on GEF-financed projects, IW:LEARN will greatly expand opportunities for peer-to-peer consultation, collaborative research with physically distant colleagues, opportunities to exchange best practices and training modules among projects, and the delivery of short courses. IW:LEARN could be particularly valuable to the inter and intra-regional comparison and dissemination of successful ballast water management strategies demonstrated in the six pilot countries. Train-Sea-Coast or similar IMO based program will provide a pedagogical facility for the development of top quality ballast water course packages.

LIST OF ANNEXES

Required:

Annex A1: Incremental Cost Analysis
Annex A2: Incremental Cost Matrix
Annex A3: Incremental Cost Annex
Annex A4: Data used in Baseline calculation and Country/Private Sector Co-financing
Annex B: Logical Framework Matrix
Annex C: STAP Roster Technical Review

Optional:

Annex D:	Relationship Between IMO Regular Activities and GEF Project
Annex E:	Decision Support System, “Good Practice” Measures, Project “Tool Kit”
Annex F:	Participating Port Descriptions
Annex G:	Regional Participation Plan
Annex H:	Resolution adopted on 30 July 1998 in Cape Town, South Africa at the Meeting of the Steering Committee on Ballast Water Management
Annex I:	Copies of GEF Country Focal Point Endorsements
Annex J:	Final Reports from Project Preparation (PDF-B) phase: 1. Mission Report on the Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries (Brazil, South Africa, Bahrain, China, India, Poland) 2. Summary Report on the Removal of Barriers to the Effective Control and Management of Ships Ballast Water to Minimize the Introduction of Harmful Aquatic Organisms, for Developing Countries 3. Mission Report on the Consequences of Ships Ballast Water Transfer of Exotic Species, with Emphasis on Health Impacts, Particularly on Women and Children in Developing Countries 4. Report on the Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries
Annex K:	Guidelines for the Control and Management of Ships Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens, International Maritime Organization Resolution A.868(20), 1998.

Annex A1

Incremental Cost Analysis

Broad Development Goals

Each year, over 40,000 ships traverse the globe transporting raw materials and goods between a vast network of exporting and importing nations. In addition to transporting cargo, through their ballast water these trips transfer hundreds of millions of tons of seawater and freshwater between thousands of ports spanning a diverse range of aquatic ecosystems. On average, ship ballast water may contain 3,000-4,000 species. Of these, while only a small minority may actually survive the journey and subsequent re-introduction to foreign waters, those that do survive at times will thrive, wreaking havoc on the existing ecosystem balance. Numerous examples now exist of aquatic 'exotic species' introductions disrupting ecosystems, and causing severe socioeconomic losses and threats to human health.

In recent years, the international community has recognized the global significance of the problem of ballast water transfer of harmful, non-indigenous species and pathogens. The International Maritime Organization (IMO), through its Marine Environment Protection Committee (MEPC) and Ballast Water Working Group, has taken a lead role in trying to mobilize awareness and support for actions required to stem the tide of exotic species invasions through ballast water transfers. IMO Resolution A.868 (20) identifies the practical means by which the accidental introduction of harmful aquatic species, from one aquatic ecosystem to another, through the vector of ship's ballast water, can be minimized. In addition, a new Annex to the MARPOL Convention is anticipated by the year 2000, which will make ballast water management and control procedures part of international law. While a number of developed states (US, Australia, Canada, etc.) have taken concerted actions on this issue through adoption and enforcement of national legislation, few developing countries have begun to take the necessary steps towards being able to implement the IMO guidelines.

The broad development goal of this project is to assist developing countries to reduce the transfer of harmful aquatic organisms from ship ballast water by increasing the extent to which ships calling on developing country ports adhere to the IMO guidelines, and to enable developing countries to effectively participate in the preparation of, and be able to adhere to, an anticipated ballast water annex to the MARPOL Convention.

Baseline:

The baseline (no GEF intervention) situation is that, while selected developed countries may continue to take unilateral action to protect their own aquatic resources from exotic species invasions, the vast majority of developing countries do not possess the awareness, technical or institutional capacities to implement the IMO guidelines nor adhere to the anticipated Annex to the MARPOL Convention or separate, ballast water related Convention. In the absence of a GEF intervention on a global scale, this situation would persist leading to a continuing increase in invasions, with concomitant ecological and socioeconomic disruptions, as global shipping traffic continues to climb.

Principal baseline activities include:

Developed countries (esp. US, Australia, Canada, Europe):

- Studies of the extent and impacts of ballast water transfers
- Tests of different ballast water treatment and/or management approaches
- building awareness of the issue among port and shipping communities and broader stakeholders (aquaculture, recreational fisheries, etc.)
- Inventories of target species
- Development, passage and enforcement of ballast water legislation at national level
- Development of ballast water risk assessment/decision support systems

Developing Countries:

- Limited testing of ballast water treatment and management approaches (heat, chlorine, dilution, etc.)
- Limited identification of non-indigenous species in ship ballast water
- Limited inventories of (native) coastal flora and fauna
- Limited academic research on subjects related to ballast water issue
- Limited application of IMO guidelines by shipping companies and port authorities
- Limited or no country coordination between different government agencies with interest in the ballast water issue (environment, transport, fisheries, etc.)

International Agencies (principally IMO):

- Creation and promulgation of guidelines on ballast water control and management
- Ongoing work of MEPC on draft ballast water Annex to MARPOL Convention
- Preparation of implementation guidelines for effective application of Convention regulations
- Collecting information on ballast water management practices in member states

Global Environmental Objective:

The global environmental objective is to help create the conditions necessary in developing countries to minimize the transfer and introduction of harmful species in ship's ballast water. This will be achieved through a combination of increasing awareness of the issue in the world's developing regions, and demonstrating approaches to building national and regional capacities to implement the IMO ballast water management guidelines and ultimately to adhere to the anticipated MARPOL Ballast Water Annex. The latter will involve assisting six developing country demonstration sites (Iran, China, India, South Africa, Ukraine and Brazil) in removing barriers to the establishment of effective ballast water management and control approaches.

GEF Alternative:

The GEF alternative will support efforts at the national, regional and global levels to assist developing countries to reduce the transfer and introduction of harmful organisms from ship ballast water by increasing the extent to which countries adhere to and implement IMO guidelines and the anticipated annex to the MARPOL Convention. The GEF Alternative would support:

- Project coordination at the national, regional and global levels.
- Removal of barriers to the establishment and implementation of effective ballast water management plans.
- Development of generic, country and port-specific programs needed to increase the rate of compliance with IMO guidelines.
- Enhanced protection for identified, country specific most sensitive values at risk.
- Development of generic, country and port-specific ballast water/invasive species compliance and monitoring programs.
- Identification of options for sustaining the program following the GEF intervention.

Project sites were selected to provide the broadest possible breadth of environmental, socioeconomic and port/harbor conditions and to include at least one site in each of the world's major development regions (Latin America, Eastern Europe/CIS, Africa, Asia, Arab States). Collectively, the six sites represent over one-half of the populations of the developing world as well as some of the fastest growing economies. With economic growth comes increasing inbound and outbound shipping traffic, so the global impact of pre-emptive action in these countries towards ensuring compliance with IMO Guidelines/MARPOL annex is particularly valuable.

System Boundary:

The time boundaries for the project are the three year project period during which it will be implemented. The geographic boundaries include the global oceans, enclosed and semi-enclosed seas, and selected river, estuary and lake systems with international ship traffic.

Incidental Domestic Benefits:

Incidental domestic benefits provided by the project may include:

- Increased knowledge of the ballast water issue among national governments and other stakeholder constituencies
- Enhanced coordination, assessment, participation and training at national level
- Increased knowledge at national level of IMO provisions
- Enhanced national capacities to define and implement ballast water management strategies
- Enhanced marine and coastal monitoring capacities in participating countries
- Increased knowledge of the flora and fauna in coastal waters of demonstration countries
- Increased knowledge of most sensitive aquatic values at risk in participating countries
- Enhanced national capacities to implement IMO guidelines and to ratify and adhere to the expected MARPOL Annex.

Costs:

Baseline:	$36,788,000
Alternative:	$44,180,000
Increment:	$7,392,000

Incremental Cost Matrix:
See below, Annex 1b

Annex A2
Incremental Cost Matrix

Domestic Benefits	**Baseline**	**Alternative**	**Incremental**
	Environmental management policies, strategies and programs within participating countries lack sufficient co-ordination.	Coordination and management achieved through development of CPTF , which is interministerial in nature.	Develop knowledge of the ballast water issue among government representatives and creation of an integrated management system.
	Participating countries and ports face growing environmental, social and economic threats from unmanaged ballast water practices in their receiving waters.	Efforts targeted at removing the most important barrier to action, the lack of information and communication.	Support for effective, coordinated participation, education, assessment and training initiatives at the country level.
	At present knowledge about existing IMO provisions is negligible and an identification of participating country and port most sensitive values at risk almost non-existent.	Increase the level of knowledge about existing IMO provisions and engender information dissemination about and participation in new IMO initiatives to strengthen existing provisions.	Support increased knowledge of IMO provisions and capacity to participate in ongoing development of new provisions will enable countries to define model ballast water strategies and participate more effectively in ballast water related fora
	There are at present no or extremely limited regional information capacity to with regard to the unmanaged release of ballast water. Participating countries have no capacity to bring about any level of regional involvement.	As participating countries and ports develop and implement ballast water management strategies, regional participation will help participating ports protect themselves from unfair competition.	Participating countries and ports will be protected from, in effect, being penalized for their involvement in the project.
Global Benefits	**Baseline**	**Alternative**	**Incremental**
	There is little or no ballast water management coordination at the country or regional levels and there is limited coordination to effect existing IMO provisions. By themselves, national efforts are insufficient to	Centralized, project related coordination unit working within the IMO will begin to address the need for pilot project development and regional replication of results thus yielding a global benefit.	Increased interactions between and among countries yields progress in the development of common approaches to combating the negative effects deriving from uncontrolled ballast water discharges.

	mitigate ballast water related threats to their receiving waters.		
	Ballast water related introduction of non-indigenous species is not seen as a priority conservation issue regionally or globally and there are currently few if any efforts to protect global biodiversity from ballast water effects.	Increase the extent to which developing countries learn from the experiences of participating project countries and ports through the development of an effective information resource center and the distribution of training manuals and course modules.	Support for creation of the information resource center, the creation of training manuals and modules, and the distribution of effective, project generated public information and education materials.
	Developing countries and ports have yet to recognize the ballast water issue as requiring special attention and thus there are no developing country initiatives that would mitigate the existing substantial threat that exists for vulnerable ecosystems.	Increase participating country and port capacity to effectively address the ballast water issue through the use of demonstration projects and create the means to ensure replicability.	Support for the development of generic and where possible country and port specific measures that will result in the creation of a ballast water management plan and action plan that can be replicated in other developing countries.
	There is at present limited or no monitoring capability in the targeted countries to determine if current ballast water discharges are placing important country and port values at risk.	As programs for the control of unmanaged ballast water discharges are being developed by participating countries and ports, effective monitoring strategies would also be developed. Data sets would be shared to enable a coordinated regional approach.	Participating countries and ports able to integrate monitoring into an overall strategy to manage the uncontrolled release of ballast water into their receiving waters.
	There are no regional efforts being undertaken to address the problems associated with the transfer of unwanted non-indigenous organisms via ballast water.	A regional approach to protect individual countries and ports from competition as they initiate ballast water programs. Activities that will maximize the replicability at the regional level.	Support for the extension of participating country and port activities and lessons learned to other developing countries in the region.

Annex A3
Incremental Cost Annex

Objective		Baseline (B)	Alternative (A)	Increment (A-B)
1	Program coordination and support	0	1,360,000	1,360,000
2	Increase Knowledge and Provide Potential Solutions	12,260,000	13,585,000	1,325,000
3	Barrier Removal Efforts	1,488,000	3,583,000	2,095,000
4	Building Monitoring Capacity	22,330,000	23,470,000	1,110,000
5	Regional and Sub-Regional Task Forces	710,000	1,410,000	700,000
6	Self Financing & Donor Conference	0	100,000	100,000
	Project Support Costs @10%			672,000
	Total	36,788,000	44,180,000	7,392,000
	PDF			219,400
	Total project cost	**36,788,000**	**44,180,000**	**7,611,400**

REMOVAL OF BARRIERS TO THE EFFECTIVE IMPLENTATION OF BALLAST WATER CONTROL AND MANAGEMENT MEASURES IN DEVELOPING COUNTRIES										
Data used in										
Baseline Calculation							Baseline by Relevant Objective			
Programme/Project	Year	Ongoing and Planned Secured Funding	Planned and unconfirmed Funding	Funding Agency and/or Country	Project Objectives and Issues Addressed	Objective 1, IMO PCU	Objective 2, Knowledge on aliens	Objective 3, Increase Compliance with Guidelines	Objective 4, Monitoring	Objective 5, Awareness
<u>Organisation Name</u>										
International Maritime Organisation	1998	120,000	0	IMO, Attending countries	Meetings of IMO MEPC			120,000		
European Union	1998-2000	225,000	0	EU MAST	Sampling methods, Awareness		75,000		100,000	50,000
Intertanko/ICS	1998	305,000	13,000	Intertanko/ ICS	Ballast Water Management Plan			13,000		
International Council for the Exploration of the Sea, Working Group on Introductions and Transfers of Marine Organisms	1998-2001	150,000	0	Attending countries	Annual Working Group Meeting		100,000			50,000
Baltic Marine Biologists Working	1998-2001	25,000	0		Working group		25,000			

Group on Non-Indigenous Estuarine and Marine Species					Meeting					
United Kingdom	1998-2001	225,000	0	United Kingdom			50,000		175,000	
Germany	1998-1999	305,000	0	Germany	Ballast water treatment, Meetings		30,000		275,000	
Sweden	1998	30,000	0	Sweden	Monitoring Harmful Algal Blooms		5,000		15,000	10,000
Norway	1998-1999	185,000	0	Norway	Risk Assessment, Ship sampling		85,000		100,000	
Finland	1998	50,000	0	NORFA	Risk Assessment		30,000			20,000
France	1998-2001	50,000	0	France	Monitoring				50,000	
Ireland	1998-2001		50,000		Monitoring				50,000	
The Netherlands	1998-2001		250,000	The Netherlands	Risk Assessment, Shipping Study		100,000		150,000	
Greece	1998-2001		50,000	Monitoring					50,000	
Croatia	1998-2001		50,000	Monitoring					50,000	
Georgia	1998-2001		50,000	Georgia	Monitoring				50,000	

Brazil	1998-2001	200,000	26,420,000	Brazil, Petrobras	Testing the Effectiveness of ballast water Exchange using the "Dilution Method", Monitoring Studies	9,150,000	200,000	17,270,000	
China	1998-2001	100,000	770,000	China	Meetings, Translation of IMO Guideline, Red Tide Study	50,000	100,000	550,000	170,000
India	1998-2001	450,000	0	India	Monitoring on Alien species, Activities on Ballast Water Guidelines	150,000	300,000		
Iran	1998-2001		2,101,000	Iran	Monitoring,scientific research, training, international conferences	1,000,000	101,000	1,000,000	
South Africa	1998-2001	95,000	380,000	South Africa	Meetings, Shipping Study, Monitoring, Red Tide Programme	130,000		265,000	80,000
Poland	1998-2001	150,000	0		Ballast Water Treatment			150,000	
Other Countries with useful Baseline			0						
USA*	1998-2001	500,000	2,174,000	USA	Ballast Water Treatment, Monitoring Studies	1,000,000	624,000	750,000	300,000
Canada*	1998-2001		1,000,000	Canada	Monitoring Studies			1,000,000	
Australia	1998-2000	40,000	80,000	BHP		30,000	30,000	30,000	30,000

New Zealand*	1998-2001		500,000	New Zealand	Shipping Study, Monitoring Study		250,000		250,000	
Subtotal		3,205,000	33,583,000			0	12,260,000	1,488,000	22,330,000	710,000
TOTAL (Secured and Unconfirmed Funding)	1998-2001	36,788,000								
Objective 1		0								
Objective 2		12,260,000								
Objective 3		1,488,000								
Objective 4		22,330,000								
Objective 5		710,000								
GRAND BASELINE TOTAL		36,788,000								

Country and Private Sector Co-Financing Summary
(Estimates based on data provided in National Reports and other sources)

Private Sector
Studies by PETROBRAS (Brazil) of Flow Through Method/Exchange of Ballast Water at Sea, $22,000.
Ballast Water Trial by PETROBRAS of Flow Through Method on Product Carrier of 30,000 TDW, $170,000
Annual Participation by Private Sector Representatives in Global, Regional and National Project Task Force Meetings, $200,000

Brazil:

Ministry of Health, $5,000; Ministry of Transport, $25,000; Ministry of Environment, $25,000; Ministry of the Navy, $100,000.

South Africa:
Department of Transport (SAMSA), $40,000; Department of Environment, $120,000; Portnet, $60,000; Shipping Industry, $100,000; University $60,000.

China:
Establishment of red tide warning system, $200,000; Testing of chemical treatment methods on board ship, $370,000; Testing and assessment of open ocean ballast water exchange in the Pacific Ocean, $350,000.

India:
Creation of sampling and analysis infrastructure for ballast water and harbour assessment, Mumbai, $400,000; Monitoring of identified alien species *Mytilopsis sallei* in Mumbai, $200,000; Evaluation of safety aspects of ballast water exchange in the Arabian Sea, $300,000.

Iran:
Participation of Ports and Shipping organizations in relevant project meetings, conferences and training, $145,000 (est.)

Ukraine:
Initiation of port of Odessa sampling program; feasibility and costing study to evaluate possibilities for adapting existing reception facilities in Odessa to receive ballast water; development by BLASKO of alternative treatment methods for ballast water on their vessels. $300,000 (estimate only).

Annex B:

Logical Framework Matrix

Intervention Logic	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
Long-term Objectives			
Assist developing countries to reduce the transfer of harmful organisms from ship ballast water by increasing the extent to which ships calling on developing country ports adhere to International Guidelines of the IMO enable developing countries to effectively participate in the preparation of, and be prepared to adhere to, an anticipated ballast water annex to the MARPOL Convention.	A framework and coordination mechanism for national and regional efforts to remove barriers to effective ballast water management.	PCU documents. RPTF Meeting. RPTF Meeting Minutes and Records. GPTF Meetings and Meeting Minutes. CATF Meetings and Minutes. IM Committee Meetings and Minutes. CPTF Meetings and Minutes.	Continued country commitment to a major focus on development of an effective ballast water management plan.. Project capacity to adequately conceptualize and implement the necessary communications framework. Involvement of key national governments and regional institutions.
	Improved national and regional capacities for the effective management of ballast water discharges.		Changes in economic, political and social conditions detract from country commitment and requisite support.
Project Purpose			
Remove barriers to the establishment of effective ballast water management plans and actions in six developing nations.	Country participation in and endorsement for project workplans.	Completed workplans for and by the six participating nations. National and additional donor commitments to workplan elements.	Fear of competition among ports may make it difficult to secure adequate country participation or adequate regional cooperation.

Intervention Logic	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
		PCU documents and working group reports.	Regional organizations and country participants are not able to work co-operatively to the extent necessary for project success.
			GEF funds not adequately complemented by country commitments and other donors.
Output 1			
Ensure effective project coordination and support through establishment of an IMO based PCU; Lead Agencies to coordinate country and port based project work.	PCU, RPTF s, and CPTF s created. Lead agencies designated.	CTA and CS employed.	Executing agency willing to commit physical space and other required support resources.
	Effective project communications system ensured. Increased capacity for national and regional level participation in project related global fora.	Staffing pattern reviewed.	Substantial investment in communications capability essential to project success. Lack of clear lines of responsibility to the GEF project hamper implementation.
	Increased capacity to create national benefits through enhanced transboundary management regimes. Legally binding IMO MARPOL Annex on ballast water management	Increased level of national governmental and regional participation in project related regional and international fora. Increased extent to which explicit national and regional positions are formed for use in various global fora.	Potential regional benefits merit high level of government participation and capacity to form regional positions. Short term national needs and competition among ports outweigh increased level of participation in regional fora.

Intervention Logic	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
		Documents of existing and potentially new project related fora. IMO formal approval of MARPOL Annex	IMO formal approval of MARPOL Annex will establish conditions for the sustainability of project activities. Given the advanced stage of IMO's legislative and diplomatic process on this Annex ,it is highly unlikely that it will not gain approval in some form.
Output 2			
Increase knowledge of generic, port and country specific dangers associated with the ballast water related of non-indigenous organisms.	Establishment of CPTFs and effective country level participation in demonstration projects.	Workshop proceedings. Approved workplan for each participating country. PCU documents and other materials. Demonstration site visits. Interviews with key stakeholders.	Countries see the long term benefit deriving from a barrier removal effort. Demonstration sites selected through application of criteria that maximizes replication.
	CPTF sponsored workshops, workplans and resulting community assessment, information, participation and education activities. Manuals and other information pertinent to education of country officials, stakeholders and ship masters.		Countries not willing to participate fully in barrier removal efforts due to other emerging priorities and fear of competition from other ports. Demonstration Projects poorly executed.
Output 3			
Develop generic and, to the extent possible, country and port specific programs defining the measures necessary to increase the rate of compliance with IMO Guidelines. Achieve enhanced protection for	CPTF s established and functioning. Generic and, to the extent possible, country and port specific guidelines defined. Existence of project workplan. Implementation plan for public	PCU and CPTF documents.	Country benefits to be gained through proposed activities justify country participation. Port countries continue to believe that risks associated with uncontrolled releases of ballast water must be addressed.

Intervention Logic	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
identified, country specific most sensitive values at risk.	participation program at each demonstration site.		
	List of existing and potential threats and information gaps	Country and port specific workplans.	Short term benefits to be gained by ports in non-participating countries in the region may impede development of a regional approach
	Report and recommendations re. Adequacy of existing legislation and regulations.	Interviews with key stakeholders.	
Output 4			
Develop generic and, to the extent possible, country and port specific monitoring programs with special attention to achieving protection of identified country specific most sensitive values at risk.	Interministerial Committees established. Lead agencies identified and monitoring officials recruited, trained and placed.	PCU documents. Interministerial committee meetings and meeting minutes.	Communities will recognize benefits of involvement. Stakeholders will recognize benefits of involvement.
	Manuals created and reporting forms developed.	Manuals and other forms related to effective monitoring.	Countries will be willing to partner with communities to improve activity results.
	Monitoring equipment purchased and deployed.	Purchase records.	Perceived benefits of participation insufficient to attract full range of stakeholders. Project aims seen as inconsistent or competing with local interests.
		Written information regarding level of compliance by ship masters.	
Output 5			
Make provision, as appropriate, for the creation of Regional or sub-regional task forces to increase	Creation of Six regional task force Chairs. Membership for each RTF completed	PCU documents; RTF meeting records of discussion and decision	

Annex C
STAP REVIEW

Review of Global Ballast Water Management project:
John S. Gray University of Oslo, Norway

1. Overall Impressions

This project is timely, important and in general, well-designed. The background to the project is clearly stated and is shown to be a global and urgent environmental and possibly public health problem. The approach taken is logical and is based on sound assessments of where the problems lie. These are the need for a global approach, based on an international lead agency such as IMO, and the recognition that in most developing countries the problem, due to ignorance, is not perceived as being important. The assessment of the technological needs and prognoses are sound and appropriate. The only reservations that I have are concerned with a) the public health aspects and b) objective 2.

2. Relevance and Priority

Undoubtedly the ballast water problem is of major economic and social significance. The two key examples used the introduction of the zebra mussel into the Great Lakes and the comb jelly to the Black Sea have had disastrous economic effects. Neither of these events has been properly costed but the assessment of millions of dollars lost is undoutbtedly true. The analyses of the international regulations and the national ones are up-to-date and informative and the project is firmly based on pursuing the IMO guidelines further. I believe this is entirely appropriate.

3. Project Approach

The general approach is both sound and logical. One area that concerns me is the claim that the cholera bacterium *Vibrio cholerae* was transported to Lima, Peru in 1991 in ballast water and spread along the coast riding on marine plankton. This has been repeated so many times that it has become an accepted fact. Yet there is no factual evidence that the introduction was by ballast water. All the available evidence suggests that *V. cholerae* cannot survive in normal salinity sea-water, (Gray et al 1996, JAMA 276 (5) 372-373). However, measurements made on-board a tanker have shown that *V. cholerae* can survive in ballast water of low salinity. Thus the often-stated risk of cholera being spread by ballast water is a perceived problem and has not yet been shown to be a real problem. Nevertheless there is a clear need to have an open mind and to ensure that pathogenic bacteria and viruses are not spread by ballast water.

Since there was a cholera outbreak in Peru in 1991 which was related to contaminated sea food I would have thought that the inclusion of Peru and especially Lima would be a major priority and would urge that efforts be made to include Peru in the programme.

I was pleased to see that not only the water but also sediment was included. It needs to be stated that dinoflagellates are able to encyst and remain dormant in sediments for decades.

The assessment of the possible technological solutions is excellent and clearly lists the need to take account of viruses, bacteria algae, protists, invertebrates and fish and also ship safety and environmental acceptability. Yet following this, the section on *Current Ballast Water Treatment Options* could usefully contain an objective to initiate discussions with the IMO and ship designers about a new generation of ships that take proper account of the need for treatment of ballast water. We need a long-term and permanent solution and there are no conclusions from this section, merely an analysis of the current situation.

GEF intervention is highly important and this is a logically argued section. The risks of competition between ports is real and the assessment of the lack of awareness of the problem at political and managerial levels is sound.

4. Objectives

The project objectives are valid and focussed, save objective 2 that I have some problems with.

Objective 1 is fine and the argument for GEF interest good. One aspect that is perhaps overlooked is the need to include countries where ships are registered, e.g. Panama, Monrovia and Norway since their regulations in conjunction with classification societies will be crucial for development of future regulations. The local case studies are ones that will convince local politicians but getting good quality data on species introductions and consequences is an enormous task and will need to involve many scientists. I like the activities, which are well organised and appropriate.

Objective 2 I understand what is intended, but have doubts as to how this can be argued on a local port basis. The key cases are still those in enclosed sea areas, the Great Lakes and the Black Sea. Can we make good case studies for open coasts? On the public health side the Peru cholera outbreak may simply have been by a bearer travelling by air and his/her faeces contaminating the water supply and Lima harbour. The examples that we have are from developed countries, which are more environmentally aware and ready to act. We have to convince local politicians of the potential problems. A better approach may be to erect scenarios of relevant local issues one of which could be based on public health, one on a coastal sea-food related issue, and one say on coastal erosion which is an important function provided by natural ecosystems. Activity 2.1 is weak and I do not see from the text how this will be done in practice. Non-experts cannot do the assessment and making predictions of the impact of potentially thousands of species is almost impossible. Scenarios made by natural and social scientists may be an option.

The targeted education program is aimed at ships- masters but the countries taking part in the pilot programme will rarely own the ships. A global education programme is needed if one is to target shipmasters, owners and operators.

Objective 3 is excellent, well designed and structured.

Objective 4 again is well designed and structured. I accept that biological monitoring of potentially damaging species is time-consuming and expensive and that physical and chemical monitoring is appropriate. However, there are new techniques being developed for the rapid assessment of public health risks (e.g. gene probes for *E. coli*, hepatitis B and cholera) and these will soon be generally available. Activity 4.1 what is implied by a country-specific monitoring programme?

Objective 5: again sound. Is it planned that 1 port per country will be used in the programme? China and India have many ports and to take in more than a few would be, in my opinion, a mistake.

Objective 6 no comment.

5. Background and Justification

The background to the project is clearly stated and the relevant information given. However, although the statements are factually correct few references are given and I would have preferred to see full documentation. GESAMP has a review of the comb jelly invasion of the Black Sea and Jim Carleton and Victor Hallgraef's extensive reviews of introduced species and their effects should be mentioned.

An important justification for not introducing non-native species is that natural coastal systems have an intrinsic value, but this is not appreciated. A major paper by Constanza et al., (CONSTANZA, R. *et al.* (1997) "The value of the world' ecosystem services and natural capital." *Nature* 387, 253-260), shows just how valuable natural systems are. This could be used very effectively in giving the justification as to why natural coastal systems should be conserved in each country. This is not mentioned in the proposal. An appropriate place where this aspect could be properly utilised is in the *Incremental Costs and Project Financing.* Here future use values are stated as recreation potential, scientific research and concentrated biodiversity. These are relatively trivial compared with the value provided by functions such as waste treatment, (sewage and contaminants) and coastal protection.

The project, as clearly mentioned in the text, does not fit within national priorities simply because countries are largely ignorant of the problem. This is not a justification for rejecting the proposal, on the contrary, there is a strong need for it!

The proposal presents clearly the rationale as to why the project should be undertaken and the existing institutional arrangements.

6. Critical Analysis of the Situation

I have commented above on the need to involve countries where ships are registered and the need for an international education programme for ships- masters. Other than these all aspects of likely externalities are fully covered. The priority problems are clearly stated and the causes, lack of appreciation of the problem by local politicians, clearly identified.

7. Activities

Under Objectives I have already mentioned my doubts about activity 2.1 and the lack of clarity in 4.1 With the exception of Objective 2 which I believe needs a thorough reappraisal, my criticisms are minor in relation to the planned activities which are extremely well argued and thought out.

8. National Priorities and Community Participation

Again national priorities are only just emerging (as a result of the Cape Town meeting) since many countries were simply not aware of the problem. Stakeholder participation on this issue is a difficult one. The main stakeholders are the ship owners and port authorities but those potentially affected are the general public. Yet until there is a problem they will be unaware of any effects. The proposal has made an attempt to take in stakeholders at all levels but I do not see that public education programmes are relevant at this stage. Education of appropriate national authorities is the right step. I am also unsure of what role NGOs can play. Local expertise on what changes occur in natural ecosystems will need ecologists, social scientists for economic assessments and users of coastal systems such as fishermen, both artisanal and commercial.

8. Institutional Arrangements

The institutional arrangements are sound and basing the PCU at IMO is appropriate for the long-term and daily contacts with shipping regulators, owners and appropriate expert groups. I believe the structure is sound and can succeed.

9. Time Frame

The time frame is appropriate.

10. Funding

The proposed level of funding is appropriate to the magnitude of the problem. Objective 2 will need a revised budget if my recommendations are followed.

11. Innovative Features/replicability

If successful the project should be applicable in other countries. I suspect that the achievement of common sets of reporting and monitoring methods will be the most likely directly transferable outcome of the project and these could then be applied simply and cheaply to other geographical areas. In the longer term the production of a database in electronic form accessible over the WWW is important, as is liaison with ship owners, classification societies and IMO on the development of standards for ballast treatment in new ships. Here the PCU can play a unique role.

12. Sustainability

This section does not do justice to the economic benefits provided by natural undisturbed marine ecosystems. There is clearly a need to sustain these functions, (e.g. coastal protection, waste treatment, provision of clean water), and prevent species introduced by ballast water from disturbing these. Powerful economic arguments can be based on Constanza et al. economic assessments, and should convince any politician on the need for sustainability of coastal ecosystems.

The argument about building up sustainable infrastructures in each country is sound.

13. Development Dimensions and Rationale for GEF Support

The potential for building up a port system whereby ballast water discharges are controlled in developing countries is important and achievable. The proposal states clearly how this can be achieved and I have no doubts about the achievability.

The rationale for GEF involvement is clearly stated and GEF has already stated that this is a problem of major concern to it. Thus the case for GEF involvement is clear.

15. Additional Comments

Annex D
Relationship Between IMO Regular
Activities and the GEF Project

IMO – Member States	GEF/UNDP
<u>Now</u> 1. IMO Natural Base 2. Voluntary Guidelines 3. No PCU to support country Activities	No country demonstrations
GEF Project	1. Jump-start PCU at IMO/HQ 2. Phase down GEF funding 3. Fund demonstration sites in six countries 4. Document barriers and strategies to overcome them 5. Demonstration sites do log checks, sampling, control, monitoring and risk assessment.
2001 – 1. Mandatory protocol in place 2. Fully funded PCU at IMO to support country activities	Countries assume ongoing responsibility for ongoing ballast water related activity.

Annex E

Decision Support System, “Good Practice” Measures, Project Tool Kit

Decision Support System

It will be essential that each demonstration site establish an organized means of evaluating the potential risk posed by vessels entering their port. Only in this way can they take the most appropriate decision regarding any required action concerning that vessels’ ballast water discharge. This evaluation is commonly known as a Decision Support System or DSS.

The DSS can be a quite basic system operated on a fully manual basis. Then, as information is assembled over time and the knowledge of those operating the system increases, the DSS can become progressively more comprehensive.

The DSS is a management system that provides a mechanism for assessing all available information relating to individual vessels and their individual management of ballast water so that, based upon assessed risk, the appropriate course of action can be taken.

Issues incorporated into a DSS, at a minimum, would include, among other things:

- vessel details, for example how much ballast water is on-board
- where the vessel may have been re-ballasted
- a review of any ballast water arrangements, documentation such as a Ballast Water Management Plan
- intent of the vessel re. discharge of ballast water
- knowledge of the port of uptake
- circumstances of uptake

Initially the DSS will be a relatively simple system based on known information. As the amount of information increases the system can be incrementally improved. The relative level of initial simplicity will make it possible for any port to adopt its own system of best practices and to improve upon those practices as increased amounts of information become available.

“Good Practice” Measures

There are a number of “Good Practice” measures, which will be essential to the Project as a whole and, in particular, at each of the demonstration sites. These criteria will be used as the benchmarks against which the implementation of the project can be evaluated. Criteria will include:

- improved knowledge of the ballast water issue
- Secured involvement and commitment of all affected interests
- Designed and implemented measures for managing shipping/ballast water in each port/region which could include, among other things, a DSS, acceptable practices, organizational roles, planning to achieve long-term sustainability, and the Ballast Water Management Tool Kit.

The Ballast Water Management “Tool Kit”

“Good Practice” measures will include options at each of the three phases in the continuum of ballast water management. These measures, part of a generic “tool kit”, would be implemented when indicated by the DSS that some action is necessary.

- at uptake, where the emphasis would be on existing IMO Guidelines, specifically Res.A866.
- en route, where treatment can be through Ballast Water Exchange (empty and refill, flow-through, or dilution method), use of a Heat Treatment option, use of Separation or UV

Process, or other approaches such as Electromechanical, Hydrogen Peroxide, or other methods as they are developed and tested.

- on arrival, where, again, the emphasis would be on existing IMO Guidelines and provision for an Alternate Exchange Site Discharge zone.

Annex F

Participating Ports

Effective, country based Pilot Demonstration Projects at specified ports within six developing nations, representative of each global development region, are at the heart of this project. The participating nations include Brazil, which has designated the port of Sepetiba, China, which designated the port of Dalian, India, which designated the port of Mumbai, Iran, which designated Kharg Island, South Africa, which designated the port of Soldanha, and the Ukraine which designated the port of Odessa.

Following are physical descriptions of each port, their geographic location, reasons for selection, issues to be addressed, and lead agencies. It should be noted that each port has been selected for reasons of their willingness to participate in the project. This requires not only agreement by the national government, but agreement as well by a range of other governmental and quasi-governmental agencies that include port administrations. The level of agreement required to ensure the participation of a port is thus no small feat.

A major concern posed by the unintentional introduction of marine non-indigenous species is that of human health. Most major port areas are also areas of high population density. Each of the port areas selected for the project has surrounding, large populations. These populations, particularly women and children, are vulnerable to severe disease epidemics such as cholera and typhoid. Coastal waters, which include those upriver which are tidal, may be used for bathing, laundry, and recreational purposes. Where contact with contaminated water occurs, the risk of disease is present. Other less direct vectors, such as the consumption of contaminated fish and shellfish, especially from wild stocks, may result in disease or death. Further information on the dangers of unintentionally introduced marine non-indigenous is described in Annex 10 (3.).

Taken together, the countries and ports selected for the project satisfy several other criteria. As a group they represent countries and ports from each GEF development region. Further, taken together they represent the full range of issues that need to be addressed in attempts to effectively manage the unintentional introduction of non-indigenous marine organisms. Taken together these ports host the full range of shipping activities – bulk carriers, ore, oil, and container vessels. They receive ships from virtually every country of the world. And, taken together, the experience of these countries and ports will yield country and regional benefits that will substantially mitigate the current level of threat that exists.

Sepetiba, Brazil

The Port of Sepetiba is located on the southern coast of Rio de Janeiro State and is immediately adjacent to Rio de Janeiro. Within 500 kilometres of the port is a concentration of industry and commerce that represents 70% of Brazilian GDP. Sepetiba's coal terminal has the capacity to handle 7,000,000 tons per year while its ore terminal has the capacity to handle 15,000,000 tons per year. The Port was constructed in 1982 to meet Companhia Siderurgica Nacional and Valesul's need to move bulk cargo from their plants and thus unencumber the Port of Rio de Janeiro.

According to an evaluation of ports done by Companio Docas do Rio de Janeiro, which acts as the Port Authority for the Ports of Rio de Janeiro, Sepetiba, Angra dos Reis, Niteori and Fornu, Sepetiba will become Latin America's largest, and the first Southern Atlantic Harbor to be a major cargo hub port capable of handling over 20 million tons of cargo per year. Additionally, it is equipped with modern port equipment and will be able to accommodate the latest generation vessels up to 8,000 TEUs. Sepetiba is intended to be a model port highlighting a concern with environmental management and the development of an Environmental Management Plan is an immediate Port priority.

The Ministry of the Navy is the key administrative entity in Brazil concerned with ballast water issues. The Ministry has been actively involved in ballast water issues in Brazil prior to the project and has been the driving force in shaping Brazil's and the Port of Sepetiba's involvement in the proposed GEF Project. Other participating agencies of government will include the Ministry of Environment, Water Resources and Legal Amazon, the Ministry of Transport, the Ministry of Health, and the Port of Sepetiba Port Authority.

The workshop in Brazil scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the June 1998 Consultants mission under the PDF:

1. The development by PETROBRAS of some alternative treatment methods (electrolytic units for chlorine generation, small mesh, self washing and back washing filters and thermal treatment). The output of these investigations would be an efficient alternative to avoid stability risks during the exchange of ballast water at sea.

2. The initiation of a sampling program in the Port of Sepetiba jointly by the Ministry of Health and Environment which might be extended to other ports. The expected results are better protection against pathogens and improved taxonomic records for ballast water discharges.

3. Twinning with more developed countries and other countries in the region aimed at reducing the costs and narrowing the area of investigations.

4. The initiation of the legal process to incorporate the IMO guidelines and to prepare for an international binding instrument in the year 2000.

5. The evaluation of the possibility of building a treatment plant and reception facilities for ballast water in the port of Sepetiba. The output of this activity could be a viable alternative for vessels trading in the SW Atlantic Ocean.

Dalian, China

The Port of Dalian is located on the south part of the Liaodong Peninsula. It is a natural port on the northeast coast of China. It faces the Bohai Sea in the west, the Yellow Sea in the east, and the Shandong Peninsula in the south. To its back is the vast landscape of Northeast China.

In 1997, 51,525 vessels visited Dalian. 3,883 of those vessels were engaged in international voyages. About 5.5 million tons of ballast water was discharged in Dalian Port and its coastal waters in 1997. This ballast water came form ships visiting from Korea, Japan, Southeast Asia, with lesser amounts from North America, and Europe.

The area around the Port of Dalian includes fish and prawn farms. In 1993 and 1994 the prawn farming industry suffered severe losses due to an unknown bacteria or pathogen, and prawns died in great numbers causing a total loss of 3 billion yuan. While no direct correlation has been demonstrated between ship ballast water and losses to the fishing and prawn industry in the Dalian area, ballast water discharged at the port is within easy reach of farming areas. The proximity of Dalian to these valuable prawn farming areas is one of the reasons Dalian has been selected for inclusion in the project.

Key agencies connected to the ballast water issue in China, and for Dalian as a port included in the project, are The Harbour Superintendency Administration, the Frontier Health and Quarantine Authority, the Frontier Plant and Animal Quarantine Authority, and Port officials in Dalian.

The workshop in China scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the June 1998 Consultants mission under the PDF:

1. Establishment of a red tide warning system for mariners;

2. Experiments of various chemical treatment approaches on board ships;

3. Ballast water exchange in open ocean areas of the Pacific Ocean;

Mumbai (Bombay), India

The port of Mumbai lies midway along the west coast of India, and possesses a deep harbour covering 400 square kilometers. The harbour is well protected by the mainland on its east and the Island of Mumbai to the west.

The Port of Mumbai is a fully integrated, multi-purpose port handling container, ro/ro, dry bulk, liquid bulk, and general cargoes. The total handling capacity of the port in 1997 was 33,727,000 tons.

Many Indian vessels sailing out of Mumbai have been carrying out ballast water tank cleaning at high seas on a tank-by-tank basis for years. The reason for such practice is that captains fear that mud and sediment mixed with ballast water would quickly settle and accumulate on the bottom of the ballast tank after being taken on board as ballast. Such practice may, however, help to reduce the possibility of the introduction of harmful organisms or pathogens, which live in shallow water or sediment. The Government encourages the practice of ballast water tank cleaning on the high seas and the Indian experience with this practice makes its participation an attractive one for this project.

Government authorities which will be involved with the project include the Directorate General of Shipping and Port Authority, under the Ministry of Surface Transport, the Environment Authority, under the Ministry of Environment and Forests, the Health Authority, under the Ministry of Health, and the Coast Guard under the Ministry of Defence. The Port Authority of Mumbai will also be involved in project implementation.

The workshop in India scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the June 1998 Consultants mission under the PDF:

1. Creation of infrastructure for ballast water and harbour water assessment;

2. Monitoring of identified alien mytilopsis sallei in Mumbai

3. Exchange of ballast water on the Arabian Sea.

Kharg Island, Iran

Kharg Island is located on the Persian Gulf and is Iran's and the Gulf's largest port facility.

The Sea Island Terminal is located on the West side of the island with two berths for vessels up to 500 000 dwt. The depth alongside these berths is 32.3 m at MLW. The terminal also provides two berths for vessels up to 300 000 dwt with a depth alongside of 29.8 m at MLW.

The management of the terminal and the operation of vessels are the responsibility of National Iranian Oil Company (NIOC), which is also in charge for the cargo storage and handling. In addition to the loading and discharging facilities the terminal provides pilotage, tug services and antipollution services. The maintenance of the terminal and the other essential facilities of a port (hospital, fire protection etc) are also responsibilities of the NIOC. The main functions of maritime administration are the responsibility of the Ports & Shipping Organisation (PSO). Vessel Traffic Control and Port State Control is performed by PSO inspectors. Other departments and ministries with direct or indirect responsibilities regarding the ballast water issue include the Department of Environment, the Marine Environment Bureau, the Ministry of Jahad (fisheries), and the Oceanographic Commission. Iran, as part of the initial consultation during the PDF-B phase, is in the process of forming a ballast water steering committee, which would function during project implementation.

The selection of Kharg Island as a demonstration site, aside from its general Gulf location and by virtue of its being the largest oil terminal in the Gulf, is due to the sensitive environmental nature of the Gulf. Gulf waters are shallow, have substantial marine biodiversity, high water temperature, and experiences little exchange of water with surrounding marine areas through the Ormuz Strait.

The workshop in Iran scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the June 1998 Consultants mission under the PDF:

1. The initiation of the legal process to incorporate the IMO Guidelines and to prepare for the adoption of a new international binding instrument in year 2000;

2. The initiation of a sampling programme in Kharg Island area jointly by the interested organisations and the development of relevant studies related thereto;

3. The dissemination of the developments regarding the ballast water issue among the other countries from the Gulf area through ROPME.

Port of Saldanha, South Africa

The Port of Saldanha is the largest port in the southern part of South Africa and covers 7430 hectares of water area in Saldanha Bay. it is South Africa's deepest port. Located in the southwest of the country on the Atlantic Ocean, Saldanha Bay is considered by South African officials to be a highly sensitive environmental area due to intensive aquaculture activities occurring in the proximity of the port site and that the surrounding area has been declared a "natural reservation" by the government.

The annual level of iron ore exports in 1996 was 19.2 million tons, with an expected level of at least 20 million tons per annum over the next five years. Crude oil is also imported and transhipped through the port, while general cargo consists of copper, zinc, lead, and phosphate. The break bulk general cargo facility (General cargo Quay) consists of a Quay 250 metres long and a storage capacity of up to 30,000 tons, both covered and open.

The environmental sensitivity of areas immediately surrounding the port, the substantial size of the port, its proximity to Cape Town, and the support of all relevant government agencies for its inclusion as a demonstration site within the GEF project were all factors in the selection of the port to participate in this project.

Relevant governmental agencies which will participate in the project include the Department of Transport, the Department of Environmental Affairs and Tourism, the Department of Health, and PORTNET. PORTNET is a public company that is responsible for port management in South Africa. Its responsibilities include maintenance of basic port infrastructure, construction and maintenance of breakwaters, channels, basins, quay walls, roads and rails in the port area. It also provides marine and navigational assistance services such as pilotage and tug assistance. One of the most important roles of PORTNET is that of pollution prevention in port areas. In this respect PORTNET develops port environmental management strategies and establishes port pollution regulations based on South African and international laws and regulations.

The workshop in South Africa scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the May/June 1998 Consultants mission under the PDF:

1. Establishment of an Environmental Management System (EMS) that will allow for the management of port operations according to internationally acceptable environmental standards;

2. Identification of priority issues upon which the EMS should focus;

3. Identification of applicable environmental standards/laws/regulations/conventions;

4. Exploration of new EIA regulation requirements;

5. Research on the taxonomy of endemic and potentially invasive zooplankton species;

6. Ballast water tank sampling and related training of port health and pollution officer(s);

Port of Odessa, Ukraine

The Port of Odessa (Odessa) is one of the largest ports in the Black Sea. Its location on historically founded merchant ways between West and East, closeness to Bosphorus and Dardanelles, convenient exit to Mediterranean Sea and Indian Ocean, round-the-year navigation in the port, proximity to the big industrial and agricultural areas of the region make it a particularly attractive, heavily used port whose volume is growing rapidly.

Odessa's location on the Black Sea, the site of a substantial GEF sponsored effort in the International Waters PoRPTF olio, makes it an important addition as a pilot demonstration site. Located on the northwestern shelf of the sea, the areas in close proximity of the port are important nursery and feeding areas for the Black Sea fishery.

The port includes seven facilities for handling dry-cargo, passenger traffic, oil, and container handling. The port has the capacity to handle up to 14 million tons of dry-cargoes and about 24 million tons of oil products per year. Port passenger capability is up to 4 million passengers per year. Entering, leaving and shifting of vessels is constant and assisted by pilot service whose technical facilities allow manoeuvring in poor visibility. The open storage area is 215 400 sq. m,, the warehouses area 78 800 sq. m., and the cargo storehouse can accommodate up to 13 500 tons at a storage temperature from 8^0 C up to -30^0 C. The port silo can store up to 60 000 tons of cereal product.

A list of handled cargo includes non-ferrous and ferrous metals, equipment, vehicles, chemical fertilisers (packed or in bulk), citrus fruits, bananas and other cargoes packed in bags, boxes, bags, barrels and containers.

While exact information on the amount of ballast discharge in the port are not available, calculations from the oil products sector is indicative of large volumes. More than 14,400,000 tons of oil and oil products were transited through Odessa oil terminal, and from this figure it is calculated that a total quantity of 5.489,000 tons of ballast water were discharged into and around the port area.

A significant part of Ukrainian port traffic is oriented towards Europe (14%), China (6%) and the largest part represents the exchanges and transit with CIS countries (42%). It may be therefore assumed that the largest amounts of ballast water discharged may originate from Europe and Far East.

The Ministry of Transportation is the major regulatory body for shipping in Ukraine. It works through the State Department of Marine and River Transports (SDMRT). The SDMRT assumes the role of the Maritime Administration of Ukraine and acts as the administrator of IMO Conventions and other international legal instruments. The SDMRT also co-ordinates ports Harbour Masters and assumes the prerogatives of Port State Control. The Transportation Law of 1994 (No 232/94 -BP) empowers the Ministry of Transportation through the SDMRT to study and propose new and updated directives regarding national maritime policy, port development, shipping companies and shipyards and for the development of regulations to ensure ship safety and control marine pollution. The SDMRT and the Port of Odessa are fully supportive of and agreeable to participation in this project. As a result of Ukraine's participation in the PDF-B phase of the project there is now a ballast water steering committee comprised of federal and local officials and members of the research community.

The workshop in Ukraine scheduled under Activity 3.4 will, in addition to the more generic activities covered under Objectives 2-4, consider possible elements of a country work plan which may include the following demonstration activities identified in the June 1998 Consultants mission under the PDF:

1. The initiation of a sampling programme in the port of Odessa jointly by the Ministry of Public Health and State Inspection for the Protection of the Black Sea. The expected results are better protection against pathogen factors and faster results of the analysis;

2. The initiation of the legal process to incorporate IMO guidelines and to prepare for the ratification of an international binding document in year 2000;

3. The evaluation of the possibility and costs for adapting the existing reception facility in Odessa to receive ballast waters. The output of this investment could be a viable alternative for vessels trading in the Black and Mediterranean Seas where the alternative exchange zones are still unclear;

4. The development by BLASKO of alternative treatment methods for ballast water on board their vessels. The output of these researches would be an alternative to avoid stability risks during the exchange of ballast at sea.

Annex G

Regional Involvement

One of the early tasks of the project will be preparation of a Strategic Plan to secure effective regional participation and cooperation and to ensure replication of results. The objective of a regional approach is to convene key regional actors, through the creation of regional task forces convened by the PCU with IMO assistance, to plan and execute a regional approach that will be driven in part by the demonstration projects developed at each of the participating ports and countries. Key principles in the work of the regional task forces will include:

- development of an integrated approach
- use of a lead agency and key managers in each country
- a commitment to risk minimization re. ballast water discharge
- effective communications
- recognition of the need to recognize the essential role of shipping, the importance of the marine environment, and to balance the two
- recognition of the sovereign rights and obligations of each country
- the incorporation of new knowledge and information into regional decision-making
- the need for consistency with IMO/MEPC directions in ballast water management.

The key elements of a regional strategy would include:

- improved knowledge of invasive marine species issues and its relationship to ballast water management
- development and implementation of a set of arrangements which will, to the maximum extent practicable, minimize the transfer and establishment of invasive marine species
- identification of affected interests and the productive involvement and cooperation of those interests in the work of the project
- provision of information to, and collection of information from, affected interests on problems identified, solutions developed, and practical approaches to application and management
- development of regional consistency in management of the issue and approaches to be adopted
- provision of linkage between international regulatory approaches and a legally binding IMO Guideline (expected new MARPOL Annex) under development.

Annex H

RESOLUTION
(adopted on the 30 July 1998 in Cape Town, South Africa)

Meeting of the Steering Committee on Ballast Water Management
Cape Town, South Africa, 29-30 July 1998

The Steering Committee on Ballast Water Management, established under the UNDP/IMO/GEF project "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" at its meeting in Cape Town, South Africa on 29 and 30 July 1998,

RECOGNIZING that the marine environment and the living resources which it supports are of vital importance to mankind, particularly for the coastal pollution,

RECOGNIZING FURTHER that invasions of non-indigenous harmful aquatic organisms and pathogens in new regions are occurring at increasing rates, threatening the conservation and sustainable use of aquatic biodiversity,

NOTING that besides ecological consequences, severe economic losses and threats to human health are being faced in many countries resulting in national unilateral actions to avoid further threats,

BEING AWARE that the transfer of harmful aquatic organisms and pathogens with ships' ballast water constitutes a main vector of unintentional introduction of organisms,

BEING FURTHER AWARE that the safety of a ship and its crew is of paramount importance,

NOTING that action to minimize the risk of new introductions of non-indigenous species with ballast water is being taken in several regions of the world,

NOTING FURTHER the support for this GEF project as expressed by the representatives of the six participating countries, the International Maritime Organization (IMO) and interested non-governmental organizations, including those of shipping and port industries,

HAVING CONSIDERED the draft GEF project brief entitled "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" presented at this meeting:

1. ENDORSES the draft GEF project brief as amended at this meeting;

2. INVITES governments from both industrial and developing countries, international and national organizations and the private sector to support the project;

3. REQUESTS the Marine Environment Protection Committee (MEPC) to co-operate with the Project Co-ordinating Unit (PCU) as appropriate; and

4. URGES the GEF Council to approve the project brief.

Annex I

Copies of GEF Country Focal Point Endorsement letters

Annex 10

Final Reports from Project Preparation (PDF-B) phase

MISSION REPORT

on the

Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries

(23 May - 9 June 1998)

Project Title :	Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries
Requested by :	United Nations Development Programme
Countries of Assignment :	Brazil and South Africa
Duration :	23 May – 9 June 1998
Funded by :	Global Environment Facility through United Nations Development Programme
Executing Agency :	International Maritime Organization (IMO)
NOTE :	The views expressed in this report are those of the author and are not attributable in any way to the United Nations or the International Maritime Organization.
Signatures :………………… Dandu C. PUGHIUC IMO consultant	*Date: 15 June 1998*

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BACKGROUND

It is assumed that shipping moves 80% of the world commodities and is fundamental to international trade. Ships have sailed across the ocean for centuries since the introduction of steel hulled vessels the solid ballast was replaced by water. During the last hundred years the ballast water transfers have increased considerably throughout the world and the probability of successful establishment of populations of non-indigenous species through ships ballast increased with greater volumes of ballast water as well as with reduced ship travel times.

It has been estimated that the world fleet is transferring 10 billion tonnes of ballast water per year; the water may originate from eutrophicated coastal areas containing hundreds of species which may survive voyages of several months duration. It has been demonstrated that in average 3,000 to 4,000 species are transported daily by ships. The alien species may threaten native populations, fishing industries, aquaculture and public health. The likelihood of an introduced species to adapt in new regions and to create problems depends on a number of factors, primarily related to the biological characteristics of the species and to the new environmental conditions. If the port of origin and the port of destination are ecologically compatible the risk of alien species introduction is relatively high.

The potentially adverse effects of such introductions were illustrated by the discovery in the 1980s of the fouling European Zebra mussel (Dreisseria Polymorpha) in the Great Lakes, a toxic Japanese dinoflagellate in Australia and a carnivorous North American comb jellyfish (Mnemiopsis Leidyi) in the Black Sea. These three introductions alone have cost many millions of dollars in remedial action, had deep and detrimental ecological repercussions and have focused government, public and scientific attention on the role of shipping as a dispersal vector for non-indigenous aquatic organisms.

Action to control unwanted introductions is being considered by several individual states and in the international arena under the auspices of the International Maritime Organisation (IMO). Following the continuously increasing concern of the international community regarding the problem of ballast water containing harmful life forms transfers and in response to the request of the 1992 United Nation Conference on Environment and Development (UNCED), IMO submitted through UNDP to the Global Environment Facility a proposal for a grant. The purpose of the grant was to establish a project to assist less developed countries in their efforts to implement national regulations regarding the management and control of ballast water. The proposal was agreed and under the project "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" two fact finding missions were organised by IMO in co-operation with focal points and UNDP Resident Representatives from Brazil, Poland, South Africa, Bahrain, India and China. The missions took place from 18 January to 8 March 1998.

As a follow-up of this mission a new one was also organized by IMO in co-operation with focal points and UNDP Resident Representative from Brazil and South Africa. The follow-up mission took place from 23 May to 9 June 1998.

The terms of reference for the second mission are attached as Annex 1. In Annex 2 details of the itinerary and schedule of meetings are provided.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The main objective of the present "Project Preparation and Development Facility" (PDF) project is to provide background material for the preparation of a full-scale project document regarding the ballast water transfers, to be submitted to the Global Environment Facility (GEF) Council in October 1998. Based on the results of the previous fact-finding missions, early this year, and on the progressing discussions with the countries focal points, the follow up mission in Brazil and South Africa accomplished its tasks by extensive discussions with government officials and other stakeholders.

An increased interest for IMO guidelines for control and management of ships` ballast water to minimise the transfer of harmful aquatic organisms and pathogens was shown by the involved authorities and willingness to implement the guidelines was expressed during the discussions. Some of the barriers to the efficient implementation of the ballast water management and control, identified during the first mission, seemed to be already approached by the relevant officials. As a common feature for the two visited countries, the communication among different authorities interested in ballast water transfers has been improved. The concern of the health authorities regarding the threat of pathogen factors introduced through ballast water increased significantly. The willingness of the health authorities to get involved in ballast water management and control procedures was clearly expressed during the discussions and a more effective co-operation with the other authorities involved is expected in the near future.

In both visited countries, the willingness to select a specific port as demonstration site was not only confirmed by the relevant authorities, but concrete steps have been made towards the official nomination of the demonstration sites, the institutionalisation of the steering committees and the appointment of the national focal points during the visits. The extension of the character of the steering committees by inviting other countries from the region at its proceeding was positively considered for the next stages of development.

The possibility of twining with developed countries in the future developments raised the interest of the national authorities and preliminary bilateral discussions in this respect are currently initiated by the appropriate factors.

A new and more proactive attitude from the shipping industry has been noticed. The willingness to continue the on-going trials concerning the ballast water management on board and to co-operate for the identification of the most cost effective treatment methods has been expressed by the industry representatives interviewed during the mission. Many of the provisions of IMO guidelines regarding the ballast water transfers are already included in the policy of the main shipping companies of the two countries.

A rough evaluation of the base line operation costs has been made together with the relevant authorities and an estimation of what is envisaged for the future resulted from the discussions.

Favourable attitudes with regard the ballast water issues were noticed during the consultations with GEF Focal Points and UNDP Resident Representatives. The local UNDP` representatives particularly expressed their support for the future project and a series of valuable suggestions were put forward for the future developments.

In both visited countries the increased support from the international community was appreciated as crucial for the continuation of the current researches and for the successful implementation of IMO guidelines for control and management of ships` ballast water to minimize the transfer of harmful aquatic organisms and pathogens.

A more extensive presentation of the particular situations existing in the two countries will be made in the following chapter of this report.

2. IMO GUIDELINES FOR CONTROL AND MANAGEMENT OF SHIPS` BALLAST WATER TO MINIMIZE THE TRANSFER OF HARMFUL AQUATIC ORGANISMS AND PATHOGENS

2.1. Review of the previous stages related to ballast water transfers

The 1993 ballast water procedures adopted by IMO through resolution A. 774 (18) were heavily based on the exchange of ballast water at sea. Nevertheless, during the last four years, a large number of chemical and physical treatment methods have been investigated, most of them being found too expensive and at times environmentally unacceptable. Since the ballast water exchange at sea is broadly accepted as the most cost-effective and environmentally sound prevention strategy currently available, MEPC agreed that a new IMO Assembly resolution should be prepared for adoption in 1997. The new set of guidelines adopted by IMO as resolution A. 868 (20) bridges the time period needed until legally binding provisions and regulations will enter into force and provides additional guidance on ballast water management on board ships and on control procedures to be applied to port state authorities.

2.2. Brief introduction of Ballast Water Guidelines (IMO Resolution A. 868 (20))

The Ballast Water Guidelines contain management tools to minimize the risks of introducing harmful aquatic organisms and pathogens via ballast water discharges. Different countries and organizations around the world are currently considering a series of risk minimization methods. Most of them depend upon : the type of target organisms, level of risks involved, environmental acceptability, economic and ecological risks.

The Guidelines can apply to all ships but Port State Authorities have the liberty to exempt ships in the area under their jurisdiction from the provisions of the above Guidelines. It is particularly important that Member States follow the Guidelines when developing national legislation and procedures and take the necessary measures to implement the Guidelines in a standard and uniform manner.

For the global benefit of the international community Member States should provide IMO with information on outbreaks or infestations which may pose a risk for the intake of ballast water, on the specific national laws and regulations, R&D information and educational materials.

The Flag States are supposed to request each ship under their jurisdiction to prepare a “Ballast Water Management Plan” based on their Guidelines and particular importance should be given to the required records. Masters should be instructed to report to Port States Authorities any failure to apply the requirement of the “Ballast Water Management Plan”.

At their turn the Port States should be ready to provide ships with details of ballast water management requirements, location and terms of use of alternative exchange zone for ballast water, availability, location, capacities of and applicable fees for the reception facilities.

It is crucial for the successful implementation of these Guidelines that no action, which imperils the lives of seafarers or the safety of the ships, should be required by the Port States. For this reason, particular guidance on safety aspects of ballast water exchange at sea has been provided by the Guidelines and one of the main aspects refers at the necessity of new training and familiarization methods and nomination of shipboard responsible personnel.

The Guidelines have been published and disseminated through the Member States in the form of a booklet early this year.

3. PART A - BRAZIL

3.1. ADMINISTRATIVE STRUCTURES CONCERNED WITH THE IMPLEMENTATION OF IMO GUIDELINES ON BALLAST WATER

3.1.1. Description of the main administrative bodies interested in the implementation of ballast water guidelines

In Brazil, a number of four governmental bodies express their interest for the ballast water regulations :

- Ministry of the Navy
- Ministry of Environment and Legal Amazon
- Ministry of Transport
- Ministry of Health

The Ministry of the Navy is one of the key governmental bodies regulating the shipping industry. By virtue of its constitutional attributions and its competence given by the Decree Law No. 200, of 25 February 1997 the Navy is responsible for studying and proposing directives for the national maritime policy. As a subsidiary attribution according to the said legal instrument, the Ministry of the Navy is in charge with the guidance and control of the National Merchant Marine and other correlated activities in the interest of national security and the provision of safety regulations for navigation, be it maritime, fluvial or lacustrine. In accordance with Complementary Law No. 69, of 23 July 1991, the particular attributions of the Navy are:

i) Guide and control the merchant marine and its correlated activities in the interest of national defence;
ii) Provide safety in maritime and waterways navigation;
iii) Contribute for the formulation and conducting of national policies in respect of the sea; and
iv) Implement and control the compliance with laws and regulations on the sea and on interior waters.

Through the Office of the Commander of Naval Operations, the Ministry of the Navy co-ordinates the activity of the Directorate of Ports and Coasts which is basically performing the attributions of the maritime authority. All the regulations and other legal instruments relating to shipping are initiated or endorsed by the directorate, which also comprises a specialised division for liaison with the International Maritime Organization. One of the attributions of the Directorate of Ports and Coasts in its control function, is to co-ordinate the activity of Port Captains Officer which have particular responsibilities in dealing with ships calling in Brazilian ports. At the same time the Ports Captains are military sub-ordinate the Naval Districts, administrative divisions under the Ministry of the Navy. The Port Captain's Office, as a local authority, also performs the duties related to Port State Control. The Figure 2.1 gives the structure and the organizational chart of the Directorate of Ports and Coasts.

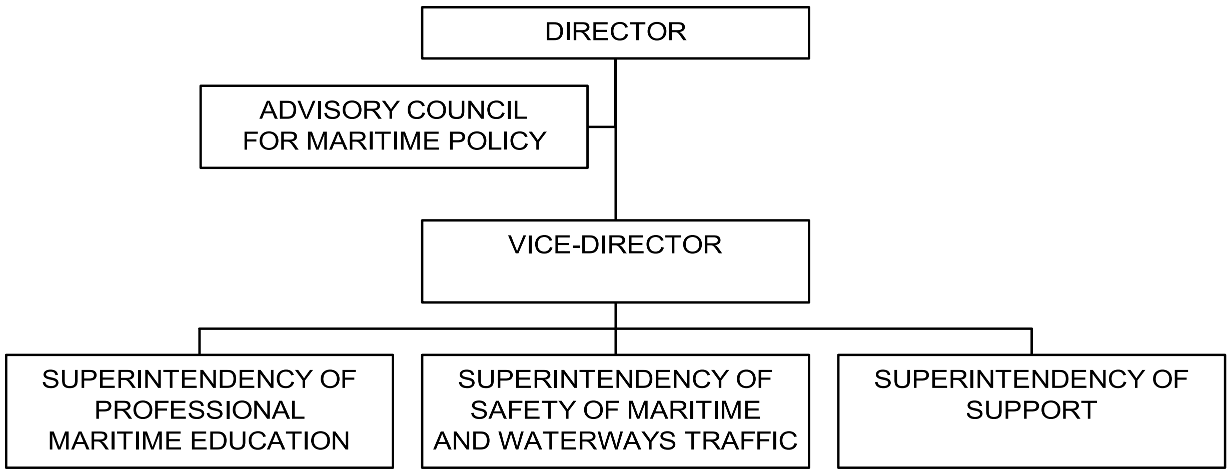

Figure 2.1

The Ministry of Environment, Water Resources and Legal Amazon is the governmental body in charge with the federal policies relating to the environment protection. The ministry performs its main duty through the Executive Secretariat which comprises four secretariats :

- Secretariat for Water Resources;
- Secretariat for Environmental Affairs;
- Secretariat for Amazon;
- Secretariat for Integrated Development.

The organizational chart of the main structure of the ministry is given in the Figure 2.2. The main responsibilities of the ministry include the planning, co-ordination, supervision and control of the national environmental policy and the preservation, conservation and sustainable use of renewable natural resources. The specific activities relating with the marine environment are carried out by the Secretariat for Environmental Affairs which currently undertakes a restructuring process. The central structure, based in the capital city, Brasilia, performs its duties in the territory through environment inspectors in each state of the federation. During the last years an increasing concern of the ministry was noted for the protection of the marine environment. Under its co-ordination a series of national programmes were set in place with other interested governmental entities. Among these, the most important ones mentioned during the discussions were : Assessment Programme of the Sustainable Potential of the Living Resources of the Exclusive Economic Zone, Investigation of the Brazilian Continental Shelf Plan, Pilot Programme in Marine Sciences, Macroplan of Management for the South Coastal Zone of Rio de Janeiro (Sepetiba Bay and Angra dos Reis Area) and Coastal Zone Management Programme in the State of Rio de Janeiro. Although the attributions of the ministry are mainly related to the areas outside the ports, a strong interest is manifested for the ballast water discharges due to their potential impact on the environment as a whole.

The Ministry of Transportation is the governmental body in charge with development and implementation of federal public policies regarding all the means of transportation. The Secretariat for Water Transportation sub-ordinate directly to the Executive Secretary is particularly dealing with ports and maritime issues. Among its main attributions are :

i) elaboration and supervision of the implementation of the policies and directives concerning the water transports;

ii) analyses of the proposals regarding the concessions, permits and authorisations of public investments and public budget expenses;

iii) monitoring the implementation of the regulations for the authorisation of services supplied in ports and other related areas under its competency.

iv) elaboration and evaluation of the tariffs policy and salaries in its area of competence.

The ministry supervises the implementation of the national policy regarding the water transportation through local agencies called “Port Authorities”, that are in essence dealing with ports administration. An organization chart of the Secretariat for Water Transportation is provided in Figure 2.3.

The Ministry of Health is the governmental body in charge with public health and sanitary surveillance. Its structure is shown in Figure 2.4. The duties related to the maritime activities are performed through the Secretariat for Sanitary Surveillance by its General Directorate for Ports, Airports and Boundaries. The main areas competence of the general directorate are concerned with :

- means of transportation;
- environment;
- imported and exported products; and
- travellers (crews and passengers)

The organizational chart of the directorate is given in Figure 2.5.

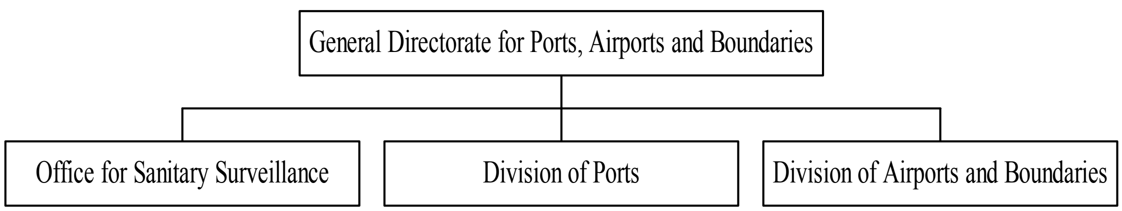

Figure 2.5

The regulatory body concerned with ports consists in one division at the national level, located in the capital city and 35 compartments acting as local representatives of the Health Authority in the main ports of the country.

The policy regarding the water quality control is enforced by the Law No. 8.080 of 1990 and Ministerial Ordinances GM/MS No. 36 of 1990 and MS/S VS No. 111 of 1993, harmonised with the provisions of the International Sanitary Regulations. In controlling the water quality the main objectives of the Ports Sanitary Divisions are the protection of the public health against contagious diseases spread by micro-organisms transported by water (e.g. *Vibrio Cholerae, Disinteria Bacil, Salmonella Typhi and Shiggella Proteus*). This activity is supported by local states health laboratories co-ordinated by a Central Laboratory in Brasilia.

3.1.2. Co-operation among the administrative bodies involved

Although some difficulties of communication among the governmental entities interested in ballast water discharged have still been noted, a much closer co-operation of the different authorities exists at a local level. Improved co-ordination between the Port Captain, Port Authorities, Health Affairs raised the awareness regarding the risks posed by the ballast water transfers and the implementation of the IMO recommended "Ballast Water Reporting Form" was decided by the Health Authorities during the visit. Specific co-operation with the Ministry of the Navy was mentioned by the Health representatives concerning the common implementation of new system of treatment of the residual waters originating from the port areas. The distribution of the IMO Guidelines for the Control and Management of Ships`Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens was particularly appreciated by the participants at the discussions and a common strategy to deal with ballast water is expected in the near future.

3.2. LEGAL PROCESS OF IMPLEMENTING THE IMO GUIDELINES

3.2.1. Preparation of national rules and regulations

It was unanimously agreed during the discussions with the representatives of the involved ministries that a set of national regulations has to be prepared with the joint participation of the organization involved. Support from UNDP Resident Representative Office was seeked for the translation of the guidelines in Portuguese in order to incorporate their provisions in the national regulations and to speed up the process. The fact that the new regulations should harmonise with the existing legal framework was also mentioned during the consultations and the recent ratification of MARPOL 73/78 by the Brazilian Government was seen as an additional support in this endeavour. The opinion that the National Regulation Regarding the Water Quality in Brazilian Ports could incorporate in the future the provisions for ballast water discharges put forward by the Ministry of Health was sought as an alternative for the process of adopting the IMO guidelines.

3.2.2. Legal procedures regarding the incorporation of IMO guidelines into the national regulations

During extensive discussions in a "round table" session with representatives of the four ministeries involved different legal procedure aiming at incorporating IMO resolution on ballast water in the national regulations were investigated. It appeared that the most appropriate legal procedure might be the issuance of an "Interministerial Ordinance" (Interministerial Portaria) signed by the interested ministries.

Although further consultations are expected to take place on this subject, it may be concluded that all the representatives of the governmental bodies involved confirmed their willingness to implement the IMO guidelines for control and management of ships` ballast water to minimise the transfer of harmful aquatic organisms and pathogens.

3.3. PROPOSED CO-ORDINATING STRUCTURES FOR THE PURPOSE OF THE PROJECT

3.3.1. Regional Steering Committee

The need for a common structure (steering committee) to manage the future developments regarding the ballast water was mentioned by all the representatives of the interested ministries during the discussions. It was stressed in several occasions that such an organism could not only be a forum for the future decisions regarding the ballast water, but could substantially improve the communication among the parties. The steering committee was seen as the appropriate organ to co-ordinate the activities related to ballast water from different ministries by periodic meetings. The proposal to have a member and a suppliant member from each involved ministry (i.e. Navy, Environment, Transport and Health) was adopted by the government officials participating at the discussions. The possibility to invite any other governmental structures, non-governmental or commercial organizations was considered based on the interest shown by UNDP in attending the committee's works and it was agreed to welcome such participation.

Intensive consultations took place with regard to the legal ways to institutionalize the steering committee. Three already existing interministerial structures were considered to accommodate the works of the committee under their umbrella :

- The Integration Group of Coastal Management Activities;
- The Programme for the Harmonization of Authority Agencies Activities in Brazilian Ports, and
- The Interministerial Working Group on IMO Affairs.

The third proposal, put forward by the representative of the Ministry of Environment, Water Resources and Legal Amazon enjoyed favourable comments from the other participants and finally it was agreed that the Steering Committee on Ballast Water (SCBW) will be officialized under the Interministerial Working Group on IMO Affairs. The fact that IMO acts as Executing Agency for the GEF / UNDP / IMO project contributed significantly the final decision.

The possibility of twining with developed countries for further action was also explored by the relevant authorities. The benefits of such co-operation were acknowledged by the participants with the view of reducing the national efforts and narrowing the area of investigation based on the existing expertise and experience. As a second stage after officially establishing the SCBW, the possibility to expand its work at regional level by inviting other countries with an interest in ballast water transfers was mentioned.

The main duties and responsibilities of the Steering Committee and its agenda were to be established by further consultations of the interested governmental structures in parallel with the preparation of the official document to be signed by the appropriate authorities.

It might be concluded that the government officials interested in harmful aquatic organisms carried in ballast water have not only confirmed their willingness to establish the steering committee but have already made significant steps towards this objective.

3.3.2. National Focal Point (NFP)

From the discussions held by the emerging Steering Committee clearly appeared the intention to select the national focal point (NFP) from the structures of the Ministry of the Navy. The initial proposal to assign this task to the Ministry of Environment, Water Resources and Legal Amazon was left aside during the consultations. Since the liaison with IMO will continue to be one of the main duties of the national focal point, the participants were of the oppinion that based on the previous performances, the NFP should be related to the Directorate of Ports and Coasts (DPC). It was mentioned in this respect the excellent work done by the specialised compartment of DPC in charge with IMO affairs and the determinant role played by the Ministry of the Navy in co-ordinating this process.

It may be concluded that having enjoyed the support of the government officials participating at the discussions, the proposal to select the Ministry of the Navy and the Directorate of Ports and Coasts as national focal point for the purpose of "Ballast Water Project" confirmed the real interest to continue and speed up the whole process.

3.4. PROPOSED DEMONSTRATION SITES

Although the interest for IMO guidelines and for the continuation of "BALLAST Water Project" increased considerably in the last months, a decision regarding the selection of a specific port as demonstration site could not been made before the consultant mission.

During extensive consultations among the responsible officials, the final decision had to be made between the ports of Angra dos Reis and Sepetiba. The following paragraphs will introduce the two selected ports and the reasons for the final decision.

3.4.1. Description of the demonstration sites

The first proposed demonstration site visited was the port of Angra dos Reis consisting of a pier with double berths operated as an oil terminal by PETROLEO BRASILIERO S/A – PETROBRAS. The terminal operates around the clock and has on "open L" shapped pier for accommodating oil tankers, about 1318 meters long and oriented in a east-westerly direction. The port is situated in Baia da Ilha Grande, a large bay with deeply indented shores. Ilha Grande lies in the entrance and it is a mountainous island covered with dense forest down to the water's edge. Pico da Pedra D`Agua, the highest summit, raises to an elevation of 984 metres. The port is situated on mainland, in front of the central part of the bay and has berthing space for tankers up to 500,000 TDW with a maximum draft of 25 m.

Local and diurnal tidal rise approximately 1.20 metres above mean low water springs and at neaps, and 1.70 metres in high water springs. Tidal streams are west going during the in going tide, running nearly parallel to the pier direction, and east going during the out going tide. Tidal stream normally attains a rate from 1 to 2.2 knots. Easterly winds predominate, but due to the Ilha Grande high mountains they may blow from several directions. South – south – west winds due to cold fronts may cause heavy seas and swells on exposed areas. South – south – west often blow in the afternoon period. Wind speed ranges from 3 to 60 knots in the terminal area. The average annual rainfall is about 2000 mm in the area and the humidity is comparatively high ranging from 76 to 81 percent. Local average temperature ranges from 18°C, in June and July, to 35°C in December and January. The pressure over the area is about 1,015 Mb in good weather.

Pillotage is compulsory when making for the pier. Display of quarantine signals on approach to Angra dos Reis must be mentained until free practique is granted. Vessels entering are inspected by the Health and Custom Officers between 07.00 and 19.00; by previous application, special visits may be granted outside this period on payment of an extra tax. The Captain of the Port of Angra dos Reis authorises ships clearance upon berthing along side the terminal pier.

Brazilian law is very strict about water pollution and discharge into the sea of oil base products either alone or in combination with ballast water is heavily finned. The Port of Angra dos Reis has a Sea pollution and Training Center (CENTROPOL) equipped with modern oil spill removal equipments. In CENTROPOL are carried out often oil spill clean-up drills or training sessions. In case of oil spill events a round a clock assistance is provided by the terminal employees in conformity with the Contingency Plans. The Center is strategically located to assist quickly any oil spillage removal and in its shed are stowed several intervention equipments :

- Contention bars (booms);
- Oil removal small boat;
- Destroy skimmer pump;
- Disk oil collecting; and
- Supporter boats.

All the oil removal small boats and supporter boats are alongside the pier ready to provide immediate assistance. PETROBRAS responsibilities include the report of any oil leakages, spills, overflows etc., to the Port Captain. Nevertheless Masters and vessels` personnel are hold responsible at all the time for ship's safety and pollution prevention. All deck scuppers must be kept plugged and, as far as possible, discharging of waste water from the lavatories on terminal sides must be prevented. In accordance with the Port's Regulations, the ballast water to be discharged into the sea shall be entirely free from oil or other substances that may pollute the sea water. No other specific measures regarding the ballast water have been identified except the discharged quantities requested by the Health Reporting Form of the sanitary officers. The Port of Angra dos Reis does not provide any facilities for ship's garbage or refuses.

The second proposal for a demonstration site was the Port of Sepetiba. Situated in the Southern coast of Rio de Janeiro State the port is considered privileged thanks to its strategic location very close to Brazil most important and largest geo-economic area. Within a 500 km radius are located industrial and commercial corporations that contribute to the formation of some 70% of Brazilian GNP. Sepetiba is also one of Brazil's harbours to feature highly competitive characteristics being installed in depths enough to dock large vessels. The coal terminal with depth of 15 metres is capable of handling up to 7,000,000 tons / year and the ore terminal allowing a maximum draft of 18.5 meters is able to handle 15,000,000 tons/ year. The future multiple purpose wharf for containers, still under construction but already brought at 14.5 depth, is designed to handle 1,000,000 TEUs / year. The Port of Sepetiba opened in 1982 to meet Companhia Siderurgica Nacional and Valesul`s needs to move bulk cargo for their plants thus un-encumbering the Port of Rio de Janeiro. Since the port is located in the northern part (Lat. 22°56'S and Long. 43°50'W) of Sepetiba Bay which continues southerly with Angra dos Reis (the distance between the two ports is less than 50 km) the weather conditions are very much alike with the ones previously described. The general requirements of the port regulations mentioned for Angra dos Reis also apply for the Port of Sepetiba .

According to the prognosis of Compania Docas do Rio de Janeiro, which acts as Port Authority for the ports of Rio de Janeiro, Sepetiba, Angra dos Reis, Niteroi and Fornu, Sepetiba will become Latin American largest and Southern Atlantic first harbour to be a major cargo hub port, technically capable to handle over 20 million tons/year. Equipped with modern port equipment Sepetiba will berth the latest generation vessels up to 8,000 TEUs offering competitivity, low operating costs and high level of productivity. In addition the port offers a new industrial center situated in its vicinity area created under new concepts of leading age technology. The 10,000,000 square meters even area is served by a 20 metres deep access channel and a docking wharf on sheltered waters. It holds on Industrial Logistics Zone complet with full infrastructure and state-of-the-art technology of telecommunications and energy supply, multi-mode accesses and easy transport facilities. Sepetiba is declared to be a modern port that highlights a permanent concern with environmental management. From the environmental protection stand point Sepetiba is intended to be a model undertaking international quality standards and carefully following the requirement of MARPOL 73/78 Convention. Essential for the development programme is believed to be the control of the contamination by agents that does not belong to the port activity. Among those agents the following were seen as priorities for the future studies :

- Effluents from urban areas carried by the rivers that flow into Sepetiba Bay;
- Effluents from industrial plants located near port area; and
- Ballast water discharges.

The need to control the environmental actions in Sepetiba was underlined by the relevant officials and the development of an Environment Management Plan was seen as an immediate priority.

3.4.2. Main reasons for selecting the Port of Sepetiba as demonstration site

Based on the results of the site visit, a final decision was made by the relevant authorities to select the Port of Sepetiba as the demonstration site for the purpose of the "Ballast Water Project". The main reasons for the final decision as mentioned during the discussions were as follows :

- Sepetiba is a loading port. Large quantities of iron ore 6,000,000 tons and coal 3,500,000 tons are currently handled yearly. By consequences large amounts of ballast water are discharged in the area. The fact that Sepetiba is a relatively small port for large vessels (mainly bulk carriers) was seen as an additional justification.
- The location of the port not very far but far enough from Rio de Janeiro allows for technical and scientific support for the future developments regarding the ballast water. The proximity of the laboratories and scientific resources as well as the avalabilities of the appropriate administrative structures was considered another reason to support Sepetiba
- The Bay of Sepetiba is a sensitive area from the environmental point of view. The co-ordination of the ballast water researches with the existing projects regarding the coastal waters management run by the Ministry of Environment, Water Resources and Legal Amazon may help and speed up the process by taxonomic information and specialised assistance.
- The particular interest of the Brazilian Government for the development of the Port of Sepetiba, which is included in a large national programme called "Brazil in action" and the impressive investments planned for the near future was seen as a positive argument by the involved authorities.
- The fact that in their ambitious plan Compania Docas do Rio de Janeiro included the environmental aspects considering the possibility of building a water plant and reception facilities for the ballast water encouraged the official decision.
- And last but not least the enthusiasm expressed by the management of the Port of Sepetiba for the "Ballast Water Project" and related IMO guidelines was determinant for the final decision.

The fact that all the interested authorities supported the selection of the Port of Sepetiba as demonstration site for the purpose of "Ballast Water Project" may be of particular relevance for the further developments.

3.5. DESCRIPTION OF THE ACTIVITIES AND ESTIMATION OF THE COSTS

3.5.1. Previous activities related to ballast water control and management

Some of the activities regarding the ballast water transfers and their impact on the environment of the port of discharge have been already identified and some are currently under preparation.

Since some of the activities have tangential links with ballast water issues or refer to global aspects of the marine environment only rough estimation of the costs involved was possible, therefore the figures given bellow should be looked as being largely approximated.

Particular interest was expressed by PETROBRAS with regard to optimisation of methods for effective on board management of the ballast water based on the studies conducted by PETROBRAS, Brazil has already presented in IMO a proposal regarding the exchange of ballast water at sea. The proposal is based on the Flow Through Method with a series of improvements which eliminate illness risk for the crew and excessive pressure. The advantages foreseen in the Brazilian proposal are :

- The new method keeps the ballast water tank level constant thereby avoiding stability and stress problems;
- It is safe for use on board; crew members are not exposed to hazards such as contact with contaminated water overfilling on deck;
- It is flexible for the adoption of several types of water treatment;
- It is simple and economical for shipbuilding;
- Facilitates sediment removal;
- Allows for system automation in the future;
- Matches the environment and safety requirements.

An estimation of costs of this study including tank flow simulation and documentation of the PETROBRAS experts amounts at USD 22,000.00.

As the second stage of the development of the proposed method, PETROBRAS made the necessary arrangements for a "Ballast Water Trial on Board a Product Carrier of 30,000 TDW to demonstrate the effectiveness of the method and to provide MEPC 42 with the results of the trial. The ballast water flow simulation will be conducted, based on an elaborated test procedure for one wing tank aiming at establishing the best sampling procedures and the most appropriate sampling points. For technical assistance and specialised survey of the experiment, a Classification Society was contracted. A contract was also concluded with the Federal University of Rio de Janeiro / Marine Biology Department in order to assess the aquatic organisms carried in ballast water; their behaviour and the effectiveness of the method in biological terms. The expected outputs of this experiment are: larger recognition of the method, a possible sampling manual and a set of recommendations regarding the exchange of ballast water at sea for the PETROBRAS fleet of tankers "FRONAPE". Large perspectives of international co-operation are currently envisaged by PETROBRAS in connection with this experiment. Contacts have already been concluded with scientists and interested organizations from Australia, Germany, New Zealand and Argentina, and some shipowners associations (SIGTTO and OCIMF) are expected in the future. The estimated costs related to this programme amounted at USD 170,000.00.

Among the other relevant environmental undertakings :

- Environmental monitoring / diagnosis programme in Campus Basin, State of Rio de Janeiro;
- Coastal Zone Programme for Angra dos Reis Bay;
- Biologic Treatment Plant for Industrial Effluents in Bahia;
- Education Programme for Increasing the Ecological Awareness;
- Treatment Plant for Liquid Effluents in Duque de Caxias;
- Treatment Plant for Liquid Effluents from the Terminal of Cabimidas;
- Ecosystem Monitoring Program at Todos os Santos Bay.

Out of USD 163,810,000.00 which represent the total amount engaged by PETROBRAS as contributions to the integrated coastal management approximately USD 20,000,000.00 might be considered as having a direct contribution to the ballast water studies and developments in Brazil.

The Ministry of Environment, Water Resources and Legal Amazon are currently conducting large projects relating to the coastal zone management in particular and to marine environment in general. Two specific projects regarding the State of Rio de Janeiro were indicated by the environment experts as having direct outputs for the Ballast Water Project in Brazil :

- Macro Plan of Management for the South Coastal Zone of Rio (Sepetiba Bay and Angra dos Reis Area)
- Coastal Zone Management Programme in the State of Rio de Janeiro.

The total cost for these two projects was estimated at USD 6,300,000.

Significant investment regarding the marine environment were mentioned during the discussions with the representatives of the Ministry of Transport and Companhia Docas do Rio de Janeiro. The possibility of appropriate reception facilities for ballast water to be build in the future in the Port of Sepetiba was also put forward by relevant officials. Unfortunately no estimation of nor the baseline costs or additional costs in the perspective of "Ballast Water Project" could be made available.

Some of the activities currently conducted by the Ministry of Health in Port areas may be easily adapted for the purpose of ballast water discharges control. Particularly the sampling process which is quite common for the sanitary officers may be extended with a minimum training from the fresh water tanks to the ballast tanks. The existing education facilities available in the health network may be used as an efficient tool for raising the awareness about the risks posed by ballast water discharges. The water quality control in the port areas includes :

- The prevention of cholera and other human diseases (training of the technicians and laboratory materials);
- The inspection of the vessels (drinking water control, education of the crews);
- The inspection of the fresh water supply in ports and terminals; and
- The control of used waters from ships .

A specific programme for the modernization of the port inspection methods is also carried out by the Ministry of Health. The final output of the programme is expected to be a set of harmonised procedures for inspection and control. The experts of the Ministry of Health estimated the costs which may be directly linked to ballast water control at USD 800,000.00.

As a common feature all the organisations involved within the "Ballast Water Project" indicated a series of additional costs related to participation at international meetings, attending the IMO-MEPC sessions and other costs occurred through specific day by day activities.

Table 3.1. gives a general idea about the costs incurred by Brazil with regard to ballast water control and management.

Table 3.1. Approximated baseline costs concerning the ballast water control management in Brazil.

Organization / Type of activity	Ministry of Health	Ministry of Transport	Ministry of Environment	Ministry of the Navy	Industry	Grand Total
Dedicated activity costs*	-	-	6,300,000	100,000	192,000	6,592,000
Tangential activity costs	800,000	-	-	-	20,000,000	20,800,000
Other costs	5,000	25,000	25,000	100,000	100,000	255,000
TOTAL COSTS	805,000	25,000	6,325,000	200,000	20,292,000	27,647,000

** All costs in USD*

3.5.2. Prospective activities related to ballast water control and management

A series of new activities envisaged by interested authorities and organizations were mentioned during the discussions. Some are complementary to what is being done now and some other are totally new. Although a part of the intended activities may lead to a certain globalization of the ballast water issues with real benefits for the international community, due to the time constraints, no relevant information on the incremental cost could be made available during the discussions. Most of the interviewees were of the opinion that the relatively new concept of incremental costs would require additional study and more accurate estimations.

Among the most relevant future activities mentioned during the discussions were :

- The development by PETROBRAS of some alternative treatment methods (electrolytic units for chlorine generation, small mesh, self washing and back washing filters and thermal treatment). The output of these researches would be an efficient alternative to avoid stability risks during the exchange of ballast water at sea.
- The initiation of a sampling programme in the Port of Sepetiba jointly by the Ministry of Health and Environment which might be extended to other ports. The expected results are better protection against pathogens and improved taxonomical records for the ballast water discharges.
- Twinning with more advanced and other countries of the region aiming at reducing the costs and narrowing the area of investigation.
- The initiation of the legal process to incorporate the IMO guidelines and to prepare for an international binding instrument in year 2000.
- The evaluation of the possibility of building a treatment plant and reception facilities for ballast water in the port of Sepetiba. The output of this activity could be a viable alternative for vessels trading in South Western Atlantic Ocean.

3.6. CO-ORDINATION WITH GLOBAL ENVIRONMENT FACILITY (GEF) OPERATIONAL FOCAL POINT

In Brazil the GEF Operational Focal Point is located in the Ministry of Planning and Budget. Consultations took place on two occasions in the Ministry of the Navy and in the Ministry of Planning and Budget. A certain interest was expressed during the discussions but due to the internal guidelines and procedures no normalisation of the intention of support could be made available before the submission of the appropriate project document for analysis. Nevertheless the willingness to speed up the necessary procedures in due time was expressed by the relevant GEF Focal Point Officials.

3.7. CO-ORDINATION WITH THE UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) RESIDENT REPRESENTATIVE

The consultations with UNDP in Brazil took place on two occasions in the Ministry of the Navy with the Co-ordinator of the Environment Unit and at the Resident Representative Office. During the particularly fruitful discussions the intention to support the project was expressed in several occasions. Some of the pending problems regarding the PDF project and the procedures for the full-scale project document were clearly explained and the possibility of developing a national plan was analysed with all the interested government officials. The previous introduction of the "Ballast Water Project" to UNDP Brazil was particularly beneficial for the purpose of the discussions. With the direct participation of UNDP experts the immediate priorities were clearly summarised as follow :

- establishment of the steering committee;
- appointment of a leading agency;
- selection of a demonstration site;
- evaluation of the baseline activities; and
- evaluation of the needs.

The participants agreed that UNDP recommendations were extremely useful and further consultations should be convened in the future.

3.8. CONCLUSIONS AND RECOMMENDATIONS

Early involvement of all interested parties is important to the successful implementation of IMO guidelines for control and management of ships` ballast water to minimise the transfer of harmful aquatic organisms and pathogens. The problem of alien species transfer has global implication for the society and is not simply an issue for the shipping industry. It is therefore recommended to improve the co-operation between relevant agencies involved at the national level and to extend the co-operation regional and international basis. It is also recommended to investigate the possibility of expanding the works of the steering committee at regional level and promote and encourage international co-operation by providing IMO with relevant information about specific national and regional developments.

It may be concluded that the relevant authorities confirmed their willingness to implement IMO guidelines and undertook concrete steps to meet the objectives of the project. Further consultations with GEF Operational Focal Point and UNDP Office will significantly benefit their endeavours and speed up the process.

4. PART B – SOUTH AFRICA

4.1. ADMINISTRATIVE STRUCTURES CONCERNED WITH THE IMPLEMENTATION OF IMO GUIDELINES BALLAST WATER

4.1.1. Description of the main administrative bodies interested in the implementation of ballast water guidelines.

In South Africa a number of four governmental bodies and organizations have shown their interest for the ballast water issues :

- Department of Transport through its specialised agency, South African Maritime Safety Administration (SAMSA);
- Department of Environmental Affairs and Tourism;
- Department of Health; and
- PORTNET

The Department of Transports (DOT) is the regulatory body for all transport means including railways, road transportation, air transport and shipping. Recently the duties and responsibilities regarding the maritime administration were delegated to South African Maritime Safety Authority established after the model of Australian Maritime Safety Authority. SAMSA performs its duties in according with the 1996 Merchant Shipping Act through its representatives in all the South African ports supervised by an Operations Manager based in Cape Town. SAMSA also have the responsibility of administer the IMO conventions and other instruments. Since SAMSA acts as administrator for MARPOL 73/78 all the regulations regarding the ballast water control and management are to be issued under its authority. The regulatory function of SAMSA operates by means of national laws approved by the Parliament, harbour regulations and marine notices. The organizational chart of SAMSA is given in Figure 4.1.

SAMSA was created only recently by an Act of the Parliament and has a more flexible structure. The decisions can be made at the CEO level with the obligation to report to the Minister. The CEO is also responsible to a "Board" which has a non-executive character. The main duty of this Board is to verify if SAMSA is properly discharging its obligations in accordance with the provisions of the Parliamentary Act. The board includes experts from the trade unions, marine legal advisors, shipping industry representatives and financial experts.

The Department of Environmental Affairs and Tourism (DEAT) whose mission is "to ensure the effective protection and sustainable utilisation of the environment for the benefit of everyone" has the overall responsibility for environmental conservation in South Africa. Before 1998 the administration of 1972 London Convention was the responsibility of DEAT Chief Directorate for Sea Fisheries. Early this year a new Chief Directorate for Pollution Control took charge performing its duties related to marine environment through its Marine Pollution Division. The Chief Directorate for Pollution Control strives to develop, implement and maintain an integrate pollution waste management system which contributes to sustainable development and a measurable improvement in the quality of life through harnessing the energy and commitment of the population for the effective prevention, minimisation and control of pollution and waste. The marine responsibility of the Sea Fisheries Chief Directorate remained to manage and control marine fisheries research and policy and supervise the law enforcement in South Africa as per the provisions of the Sea Fisheries Act 12 of 1988. Figure 4.2. shows the organizational chart of the DEAT. Of particular relevance is the fact that DEAT acts as Global Environment Facility Operational Focal Point for South Africa.

The Department of Health performs its duties based, among others, on the Health Act 63 of 1977 and the International Health Regulations Act 28 of 1974 which requires that every seaport must be provided with an effective system for the removal and the disposal of waste water and other materials dangerous to health. A health authority (the port health officer) is empowered to adopt all practical measures to control the discharges from ships that may contaminate the port, including ordering such measures to the ship masters. Despite the adequate legal frame the Department of Health appears to traverse a difficult period from the personnel point of view. In most of the South African ports there is a lack of sanitary officers and in some they are totally unavailable, their duties being discharged by the customs officers. According to the existing laws and regulations the Department of Health has a key role regarding the control of water quality in South Africa.

Portnet is a public company which is responsible for port management in South Africa. Portnet belongs to Transnet, structure in charge with all the transportation infrastructure administration subordinated to the Department of Public Enterprises (DOPE). Portnet responsibilities includes maintenance of the basic infrastructure of the ports, construction and maintenance of breakwaters, channels, basins, quay walls, roads and rails in the port area. It also provides marine and navigational services such as pilotage and tug assistance. One of the most important role of Portnet is the prevention of pollution of the ports from shipping and other related activities. In this respect Portnet develops port environmental management strategies and sets port regulations with regard to pollution based on South African and international laws. Portnet also provides waste disposal facilities that comply with international requirements and monitors port activities for non compliance with pollution prevention requirements. Because Portnet is not a Governmental body, it can not be responsible for the enforcement of any pollution legislation. It is, however, affected by some of the legislation pertaining to pollution from shipping activity and has the ability, through Port Captain's Office, to intervene for the prevention or minimisation of pollution and other detrimental effects. Currently Portnet is experiencing a restructuring period. Now the highest office in a port is the Port Manager. His office sub-ordinates the Port Captain in charge with nautical maters from sea to the berth (i.e. tugs, pilotage, manoeuvring, etc.). The Port Captain has basically the duties of a Harbour Master. The Port Engineer, also sub-ordinate to the Port Manager is dealing with cargo operations, quays maintenance, dry dock facilities and all the other activities on shore. The policy making decisions are taken at the level of the General Manager Technical in Portnet Head Office in Johannesburg. The operational activities are co-ordinated by two Regional General Managers in Durban and Cape Town. In 18 months time a new structure where the Port Authority will be separated by the Port Operator will be legislated. The organizational chart of Portnet is given in Figure 4.3.

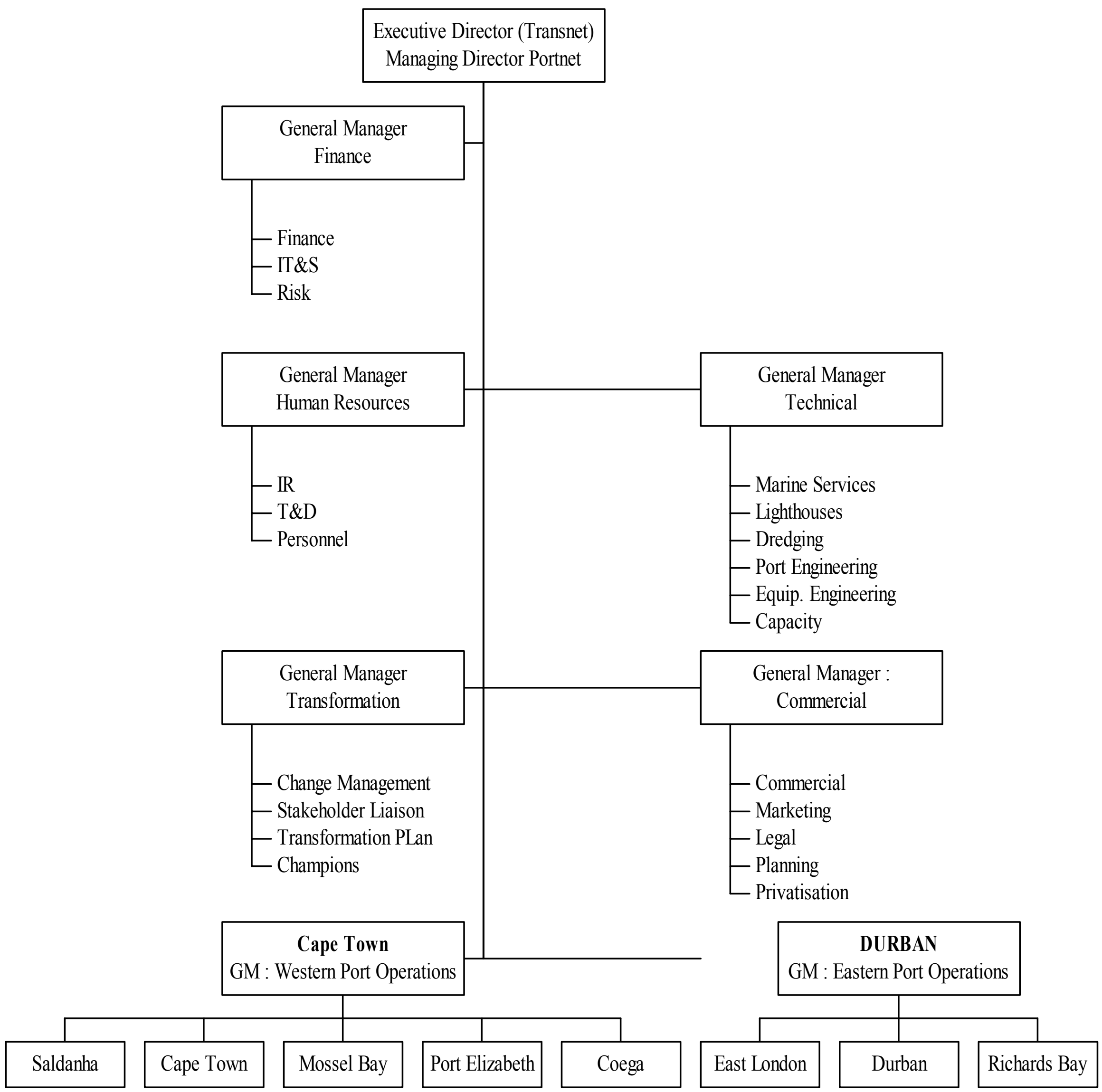

Figure 4.3 : Structure of Portnet.

4.1.2. Co-operation among the administrative bodies involved

Better co-operation between the Port Captains, Port Authorities and Health Officers regarding the ballast water issues raised to a certain extent the awareness, but some difficulties of communication still persist. If smooth and efficient co-operation has been noted among SAMSA, DEAT and Portnet, the exchange of information and the co-operation of the first Three with the Department of Health and its structures appeared to be insufficient at this stage. Nevertheless, during the discussions on ballast water issues the representatives of the relevant governmental bodies, clearly expressed their intention to improve co-operation and to eliminate communication shortcomings.

4.2. LEGAL PROCESS OF IMPLEMENTING THE IMO GUIDELINES

4.2.1. Preparation of national rules and regulations

All the relevant officials agreed upon the necessity to prepare a national set of regulations regarding the ballast water. The IMO guidelines for control and management of ships`s ballast water to minimise the transfer of harmful aquatic organisms and pathogens were unanimously recognised as the only possible basis for the national regulations and the only way to bridge the gap between now and the moment of the adoption of a new Annex to MARPOL 73/78 Convention. A particular concern was shown for the harmonisation of the IMO guidelines with the national legislative aiming at creating the adequate conditions for the efficient implementations.

4.2.2. Legal procedures regarding the incorporation of IMO guidelines into the national regulations

Different ways of accommodating IMO guidelines into the national legislation were explored with afferent government officials during the visit. The most appropriate legal procedures were identified during the discussions held with SAMSA representatives and CEO.

In order to incorporate the IMO guidelines regarding the ballast water into the national legislation and to provide for their efficient implementation a strategy in two stages has been proposed by SAMSA.

The first stage should consist in the elaboration of a Marine Notice addressed to all port managers, agents and shipping companies operating in South African ports, providing for application of IMO guidelines for control and management of ships` ballast water to minimise the transfer of harmful aquatic organisms and pathogens. This will be followed by the dissemination of IMO Ballast Water Reporting Form (Appendix 1 to the Guidelines) to be employed for all the vessels calling the South African Ports. This storage could be rapidly accomplished at SAMSA level since Marine Notices are issued by this particular authority, Although the Marine Notices have not the power of a law, they are seen as strong legal recommendations and consequently carefully observed by interested parties.

The second stage would be the incorporation of IMO guidelines into the national regulations by virtue of an act signed by the Minister of Transport who is empowered by law to adopt all the recommendations, regulations, guidelines or codes elaborated and published by IMO with reference to the incorporation of international shipping standards in regulations the South African Merchant Shipping Act abilities the Minister of Transport "to incorporate" in the regulations any international shipping standard or any part thereof, without stating the text thereof, by more reference to the number, title and year of issue of that shipping standard or to any other particulars by which that shipping standard is sufficiently identified". A notice in this regard has to be issued in the National Gazette. The meaning of "international shipping standards" in the section cited is any code, guideline, resolution or standard adopted and published by the International Maritime Organization.

A different and much longer procedure shall apply when a new Annex to MARPOL 73/78 Convention will enter into force.

4.3. PROPOSED CO-ORDINATING STRUCTURES FOR THE PURPOSE OF THE PROJECT

4.3.1. Regional Steering Committee

The need for a steering committee as a forum where the interested parties expose them points of view on the ballast water issue was emphasised by all the relevant officials. Such a forum could substantially improve the communication among the parties, to identify the difficulties and the needs during the implementation process and to prepare for the coming mandatory instrument.

Based on the initial proposal put forward by SAMSA the interviewed government officials agreed that the steering committee should include (at least for the beginning) only the representatives of the main governmental structures involved (i.e. SAMSA, DEAT and Department of Health). Portnet as a key participant in the "Ballast Water Project" could also attend the works of the steering Committee as the representative of the Department of Public Enterprises. The other stockholders, non-governmental structures, might be invited to the works of the Committee in order to give their points of view every time when deemed appropriate. For the purpose of the steering Committee it was suggested that each involved authority should nominate a representative and an alternate.

In order to institutionalise this new forum, the idea of accommodating the Ballast Water Steering Committee (BWSC) under the auspices of the already existing "Inter-departmental Committee for Maritime Affairs" (ICMA) was put forward also by SAMSA. The advantages of this proceeding could be :

- The terms of reference of ICMA are wide enough to permit the establishment of BWSC under its auspices.
- The Department of Health and other organizations could be invited at to proceedings.
- The BWSA may appoint local sub-committees to provide it with accurate information about the "on site" developments.
- The next meeting of the ICMA is die in the next period of time.
- The establishment of the BWSC may be officialised by "Decision" of ICMA recorded as a "minute".

The details regarding duties and responsibilities, periodicity of the meetings and the agenda, were to be established by further consultations of the involved authorities.

It may be concluded that the government officials and other parties interested have confirmed their willingness and interest for the establishment of the steering committee as soon as possible.

4.3.2. The National Focal Point (NFP)

The necessity to appoint a National Focal Point for the purpose of the "Ballast Water Project" was mentioned by almost all the relevant officials during the discussions. Having considered the excellent results obtained by the existing NFP who ensured the liaison with IMO and guided the project in South Africa, all the relevant officials strongly recommended the representative of DEAT - Chief Directorate for Pollution Control Marine Pollution Division for this responsibility.

The conclusion that the governmental officials interested in harmful aquatic organisms carried in ballast water deal with the issues of the National Focal Point clearly demonstrated their intention to continue their support for the "Ballast Water Project".

4.4. PROPOSED DEMONSTRATION SITE

4.4.1. Description of the demonstration site

The proposal to select Port of Saldanha as a pilot demonstration site enjoyed the full support of involved officials. The port is the largest one in the Southern part of the country and covers 7430 ha of water area in Saldanha Bay. It is the deepest port of South Africa with a maximum depth of 23 meters at normal low tide. Saldanha Bay located in the south-west of the country at the Atlantic Ocean is considered a very sensitive area from the environment point of view. Its neighbourhood was declared natural reservation and significant aquaculture activities were reported in the area. Known as a fishing port in the early 1900`s, Saldanha gained strategy importance during World War II as a natural harbour for the naval and air forces based in the area. However, little development occurred until a secure water supply was made available via the Berg River water transfer scheme in the mid 1970`s. Over the last two decades four developments have marked the history of the port :

- the construction of the Sishen-Saldanha railway line;
- the construction of the deep water port;
- the construction of the iron-ore export facility; and
- the extension of the ore facility to handle the import of ore.

The annual level of iron exports in 1996 was at 19.2 million tonnes, with an expected level of at least 20 million tonnes per annum for the next five years. The dry bulk facility comprise of : a reclaimed area on which about three million tonnes of iron ore can be stockpiled and which houses the ore-handling facility, a cause way 2.3 Km long from the reclaimed area to the ore quay and an ore quay with two berths.

Crude oil is also imported and transhipped through the Port of Saldanha, whilst general cargo consists mainly of concentrates of cooper, zinc, lead and phosphate, with zircon and rutile being considered for future handling. The liquid bulk facility or Oil Jetty includes berthing and unloading facilities. The oil is pumped to storage facilities outside the port's jurisdiction via a pipeline. The oil company were recently considering expanding their facilities in Saldanha Bay. Part of the expansion proposals was a suggestion that they construct a ballast water reception facility which would have been able to handle some 40 million cubic meters ballast water per year. According to the study conducted on this occasion the cost of such an investment would have been between 16 to 18 million USD. However, the studies showed that the company's tankers contributed less than 10% of the ballast water discharges in Saldanha Bay. As a result, and given the expenses involved the proposal was left aside. Instead the oil company included in its charter agreements a requirement that the vessels exchange their ballast in the open ocean.

The break bulk general cargo facility (General cargo Quay) consists of a quay 250 m long and storage capacities of 30,000 tonnes, both open and covered.

The pollution protection requirements in the Port of Saldanha are very severe. No dumping of dirty ballast or any waste or oil from any vessel is permitted within harbour limits or within South African waters. Any person who contravenes or fails to comply with any such regulation shall be liable on conviction to a fine, or in default of payment, imprisonment or to both such fine and such imprisonment. In addition, the infringes can be levied with a fine and imprisonment for any pollution which may affect the sea-life, seafood, food or fish or seaweed, in terms of Sea Fisheries Act No. 12 of 1988 as amended. In addition, any pollution of the water may be prosecuted under the Prevention and Combating of Pollution of the Sea by Oil Act No. 6 of 1981 as amended.

All vessels bound for Saldanha must ensure that the ballast tanks and piping systems are free of oil contamination prior to arrival and secure bilge systems while in port. A Pollution Control Officer will inspect the bilge valves soon after docking and issue a control checklist, to be completed by the Master. Accidental or deliberate discharge or spillage of oil waste, refuse or oily mixture in the area must be reported to Saldanha Port Control immediately. Discharging of ballast water will be continuously monitored by staff of the Port Captain. Vessels failing to comply with any Pollution Regulations shall be requested to stop deballasting, and may be instructed by the Port Captain to leave the berth and/or harbour.

4.4.2. Main reasons for selecting the Port of Saldanha as demonstration site

The main reasons for selecting Saldanha as demonstration site underlined by relevant officials during the discussions were the following :

- According to the traffic figures mentioned in the previous sub-chapter Saldanha has the characteristics of a loading port. The fact that large quantity of ballast water is currently discharged is of particular relevance for the objectives of the project.
- The Port of Saldanha is located approximately 60 nautical miles or 150 Km by road, NNW of Cape Town which allows additional scientific support.
- Saldanha Bay and adjacent area is of special environmental interest for the South African authorities. The possibility to combine the existing environmental project with the new Ballast Water Project could be particularly beneficial for the future developments. It may also be relevant that during discussions with various government officials and representatives of the parties interested in harmful aquatic organisms carried in ballast water, the idea to nominate Saldanha as demonstration site was unimously supported.

4.5. DESCRIPTION OF THE ACTIVITIES AND ESTIMATION OF THE COSTS

4.5.1. Previous activities related to ballast water control and management

In South Africa, concerns over the ballast water issues were raised only recently. In early 1990`s, a preliminary investigation to assess the extent and nature of the problem took place. The investigation has been conducted basically in two directions :

- identification and classification of the existing marine organisms in South African ports; and
- identification of non-indigenous species imported in ballast water.

Although the scientific resources are available the process is still very slow. Some results were achieved on the taxonomy of the existing phytoplankton in the port of Saldanha by the Wits University of Johannesburg. A fairly clear image of harmful alga blooms in the adjacent waters has been presented after approximately two years of scientific researches. The study was co-ordinated by the Wits University and conducted with students therefore the costs involved are very relative. Even so by means of approximation it could be concluded that some 60.000 USD have been spent for the sampling process during the last three years. A rough estimation of the scientific researches in the University may raise at other 60.000 USD for the same period.

The problem of alien species transported in ballast water was initially approached in South Africa by the Sea Fisheries Research Institute. The Institute, located in Cape Town, is co-ordinated by the Department of Environmental Affairs and Tourism and is a part of the Chief Directorate for Sea Fisheries. For the last four years statistic data have been collected by the scientifists of the Institute. The outcome of this activity was a comprehensive and informative report on the alien species identified in South African waters and a series of essays refereed to the ballast water transfers. The experts of the Institute evaluated the statistic activity at about 80.000 USD for the entire period.

From the discussions with the representatives of the shipping industry resulted that some of the South African companies have particular requirements regarding the exchange of ballast in mid ocean and implementation of IMO guidelines for control and management of ships` ballast water. If the average costs of an exchange of ballast for a bulk carrier is around 2000 USD it may be estimated that the additional costs for South African vessels calling in Saldanha would be around 100.000 USD / year.

The participation of South African experts from the Department of Transport and Department of Environment at IMO - MEPC sessions was also estimated at the amount of 80.000 USD. Further quantification of the costs involved by various studies and global environmental projects, which may be related to ballast water transfers was not available at this stage.

Table 4.1 provides a rough estimation of the costs incurred by South Africa with regard to ballast water control and management.

Table 4.1. Approximated baseline costs concerning the ballast water management in South Africa.

Organisation	Department of Transport (SAMSA)	Department of Environment	Portnet	Shipping Industry	University	Total
Costs*	40,000	120,000	60,000	100,000	60,000	380,000

** All costs in USD*

4.5.2. Prospected activities related to ballast water control and management

A series of future projects regarding the development of Saldanha have been mentioned during the discussions with government officials and other parties interested in harmful aquatic organisms carried in ballast water. One of the most relevant for the purpose of the "Ballast Water Project" is the elaboration of an Environmental Management Strategy. The aim of such is to facilitate the establishment of an Environmental Management System (EMS) that will allow for the management of port operations according to internationally acceptable environmental standards. The following objectives were proposed to support the achievement of this aim :

- to discuss the process of implementing an environmental management system;
- to develop an Environmental Policy;
- to identify priority issues upon which the EMS should focus and to identify additional issues to be addressed by means of the EMS;
- to identify a time scale for implementing an EMS;
- to identify applicable environmental standards /laws/ regulation/ conventions/ guidelines;
- to discuss new environmental impact assessment regulation requirements.

Internationally, environmental management systems have been promoted as a way of monitoring and managing impacts of day-to-day activities of organizations. It was agreed that to ensure that port operations have a limited impact on the biophysical, social and economic environment at Saldanha Bay, sound environment management is essential and the need to set up an environmental management system is a priority.

The following issues / concerns should receive priority when setting up the EMS :

- Iron ore dust system to control pollution;
- Cargo handling procedures;
- Emergency response procedures;
- Water quality management;
- Ballast water disposal procedures; and
- Public communication.

In this context some activities directly linked to the "Ballast Water Project" have also been underlined for the near future :

- To extent the current researches to the taxonomy of zooplankton which was evaluated at 40,000 USD / year involving two scientists;
- To hire a consultant to manage the "Ballast Water Project" in South Africa, to set up a national plan on this respect and to act as a project co-ordinator with an estimated cost of 20,000 USD /year;
- To hire a scientific research co-ordinator with a pure scientific background; costs also estimated at 20,000 USD /year;
- "On the job" training with more advanced countries to learn from their experience. The estimated costs for four persons would be 40,000 USD;
- To organize two workshops, at the beginning and end of the project, to create an organized forum to get opinions from all the stakeholders. These costs were estimated at 40,000 USD;
- To organize a regional workship with the participation of 15 maritime countries of the Southern Africa in order to raise the regional awareness on ballast water transfers and their impacts. The total costs were estimated at 200,000 USD;
- To train the health and pollution officer as "on scene" factors, to sample the tanks and control the ballast water discharges, which may increase the total costs with 20,000 USD for the period.

It can be seen that the total costs envisaged by the relevant authorities raise at a total amount of 380,000 USD.

4.6. CO-ORDINATION WITH GLOBAL ENVIRONMENTAL FACILITY (GEF) OPERATIONAL FOCAL POINT

In South Africa the GEF Operational Focal Point is based in the Department of Environmental Affairs and Tourism. The fact that GEF representatives were closely informed about the developments regarding the Ballast Water, both by the National Focal Point who reports to the Department of Environment and by the IMO consultant during its mission appeared to be extremely important. Particular interest with regard to the evolution of the project was expressed and full support was promise by means of a "Letter of Support" addressed to UNDP Resident Representative in South Africa with copies to UNDP and GEF Headquarters. The same interest was manifested for the works of the Steering Committee and the direct participation was considered as a possibility.

4.7. CO-ORDINATION WITH THE UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP) RESIDENT REPRESENTATIVE

During the second round of consultations of the IMO Consultant with the Environment Division of the UNDP Resident Representative Office, an extensive up-to-date presentation of the project has been made. The new appointed Programme Officer for Sustainable Development of UNDP South Africa stressed the particular interest for the future developments and the intention to support the efforts of relevant authorities in South Africa. On this occasion the possibility of involving the local NGO`s in the future stages of the process was also explored. Based on the extensive discussions held with UNDP representatives it may be concluded that substantial support from their part might be expected in the future.

4.8. CONCLUSIONS AND RECOMMENDATIONS

From a global point of view the discussions and consultations with relevant authorities and other interested parties confirmed their willingness to implement IMO guidelines for control and management of ships` ballast water to minimize the transfer of harmful aquatic organisms and pathogens. They also expressed their intention to select the Port of Saldanha as a demonstration site and nominated a national focal point. A national Steering Committee is about to be established and the shipping industry representatives expressed their willingness to co-operate for making the IMO guidelines as practical as possible and finding the most acceptable solutions for their successful implementation.

To achieve these goals it is recommended to improve co-operation between relevant governmental organization and in particular get the Department of Health more involved in Ballast Water Project.

Close co-operation with GEF and UNDP representatives appears to be of significant importance for the future project. It is therefore recommended to continue the consultations with the two international organisms.

The relevant authorities should also explore the possibility of selecting alternative zones for the exchange of ballast water in the future.

It is also recommended to promote and encourage regional co-operation by expending the works of the Steering Committee at regional level.

ANNEX 1
TERMS OF REFERENCE FOR CONSULTANT TO VISIT DEMONSTRATION SITES IN BRAZIL AND SOUTH AFRICA

PROJECT TITLE : **REMOVAL OF BARRIERS TO THE EFFECTIVE IMPLEMENTATION OF BALLAST WATER CONTROL AND MANAGEMENT MEASURES IN DEVELOPING COUNTRIES**

PROJECT NO. : **T011-GLO/97/G4/A/1G/19**

Background

One of the main objectives of this project to collect background material for the preparation of a full-scale project document to be submitted to the GEF Council in October 1998. In order to collect such material, a mission was undertaken in early 1998 to Bahrain, China, India, Poland and South Africa. This is a follow up to that mission.

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Acting upon the instructions of the Secretary-General of IMO or other officials acting on his behalf, the consultant shall, during the period 23 May to 11 June 1998, carry out the following tasks :

-	travel to Brazil and South Africa to hold discussions with government officials and other parties interested in harmful aquatic organisms carried in ballast water, including maritime, port and health authorities and the shipping industry;
-	confirm their willingness to implement the IMO guidelines for control and management of ships` ballast water to minimises the transfer of harmful organisms and pathogens;
-	confirm their willingness to : a) select a specific port as demonstration site, and b) select a national focal point (NEP) and a steering committee including representatives from the region;
-	confirm their willingness to carry out, or take part in, specific treatment methods for ballast water;
-	define demonstration activities in terms of objectives, outputs and activities and inputs with a costing for each item;
-	include consideration of special modalities like manpower surveys, twining with developed countries, use of existing facilities, links to existing projects (east Asian Seas, Black Sea) where apropriate;
-	consultant should be familiar with GEF incremental cost procedures;
-	consult with UNDP Resident Representative, GEF operational focal

	points and others to obtain a letter from the GEF operational point to the UNDP Resident Representative with a copy to the GEF Secretariat (Mr. Al Duda) and UNDP Headquarters (Mr. P. Reynolds) in support of the project;
-	keep careful records of the names, titles, organizations, telephone/fax numbers and E-mail addresses of all persons contacted
-	carry out relevant duties falling within the scope of his competence;
-	visit IMO for a two-day debriefing session;
-	submit a report in hard copy and on diskette to IMO by 15 June 1998.

ANNEX 2
ITINERARY AND SCHEDULE OF MEETINGS

Saturday, 23 May 1998	
P.M.	Travel to Brasilia
Sunday, 24 May 1998	
P.M.	Arrival at Brasilia International Airport, Brazil
Monday, 25 May 1998	
A.M.&P.M.	Discussions with government officials representing the Brazilian authorities interested in harmful aquatic organisms carried in ballast water. Participants : - Cdr. Wagner de Sousa Moreira, Division for Maritime Affairs, Ministerio da Marinha, Brasilia tel.: +5561 312 1054, fax: +5561 312 1051, e-mail: wmoreira@nutecnet.com.br - Mr. Aloysio Bastos Vianna da Silva, Chief Advisor for International Affairs, Directorate of Ports and Coasts, Rio de Janeiro, tel.: +5521 516 5908, fax: +5521 216 5226. - Mr. Servulo Moreira, Advisor, Secretariat for International Affairs, Ministry of Planning and Budget, Brasilia tel.: +5561 215 4847, fax: +5561 225 4022 e-mail: servulov@SEPLAN.GOV.br - Mr. Jose Ricardo R. dos Santos, Division for Port Works and Services, Secretariat for Water Transportation, Ministry of Transports, Brasilia tel.: +5561 315 8126, fax: +5561 315 8130 e-mail: joseruschel@TRANSPORT.gov.br - Ms. Sonia Lucia dos Reis Alve, Technical Adviser, Division for Co-ordination of Ports, Airports and Boundaries, Ministry of Health, Brasilia, Member of the National Committee for the Harmonization of Ports Inspection

	tel.: +5561 315 2409, fax: +5561 315 2325 - Ms. Marilena Matera do Monte Lins, Head, Division of Sanitary Surveillance of Rio de Janeiro, Member of the Local Committee for the Harmonization of Ports Inspection tel.: +5521 240 8191, fax: +5521 240 8438 - Ms. Cristina Montenegro, Co-ordinator, Environment Unit, United Nations Development Programme Brazil tel.: +55 61 329 2030, fax: 5561 329 2069 e-mail: cristina@undp.org.br - Mr. Robson Jose Calixto, Oceanographer, National Environment Programme, National Coastal Zone Management Programme, Ministry of Environment, Water Resources and Legal Amazon, Brasilia tel.: +5561 317 1156, fax: +5561 224 2466 e-mail: rjcalixto@mma.gov.br - Mr. Fernando Pimentel, Advisor, Division of Transports, Communication and Services, Ministry of Foreign Affairs, Brasilia tel.: +5561 211 6374, e-mail: fpimentel@MRE.gov.br
Tuesday, 26 May 1998	
A.M.	Conclusion session with government officials representing the Brazilian authorities interested in harmful aquatic organisms carried in ballast water (i.e. Ministerio da Marinha, Ministry of Transports, Ministry of Health and Ministry of Environment) Consultations regarding the "Ballast Water Project" with UNDP Resident Representative Office in Brazil, Participants : - Mr. Walter Franco, Resident Representative, United Nations Development Programme, Brazil tel.: +5561 329 2036, fax: +5561 329 2069 - Ms. Cristina Montenegro, Co-ordinator, Environment Unit, UNDP, Brazil
P.M.	Consultations regarding the "Ballast Water Project" with the Secretariat of International Affairs of the Ministry of Planning and Budget, Global Environment Facility Focal Point in Brazil. Participants : -Mr. Washington Aquino de Mendonca, General Co-ordinator of Financial Affairs, Ministry of Planning and Budget, Brazilia tel.: +5561 321 2442, fax: +5561 225 4022 - Mr. Servulo Moreira, Advisor Secretariat for International Affairs, Ministry of Planning and Budget Travel to Rio de Janeiro.
Wednesday, 27 May 1998	
A.M.	Discussions with government officials and other parties interested in harmful aquatic organisms carried in ballast water. Participants : - Mr. Armando Amorim Ferreira Vidigal, Shipowners Union (SYNDARMA), Rio de Janeiro, tel.: +5521 223 1202 - Mr. Francisco Dias de Andrade, Centro de Capitaes da Marinha Mercante, Rio de Janeiro, tel.: +5521 393 6981 - Mr. Claudio Goncalves Land, Naval Architect, Maritime Transportation Management Division, Petroleo Brasileiro S.A. (PETROBRAS), Rio de

	Janeiro, tel.: +5521 534 9411, fax: +5521 534 1641 - Mr. Nelson de Farias Almeida, Head, Maritime Transportation Management Division, Petroleo Brasileiro S.A. (PETROBRAS), Rio de Janeiro, tel.: +5521 534 2430, fax: +5521 534 1641, e-mail: dtv3@abast.petrobras.com.br - Mr. Jose Augusto Massena Reis, Technical Advisor, Directorate of Ports and Coasts, Rio de Janeiro, tel.: +5521 516 5908, fax: +5521 216 5526 - Mr. Francisco Carlos P. Barreto, Petroleo Brasiliero S.A. (PETROBRAS), Rio de Janeiro, tel.: +5521 566 5372 - Mr. Marcus Vinicius Lisboa Brandao, General Inspection for Environment, FRONAPE, PETROBRAS, Rio de Janeiro, tel.: +5521 534 6481, fax: +5521 589 5482 - Mr. Nilton Lemos Marroig, Petroleo Brasiliero S.A. (PETROBRAS), Rio de Janeiro, tel.: +5521 534 6483 - Mr. Cleiver Ferraz Moulin dos Reis, Brazilian Society for Naval Engineering (SOBENA), Rio de Janeiro, tel.: +5521 516 1654 - Mr. Guilherme Accioly Fragelli, Consultant, National Training Programme for Ports, Maritime Studies Fundation, Rio de Janeiro, tel.: +5521 553 1347, fax: +5521 552 7825, e-mail: femar@openlink.com.br - Ms Maria Helena Nadiamasurk, Directorate of Ports and Coasts, Rio de Janeiro, tel.: +5521 216 5214 - Mr. Celsio Aleluia Mauro, Research Center of PETROBRAS, Rio de Janeiro, tel.: +5521 598 6817 - Ms. Maria Luiza Braganca Tristao, Head, Inorganic Chemistry Section, Research and Development Center of PETROBRAS, Rio de Janeiro, tel.: +5521 598 6188, fax : +5521 598 6296, e-mail: mlu@cenpes.petrobras.com.br - Ms. Silvia Algarve, Ministry of Health, Rio de Janeiro, tel.: +5521 240 8533 - Mr. Cesar de Azerdo Quelhas, Commercial Division, Port Authority (Compania Docas do Rio de Janeiro), Ministry of Transports, tel./fax: +5521 253 8876 - Ms. Dina da Luz M. Aguiar, Environmental Division, Port Authority (Compania Docas do Rio de Janeiro), Ministry of Transports, tel./fax: +5521 253 8876
P.M.	Discussions with Port Authority (Companhia Docas do Rio de Janeiro) representatives and introduction of the Port of Sepetiba. Participants: - Mr. Antonio Machado, Director, Companhia Docas do Rio de Janeiro, Ministry of Transports, Rio de Janeiro, tel.: +5521 233 0889, fax: +5521 263 7386 - Mr. Bertoldo Gancz, Advisor to the General Co-ordinator for Engineering and Development, Port Authority (Companhia Docas do Rio de Janeiro), Ministry of Transports, Rio de Janeiro, tel.: +5521 296 5151, fax: +5521 233 4676, e-mail: cdrjb@openlink.com.br - Mr. Renato da Silva Diniz, Advisor to the Operational Director, Companhia Docas do Rio de Janeiro, Ministry of Transport, Rio de Janeiro, tel.: +5521 296 5151, fax: 5521 263 7386 - Mr. Leo Teixeira Guiabano Advisor to the Chairman of the Port Authority Council of Ports of Rio de Janeiro Sepetiba, Forno and Niteroi, Rio de Janeiro, tel.: +5521 233 3526, fax: +5521 263 4172.

Thursday, 28 May 1998	
A.M.&P.M.	Site visit to ports of Angra dos Reis and Sepetiba. Discussions with : - Mr. Paulo Penchina Cortines Pereira, General Manager of Port of Angra dos Reis, PETROBRAS, tel: +5524 361 2550, fax: +5524 361 2519 - Dr. Horacio Jorge Serpa Paes Leme, Sanitary Surveillance Division of Rio de Janeiro, Petropois, tel: +5524 243 7117 Mr. Bertoldo Gaucz, Port Authority
Friday, 29 May 1998	
A.M.	Conclusion session with government officials and other parties interested in harmful aquatic organisms carried in ballast water. Participants : same as on 27 May 1998.
P.M.	Final discussions at Directorate of Ports and Coasts . Travel to Johannesburg, South Africa.
Saturday, 30 May 1998	
P.M.	Arrival at Johannesburg International Airport.
Monday, 1 June 1998	
A.M.	Discussions with Portnet representatives in Johannesburg Head Office. - Capt. Rick von der Krol, Executive Manager (Marine Services), Portnet, Johannesburg, tel : +2711 773 6489, fax: 2711 773 6680, e-mail: ian.smith@port.ssw.transnet.co.za
P.M.	Travel to Pretoria by bus. Discussions with South African Maritime Safety Authority (SAMSA) in Pretoria Head Office. - Capt. Brian R. Watt, Chief Executive Officer of SAMSA, Pretoria, tel: +2712 342 3049, fax: +2712 342 3160, cell.tel: 082 445 3155, PO BOX 13186, Hatfield 0028
Tuesday, 2 June 1998	
A.M.	Discussions with Department of Environmental Affairs and Tourism representative in Pretoria Head Office. - Mr. Brian A.D. Egan, International Liaison and acting Global Environment Facility Focal Point for South Africa, Department of Environmental Affairs and Tourism, Pretoria, tel: +2712 310 3534, fax: +2712 322 9231, cell.tel: 083 6562 844, e-mail: sek_rs@ozone.pwo.gov.za
P.M.	Consultation with UNDP Resident Representative Office in South Africa. - Ms. Jaana Rannikko, Programme Officer (Sustainable Development), United Nations Development Programme, PO BOX 6541, Pretoria, tel: 2712 338 5034, fax: 2712 320 4353, e-mail: jrannikko@un.org.za Travel to Cape Town by plane.

Wednesday, 3 June 1998	
A.M.	Discussions with Department of Environmental Affairs and Tourism representatives in Cape Town. - Dr. Lynn Jackson, Assistant Director, Marine Pollution Division, Chief Directorate for Pollution Control, Department of Environmental Affairs and Tourism, Cape Town, and Focal Point for the GEF /UNDP /IMO /Project in South Africa, tel: +2721 402 3344, fax: +2721 215 342, e-mail: ljackson@sfri2.wcape.gov.za
P.M.	Discussions with the shipping industry representatives in Cape Town. - Dr. Piet van Aswegen, President of South African Shipowners Association, Cape Town, tel: +2721 408 6022, fax: +2721 419 6499, PO BOX 27, 8000 Cape Town - Capt. Stuart Mc Allister, Marine Manager, SAFMARINE Ship Management, PO BOX 7487, Roggebaai 8012, Cape Town, tel: +2721 408 6285, cell.tel: 083 259 1748, e-mail: mcals@shub.safmarine.co.za
Thursday, 4 June 1998	
A.M.	Discussions with Department of Health representative in Cape Town - Mr. Keith Saaymon, Chief Environmental Health Officer, Port Health, Cape Town, tel: +2721 211124, fax: +2721 418 5685
P.M.	Consultation with the National Focal Point for South Africa (Dr. Lynn Jackson).
Friday, 5 June 1998	
A.M.&P.M.	Site visit to port of Saldanha, selected pilot demonstration site. Discussions with: - Capt. Graham O. Harling, acting Port Captain of Port of Saldanha, Portnet, tel: +2722 703 4100, fax: +2722 703 4406 - Mr. Martin R. Slabber, Ship Surveyor, South African Maritime Safety Authority (SAMSA), PO BOX 33, Saldanha 7395, tel: +2722 714 1612, fax: +2722 714 3635, cell.tel: 082 789 6764 - Mr. Alwin Kuys, Senior Customs Officer Customs Office, Port of Saldanha, tel: +2722 715 3720, cell.tel: 082 451 8254.
Saturday, 6 June 1998	
	Travel to London.
Monday, 8 June 1998	
A.M.&P.M.	Debriefing session at IMO Headquarters in London.
Tuesday, 9 June 1998	
A.M.&P.M.	Debriefing session at IMO Headquarters in London.
Wednesday, 10 June 1998	
	Return to flight to Bucharest.

Mission Report on the Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries (18 May to 9 June 1998)

Project Title :	Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries
Requested by :	United Nations Development Program (UNDP)
Countries of Assignment:	China and India
Duration:	25 May to 9 June 1998
Funded by:	Global Environment Facility through UNDP
Executing Agency:	International Maritime Organization (IMO)

Note:
The views expressed in this report are those of the author and are not attributable in any way to the United Nations or the International Maritime Organization.

Signature: Zhao Dianrong **Date: 10 June 1998**
IMO consultant:

ACKNOWLEDGEMENT

The consultant wishes to express his appreciation to all persons who helped him in his task of gathering the information necessary for the compilation of his report.

In particular he would like to thank Mr. H. Brathaug, Implementation Officer, Marine Environment Division IMO, Mr. Manfred Nauke, Chief Office for the London Convention 1972, Marine Environment Division IMO, Mr. Song Jiahui, Deputy Director-General of the Bureau of Harbour Superintendency , the People's Republic of China, Mr. Chen Huan , Deputy Chief of Social Development Division, World Bank Dept. the Ministry of Finiance P.R. China, Mr. Pan Jiahua, Senior Program Officer, United Nations Development Program, Beijing, China, Mr. Jiang Yong, Deputy Director-General, Dalian Harbour Superintendency Administration of P.R. China, Dr. Pradeep Monga, GEF Co-ordinator, UNDP New Delhi, India, Mr.Abhas Kumar Jha, Under Secretary, Ministry of Finiance, Dept. of Economic Affairs, New Delhi, India, and Mr. B.K. Biswas, Chief Surveyor with Government of India, Directorate General of Shipping, Mumbai India, for their kindness, hospitality and cooperation which made the consultant's visit successful.

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BACKGROUND

For a decade the introduction of unwanted aquatic organisms and pathogens through ships' ballast water has drawn increasing attention in the world. Such unwanted introduction may pose threats to indigenous human, animal and plant life, and the marine environment. Actions and control measures are being considered by some individual States. Since 1993 IMO has been working towards the development of legally binding provisions on ballast water management. In 1997, the 20th Assembly of IMO adopted, by Resolution 868(20), the Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful aquatic Organisms and Pathogens. The Resolution requests Governments to take urgent action in applying these Guidelines.

To minimize the transfer of harmful aquatic organisms and pathogens needs global efforts. A proposal for a grant has been submitted by IMO through UNDP to GEF with a view to establishing a project "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries". A fact finding mission was organized by IMO and completed by 8 March 1998. The report of the mission was submitted to the Ballast Water Working Group at 41st Session of MEPC for comments.

The same consultants were chosen to carry out another mission "Visiting Demonstration Sites" The second consultant visited China and India. The mission took place from 25 May to 10 June in coorperation with theUNDP Resident Representatives and the focal points from the two countries.

The terms of reference for the mission are attached as Annex 1. In Annex 2 the details of the itinerary and schedule of meetings are provided.

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TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

The Bureau of Harbour Superintendency of the People's Republic of China has confirmed its willingness to participate in the ballast water project and to implement the IMO Guidelines.

Dalian has been selected as the demonstration site for the project for the reasons that it has the biggest oil port in the country, there are plenty of fish farming activities along the coast, and it enjoys the expertise from the Dalian Maritime University and other research organizations.

Three activities have been proposed to be carried out under the project, all of which are considered beneficial both to the country and to the world.

At present there are three authorities involved in the management of ships' ballast water discharge. in China. However by the end of 1998, the Health Authority and the Animal and Plants Authority will be consolidated into one authority under the Government's reform plan. There will be two authorities involved in the management of ballast water in the future.

The willingness of India to participate in the project has been confirmed from the Directorate General of Shipping under the Ministry of Surface Transport of India.

Mumbai has been selected as the demonstration site for the project. Three activities have been proposed to be carried out under the project.

Five Government authorities are involved in the future implementation of IMO Guidelines on ballast water management. Co-ordination work in of great importance.

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2 BASIC PRESENTATION OF THE IMO GUIDELINES

2.1 Review of the previous stages concerning the ballast water issue

Discharge of ballast water or its sediments may result in the establishment of harmful aquatic organisms and pathogens in geographically separated water bodies, posing threats to the human health and the marine environment. To address this issue, the Marine Environment Protection Committee(MEPC) of IMO at its 31st session in 1991 adopted voluntary guidance in the form of the International Guidelines for Preventing the Introduction of Unwanted aquatic Organisms and Pathogens from Ships' Ballast Water and Sediments. In 1993 these Guidelines were adopted by Resolution A.774(18) at the 18th IMO Assembly.

In 1997, the IMO 20th Assembly adopted,by Resolution A.868(20), the Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens. The Resolution which revoked Resolution A.774(18) further requests Governments to take urgent action in applying these new Guidelines.

Legally binding provisions in the form of a new Annex to MARPOL 73/78 on ballast water control were considered during the 40th and the 41st session of MEPC.

To assist developing countries in carrying out effective ballast water management and control measures, a GEF project was proposed under the title" Removal of barriers to the effective implementation of ballast water control and management measures in developing countries". After the completion of a fact-finding mission which took place from 18 January to 8 March, five developing countries were selected as piloting countries (demonstration sites) for implementation of the project through consultation among IMO, UNDP and the relevant focal points of the countries.

2.2 Importance of the implementation of IMO Guidelines

Although the ballast water issue, especially the potentially adverse effects of the harmful aquatic organisms and pathogens transferred by the ships' ballast water have been increasingly aware in the world, there has no a legally binding instrument which provides mandatory requirements on the control and management of ballast water operation.The IMO Guidelines are not to be considered as a certain solution to the problem. Rather, each part of the Guidelines should be viewed as tools which, if correctly applied, will help to minimize the risks associated with ballast water discharge. Voluntary implementation of the Guidelines by more countries will surely paved the way for the coming into being of the new Annex to MARPOL 73/78 as a legally binding instrument on the ballast water control.

Several states have taken unilateral action by adopting provisions for local, regional or national application with a view to minimizing the risks of introducing harmful aquatic organisms and pathogens through ships' ballast water discharged into their ports and coastal waters. However, such an issue, being of world-wide concern, demands global action towards the effective implementation of the Guidelines and the adoption of the legally binding instrument.

Action to implement the Guidelines by the developing countries are of great importance in this regard. Action taken only by several countries can not solve the problem globally.

Action to minimize the transfer of harmful aquatic organisms and pathogens should be taken in a standard and uniform manner. The Guidelines just serve for this purpose. It is very important that all countries ship operators, relevant authorities and interested parties apply the Guidelines.

3 PART A --- CHINA

3.1 Administrative structure concerned with the implementation of IMO Guidelines

Under the present Chinese administrative structure, there are three government authorities involved in ships' ballast water management. They are the Bureau of Harbour Superintendency (also known as the Maritime Safety Administration) under the Ministry of Communications, the Frontier Health and Quarantine Authority under the Ministry of Health, and the Frontier Plant and Animal Quarantine Authority under the Ministry of Agriculture and Fishery. Now the Chinese Government is undertaking a reform plan for the government bodies. The administrative structure is being simplified with a view to raising efficiency and eliminating red tape. The Frontier Health and Quarantine Authority and the Frontier Plant and Animal Quarantine Authority will be consolidated into one authority under the Customs. Such consolidation is planned to be completed by the end of 1998. So in the future there will be mainly two authorities involved in the implementation of the Guidelines.

3.1.1 Description of the main administrative bodies involved

The Bureau of Harbour Superintendency of the People's Republic of China is a Government authority under the Ministry of Communications, responsible for maritime safety, prevention of pollution from ships, certification of seafarers, navigation aids , search and rescue and maritime traffic control. It has branches at all the ports of the country, namely the Harbour Superintendency Administrations. The Harbour Superintendency Administrations at different ports carry out inspections and exercise controls in the scope of their responsibilities. Ships are required to report to the Harbour Superintendency Administration,before discharging the ballast water, the amount of ballast water to be discharged, the place where the ballast water was taken. Ships are allowed to deballast upon approval.

The Frontier Health and quarantine Authority is responsible for prevention of quarantinable diseases and health inspection. Its headquater office is located in Beijing under the Ministry of Health. It has branches in all the ports which are open to foreign trade and international traffic. Under the Frontier and Health Law of the People's Republic of China, ships' ballast water which was taken at the places which have been identified as infected areas by the World Health Organization are required to be treated before discharge usually by biocides such as chlorine compounds.

The Frontier Plant and Animal Quarantine Authority, with its head office in Beijing ,has its branches in all the ports which are open to foreign trade and international traffic. The Frontier Plant and Animal Quarantine Authority is responsible for quarantine inspections of plant and animals. As mentioned above, the two quarantine authorities will be consolidated into one authority under the government reform plan by the end of 1998.

3.1.2 Cooperation among the administrative bodies involved

Regular meetings on facilitation matters are held. Some co-ordination work is done. General speaking, the cooperation among the authorities is good. However, in some overlapped areas like garbage control, lack of cooperation was observed. Since ballast water management can not be effectively implemented by only one authority, co-ordination is necessary in order to ensure good cooperation between the authorities concerned. During the consultant's visit, all the authorities expressed their willingness to cooperate in the implementation of ballast water control and management measures.

The Harbour Superintendency Administration at different ports are in a position to control the discharge of ballast water and may act as the co-ordinator in the implementation of the Guidelines.

3.2 Legal process of the implementation of IMO Guidelines

3.2.1 Preparation of national rules and regulations

The Chinese laws and regulations can take form of the following levels:

National laws

National laws are the highest level of the country's legislation. National laws are adopted by the People's Congress. It may take a considerably long time to adopt or amend the laws at this level because of the legal procedure.

Administrative regulations

Administrative regulations are the second level of the country's legislation. They are adopted and formulated by the State Council. Ratification of Annex VII to MARPOL73/78 needs approval by the State Council. Once the Annex is ratified, it become effective to the country. There is no need for any special legislations.

Departmental rules and codes

Departmental rules and codes are the third level of the country's legislation which are adopted and promulgated by the Ministries. Most of this kind of rules and code are of technical nature.

Local provisions and rules

Local provisions and rules are the fourth level of legislation which are adopted and promulgated by the local governments.

3.2.2 Procedures related to the approval of national rules and regulations

National laws as above-mentioned are submitted through the State Council to the People's Congress. The People's Congress holds debates on the drafted law and decides whether to pass it. So both adoption and amendment of such laws are time-consuming. Sometimes years may be needed.

The procedure for adoption of administrative regulations is less complicated compared with that of the national laws. But it need co-ordination between ministries and among different departments.

The procedure for approval of departmental rules and codes comparatibly simple because it usually concerning a specific field of management.

Considering the nature of ballast water management and the treatment measures involved, the best way in China for implementation of the Guidelines before the new Annex comes into being, is through the departmental rules issued by the Bureau of Harbour Superintendency in consultation with the relevant authorities.

3.3 Proposed demonstration site

Dalian has been selected as the demonstration site for this project.

3.3.1 Description of the demonstration site

The Port of Dalian, located on the south part of the Liao Dong Peninsula, was constructed in the year of 1899. Through the 100 years of existence, it played an important role both commercially and militarily.

Dalian Port is open to maritime traffic all year round. Being a natural harbour and sheltered by mountains from three sides, the port enjoys its deep and calm water in the harbour with little mud accumulation on the bottom. Dalian has the largest oil terminal in the country. There are 60 berths which can accommodate ocean-going ships. The main cargoes handled by the port include crude oil, refined products, grain, coal, timber, cement, fertilizer, ro/ro cargo, container cargo and general cargo.

Dalian received 8458 ocean-going vessels (including domestic voyages) in 1997, of which 3883 were engaged in international voyages.

3.3.2 Reasons for selection of Dalian as the demonstration site

The reasons for Dalian to have been selected as the demonstration site for this project in China are mainly as follows:

a. Dalian has the biggest oil terminal in the country. Of the total number of the vessels which visited Dalian in 1997, 3890 were tankers. Most tankers come to Dalian for loading oil. They deballast in the port or its coastal waters. About 5.5 million tons of ballast water was discharged in Dalian in 1887.

b. There are quite a number of fishing farms along the coast near the port. Some of them are located so near the port that one can see them from onboard the ships. The Bohai Sea where Dalian exists is a shelf area which suffers from red tide occasionally.

c. Dalian Maritime University has carried out some studies on the ballast water, some professors are very familiar with the ballast water issue. The World Maritime University has its branch in Dalian. There are well-equipped laboratories in Dalian Frontier Health and Quarantine Authority and the Dalian Fishery Institution. Those resources can be used for ballast water studies and training of personnel.

3.3.3 Specific treatment methods and activities for ballast water considered

Three activities have been proposed to be carried out under this project in China.

Activity 1---Establishment of red tide warning system to mariners

China suffers a lot from red tides in resent years. In 1993 19 red tides were observed. 12 were observed in 1995. The red tide which took place in the spring of 1998 caused great losses to the fishing industry especially in Hong Kong. Studies on red tides have been carried out by the research organizations supported by the government and the World Bank. The information of red tides observation and tracking is available. But at present there is no information given to ships on the position and moving tendency of the red tide observed. Because of being unknown of the position of the red tide, ships sailing in the red tide area may take ballast water , causing the harmful blooms to be carried by the ballast water taken up on board.

It is proposed that a warning system on red tides be established by using the information from the relevant authorities. The purpose of the system is to provide ships with the red tide information including the time, position and moving trend of the observed red tide so that ships are advised not to take up or minimize to take up ballast water when they are sailing through or near the red tide area. Such information may be included in the navigation warnings which have been sending by the Harbour Superintendency Administrations. Such warning system would help ships avoid up take of ballast water at red tide area and prevent the harmful organisms from being transferred to other places through ballast water operation.

Activity 2-- Experiment on the chemical treatment method on board ships

Chemical treatment for disinfection of the ships' ballast water which was taken from the places identified as the infected areas by WHO has been required by the Chinese Health Authority for public health reasons. Some fishing farms are also using this method to clean the water. However, some questions need to be addressed through the study as to how effective the method is on the other aquatic organisms and pathogens, what secondary pollution may this treatment method cause and how to eliminate it, whether such method can be used on board in a environment friendly way. Experiments will be carried out with a view to answering those questions.

Activity 3-- Ballast water exchange at deep sea of the Pacific Ocean

Many COSCO ships engaged in Pacific voyages. It is proposed that several types of ships be selected to carry out experiments of ballast water exchange at deep sea of the Pacific Ocean to gain experience and data. Such experiments will be conducted with a view to ensuring ships safety while obtaining the satisfied results of ballast water exchange.

The details of the proposed activities are described in the following sub-sections.

3.4 Description of activities and estimation of costs

3.4.1 Previous activities related to ballast water transfers, using of existing facilities, manpower surveys and the estimation of the baseline costs

Activity 1-- Establishment of red tide warning system to mariners

Red tide studies have been carried out in China for years. The Government has already set up a red tide observing system in the Ministry of Agriculture and Fisheries. Such information can also be available from the Bureau of Ocean of China. The proposed activity of establishing a red tide warning system to mariners can make use of the information available from the above-mentioned authorities and take the form of the existing navigation warning. The existing facilities and manpower engaged in the navigation warning can also be utilized.

The baseline costs for Activity 1 are estimated to be 220,000USD.

Activity 2-- Experiment on the chemical treatment method on board ships

This activity can be conducted by Dalian Harbour Superintendency Administration together with Dalian Health Authority and Dalian Maritime University. Several ships of different types from COSCO may be selected for carrying out this activity. Samples will be analysed to see the effectiveness of such treatment and measures will be invanstigated for eliminating the possible secondary pollution cause by such treatment. Different biocides may be considered for carrying out the experiment. The ships from COSCO, the resources including manpower can be provided as input of the country.

The baseline costs for Activity 2 are estimated to be 350,000USD.

Activity 3-- Ballast water exchange at deep sea of the Pacific Ocean

Some COSCO tankers and bulk carriers have been carrying out ballast water exchange operation as required by some port States. Some studies have been carried out by COSCO on the safety issue. For conducting Activity 3, four or five ships of different types engaged in Pacific voyages will be selected for this purpose. COSCO can provide the ships as well as manpower for this activity and one supervisor from the Harbour Superintendency Administration may be on board for data collecting and supervising purpose.

The baseline costs of Activity are estimated to be 300,000USD.

3.4.2 What is expected to be achieved and the estimation of the incremental costs

Activity 1-- Establishment of red tide warning system to mariners

Through a red tide warning message in the form of a navigation warning, ships are advised not to take up or to minimize its up take of its ballast water at the area where a red tide is reported. By so advised the captains of the ships can avoid up taking ballast water at such areas, thus reducing the possibility for the harmful blooms in the red tide to be transferred to other places and port States. While the country can benefit from the warning system by preventing the blooms being carried to other ports, it is very beneficial globally. The expected result of this activity will be an effective red tide warning system to the mariners.

The incremental costs for Activity 1 are estimated to be 200,000USD.

Activity 2-- Experiment on the chemical treatment method on board ships

The purpose of Activity 2 is to see how effective the chemical treatment is on killing the harmful organisms and pathogens in the ballast water and to find out a possible way to neutralize the excessive chlorine in the water by adding another kind of chemical with a view to eliminating the secondary pollution which may be caused by such treatment. Such method seems practicable since some fish farming industries have used this method to clean the water for raising young fishes.

The outcome of Activity 2 will be a comprehensive report and an operational procedure for such treatment and neutralization of treated water.

The incremental costs of Activity 2 are estimated to be 370,000USD.

Activity 3-- Ballast water exchange at deep sea of the Pacific Ocean

Several types of ships will be selected for carrying out this activity of ballast water exchange at deep sea of the Pacific Ocean. The purpose of this activity is to identify and analyse the impact of differerent weather and sea conditions on the effectiveness of the operation and the safety of the ship in question. So measure for solving the problems will be found out. The result of Activity 3 will be a guiding operational manual of ballast water exchange for each type of ships. An implementation officer may be sent on board ships for supervising the procedure.

The incremental costs of Activity 3 are estimated to be 350,000USD.

3.5 Proposed Co-ordinating structures

A national co-ordinating group consisting of the following seven people was proposed during the consultant's visit:

Chief of the group
Capt. Song Jiahui, Deputy Director-General of the Bureau of Harbour Superintendency of the People's Republic of China

Members of the group
Mr. Huang He, Division Director of Ships Safety and Pollution Prevention , the Bureau of Harbour Superintendency

Ms. Tang Guomei, Division chief of International Organizations, Department of Foreign Affairs, Ministry of Communications

Mr. Lao Hui, General Engineer of the Pollution Prevention Canter, the Ministry of Communications.

Mr. Jiang Yong, Deputy Director-General of Dalian Harbour Superintendency Administration

Mr. Guo Zhizhong, Chief Engineer from COSCO China.

one member from the Quarantine Authority to be decided.

3.5.1 National Focal Point (NFP)

The national focal point for the project is,

Mr. Huang He
Division Director of Ships Safety and Pollution Prevention,
the Bureau of Harbour Superintendency , the Ministry of Communications
Phone: 86 10 6529 2809
Fax: 86 10 6529 2245

3.5.2 Regional Steering Committee (RSC)

The member to the Regional Steering Committee of this project is,

Capt. Song Jiahui
Deputy Director-General
the Bureau of Harbour Superintendency
Ministry of Communications
Phone: 86 10 6529 2810
Fax: 86 10 6529 2245

3.6 Co-ordination with GEF Operational Focal Point China

The consultant visited the GEF Operational Focal Point Beijing on 25 May. Mr.Li Guanghui, the listed GEF Focal Point in the Ministry of Finiance of China has been abroad and no longer worked in the position. The present official who has taken Mr. Li's place is,

Mr. Chen Huan
Deputy Director
Department of Social Development
World Bank Department
Ministry of Finiance
Sanlihe,Beijing, China
Phone: 86 10 6855 1580
Fax: 86 10 6851 6072

Mr. Chen Huan Expressed his support for the project and explained that he would issue the letter of support for this project as soon as he received a letter of confirmation from the Ministry of communications (the Bureau of Harbour Superintendency through the Depart. of Planning of the Ministry of Communications). Now the process has been initiated. The letter of support from the GEF Operational Focal Point Beijing will be available in about 10 days.

3.7 Co-ordination with the UNDP Resident Representative Beijing

The consultant visited UNDP Beijing on the afternoon of 25 May. The present UNDP Resident Representative Beijing is,

Ms. Kerstin Leitner
UNDP Resident Representative
2 Liangmahe Nalu
Beijing 100600
China
Phone 86 10 65323731
Fax 86 10 65322567

Mr Pan Jiahua, senior Program Officer received the consultant. After hearing the introduction of the ballast water project, Mr.Pan expressed that he was very interested in the project which would benefit both to China and the world. He said that supported China to participate in the project and would be ready to cooperate in this respect.

3.8 Recommendations

Considering China is willing and ready to carry out the ballast water project with a view to implementing the IMO Guidelines, it is recommended that:

a) the co-ordination group as described in 3.5 be responsible for the implementation of the project in China,

b) the three activities proposed be considered for the project, Activity 1 be undertaken by the Environment Protection Centre of the Ministry of Communications, Activity 2 be undertaken by Dalian Harbour Superintendency Administration in cooperation with other organizations, and Activity 3 be undertaken by COSCO China,

c) on-job training courses be considered with a view to ensuring the successful implementation of the project.

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4 PART B --- INDIA

4.1 Administrative structures concerned with the implementation of IMO Guidelines

There are five Government authorities which may be involved in the implementation of IMO Guidelines.

The Directorate General of Shipping under the Ministry of Surface Transport is mainly responsible for maritime safety and prevention of pollution from ships, including Flag State control, Port State control, implementation of ISM Code and STCW Convention etc.

The Port Authority is also under the Ministry of Surface Transport. It is mainly responsible for the operation of the port, pollution control in the port area, and reception facilities for oily water and garbage fro ships.

The Ministry of Environment and Forests is responsible for funding of the environment protection activities. It does not have branches at the ports.

The Health Authority is responsible for quarantine inspections.

The Coast Guard under the Ministry of Defence is authorised to take action against any pollution detected in the coastal waters especially 5 miles beyond the land limits.

4.1.2 Cooperation among the administrative bodies involved

Since five authorities may be concerned with the implementation of IMO Guidelines for ballast water management, cooperation and co-ordination among the authorities seem to be of most importance. Lack of information exchange between the authorities and between the authorities and research organizations was observed during the consultant's first visit. The Directorate General of Shipping is responsible for developing procedures in this regard. Considering ballast water management should be focused on onboard treatment, the Directorate General of Shipping is in a position to act as the co-ordinating authority in the implementation of ballast water control and management measures, while the Port Authority, Health Authority and the Coast Guard can cooperate in the work under the scope of each responsibilities.

4.2 Legal process of implementation of IMO Guidelines

4.2.1 Preparation of national rules and regulations

The legislation of India can be described as follows,

Act

Act are the highest level of the national legislation. The proposal of an act should be formulated by a relevant government body and submitted through the cabinet to the parliament for adoption. It may take years for an act to be adopted or amended.

Rules

Rules are the second level of the country's legislation system. Rules are adopted and promulgated by the ministry or local governments for effective implementation of act. Rules should be approved by the Ministry of Law before entering into force. It needs considerable consultation and c-ordination in the process of adoption.

Executive orders

Executive orders are issued by a relevant authority for a particular issue under the legislation system for enhancement and effective implementation of act and rules.

4.2.2 Procedures related to the approval of national rules and regulations

As mentioned above, the procedures for approving an act is rather complicated. It needs debate and adoption by the parliament. It is said that the reason for India not having ratified the optional Annexes of MARPOL 73/78, as amended is mainly because of the national legal procedure concerning ratification of international instruments.

Although the procedure for approving rules is less complicated, it needs much c-ordination among the departments and authorities.

Considering the nature of implementation of IMO Guidelines for ballast water control, the best way for its implementation in the country is through an executive order issued by the Directorate General of Shipping in consultation with other relevant authorities as well as the shipping industry.

4.3 Proposed demonstration site

Mumbai has been proposed and selected as the demonstration site for this project.

4.3.1 Description of the demonstration site

The port of Mumbai has long been the major port and principal gateway of India. The port enjoys a well-protected deep water harbour of 400 square kilometres. Mumbai with a population of 900 million is a busy city with a shipping nature.

Mumbai is influenced by the north-east and south-west monsoon. From mid-May to mid-September the south-west winds is quite severe and strong gusty south-west winds are experienced.

The port of Mumbai is a fully integrated multi-purpose port, handling different kinds of cargo. In 1997 Mumbai received 2627 vessels , including 100 bulk carriers, 966 tankers, 863 container vessels, 654 general cargo vessels and 44 other ships. Most ships ballast or deballast at the port or in its coastal waters.

Fishing activities are also of great importance to the city. In Mumbai studies on the organisms and pathogens from the city sewage have been carried our for 8 years supported by the government. Such studies are focused on the control of the pollution caused by the city-generated waste water.

4.3.2 Reasons for the selection of Mumbai as the demonstration site

Mumbai has been selected as the demonstration site mainly for the following reasons:

a) Mumbai is a city with a long shipping history. Shipping industry is of the greatest importance to the development of city. Actually the city is called "the capital of shipping". Port of Mumbai is visited by a big number of ships including oil tankers and bulk carriers.

b) the studies on the introduction of the alien mussel Mytilopsis Sallei was carried out in 1970s in Mumbai by the research organizations.

Directorate General of Shipping Mumbai is in a strong position to carry out c-ordination work among the authorities and organizations concerned.

4.3.3 Specific treatment methods and activities for ballast water considered

Three activities are proposed to be implemented in India under this project.

Activity 1 --- Creation of infrastructure for ballast water and harbour water assessment

Activity 1 is proposed on the consideration that there has been no basic biological data available with reference to the harmful aquatic organisms and pathogens in the ballast water. A detailed bio-systematic study is imminent with a view to identifying the harmful aquatic organisms and pathogens in ballast water as well as in the harbour water of Mumbai. Such assessment is proposed to be carried out by analysing water samples against the selected harmful species according to ED Goldberg (1995) which listed about 20 harmful species identified, including dinoflagellata, cnidaria, ctenophora, annelida, crustancea, mollusea, ectoprocta pisces, scyphozoa, hydrozoa, oligochaeta, etc.

Activity 2 --- Monitoring of the identified alien mytilopsis sallei in Mumbai

Mytilopsis sallei, a kind of mussel, was first identified as an invader to Indian waters in 1970s. The scientists believed that mytilopsis sallei had been introduced to Vishakhapatnam and Mumbai by ships from North America waters. Mytilopsis sallei has well settled in the ports along the Indian coast through the years. Some of the coastal industries are facing maintenance problems due to the fouling effects of the mussels especially in cooling water systems of plants. Since no further study on the Mytilopsis sallei has been conducted since late 1970s, the proposed Activity 2 will be carried out through field monitoring and computer analysis of the present status of the mussels in question.

Activity 3--- Exchange of ballast water at Arabian Sea

Exchange of ballast water at deep sea is considered one of the most effective methods to minimize the introduction of harmful aquatic organisms and pathogens by ships' ballast water. The proposed Activity 3 is intended to supplement the action as per IACS report and the working group report submitted to the 40th MEPC session. Activity 3 is proposed to be implemented by selecting several ships engaged in the Arabian Sea voyages to conduct ballast water exchange by applying the safety measures as indicated by IACS.Activity 3 may be undertaken by the Indian Register of Shipping along with two Indian shipowner, M/S Great Eastern Shipping and the Shipping Cooperation of India.

4.4 Description of the activities and estimation of the costs

4.4.1Previous activities related to ballast water transfer, use of the existing facilities, manpower surveys and the estimation of the baseline costs

Activity 1 --- Creation of infrastructure for ballast water and harbour water assessment

No activities were conducted in this regard previously. However Activity 1 can be implemented by the Regional Canter of the National Institute of Oceanography (represented by

Dr. K. Govindan). The existing resources, including the well-equipped laboratories, and technical personnel can be used for this purpose.

The estimated baseline costs are estimated to be 600,000USD.

Activity 2 --- Monitoring of the identified alien mytilopsis sallei in Mumbai

Field and laboratory investigations were conducted in 1970s on mytilopsis sallei with a view to ascertaining its breading pattern and its tolerance limits for salinity and temperature in coastal waters. Some results of such studies have been published. Through the study people have know that mytilopsis sallei settled in abundance only in harbours. The results of the previous studies can be used as the basis for further monitoring of the mussels. The proposed Activity 2 can be implemented by the Naval Materials Research Laboratory under the Defence Research and Development Organization (represented by Dr. S.N. Gaonkai). The manpower and equipment of the laboratory can be used for carrying our this activity.

The baseline costs of the proposed Activity 2 are estimated to be 150,000USD.

Activity 3--- Exchange of ballast water at Arabian Sea

Ballast tank cleaning has been conducted on a tank by tank basis for years by many Indian vessels. The reason for such practice is that the captains of the ships feared that the mud and sediments mixed with the ballast water would soon settled at the bottom of the tanks. Many ships have such experience. The ships for carrying out Activity 3 as well as manpower needed can be provided by the above-mentioned shipping companies.

The baseline costs for Activity 3 are estimated to be 300,000USD.

4.4.2 What is expected to be achieved and the estimation of the incremental costs

Activity 1 --- Creation of infrastructure for ballast water and harbour water assessment

The objective of Activity 1 is to identify the harmful aquatic organisms and pathogens in ships' ballast water and in the harbour water by analysing the water samples against the list as mentioned in 4.4.

The output of Activity 1 should be a comprehensive report on the findings of the study, showing what harmful aquatic organisms and pathogens are identified in Mumbai. Such findings will help the port as well as the ships using it to take action as appropriate concerning ballast water management.

The incremental costs for Activity 1 are estimated to be 400,000USD.

Activity 2 --- Monitoring of the identified alien mytilopsis sallei in Mumbai

The objective of Activity 2 is to ascertain ,through study and monitoring, the present status of mytilopsis sallei after 20 years of its settlement and its fouling impact on the environment and underwater structures.

The output of Activity 2 will be a comprehensive report on the monitoring and findings thereof, which will justify any action to be taken in the future.

The incremental costs for Activity 2 are estimated to be 200,000USD.

Activity 3--- Exchange of ballast water at Arabian Sea

The objective of Activity 3 is to evaluate the safety aspects in relation to ballast water exchange by applying IACS standards and find out additional safety measures to be followed for different type of ships.

The output of Activity 3 will be a comprehensive report on the experiments and possibly some operational measures relating to ships safety.

The incremental costs for Activity 3 are estimated to be 300,000USD.

4.5 Proposed c-ordinating structures

Since several authorities may be concerned with the implementation of the IMO Guidelines, a national c-ordination group seems necessary for an effective implementation of the Guidelines.

4.5.1 National Focal Point (NFP)

It is proposed that,

Mr. K. A. Simon
Engineer & Ship Surveyor
Directorate General of Shipping
"Jahaz Bhavan" W.H. Marg
Mumbai 400038, India
Phone: 91 22 2613651 Extn 414
Fax: 91 22 261 3655

will serve as the National Focal Point (NFP) India for this project.

4.5.2 Regional Steering Committee (RSC)

It is proposed that,
Mr. B.K. Biswas
Chief Surveyor with Government of India
Directorate General of Shipping
"Jahaz Bhavan" W.H. Marg
Mumbai 400038, India
Phone: 91 22 261 1788
Fax: 91 22 261 3655

will serve as the member to the Regional Steering Committee.

Mr. B.K. Biswas has taken the place of Mr. S.M. Mukherjee who had retired a month before as the chief surveyor with the government of India. Mr. Biswas will be in such position in Mumbai for at least four years.

4.6 Co-ordination with GEF Operational Focal Point New Delhi India

Mr. D.N. Narasimha Raju, Deputy Secretary, Ministry of Finiance India, who served as the GEF Operational Focal Point has been transferred to another department. The present GEF Operational Focal Point is:

Mr. Abhas Kumar Jha
Under Secretary
Department of Economic Affairs
Ministry of Finiance
New Delhi 110001
India
Phone: 91 11 3015 936
Fax: 91 11 3012477
91 11 3015024
e-mail abhas@finance.delhi.nic.in

With the help and arranged by UNDP New Delhi , the consultant visited the GEF Operational Focal Point New Delhi.. Upon hearing the introduction of the ballast water project, Mr. Abhas Kumar Jha expressed his interest and explained that the letter of support could be issued by his focal point provided that the project was confirmed by the Ministry of Surface Transport through the Ministry of Environment and Forests.

With the help of UNDP NEW New Delhi, the consultant then visited Mr. Ujhwal Choudary, Director of Dept. of International Cooperation, the Ministry of Environment and Forests, India, who has been in charge of the environment projects in India. Mr. Ujhwal Choudary expressed that he would consult with the Ministry of Surface Transport and the Department of Ocean Development (another Government established organization) for technical advices and then he could be in a position to confirm the project to the GEF Operational Focal Point. Such consultation might take 4 weeks.

Considering the Directorate General of Shipping should be the right body to initiate and push forward such process, the consultant, when in Mumbai, requested and urged the Chief Surveyor of Directorate General of Shipping Mumbai to send a letter along with the necessary information to the above-mentioned authorities to enable GEF Operational Focal Point to issue the letter of support for this project.The Chief Surveyor said he would report this matter to the Director General to take action as necessary.

4.7 Co-ordination with UNDP Resident Representative New Delhi, India

The consultant visited UNDP Resident Representative New Delhi, India on the morning of 1 June 1998. Mr. M. Lal, Program Officer received the consultant and introduce him to Dr. Pradeep Monga, GEF Co-ordinator of UNDP India. After the consultant's introduction of the ballast water project, Mr. Monga expressed his interest and support for this project. He then kindly appointed Mr. Sudarshan Rodriguez, GEF Consultant of UNDP to help arrange the meetings with the GEF Operational Focal Point in the Ministry of Finance and then with the Ministry of Environment and Forests as mentioned in 4.6. The consultant thanked the UNDP Resident Representative New Delhi,India for their help. Without their assistance, it would have been impossible for the consultant to carry out his mission successfully in New Delhi.

4.8 Recommendations

Considering the Directorate General of Shipping has confirmed their willingness to participate in the ballast water project and the three proposed activities, it is recommended that,

a) a national c-ordination group be established in Mumbai with Directorate General of Shipping as the c-ordinator for the effective implementation of the project,

b) Directorate General of Shipping initiate and push forward the process as mentioned in 5.6 to enable the GEF Operational Focal Point in the Ministry if Finance India to issue the letter of support for this project,

c) the three activities proposed for this project be considered, and

d) a 2-day seminar be convened for awareness of the ballast water issue.

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ANNEX 1---- TERMS OF REFERENCE OF THE CONSULTANT

PROJECT TITLE: REMOVAL OF BARRIERS TO THE EFFECTIVE IMPLEMENTATION OF BALLAST WATER CONTROL AND MANAGEMENT MEASURES IN DEVELOPING COUNTRIES

PROJECT NO: T011-GLO/97/G4/A/1G/19

Background

One of the main objectives of this project is to collect background material for the preparation of a full-scale project document to be submitted to the GEF Council in October 1998. In order to collect such material, a mission was undertaken in early 1998 to Bahrain, Brazil, China, India, Poland and South Africa. This is a follow up to that mission.

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Acting upon the instructions of the Secretary-General of IMO or other officials acting on his behalf, the consultant shall, during a period of three weeks between April and June 1998, carry out the following tasks:

- travel to China and India to hold discussions with government officials and other parties interested in harmful aquatic organisms carried in ballast water, including maritime, port and health authorities and the shipping industry;
- confirm their willingness to implement the IMO guidelines for control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens;
- confirm their willingness to: a) select a specific port as demonstration site; and b) select a national focal point (NEP) and a steering committee including representatives from the region;
- confirm their willingness to carry out, or take part in, specific treatment methods for ballast water;
- define demonstration activities in terms of objectives, outputs and activities and inputs with a costing for each item:
  - include consideration of special modalities like manpower surveys, twining with developed countries, use of existing facilities, links to existing projects (east Asian Seas, Black Sea) where appropriate;
  - clearly distinguish between the cost of baseline operations (what is being done now) and incremental costs and benefits (what will be done additionally) using inputs from government, private sector and GEF/UNDP/IMO;
  - consultant should be familiar with GEF incremental cost procedures;
- consult with UNDP Resident Representative, GEF operational focal points and others to obtain a letter from the GEF operational point to the UNDP Resident Representative with a copy to the GEF Secretariat (Mr. Al Duda) and UNDP Headquarters (Mr. P. Reynolds) in support of the project;

- keep careful records of the names, titles, organizations, telephone/fax numbers and E-mail addresses of all persons contacted;

- carry out other relevant duties falling within the scope of his competence;

- visit IMO for a two-day debriefing session;
  - submit a report in hard copy and on diskette to IMO by 1 June 1998.

ANNEX 2 THE ITINERARY SCHEDULE OF MEETINGS AND THE LIST OF PERSONS MET BY THE CONSULTANT

THE ITINERARY AND SCHEDULE OF MEETINGS

25 - 27 May 1998	meet with GEF Operational Focal Point Beijing China the Ministry of Finance,Beijing,China
	meet with UNDP Resident Representative Beijing, China
	meeting with the Bureau of Harbour Superintendency and other relevent authorities and organizations
27 May 1998	depart Beijing and arrive in Dalian
28-29 May 1998	meet with Dalian Harbour Superintendency Administration and other relevant authorities and research organizations
30 May 1998	depart Dalian and arrive in Beijing
31 May 1998	Depart Beijing and arrive in New Delhi India
1-2 June	meet with UNDP Resident Representative New Delhi India meet with GEF Operational Focal Point, the Ministry of Finance, India
	meet with the Ministry of Environment and Forests, India
2 June 1998	depart New Delhi and arrive in Mumbai India
3-6 June 1998	meet with the Directorate General of Shipping and other relevant authorities and organizations
7 June 1998	depart New Delhi and arrive in London U.K.
8-9 June 1998	debriefing in IMO
10 June 1998	Depart London
11 June 1998	Arrive in Bejing, China

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LIST OF PERSONS MET BY THE CONSULTANT

BEIJING CHINA

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SENIOR PROGRAM OFFICER, UNDP,BEIJING
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FAX: 91 22 4950356

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M I S S I O N   R E P O R T

on the

Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries

(5 - 16 July 1998)

Project Title :	Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries
Requested by :	United Nations Development Programme
Countries of Assignment :	Ukraine and Islamic Republic of Iran
Duration :	5 - 16 July 1998
Founded by :	Global Environment Facility through United Nations Development Programme
Executing Agency :	International Maritime Organisation (IMO)
NOTE :	The views expressed in this report are those of the author and are not attributable in any way to the United Nations or the International Maritime Organisation.

Signature .... Date: 20 July 1998

Dandu C. PUGHIUC
IMO Consultant

ACKNOWLEDGEMENTS

The consultant wishes to express his appreciation to all persons who helped him in his task of gathering the information necessary for the compilation of this report.

In particular, he would like to thank Mr. Manfred Nauke, Chief, Office for the London Convention 1972, Marine Environment Division, IMO, Mr. Henning Brathaug, Implementation Officer, Marine Environment Division. Mr. Philip Reynolds, Senior Programme Adviser, Sustainable Energy and Environment Division, UNDP, Mr. Vladimir Robotniov, Head of Ecological Division, State Department of Maritime and Inland Waters Transport, Odessa, Ukraine, Mr. Sergey Limanchuk, Chief Expert, Southern Institute of Merchant Marine, Odessa, Ukraine, Prof. Yuvenaly Zaitsev, Doctor of Biological Sciences, full member of the National Academy of Sciences of Ukraine, Mr. Mohammad Reza Ghaderi, Director General, Maritime Affairs, Ports & Shipping Organisation, Ministry of Roads and Transportation, Teheran, Islamic Republic of Iran for their kindness, hospitality and co-operation.

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BACKGROUND

It is assumed that shipping moves 80% of the world commodities and is fundamental to international trade. Ships have sailed across the ocean for centuries, since the introduction of steel hulled vessels the solid ballast was replaced by water. During the last hundred years the ballast water transfers have increased considerably throughout the world and the probability of successful establishment of populations of non-indigenous species through ships ballast increased with great volumes of ballast water as well as with reduced ship travel times.

It has been estimated that the world fleet is transferring 10 billion tons of ballast water per year; the water may originate from eutrophicated coastal areas containing hundreds of species which may survive voyages of several months duration. It has been demonstrated that in average 3,000 to 4,000 species are transported daily by ships. The alien species may threaten native populations, fishing industries, aquaculture and public health. The likelihood of an introduced species to adapt in new regions and to create problems depends on a number of factors, primarily related to the biological characteristics of the species and to the new environmental conditions. If the port of origin and the port of destination are ecologically compatible the risk of alien species introduction is relatively high.

The potentially adverse effects of such introductions were illustrated by the discovery in the 1980s of the fouling European Zebra mussel (Dreisseria Polymorpha) in the Great Lakes, a toxic Japanese dinoflagellate in Australia and a carnivorous North American comb jellyfish (Mnemiopsis Leidyi) in the Black Sea. These three introductions alone have cost many millions of dollars in remedial action, had deep and detrimental ecological repercussions and have focused government, public and scientific attention on the role of shipping as a dispersal vector for non-indigenous aquatic organisms.

Action to control unwanted introductions is being considered by several individual states and in the international arena under the auspices of the International Maritime Organisation (IMO). Following the continuously increasing concern of the international community regarding the problem of ballast water containing harmful life forms transfers and in response to the request of the 1992 United Nations Conference on Environment and Development (UNCED), IMO submitted through UNDP to the Global Environment Facility a proposal for a grant. The purpose of the grant was to establish a project to assist developing countries in their efforts to implement national regulations regarding the management and control of ballast water. The proposal was agreed and under the project "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" two fact finding missions were organised by IMO in co-operation with focal points and UNDP Resident Representatives from Brazil, Poland, South Africa, Bahrain, India and China. The missions took place from 18 January to 8 March 1998

As a follow-up of this mission a new one was also organised by IMO in co-operation with focal points and UNDP Resident Representatives from Brazil and South Africa. The follow-up mission took place from 23 May to 9 June 1998.

The last part of the project consisted in a mission organised by IMO in co-operation with focal points and UNDP Resident Representatives from Ukraine and Islamic Republic of Iran. This mission took place from 5 to 16 July 1998.

The terms of reference for the last mission are attached as Annex 1. In Annex 2 details of the itinerary and schedule of meetings are provided.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The main objective of the present "Project Preparation and Development Facility" is to provide background material for the preparation of a full-scale project document regarding the ballast water transfers, to be submitted to the Global Environment Facility (GEF) Council in October 1998.

The last two countries considered for the establishment of pilot demonstration sites for further studies reported significant quantities of ballast water discharges in their ports and territorial waters, are located in extremely sensitive environmental areas (Black Sea and The Gulf) and have substantial scientific resources. In addition a genuine intention to observe and implement the IMO Guidelines regarding the ballast waters transfers has been expressed during the visit.

A series of barriers to the efficient implementation of the ballast water management and control were identified through extensive discussions with relevant officials and other stakeholders. Although the ballast water management and control is not seen as an immediate priority, the involved authorities in the visited countries manifest a certain degree of concern for the matter. As a common feature of the two countries an almost total lack of regulations regarding the ballast water discharges were identified. The few existing provisions mainly relate to safety of ports and specific health restrictions. While national regulations are strictly implemented for oily water pollution prevention, ballast waters which does not contain oil is freely discharged into the harbours and coastal waters. Even so, the respective maritime authorities expressed their intention to introduce appropriate rules inspired from IMO Guidelines for vessels under their flag. In particular the recommended "Ballast Waters Reporting Form" and the record maintaining requirements are considered for implementation in the near future.

Although significant scientific resources are available for the analysis of the phenomena occurring from the ballast waters transfers, poor support exists for scientific sampling of the discharges. The samples, when taken, are at random from the surface of the tanks and the analysis facilities are in some cases situated within the Universities far from the port areas. The eventual investigations are, therefore, delayed and in most cases a prompt decision is not possible.

Particular concern is expressed for the threat posed by pathogen factors introduced through ballast waters and much deeper involvement of the Health Authorities is claimed in this respect. The adoption by IMO of appropriate legally binding rules on ballast water discharges is considered of crucial importance for the initiation of national mandatory regulations. Nevertheless, the continuation of the current projects is seen as a prerequisite for future successful implementation.

In both visited countries, the willingness to select a specific port as demonstration site was not only confirmed by the relevant authorities, but concrete steps have been made towards the official nomination of the sites during the visit. The appointment of the National Focal Points (NFP) and the institutionalisation of the Steering Committees were also treated as immediate priorities. The extension of the characters of the Steering Committees were also treated as immediate priorities. The extension of the character of the Steering Committees by inviting countries from the region at its proceedings was positively considered as a next stage of development. The possibility of twining with developed countries in the future activities raised the interest of the national authorities and preliminary bilateral discussions in this respect are supposed to be initiated by the appropriate factors. A rough evaluation of the base line operation costs has been made together with the relevant authorities and an estimation of what is envisaged for the future resulted from the discussions.

Favourable attitudes with regard to the ballast waters issue were noticed during the consultation with GEF Focal Points and UNDP Resident Representatives. All these organisations expressed their support for the future project and a series of valuable suggestions were put forward for the future developments.

In the visited countries the increased support from the international community was perceived as particularly important for the continuation of the current researches and for the successful implementation of IMO Guidelines for control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens.

A more extensive presentation of the particular situations existing in the two countries will be made in the following chapters of this report.

2. IMO GUIDELINES FOR CONTROL AND MANAGEMENT OF SHIPS' BALLAST WATER TO MINIMISE THE TRANSFER OF HARMFUL AQUATIC ORGANISMS AND PATHOGENS

2.1 Review of the previous stages related to ballast water transfers

The 1993 ballast water procedures adopted by IMO through Resolution A. 774 (18) heavily based on the exchange of ballast water at sea. Nevertheless, during the last four years, a large number of chemical and physical treatment methods have been investigated, most of them being found too expensive and at times environmentally unacceptable. Since the ballast water exchange at sea is broadly accepted as the most cost-effective and environmentally sound prevention strategy currently available, MEPC agreed that a new IMO Assembly Resolution should be prepared for adoption in 1997. The new set of guidelines adopted by IMO as Resolution A. 868 (20) bridges the time period needed until legally binding provisions and regulations will enter into force and provides additional guidance on ballast water management on board ships and on control procedures to be applied to port state authorities.

2.2 Brief Introduction of Ballast Water Guidelines (IMO Resolution A.868(20))

The Ballast Water Guidelines contain management tools to minimise the risks of introducing harmful aquatic organisms and pathogens via ballast water discharges. Different countries and organisations around the world are currently considering a series of risk minimisation methods. Most of them depend upon : the type of target organisms, level of risks involved, environmental acceptability, economic and ecological risks.

The Guidelines can apply to all ships but Port State Authorities have the liberty to exempt ships in the area under their jurisdiction from the provisions of the above Guidelines. It is particularly important that Member States follow the Guidelines when developing national legislation and procedures and take the necessary measures to implement the Guidelines in a standard and uniform manner.

For the global benefit of the international community Member States should provide IMO with information on outbreaks or infestations which may pose a risk for the intake of ballast water, on the specific national laws and regulations, R&D information and educational materials.

The Flag States are supposed to request each ship under their jurisdiction to prepare a "Ballast Water Management Plan" based on the Guidelines and particular importance should be given to the required records. Masters should be instructed to report to Port States Authorities any failure to apply the requirement of the "Ballast Water Management Plan".

At their turn the Port States should be ready to provide ships with details of ballast water management requirements, location and terms of use of alternative exchange zone for ballast water, availability, location, capacities of and applicable fees for the reception facilities.

It is crucial for the successful implementation of these Guidelines that no action, which imperils the lives of seafarers or the safety of the ships, should be required by the Port States. For this reason, particular guidance on safety aspects of ballast water exchange at sea has been provided by the Guidelines and one of the main aspects refers at the necessity of new training and familiarisation methods and nomination of shipboard responsible personnel.

The Guidelines have been published and disseminated through the Member States in the form of a booklet early this year.

3. PART A - UKRAINE

3.1 GENERAL INFORMATION

3.1.1 Historic Note

Ukraine proclaimed its independence in 1990 after the disintegration of the Soviet Union, but its history goes back through the centuries to the ancient times. The main port of the country counts its history from 2 September 1794 when the first piles were rammed in the coastal strip as a follow-up of the order signed at 27 May 1794 by Empress Catherine II to build a military harbour and merchant berths near the fortress of Khadjibey. Convenient geographical situation, the links with the raw sources in Russia, external trading between East and West exerted favourable influence upon the quick growing and development of the port. During World War II the port was considerably demolished, but thanks to the efforts of the port workers and Odessa inhabitants it began functioning and was restored in a relatively short period of time.

3.1.2 Location

Ukraine is located in the South-Eastern part of the European continent and it is bordered on the East by Russia, on the North by Belorussia, on the West by Poland, Slovakia and Hungary and on the South West by Romania and Moldova. The Southern boundary is the Black Sea with a coast line of 1628 km and the Sea of Azov with a coast line of 1107 km. The total length of Ukraine border is 6500 km. The country has a total area of 603,700 sq. km, the capital city is Kiev and the largest cities are Harkov, Lwow and Odessa.

The location on the Black Sea and the Sea of Azov coasts gave Ukraine an opportunity to develop its maritime sector. There are 24 ports for commercial activities and fishing on the coast line and on the rivers Danube and Dnipro. Odessa, Ilyichevsk, Yuzhny, Nicolaev, Cherson, Izmail and Marinpol are considered the largest ones.

3.1.3 Population

The population of Ukraine (1990 estimates) is about 51,700,000 giving the country an overall population density of about 86 persons per sq. km. According to the Geographical Encyclopaedia of Ukraine of 1993, 68% of the population is urban, living in 436 towns.

The official language is Ukrainian but a large majority of the population speaks Russian as well.

3.1.4 Meteorological and Oceanographic Data

Situated between 22^0 08' E and 40^0 05' E longitude and from 44^0 22' N to 52^0 18' N latitude, Ukraine enjoys a continental temperature climate. Average temperature in January is from 2^0 C to 4^0 C in Southern Crimea and from -7^0 C to -8^0 C in NE part. In July, the temperature ranges between 22^0 C - 23^0 C in Southern parts and 17^0 C - 18^0 C in the NW area. The precipitation vary from 300 - 500 mm/year in coastal zones to 1200 - 1500 mm/year in mountain areas. The country enjoys a large hydrographic network with 4160 rivers out of which 160 are more than 100 km length. The largest rivers are the Danube, Dnipro, Dnister and Southern Bug.

Some 50 - 60 million years ago, before the beginning of the Tertiary Period, a vast oceanic basin extended from West to East across Southern Europe and Central Asia, linking the Atlantic and the Pacific Oceans. It was the salty Tethys Sea. By the middle of the Tertiary Period, as a result of the crust upheavals, the Tethys Sea had become separated first from the Pacific and later from the Atlantic Ocean. Major crust movements led to mountain building in the Miocene (7 million years ago) and the formation of the Alps, the Carpathians, the Balkan and the Caucasus mountains. As a result of theTethys Sea shrunk in size and became divided into a number of brackish basins. One of them, the Sarmatic Sea stretched from the present location of Vienna to the foothills of the Tien Shan Mountains and included the modern Black Sea, Sea of Azov, Caspian Sea and the Aral Sea. The Sarmatic Sea was separated from the ocean, and gradually its salinity fell as a result of the inflow from rivers. Only 7.000 years ago the present connection to the Mediterranean Sea and the World Ocean was established through the Bosphorus and the Dardanelles. A gradual salinisation of the Black Sea followed and today about 80 per cent of the fauna are Mediterranean settlers. The surface area of the Black Sea is 423,000 sq. km. It contains a total volume of 547,000 cubic km. of water and has a maximum depth of 2,212 m. The Black Sea shore line is about 4340 km long. The average salinity of the open Black Sea is 17 - 18 per thousand at surface and 22 - 24 per thousand at a depth of 2000 m. Coarse detrital deposits, including pebbles, gravel and sand, dominate the coastal zone. Further from the shore they are quickly replaced by fine silt. Shell limestone is widely spread in the North-Western part of the sea. Pelitic muds are characteristic of the slope and seafloor.

Widely considered as the most damaged sea on our planet, the Black Sea should serve as an example to future generations of mankind's ability to understand, save and protect an internationally shared resource.

3.2 SHIPPING TRAFFIC IN THE PORTS OF ODESSA AND ILYICHEVSK.

3.2.1 Ports description

Odessa Sea Port is actually one of the largest ports in the Black Sea. Its location on historically founded merchant ways between West and East, closeness to Bosphorus and Dardanelles, convenient exit to Mediterranean Sea and Indian Ocean, round-the-year navigation in the port, closeness to the big industrial and agricultural areas of the region are particularly attractive characteristics of the port.

The port includes seven facilities for handling dry-cargoes, the passenger area, the Oil Harbour and the container handling facility. Port's capacities may handle up to 14 million tons of dry-cargoes and about 24 million tons of oil products. Port passenger area may receive up to 4 million passengers per year. Entering leaving and shifting of vessels is round-the-clock and assisted by pilot service whose technical facilities allow manoeuvring in poor visibility. Safe navigation of the ships is provided by traffic station modernly equipped. The cargo may be delivered to and forwarded from the port by railway, roads or river transport. The port disposes of gantry, forklifts, cranes, floating cranes, container gantry from 5 to 100 tons hoisting capacity. A floating cereal discharger is also operational. On the open areas and in the storehouses of the port any cargo may be stored excepting ecologically harmful, poisonous and explosive ones. The open storage area is 215 400 sq. m, warehouses area 78 800 sq. m and the storehouse for perishable cargoes may accommodate up to 13 500 tons at a storage temperature from 8^0 C up to -30^0 C. The port silo may store up to 60 000 tons of cereals.

A list of handled cargoes may include: non-ferrous and ferrous metals, equipment, vehicles, chemical fertilisers (packed or in bulk), citrus fruits, bananas and other cargoes packed in bags, boxes, big bags, barrels and containers.

The port of Ilyichevsk is considered among the largest ports of Ukraine. The port complex also includes the largest ship repair yard, a fishing port, the sea fishery company and the largest port dependant railway station. The port is relatively new, in the mid fifties the freight traffic going via Odessa increased so sharply that the productive capacity could not cope. It was decided to construct another port not far from Odessa on the banks of the Sukhoi Liman. The first 336 metres of berth were put into operation in 1958, and the first six gantry cranes were installed. At present, the berth area extends for 5.2 kilometres. The port includes four cargo handling zones: Ilyichevsk-Varna railway ferry complex, 28 berths, specialised cargo-transfer complexes and a container terminal. Container repair workshops are available in the port. In its best years, the port handled up to 19 million tons of general cargo. After the completion of the second phase of construction, the container terminal will reach the capacity of 300.00 TEU. A grain elevator-reloader complex was built during the last period. The complex includes 12 metal silos, 30 metres high and 18 metres in diameter for grain storage. The capacity of each silo is 5,000 tons and the capacity of the terminal in its first phase is projected to be 1,2 million tons of grain a year. The final capacity of the complex will be 2.5 million tons a year with the silo capacity of 120,000 tons. The berths are deep enough to handle 50,000 dwt vessels. The building of a complex for potassium chloride transhipment is being completed in Ilyichevsk with an annual capacity of 2 million tons. There is to be built a factory for manufacturing store-house complexes for grain in the port and a facility for processing sun-flower seeds into vegetable oil is also being designed. The storage capacity for general cargo is 60.000 sq. m in warehouses and 743,900 sq. m in open platforms. The lifting equipment varies from portal cranes of 5 - 40 tons up to floating cranes of 300 tons.

A list of commodities handled through the port of Ilyichevsk may include: rubber, jute, tea, cork, parquet, coconut, castor and mulberry oil, cotton, equipment, pipes, metal products, coal, superphosphats and potassium chloride.

3.2.2 Number and type of vessels visiting the ports

Cargo handling in the Ukrainian sea ports in 1997 increased with 12.2% in comparison with the previous year and with 22% in the first quarter of 1998 in comparison with the same period of 1997. The capabilities of the country's sea ports at present are employed less than by halves. Ukraine has 18 sea commercial ports and 12 berth points where about 120 million tones of cargoes were handled in 1990, while only 57,5 million tones in 1997.

Table 3.1: Cargo handling in Ukrainian ports in 1997
(oil transhipment excluded)

Port name	Total	Exports	Imports	Transit	Cabotage
Berdiansh	871.4	649.8	2.0	219.6	-
Belgorod-Dnestrovsky	301.3	221.4	3.0	15.9	61
Kerch	958.5	463.5	82.6	411.3	1.0
Mariupol	6447.2	3122.3	195.9	3098.3	30.7
Nikolayev	1890.7	711.7	137.5	1034	7.5
Odessa	6383.9	3732.8	325.7	2325.2	0.2
Reni	2085.4	1143.4	85.8	842.5	13.7
Sevastopol	157.3	45.6	-	-	111.7
Skadovsk	109.9	19.1	15.0	23.3	52.5
Oktyabrsk	472.0	348.0	6.2	116.9	0.9
Ust-Dunaisk	567.5	164.0	95.3	298.6	9.6
Theodosia	414.1	398.4	4.6	10.0	1.1
Kherson	1994.0	587.4	10.0	966.5	430.1
Juzhny	5105.2	3644.3	-	1332.5	128.4
Yalta	89.6	-	-	-	89.6
Yevpatoria	785.0	14.0	27.1	39.4	704.5
Izmail	4118.4	3468.2	27.9	614.9	7.4
Ilyichevsk	9149.1	5771.2	1032.6	2094.9	250.4
TOTAL	**41,900.5**	**24505.1**	**2051.2**	**13443.8**	**1900.4**

Thousand tons

Table 3.1 illustrates the break-down of the types of cargoes handled through all the Ukrainian commercial ports. The statistics clearly show that ports of Odessa and Ilyichevsk are the most representative for exports. According to the information provided by the State Department for Merchant Marine and River Transport the main exports through ports of Odessa and Ilyichevsk are metal products, oil and oil products and fertilisers.

Table 3.2 shows the structure of some cargoes in the Ukrainian ports which may be considered relevant for the purpose of the ballast water discharges.

Table 3.2: Export, import and transit of some cargoes in the Ukrainian Ports in 1997

Cargo	Total	Export	Import	Transit
Oil and oil products	15,896.7	1,100.2	896.2	13 900.3
Metal	17,007.0	13728.8	74.3	3203.9
Fertilisers	7 760.3	3330.9	35.2	4394.2

Thousand tons

Completely accurate figures regarding the number and type of vessels visiting the ports of Odessa and Ilyichevsk were not available but from the above statistics appears that the main exports of the country are metals and fertilisers. It may be concluded that the most significant number of bulk-carriers and cargo-vessels are operated in Odessa and Ilyichevsk. The fact that port of Odessa handles the main part of the oil and oil products, having the largest terminal of the country, might be considered as an additional reason for selecting Odessa as the most representative demonstration site for the purpose of ballast water management and control measures.

3.2.3 Estimated amount of ballast water discharged and main areas of origin

No consolidated information about the quantities of ballast water discharged could be gathered during the short visit in Odessa. However, based on the statistics regarding the cargo quantities handled through the port some preliminary estimations can be made.

Starting from the assumption that the total quantity exported equals the lump sum dead-weight capacity of the vessels calling Ukrainian ports in 1997 and that the capacity of the ballast tanks of a bulk carrier represents around 30% of the dead-weight capacity it may be estimated according to the figures in table 3.1 that some 7.350.000 tons of ballast water were discharged in all the commercial ports. Given the particular sensitivity of the Black Sea this quantity should be a matter of concern for the relevant authorities.

From the analysis of the exports through the port of Odessa and based on the fact that more than 14,400,000 tons of oil and oil products were transited through Odessa oil terminal, it can be concluded that a total quantity of 5.489,000 tons of ballast water have been discharged into this area.

From the discussions with various authorities and organisations resulted that a significant part of the Ukrainian traffic is oriented towards Europe (14%), China (6%) and the largest part represents the exchanges and transit with CIS countries (42%). It may be therefore assumed that the largest amounts of ballast water discharged may originate from Europe and Far East.

3.3 ADMINISTRATIVE STRUCTURES CONCERNED WITH THE IMPLEMENTATION OF IMO GUIDELINES ON BALLAST WATER

3.3.1 Description of the main administrative bodies interested in the implementation of ballast water guidelines

The Ministry of Transportation is the highest regulatory body for shipping in Ukraine. It performs its duties through the State Department of Marine and River Transports (SDMRT) led by one of the deputies of the minister of transportation. The State Department plays the role of the Maritime Administration of Ukraine and acts as the administrator of IMO Conventions and other international legal instruments.

Accordingly all the regulations and other legal instruments relating to shipping should be initiated and followed by the State Department of Marine and River Transport which also ensures the liaison with IMO. One of the main attributions of the State Department in its regulatory function is to co-ordinate the activity of the ports Harbour Masters and to perform through their Offices the prerogatives of the Port State Control. By virtue of its constitutional attributions and its competencies given by the Transportation Law of 1994 (No 232/94 -BP) the Ministry of

Transportation through its State Department is responsible for studying and proposing directives for the national maritime policy, development of the ports, shipping companies and shipyards and for the development of safety and marine pollution from ships regulations. Figure 3.1 gives the structure of the Ministry of Transportation and the organisational chart of the State Department of Marine and River Transports.

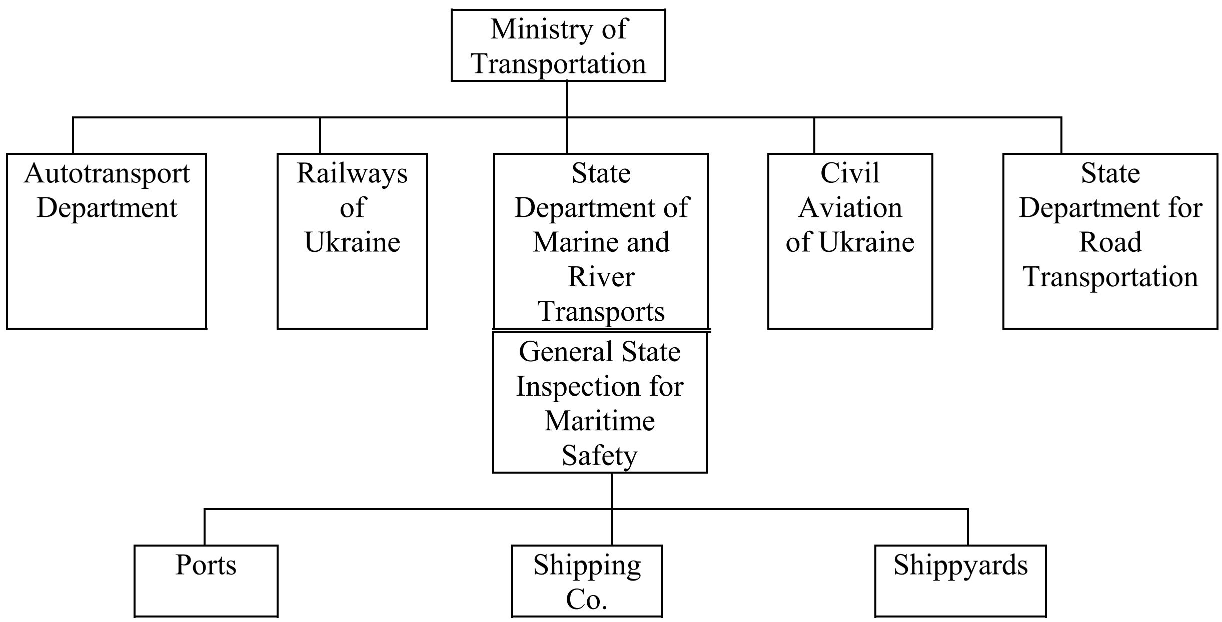

Figure 3.1: Organisational Chart of the Ministry of Transportation

The intention of the relevant authorities is to incorporate the State Inspection for River Transports which for the moment is separated into the structure of the State Department. The Maritime Administration in Ukraine is currently crossing a period of transformation which is expected to improve its efficiency in discharging the main duties according to the Transportation Law and other relevant rules and regulations.

The Ministry of Environmental Protection and Nuclear Safety is the Governmental body in charge with the national policies relating to the environment protection. The headquarters of this organisation are located in the capital city Kiev. The Ministry performs its duties, under the Law of Environment Protection of 1991 (No.1264-XII), through 25 Regional Ecological Divisions around the country. The particular tasks related to marine environment are discharged through the State Inspections for the Protection of the Black Sea and Sea of Azov subordinated by General Ecological Inspection. Offices of those State Inspections are established in all the commercial ports. The main responsibilities of the Ministry include the planning, co-ordination, supervision and control of the national environmental policy and the preservation and conservation and sustainable use of renewable natural resources. Although the attributions of the Ministry of Environmental Protection and Nuclear Safety are mainly related to the environment as a whole, a strong interest was manifested for the ballast water discharges and their impact. The organisational chart and the main structures of the Ministry are given in Figure 3.2.

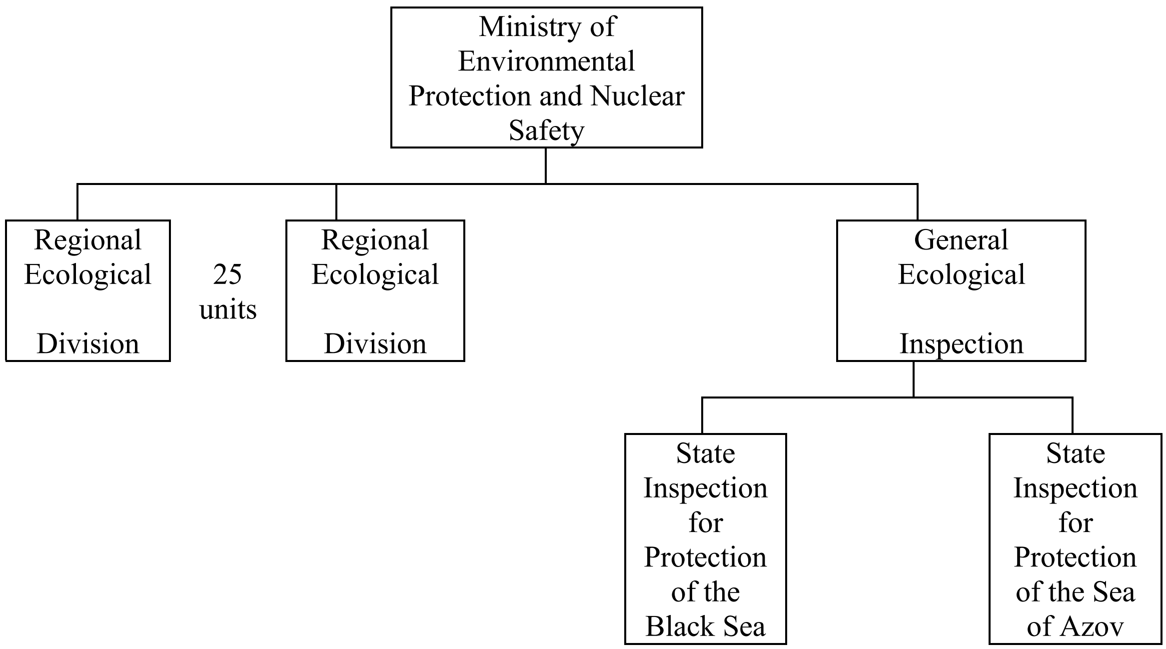

Figure 3.2. : Organisational Chart of the Ministry of Environmental Protection and Nuclear Safety

The Ministry of Public Health is the governmental body in charge with public health and sanitary surveillance. Its structure is presented in Figure 3.3. The duties related to the maritime activities are performed through the Department of Sanitary Epidemiology and its Division on Transports. Sub-divisions for all the means of transportation are dealing with environment, travellers and imported/exported products. A significant component of the scientific resources of the Ministry of Public Health is represented by the scientific research institutes. Only in Odessa, five institutes are providing specialised assistance to the ministry in various fields:

- Scientific Research Institute of Transport Medicine
- Scientific Research Institute of Marine Medicine
- Scientific Research Institute of Health Resorts
- Scientific Research Institute of Virusology
- Scientific Research Anti-Pestus Institute

At least the first three are considered directly interested in ballast water discharges and their effects on the marine environment.

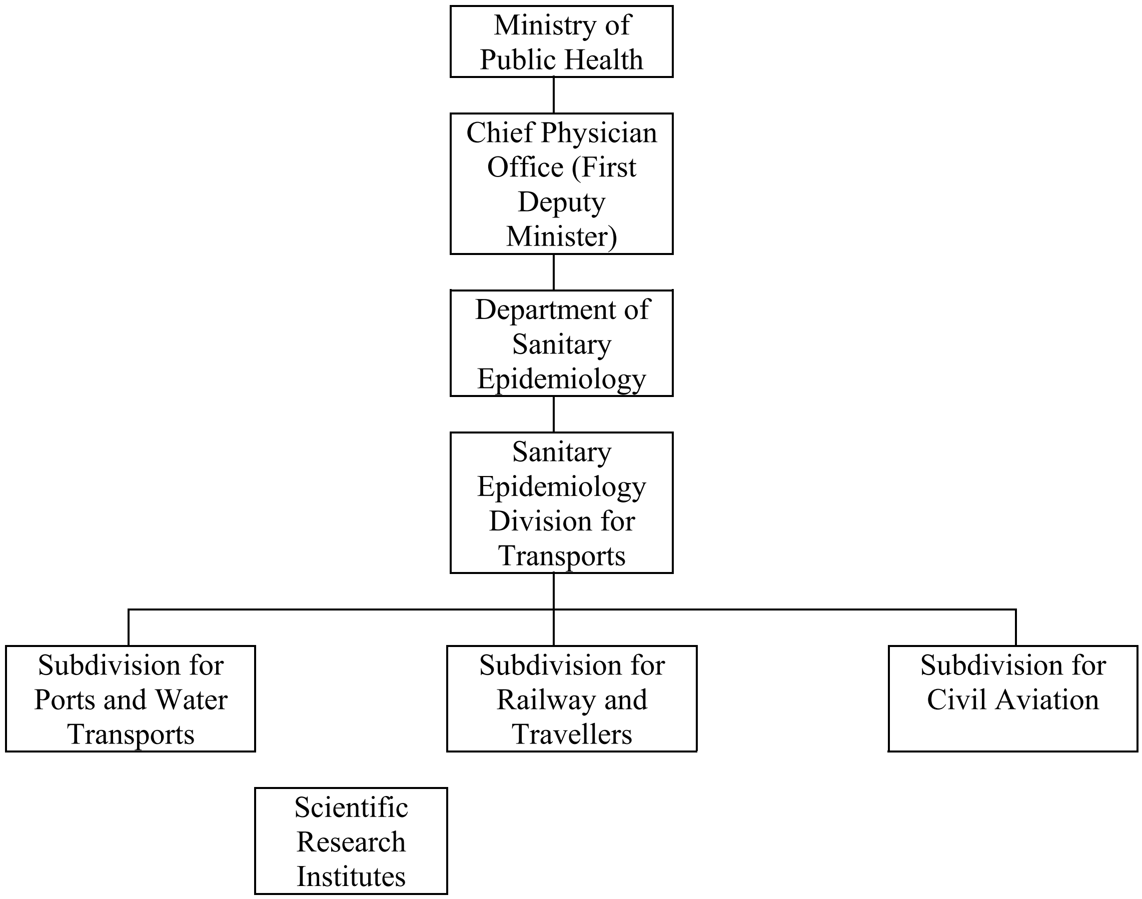

Figure 3.3.: Organisational Chart of the Ministry of Public Health

Another particularly active component of the national scientific resources interested in the transport of alien species through ballast water is the Ukrainian Academy of Sciences through its Institute of Biology of Southern Seas. One of the aprox. 90 institutes financed by the Academy, the Southern Seas Institute was established almost 100 years ago and had a significant contribution to the scientific researches regarding the fauna and flora of the Black Sea. A significant number of highly trained scientists (one member of the Academy, 4 professors and 40 PhD) are maintaining one of the most complete data bank regarding the biological resources of the Black Sea. The Institute is a counterpart for similar organisations from the other Black Sea countries and plays a leading role in almost all the scientific development of the Black Sea region.

A direct interest in the ballast water issues of the local administrative authorities was also mentioned during the discussions.

3.3.2 Co-operation among the administrative bodies involved

Some difficulties of communication and co-ordination among the governmental entities interested in the ballast water discharges have been mentioned during the discussions. The fact that some decisions of the regional authorities directly affecting the ports and shipping were taken without due consultation seemed to create a certain confusion regarding the management and control of ballast water. Nevertheless the close co-operation among the representatives of the governmental authorities at local level (State Department for Marine and River Transport; State Inspection for the Black Sea, Health authorities backed by the scientific researches institutes) made possible the establishment of a working group on ballast water control with good perspective to be officialised as a "Ballast Water Steering Committee" in the near future. Under the co-ordination of the maritime administration (SDMRT) a common strategy to deal with ballast water issues is currently being elaborated.

3.3.3 Main international conventions ratified by Ukraine and other legal instruments regarding the marine environment protection

Ukraine has ratified Annexes I, II, III, IV and V to the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 relating thereto. The fact that the majority of the other Black Sea countries have also ratified the Convention might be of particular relevance for the future regional development.

The 1969 Intervention Convention and the Convention on the Prevention of Maritime Pollution by Dumping of Wastes and other Matter, 1972 were also ratified by Ukraine.

In addition to the national legislation already mentioned, from the discussions with the appropriate authorities, a number of laws and regulations were identified as relevant for the ballast water discharges:

- Trade Shipping Code of Ukraine, 1995 (No. 176/95 - BP)
- Water Code of Ukraine, 1995 (No. 176/95 - BP)
- Decree of the Cabinet No. 269 of 29.02.1996 on Implementation of Regulations of Protection of Coastal Waters and Territorial Sea from Pollution and Littering
- Decree of the Cabinet No. 204 of 04.03.1997 on Regulations for the Implementation and Control of Safety in Transport.

A future MARPOL 73/78 Annex is currently being developed with the objective of minimising contamination of coastal waters with unwanted aquatic organisms. In order to bridge the gap between the entering in force of the binding document and the existing situation, IMO established a set of recommendations which were adopted by the General Assembly at its 20th Session as Resolution A.868(20). During the discussions it was strongly emphasised that all the national regulations regarding the issue have to be in full convergence and consistent with the IMO guidelines.

3.4 SCIENTIFIC RESEARCHES ON BALLAST WATER DISCHARGES AND THEIR IMPACT

3.4.1 Scientific resources

The problem of alien species transported in ballast water was initially approached by the Institute of Biology of Southern Seas of Odessa.

The institute has a long lasting tradition for biological researches in the Black Sea. Although the existing personnel is highly educated it appeared that a certain shortage of performant equipment and chemical ingredients considerably slowed down the researches. The scarcity of the financial resources and the fact that the transfer of harmful aquatic organisms is not seen as a priority, additionally hindered the studies. There is a clear need for systematic sampling of ballast discharges in parallel with sampling the water of the ports. It is recognised that the sampling procedures are long and the evaluation of the results may take even longer, but it appears that the laboratory facilities exist and well trained scientist are available for the purpose. Each of the authorities mentioned above has its own laboratory for sample analysis. A better co-ordination under the leadership of the Maritime Administration could ease the efforts and overcome part of the difficulties. In addition to the Institute of Southern Seas, which may take a leading role in the scientific aspects of the researches, two other institutes (the Southern Institute of Merchant Marine and the Institute of Transport Medicine) have significant capabilities of conducting marine and medical studies. All the three institutes expressed their willingness to participate in the future works related to the ballast water issue.

3.4.2 Evidence of alien species introduced in the Black Sea

Invasion by exotic species into coastal zones and inland seas and lakes of the world have become exceedingly common during last years due to many factors. These include changes in the donor ecosystem, changes in the transport sector and changes in the recipient ecosystem.

It is believed that during the last hundred years vessels brought more than 20 exotic opportunistic settlers in the coastal waters of the Black Sea (Zaitsev, Mamaev, 1997) but the most dramatic effect on the local ecosystem has been produced by the already notorious American comb jelly (*Mnemiopsis Leidyi*).

Also known as rainbow jelly, it grows to a size of up to 10-15 cm and feeds on zoo plankton, eggs and fish larvae. It was accidentally introduced in the Black Sea in the early 1980s and now is a mass planktonic species with a total Black Sea biomass of about one billion tons. According to the evaluation of Foodstuffs and Agriculture Organisation (FAO) the fisheries decline due to Mnemiopsis leidyi may be quantified at 200 million US Dollars per year and the indirect costs related to the idle fishing infrastructure (fishing fleet, ports, processing factories, etc.) raise at 500 million US Dollars per year.

The introduction and establishment of the American comb jelly in the Black Sea means that the region in general and specifically the ports are now exporting sites of *Mnemiopsis* through ocean going vessels loading ballast water. That is, the Black Sea has become a new centre of distribution for *Mnemiopsis* as it interfaces with new shipping routes. There is a dangerous potential to transport *Mnemiopsis* from the Black Sea to the Caspian Sea in ballast water. Signs that a new opportunistic settlement of the ctenophore is currently taking place have been noticed in the Caspian Sea. Strict measures to prevent a new invasion should be urgently enforced and all vessels passing from the Black Sea to the Caspian should exchange their ballast water in the freshwater sections of the river and canal sections between the two seas.

3.4.3 Training and awareness

It was evident from the discussions that the training was focused on the treatment of dirty ballast and oil contaminated waters. No training has been carried out on ballast water management and control. However a considerable number of experts from the maritime administration and from the scientific researches institutes were well aware of the severe detrimental effects of harmful aquatic organisms invasions and of the provisions included in the IMO Guidelines for the control and management of ship's ballast water to minimise the transfers.

Still the ballast water is a relatively new issue; research and education are two of the prerequisite of clear understanding of the problems. The need for further training was largely recognised and the necessity for more effective dissemination of information available internationally was stressed by the most of the interviewees. It was agreed that without a real awareness about the impact of harmful aquatic organisms' invasions, the implementation of ballast water regulations will be long and difficult.

3.5 THE LEGAL PROCESS OF IMPLEMENTING IMO GUIDELINES

3.5.1 Preparation of national rules and regulations

During the discussions with different representatives of the involved organisations clearly appeared the need for national regulations regarding the ballast water discharges which have to be elaborated with joint participation of all the interested parties.

The IMO guidelines for the control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens were unanimously recognised as the only possible basis for the national regulations.

The only legal provisions regarding the ballast water which could be identified in the existing framework was incorporated in the "Water Code of Ukraine" in Art. 67:

> *"The entrance into territorial waters for ships which have not made a replacement of segregated ballast and not equipped with tanks and closed sewage systems for collecting the sewage of any origin or sewage treatment plant corresponding to international standards is prohibited."*

Some of the officials interwied were of the opinion that the above text does not cover completely all the aspects of ballast water management and control and in the mean time leaves room for confusing practices related to ballast discharges. The issue of alternative exchange areas for ballast water is still unclear and in many cases questionable and the other methods are not considered at all. However, it may be concluded that a clear preoccupation for ballast water control already exists among the relevant authorities and steps are being made towards an efficient regulatory system for this matter. Particular concern was shown for the harmonisation of the IMO Guidelines with the rest of the national legislation aiming at creating the adequate conditions for efficient implementation.

3.5.2 Legal procedures regarding the incorporation of IMO Guidelines in the national regulations

The discussions with relevant officials revealed four levels of regulatory instruments according to the Ukrainian Constitution:

- Minister's Orders are prepared by the interested departments with the support of specialised institutes. They generally have internal character and address very specific issues of the current activity of the respective organisation. In order to enter into force the Orders have to be registered with the Ministry of Justice;

- Decision (Decree) of the Cabinet of Ministers, involves more than one ministry and its effects concern larger scale of activities from different segments of the economic activity. The level seems to accommodate the largest part of the regulatory instruments;
- Presidential Decree, similar in effects with the laws but used in some specific situations; and
- Laws which are initiated by the interested departments and institutes, finalised in the ministries and adopted as projects by the Cabinet. After extensive analysis in the Specialised Committees of the Parliament, the laws are passed through the Parliament and become the ultimate and most powerful legal instruments after their entry into force. This process appeared to be a very long and complicated one and usually refers to fundamental matters.

The different ways of accommodating IMO guidelines into the national legislation were explored with government officials during the visit. Some were of the view that the guidelines could be incorporated into the Ukrainian Manual of Activities on Board vessels which is mandatory for all the ships under Ukrainian flag, other were for Minister Order issued by the Ministry of Transportation endorsed by all the others interested ministers. Although further consultations are expected to take place on this subject in the near future it may be concluded that all the representatives of the governmental bodies and other organisations involved confirmed their willingness to implement the IMO Guidelines for the control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens.

3.6 BARRIERS TO THE EFFECTIVE IMPLEMENTATION OF BALLAST WATER MANAGEMENT AND CONTROL MEASURES

3.6.1 Legal and institutional barriers

The fact that clear and complete regulations regarding the ballast water are lacking in Ukraine calls for immediate action from the involved organisations. The Department of Marine and River Transports under the Ministry of Transportation will have to take the leading role in initiating the process. The non-existence of reliable records about the ballast water discharges may be considered a barrier to the above mentioned process. Statistics and risk analysis are fundamental to initiate and promote new regulations and this type of information were not available yet.

Efficient control and management of ballast water discharges involves scientific resources, trained people, reliable records but primarily demands co-operation among the interested authorities and organisations involved. In Ukraine the responsibilities were not in all the cases clear and some confusion has been noticed. The insufficient inter ministerial co-ordination was recognised as a source of confusion and therefore as a barrier to the smooth implementation process. No systematic meetings of the
interested parties were reported to date and the operational level was not completely aware about the IMO Guidelines.

3.6.2 Technical and financial barriers

Sampling procedures are complicated and expensive activities. Analysing the samples and reliable records are even more costly and time consuming. Currently the sampling is carried out by the State Inspection for Protection of the Black Sea with the objective to identify the content of oil, iron and suspended chemicals. No reference to unwanted organisms is being made in the sampling bulletins. The lack of trained technical personnel and associated financial resources appears to be one of the most difficult to overcome barrier.

Although the scientific resources are available, the research itself requires financial support. The scarce resources of the budget on the one hand and the lack of motivation of the private sector on the other hand are real constraints when conducting systematic researches. New equipment for laboratory and sampling may be needed. Adequate financial support is sought for the research vessels immobilised in some cases in port because of lack of bunkers.

3.6.3 Other barriers

Ports and shipping have always played an important role in Ukraine in general and in Odessa region in particular. Adverse reactions from the shipping industry may be expected when initiating new regulations which will put a greater pressure on vessels and port operators.

The lack of alternatives to contaminated ballast water discharges like on board treatment or reception facilities is also seen as a barrier to efficient implementation of new regulations.

The high costs involved by such alternatives are not of such a nature to encourage a positive approach in this respect.

3.6.4 Possible strategies for barriers removal

The insufficient inter ministerial co-operation regarding the ballast water issues was identified as a common characteristic in the visited countries. The appointment of a "national focal point" seems to be one of the most advisable step for the Maritime Administration. It is believed that in Ukraine the most appropriate organisation which could successfully assume such a responsibility is the Ministry of Transportation through its Department of Marine and River Transports.

It is also believed that without active involvement of all the interested organisations the process will remain slow and costly. Technical meetings and periodical reports on the developments could considerably improve the co-operation among the relevant governmental authorities. The establishment of a Steering Committee was strongly recommended in this respect as the most appropriate forum for further co-operation at national level and even regional level. The transfer of harmful aquatic organisms may affect not only the coastal zone of a certain country but the whole ecosystem of the region as it happened in the Black Sea. Regional co-operation may be in most of the cases the solution to split the responsibilities and accordingly reduce the pressure on national budgets.

The existence of a modern and efficient reception facility in Odessa with large storage capacities could be a comparative advantage to overcome the lack of alternate solutions. The existing filters for oily waters (which clean the water up to 0.5 ppm) could relatively easy be adapted to biological contaminated ballast while the piping system and the reservoirs are already in place.

3.7 PROPOSED CO-ORDINATING STRUCTURES FOR THE PURPOSE OF THE "BALLAST WATER PROJECT" AND SELECTION OF THE DEMONSTRATION SITE

3.7.1 Regional Steering Committee

The need for a common structure (Steering Committee) to manage the future developments regarding the ballast water was mentioned by all the representatives of the involved authorities during the discussions. On several occasions it was underlined that such a structure could not only be a forum for future decisions regarding the issue at hand, but could also substantially improve the communication among the parties. The Steering Committee was seen as the appropriate organ to co-ordinate the activities related to ballast water from different ministries by periodic meetings. The possibility to invite other governmental structures, non-governmental organisations (NGOs) or commercial organisations was also considered during the discussions.

The possibility of twining with developed countries for further action was explored by relevant authorities. The benefits of such co-operation were acknowledged by the participants with the view of reducing the national efforts and narrowing the area of investigation based on the existing expertise and experience. As a second step, after officially establishing the Steering Committee, the possibility to expend its works at regional level was considered by inviting other countries from the Black Sea area.

The legal way to institutionalise the Steering Committee, the main duties and responsibilities and its agenda were to be established by further consultations of the interested governmental structures in parallel with the preparation of an official document endorsed by all the participants in the Committee.

It may be concluded that the government officials interested in harmful aquatic organisms carried by ballast water have confirmed their willingness to create the Steering Committee and positive results could be expected in the near future.

3.7.2 National Focal Point (NFP)

Since the Ministry of Transportation through its Department of Marine and Rivers Transports is the administrator of the IMO Conventions in Ukraine and the liaison with IMO Environment Division will continue to be one of the main activities of the national focal point, the representatives of the relevant authorities were of the opinion that the NFP should be related to the Department of Marine and River Transport. Further consultations regarding this nomination are expected in the coming days.

3.7.3 Description of the demonstration site

After extensive consultations with the responsible officials, the port of Odessa was selected as a pilot demonstration site for the purpose of "Ballast Water Project".

The port of Odessa is located on the Southern-West shore of Odessa Gulf in the North-Western part of the Black Sea at $46^0$30'N latitude and $30^0$47'E longitude. The navigation in the port is secured all the-year-round by ice breaker assistance despite the fact that in some severe winter periods up to 80 days continuos ice may be observed. Odessa is the largest port of the country and in a range of 40 kilometres other two major ports (Ilyichevsk and Yuzhni) are located. Pilotage is compulsory and available 24 hours per day. The port of Odessa can basically handle all types of cargoes. Its container terminal is equipped with specialised berth, back gantries, fork lifts and other specific equipment. The terminal capacities allow for handling up to 100 000 TEU per year. Ships with length up to 240 m and draught up to 12,0 m may be accepted. The passenger terminal has recently been rebuilt and may offer all the facilities required for a modern terminal. Parking, cargo and passenger lifts, cloak-room, restaurants, bars and a hotel are also available in the terminal. A concert hall and an exhibition are also located in the terminal area. Currently, the passenger terminal is able to receive passenger ships up to 240 m in length and with a draught up to 11,0 m at 6 berths.

Ukrainian law is very strict about water pollution and discharge into the sea of oil base products either alone or in combination with ballast water is heavily finned. Oil products are handled in Odessa at a specialised terminal equipped in accordance with the most modern world technologies. An oil refining plant is available for processing, storing and handling the oil products through the terminal. The oil products are handled at 6 berths in the oil harbour, able to handle ships up to 250 m in length and draught up to 12,5 m. The fire safety on the tankers is ensured by the fire post and powerful specialised tug boat. The capacity of the oil terminal is over 24 million tons per year. Not far from the terminal there are two oil storage bases equipped with reservoirs for heavy oil (340,000 tons) and light oil products (70 000 tons). The bases are equipped with spur tracks, facilities for filling and emptying cisterns, pumping stations. One of the most modern objectives of the oil terminal is the ballast water purification plant (reception facility) whose construction has been recently completed. Situated in the vicinity of the 30.000 tons capacity reservoirs the reception facility consists in a number of floatation tanks, three filter units and a steam power plant for low temperature. The process is fully controlled by computers. During the discussions with the highly specialised staff of the facility resulted that technical solutions to use the equipment for contaminated ballast could be ensured by minimal investments.

3.7.4 Main reasons for selecting the port of Odessa as demonstration site

The main reasons for the decision of the Ukrainian authorities to select the port of Odessa as demonstration site were as follows:

- The port benefits of technical and scientific support for further developments regarding the ballast water. The proximity of the laboratories and scientific resources in Odessa town and the appropriate administrative structures were seen as another reason to support the decision
- The Gulf of Odessa is a sensitive area from the environmental point of view and the proximity of the other two major ports, Ilyichevsk and Iuzhni, was seen as an additional argument
- The north-western part of the Black Sea including Odessa area enjoys the largest continental shelf (64% of the total shelf) and it is the most entrophicated region. The richness in food determine the existence of large areas of breading and feeding of the living resources of the Black Sea which increase even more the sensitivity of the region
- Odessa may be considered a loading port. Large quantities of cargoes up to 6.000.000 tons/year are loaded or transited through Odessa and if added the oil products 15.000.000 tons/year it may be concluded that relatively large quantities of ballast are discharged in the area.

The fact that all the interested authorities supported the selection of Odessa as pilot demonstration site for the purpose of "Ballast Water Project" may also be of particular relevance.

3.8 DESCRIPTION OF THE DEMONSTRATION ACTIVITIES RELATED TO THE BALLAST WATER CONTROL AND MANAGEMENT

3.8.1 Previous activities related to ballast water control and management

A considerable number of activities regarding the ballast water transfers and their impact on the environment of the port of discharge were mentioned by the representatives of the various authorities and other interested organisations. Since some of these activities have tangential links with the ballast water matter or refer to global aspects of the marine environment only a rough estimation of the costs involved was possible, therefore the figures given below should be looked as being largely approximated.

The representatives of the Ministry of Transportation underlined during the discussions that the largest investment of the last two years in the port of Odessa is the construction of the reception facility. The total costs of this objective amount USD 7 millions. Some other expenses related to ballast water control and management like:

- liaison with IMO and participation in the ongoing works of the Ballast Water Working Group
- elaboration of normative documents

- dissemination of the relevant information regarding the issue at hand
- information support for the "ballast water unit" established in the Department of Marine and River Transports

were indicated by the experts of the Ministry of Transportation and the estimation of the costs was of USD 65.000.

The Ministry of Environment Protection and Nuclear Safety appeared to be very active represented by its State Inspection for the Protection of the Black Sea. Related to ballast sampling and analysis, a series of activities were reported for the last years among which the establishment of the laboratories, logistics for sampling and samples transport, magnetic support for the records on ballast water discharges and specific training are the most significant. The estimated costs for these activities are around the amount of USD 1.270.000.

Some of the activities currently conducted by the Ministry of Public Health in port areas may be easily adapted for the purpose of ballast water discharges control. Particularly the sampling process which is quite common for the sanitary offices may be extended, after short training courses from the fresh water/sewage tanks to the ballast tanks. A specific programme for the modernisation of the ports sanitary rules and standards is currently carried out by the Scientific Research Institute of Transport Medicine. The final output of this programme is expected to be a set of harmonised procedures for the inspection of vessels. The experts of the Ministry of Public Health estimated the costs which may be directly linked to ballast water control at USD 270.000.

Significant investments regarding the ballast water issues in general and the invasions of alien species in the Black Sea in particular were mentioned during the discussions with the representatives of the Institute of Biology of Southern Seas. The result of their studies on the opportunistic settler in the Black Sea are already well known for the international scientific community and a recent GESAMP study was published in this respect. A very approximated estimation of these studies conducted during the last years could range around the amount of USD 500.000.

Considerable efforts to deal with ballast water management on board have been made by the largest shipping company of the country named "BLASKO". Several methods of ballast water treatment on board were tested on board "BLASKO" vessels including the ultra-violet treatment, heating and treatment with exhausted gases from the main engine. Due to the scarcity of financial support the experiments had to be stopped but the company expressed its willingness to continue them in the future if any financial support could be secured. A very general estimation of the costs based on comparative assumptions ranges around USD 400.000.

Table 3.3 gives an approximated idea about the costs incurred by Ukraine with regard to ballast water control and management.

Table 3.3: Approximated costs of baseline operations regarding the ballast water control and management in Ukraine

Organisation	Ministry of Transportation	Ministry of Environment	Ministry of Health	Scientific Organisations	Shipping Industry	TOTAL
Costs*	7.065.000	1.270.000	270.00	500.000	400.000	9.505.000

* All costs in USD.

3.8.2 Prospective activities related to ballast water control and management

A number of new activities intended by interested authorities and organisations were mentioned during the discussions. Some of them are complementary to what is being done now and some are totally new. Due to the time constraints no relevant information on the incremental costs could be made available during the visit. Most of the interviewees were of the opinion that the relatively new concept of incremental costs could require particular studies and accurate estimations.

Among the most relevant future activities mentioned during the visit were:

- The initiation of a sampling programme in the port of Odessa jointly by the Ministry of Public Health and State Inspection for the Protection of the Black Sea. The expected results are better protection against pathogen factors and faster results of the analysis;
- The initiation of the legal process to incorporate IMO guidelines and to prepare for the ratification of an international binding document in year 2000;
- The evaluation of the possibility and costs for adapting the existing reception facility in Odessa to receive ballast waters. The output of this investment could be a viable alternative for vessels trading in the Black and Mediterranean Seas where the alternative exchange zones are still unclear;
- The development by BLASKO of alternative treatment methods for ballast water on board their vessels. The output of these researches would be an alternative to avoid stability risks during the exchange of ballast at sea.

3.9 CO-ORDINATION WITH UN AND GEF LOCAL REPRESENTATIVES

3.9.1 Co-ordination with Global Environment Facility (GEF) Operational Focal Point

In Ukraine the GEF Operational Focal Point is based in the Ministry of Environment Protection and Nuclear Safety. The fact that focal point is at the same time the vice-minister of environment eased substantially the consultations. Particular interest with regard to the project was expressed and close co-operation with the organs of the Ministry of Environment was recommended during the consultations. Copies of the previous reports were requested and full support was promised by means of a "Letter of Support" addressed to UNDP Resident Representative in Ukraine with copies to UNDP and GEF Headquarters.

3.9.2 Co-ordination with the United Nations Development Programme (UNDP) Resident Representative

During the particularly encouraging consultations with UNDP in Ukraine the intention to support the project was expressed in several occasions. The fact that another ongoing project for river Dniepr is currently funded by GEF in Ukraine was seen as an advantage for the participation of the country in the "Ballast Water Project". Furthermore the consultant was informed about a designated person in charge with the co-operation with GEF and advised to directly address the future issues to this expert. Particular interest was expressed for the previous reports, the report on Ukraine and the full scale project document.

3.10 CONCLUSIONS AND RECOMMENDATIONS

It may be concluded that the relevant authorities confirmed their willingness to implement IMO Guidelines and to undertake concrete steps to meet the objectives of the project. A demonstration site was selected and the Steering Committee, which already exists and had its informal meeting, will be institutionalised. The National Focal Point has been appointed and a lively interest for the future developments was shown by the representatives of the interested organisations. Based on these facts it can be concluded that the involved authorities are interested to become an active part of the "Ballast Water Project".

Early involvement of all interested parties is important to the successful implementation of IMO Guidelines for control and management of ships ballast water to minimise the transfer of harmful aquatic organisms and pathogens. The problem of alien species transfer has global implications for the society and it is not simply an issue for the shipping industry. It is therefore recommended to improve the co-operation between relevant agencies involved at the national level and to extend the co-operation on a regional and international basis. In this respect the possibility of expanding the works of the Steering Committee at regional level should be investigated in the future. Providing IMO with relevant information about specific national and regional developments is another way to encourage and promote international co-operation.

It is also recommended to explore the possibilities of twining with other countries when conducting relevant studies regarding the ballast water issues. This may ease the burden on national budget and narrow the area of investigation.

4. PART B - ISLAMIC REPUBLIC OF IRAN

4.1 GENERAL INFORMATION

4.1.1 Historic Note

Habitation in Iran can be dated in lower Palaeolithic times, but recorded history and civilisation began with the Elamites in Khuzest region some 3.00 year B.C.

Iran has a economy largely financed by petroleum production. In 1950's the country's mining and petroleum industries were nationalised. The agricultural sector accounts for about one-fifth of the gross domestic product and employs one forth of the work force in Iran. Other major industrial products are textiles, processed foods, automobiles, electrical machinery, iron, still and cement.

The history of Ports & Shipping Organisation (PSO), the maritime administration of Iran, dates back to 1914. At that time a department called "South Customs Branch" was established in the port of Bushehr. Its duty was to monitor Iranian coasts and sea ports to prevent smuggling of goods into and out of the country. In 1928 in order to manage the affairs of the ports of the country the "General Directorate of Ports" was established in Teheran, in which all the affairs of ports were concentrated. In 1946, according to a decree of the Council of Ministers, the revenue from operating ports facilities was to be collected in a special fund for the development of ports and three years later the "General Corporation of Ports and Shipping" took the place of the directorate. In 1960 the title was changed to "Ports and Shipping Organisation" and after nine years the organisation gained rights and organisational chart were formally declared. Internal regulation on financial transactions and on the employment of staff of the organisation were approved in 1970. Since 1974 PSO has been co-ordinated by the Ministry of Roads and Transportation.

4.1.2. Location

Islamic Republic of Iran is located in the Middle East and is bordered on the north by Azerbaijan, Caspian Sea and Turkmenistan, on the west by Turkey and Iraq and on the east by Afghanistan and Pakistan. The southern boundary is the Persian Gulf and the Oman Sea.

Iran has an area of 634,562 square miles, the capital city is Teheran and the largest cities are : Tabriz, Yazd, Kerman and Tezery. The location between the Caspian Sea and the Gulf and Oman Sea gave Iran an opportunity to develop its maritime sector. The country enjoys a coastline of 2.700 km of which 700 km forms the Caspian Sea coastline and 2000 km belongs to the Persian Gulf and the Gulf of Oman. There are 11 commercial ports in these areas, 3 in the northern part and 8 in the southern part of the country. The ports of Noshahr Anzali in the Caspian Sea and Bandar Imam Khomeini, Busher, Bandar Abbas and Chabahar in the south are considered the major ports.

4.1.3. Population

The population of Iran is estimated to be around 60 million inhabitants, giving the country an overall population density of about 95 persons per square mile. The majority of the population is formed by Iranians. Some other ethnic groups as Kurds, Lurs, Baloch, Turks and Armenians are widely distributed in the country. The vast majority of the population is of Muslim religion. The country has a high birth rate and the population is relatively young, more than two-fifths is less than 15 years old.

The official language is Farsi which is spoken by the overwhelming majority.

4.1.4. Meteorological and oceanographical data.

In Iran extreme temperature are very common and vary from a summer high of 55^0C to a winter low of -37^0 C. Precipitations over the country are also very different ranging from 100 mm to 1,000 mm of rainfall per year. Iran occupies a high plateau lying more than 460 m above the sea and rimmed on all sides of mountains. In the north are the Elburz Mountains, including the country highest Mount Demavand (5.604 m). The country's largest mountain range, the Zagros, stretches from Northwest to the Southeast.

The Persian Gulf is a shallow quasi-enclosed sea area situated between 24^0N and 30^0S of latitude and characterised by extreme gradients in environmental conditions. The average salinity is a bit less than 40 parts per thousand. The maximum width of the Gulf is 338 km and the length is around 1,000 km. The surface area of the Gulf is approximately 239,000 square kilometres and a mean depth of 36 m implies an average volume of 8,630 cubic kilometres. The Iranian coasts is about 1,000 km. The most well-known, and notorious weather phenomenon in the Gulf is the Shamal, a NW Wind which occurs round the year. The water average temperature varies from 27^0C during the summer to 18^0C in winter.

4.2. SHIPPING TRAFFIC IN THE PORTS OF BANDAR IMAM KHOMEINI, BUSHER AND KHARG ISLAND

Among the major ports of Iran, Bandar Imam Khomeini, Busher and Kharg Island were considered relevant for the purpose of the project. The report will focus on Kharg Island and Busher but reference will be made to Bandar Imam Khomeini as well.

4.2.1. Ports description

The Port of Imam Khomeini is located in the northern part of the Gulf at a latitude of 30^0 25' N and longitude of 49^0 04' E, at a distance of 927 km from the capital city. The port benefits of an airport located at 25 km and is connected to Teheran and to other cities of the country by road, air and rail road. The temperature ranges from 6^0 C to 50 ^{0} C and the humidity from 15% to 90% in summer.

The storage capacity of the port is 10, 980, 790 sq. m in open space and 287, 940 sq. m in warehouses. A total number of 37 berths are available in Bandar Imam Khomeini, 25 berths for general cargo and bulk, 5 for containers, 2 silo for cereals and 4 for barges, service, trans-terminal and ore. The depth varies from 4 m to 15 m in container berths.

The port is equipped with 40 cranes, 107 lift-trucks, 53 tractors, 2 gantry cranes, 2 transtainers, 5 top lifts and 5 hoppers for cereals. Eleven tugboats are available for manoeuvring and a large number of boats ensure the service in the port. For maintenance purposes the port has four dredgers. A Vessel Traffic Centre is currently developed and a dangerous goods terminal will be available in the future. A petrochemical facility which has been under construction since 1973 and suspended several times since, is still only 85% complete. A new terminal is to be built near the port to handle iron ore for a steel-works at Ahwaz, to the north of the port. The terminal will have a quay length of 250 m, capable of accommodating vessels from 30.000 - 100.000 dwt. Throughput is to be 4 million tons/year. The pilotage is compulsory and vessels should anchor at the Outer Buoy or, when weather is clear, proceed towards Fairway Buoy and await the pilot. The principal imports through Bandar Imam Khomeini are : grain, flour and rice.

The port of Busher is located in the middle part of the Gulf at a latitude of $28^0$59'N and longitude of $50^0$50'E, at a distance of 1.196 km from the capital city. Busher enjoys the facilities of an airport at only 3 km and is connected to Teheran and other cities by roads. The temperature range during the year is 15^0-40^0 C and the humidity varies from 21% to 98%.

The storage capacity of Busher is 371,900 sq. m on platforms and 29,300 sq. m in warehouses. The total number of berths available in Busher is nine with depth from 6 to 11 m. Three berths are specialised in general cargo and the rest have different other destinations. The port is equipped with 16 cranes, 26 lift-trucks, 24 tractors and 2 hoppers for cereals. Four tugboats and six boats are also available for port services. The maintenance is ensured by four dredgers. The port of Busher is also known for its fisheries and fishing industries.

In addition to the major ports mentioned in the previous chapters, Iran has a number of oil terminals. Kharg Island is the main oil export terminal of the country and is located on an island situated in the north west of the Gulf. Large quantities of oil are monthly handled through the terminal since the average number of vessels operated per month is around 60 and the overwhelming majority of them are VLCC. The terminal comprises of 12 jetties out of which 8 are T form jetties. Four "sea island" jetties are dedicated for very large tankers. Vessels are currently operated in anchor as ship to ship or by means of shuttle ships. The terminal is basically a crude oil terminal and is located in the eastern coast of the island.

Kharg Island East Bay is open and free from hazards except for coral reef about 0.4 km sea ward. Anchorage is prohibited in the north of the island in the vicinity of the pipes line.

The management of the terminal and the operation of vessels are under the responsibility of National Iranian Oil Company (NIOC) which is also in charge for the cargo storage and handling. In addition to the loading and discharging facilities the terminal provides pilotage, tug services and antipollution services. The maintenance of the terminal and the other essential facilities of a port (hospital, fire protection etc) are also ensured by NIOC. However the main functions of the maritime administration are still in the responsibility of Ports & Shipping Organisation (PSO). Vessels Traffic Control and Port State Control is performed by the PSO inspectors. Some services as garbage collection and telephone facilities are still provided by PSO, but probably the most relevant function of PSO is to control and follow legally wise any case of pollution even the removing and cleaning are the responsibilities of NIOC.

4.2.2. Number and type of vessels visiting the ports

In 1997 a total number of 3,334 vessels have called at the Iranian ports in order to perform loading discharging operations which means a 27% increase compared with 1996. These statistics refer to non oil cargoes only. In Bandar Imam Khomeini the traffic increased from 507 vessels in 1996 to 675 vessels in 1997 and in Busher from 130 vessels in 1996 to 149 in 1997. A graph of the ship calls traffic in 1997 shows that the largest number of calls was registered in Bandar Abbas (40%), Anzali (at the Caspian Sea, 21%) and Imam Khomeini (20%). The number of ship calls at ports during 1996-1997 shows a nearly uniform trend but this varies for each specific port. From a total of 36 million tons discharged in the above period in Iran nearly 89% was received by the southern ports. The highest amount of imported goods belong to the ports of Bandar Abbas and Imam Khomeini. Statistics show an annual growth of the activity with 25% while from 1988 a consistent growth characterised the ports activity. The same trend can be seen in the oil terminals. If in 1996 the average number of vessels calling in Kharg Island was around 45 to 50, in 1998 the number of calls increased to 60.

4.2.3. Estimated amount of ballast water discharged and main areas of origin

From the statistics available clearly result that the most significant quantities of ballast water discharged are in the oil terminals.

In 1996 a number of 36 vessels were monitored in Kharg Island under a "Questionnaire" meant to determine the reception facilities required in the Gulf area. The survey was conducted by the Regional Organisation for the Protection of the Marine Environment (ROPME). Starting from the total dead-weight capacity of the considered vessels and approximating that the capacity of ballast tanks represent around 30% of the dead-weight capacity an average quantity of 67,580 tons ballast water per vessel can be estimated. If the number of calls in 1996 was about 40 vessels per month, the total quantity of ballast water discharged in Kharg Island per year was 32.4 million tons.

Based on the same algorithm in 1997 the average quantity of ballast water discharged from one vessel is 75,955 tons which gives a total of 36.5 million tons per year.

In 1998 the average quantity of ballast water discharged by one vessel was calculated to be 66,675 tons, but a significant increase of the number of calls has been reported (60 vessel/month) which gives a total of 48 million tons per year.

A survey regarding the last port of call reported by tankers calling at Kharg Island showed that the largest number are coming from the Far East, South East Asia and India. A much smaller number has been reported for Europe and South America.

It can be concluded that the largest quantities of ballast water discharged in Kharg Island originate from Far East and South East Asia.

4.3. ADMINISTRATIVE STRUCTURES CONCERNED WITH THE IMPLEMENTATION OF IMO GUIDELINES ON BALLAST WATER

4.3.1. Description of the main administrative bodies interested in the implementation of ballast water guidelines

The maritime authority in charge with the administration of IMO conventions in Iran is the Ports & Shipping Organisation subordinated to the Ministry of Roads and Transportation. Among the main attributions of PSO are :

- Administration of ports as well as commercial maritime affairs of the country;
- Construction, completion and development of buildings, repair yards and related equipment in port;
- Preparation, formulation and enforcement of port, maritime, and commercial shipping regulations according to the respective laws;
- Putting into effect the Iranian Maritime Law and performing the functions which are laid down in the law establishing PSO and other related laws;
- Examinations of draft international agreements and treaties concerning port and maritime affairs and commercial navigation in order to present them to the relevant authorities;
- Membership in international organisations related to port and maritime affairs; participation in international conferences and meeting regarding the port and maritime affairs;
- Administration of loading, discharging and handling of cargoes in port areas and warehousing;
- Control of coastal and commercial shipping aiming at its development securing safety of traffic;
- Conducting studies and researches on maritime and port affairs as well as commercial navigation;
- Transfering part of the tasks of the organisation to the qualified private bodies when deemed to be advantageous.

The governing authorities of the organisation are as follows :

- The Supreme Council
- The Board of Directors
- The Managing Director

The Supreme Council consists of the following ministers :

- Minister of Financial and Economic Affairs;
- Minister of Roads & Transportation;
- Minister of Defence;
- Deputy President and Head of the Planning and Budget Organisation;
- Commander of the Navy.

The Supreme Council is presided by the Minister of Roads and Transportation and whenever he is not present the members select a president among themselves.

The declared major objectives of PSO are :

a) General supervision and development of all Iranian commercial ports;
b) Safety of life at sea;
c) Protection of marine environment from pollution.

The Board of Directors of PSO is chaired by the Managing Director of the organisation.

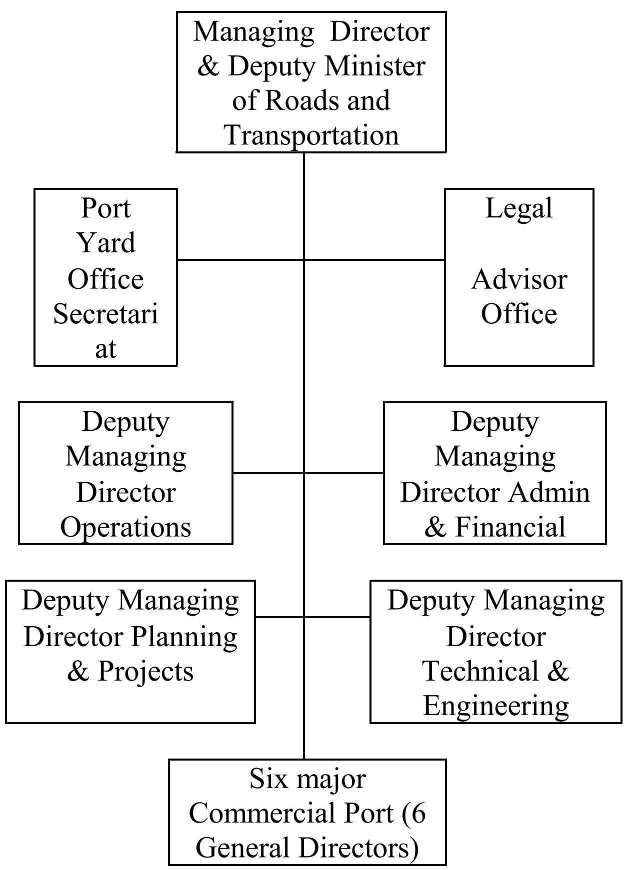

Figure 4.2. : Ports & Shipping Organization Chart

The Department of Environment (DOE) is the sole custodian for the protection of the environment within the Islamic Republic of Iran, the headquarters of which is located in the country's capital Teheran. The DOE has regional offices in all the provinces of the country including coastal provinces. The DOE is headed by the Vice-President of the Islamic Republic of Iran. The Marine Environment Research Bureau, under the DOE is the only governmental body responsible for the protection of the marine and coastal environment.

The Marine Environment Bureau and its regional offices are responsible to update data and information on different aspects of the marine and other aquatic environment such as : status of marine pollution from different sources; estimation of different pollutants in water sediments and biota; studies on biodivesrity and conservation; protection of marine living resources; studies on taxonomy of sensitive and protected areas.

The Ministry of Jahad is a relatively new governmental body and has among other responsibilities the administration of the national fisheries. The fisheries resources of the water within the jurisdiction and authority of the Islamic Republic of Iran are considered national property of the country, hence, protection and exploitation of these resources are among the government responsibilities. Management, protection and exploitation of these resources in line with the national interests of the country are carried out under the provision of the "Law of Protection and Exploitation of the Fisheries Resources of the Islamic Republic of Iran" and its executive regulations.

The Iranian Fisheries Company (Shilat) under the Ministry of Jahad carries out the following activities :

- Conducting scientific and applied research;
- Managing the fishing and enforcing the related regulations;
- Establishing, developing, monitoring the fishing ports;
- Encouraging and supporting fishing, fish farming, fish processing industries.

The duties and functions of Fisheries Company subject to the Law of Fisheries cannot be in contradiction with the ones of the Iranian Environmental Organisation.

Another governmental organisation which expressed its interest for the ballast water transfer was the national Oceanographic Commission. The commission performs its duties through the Iranian National Centre for Oceanography which is a research and educational centre established under the auspices of the Ministry of Culture and Higher Education with the collaboration of the United Nation Educational, Scientific and Cultural Organisation (UNESCO).

The statute of the centre was ratified by the Higher Education Development Council in 1992. The main functions include :

- support for marine studies and co-ordination of the research activities among marine scientific organisation and administrative bodies;
- provide opportunities for fundamental researches and stresses on the development of the technologies in areas which are not covered by other marine organisations;

- raise the level of education and research in the field of marine science, studying the most efficient use of oceanic resources aiming at creation of a national marine strategy.

The Centre has already arranged for a wide range of activities towards regional and international co-operation through Iranian National Commission of UNESCO and direct contact with other marine organisations of the world. A close co-operation with Intergovernmental Oceanographic Commission (IOC) was particularly mentioned during the discussions.

The Ministry Of Health has 28 health centres in all the country's provinces. It also co-ordinates the activities of 39 universities and medical schools. The Department of Contagious diseases also includes the quarantine services in the ports which closely observes the World Health Organisation Regulations. With regard to the ballast water discharges very little concern was expressed by the representatives of the Ministry of Health. Some interest was manifested by the representatives of General Department of Environmental Occupational Health in charge of the water quality.

4.3.2. Co-operation among the administrative bodies involved

On several occasions during the discussions the good co-operation among the interested governmental organisation was mentioned by the participants. In particular, close and efficient co-operation between PSO and the Department of Environment have been noticed. A clear distribution of responsibilities was agreed by the two organisations as all the pollution originated from ships is the task of PSO and all the other pollutants are under the duties of Department of Environment.

4.3.3. Main international conventions ratified by Iran and other legal instruments regarding the marine environment protection

The Islamic Republic of Iran has ratified the London Convention of 1972, the OPRC 1990 and the Intervention Convention of 1969 including the Intervention Protocol of 1973 as amended. MARPOL 73/78 Convention is currently under debate and its ratification is expected in near future. It should be mentioned that none of the Gulf countries, excepting Oman, ratified MARPOL. According to the PSO preliminary debates were initiated for the ratification of Civil Liability Convention and Fund Convention.

The national legislation which may relate to the ballast water issue mentioned during the discussions includes :

- The Maritime Law of Iran of 1964 (914 articles);
- The Environmental Law; and
- The Law of Protection and Exploitation of the Fisheries Resources of 1993.

4.4. SCIENTIFIC RESEARCH ON BALLAST WATER DISCHARGES AND THEIR IMPACT

4.4.1. Scientific resources

From the scientific point of view the problem of the alien organism in Iranian waters has been initially raised by PSO and DOE experts. No significant achievements have been reported until now but some concern was expressed for the Persian Gulf as very large quantities of ballast water are dumped in the area and for the Caspian Sea exposed to the threat of *Mnemiopsis Leidyi*.

A clear need for systematic sampling of ballast discharges in parallel with sampling the water of the ports and the coastal zone has been identified during the discussions. It was recognised that the sampling procedures are long and the evaluation of the results may take even longer but it appeared that the laboratory facilities exist and well trained scientists are available for this purpose.

Particularly the Iranian National Centre for Oceanography expressed its availability to co-operate with neighbouring countries in conducting research and joint studies on the causes of damages of the environment of the Persian Gulf.

The centre is prepared to participate in national marine studys programmes in order to improve the region potential and efficiencys in administering these projects. Common research cruises in Gulf waters in order to recognise the considerable common parameters are considered for the near future.

4.4.2. Evidences of alien species introduced in Iranian coastal waters

Since the ballast water issue is very new in Iran no evidence of alien species could be provided during the discussions. Some concern was expressed by the representatives of the Department of Environment and Iranian National Centre for Oceanography for the potential risk of introduction of unwanted organisms from the Black Sea through the Volga Don canals. A new project co-ordinated by UNDP, EU and World Bank was mentioned in this respect during the consultations with UNDP Office in Teheran.

4.4.3 Training and awareness

Scientific knowledge and reliable information on ballast water issues are insufficient and researches are only at the beginning. Research and training are two prerequisite of understanding the ballast water problems and how they should be managed. The establishment of a national research and education programme for existing and emerging experts might be essential in the future. The need for further training was recognised in several occasions. No evidence of any institutional programme for technical staff involved in sampling techniques could be provided. Sampling procedure are complicated and expensive activities. analysing the sample and proper records are even more costly and time consuming. The lack of trained technical personnel and associated financial resources may become a barrier to the smooth implementation of the ballast water management and control measures.

Background information on ballast water issues in the Persian Gulf is insufficient since the researches have been sporadic until now. There are only few scientific articles in aspects related to ballast water. This suggests that the interested authorities have not adequately disseminated the funding down to the operational level and to the public. Without a stronger awareness campaign being part of the process, the implementation of appropriate regulations for ballast water discharges might be difficult and long lasting.

4.5 THE LEGAL PROCESS OF IMPLEMENTING IMO GUIDELINES

4.5.1 Preparation of national rules and regulations

The large majority of the participants to the discussions shared the view that there is a need for national regulations regarding the ballast water. The IMO Guidelines for the control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogen were unanimously recognised as the only possible basis for the national regulations and the only way to bridge the gap between now and the moment of the adoption of a new Annex to MARPOL 73/78 Convention. The fact that the MARPOL is in its final stage of debate almost ready for ratification was seen as an incentive for the endeavours regarding the ballast water.

In Iran the elaboration of a new law or the ratification of an international convention comprises of certain steps. In the case of MARPOL 73/78 first the Convention was studied and analysed in PSO, then a draft text incorporating the Convention and an exposure of reasons to ratify it were submitted to the Ministry of Roads and Transportation. After thorough deliberation at this level the project of the new law is submitted to the President of the Country. The final stage is the Parliament. At the time of the visit MARPOL Convention together with first and second annexes was at the level of President Office.

4.5.2 Legal procedure regarding the incorporation of IMO Guidelines into the national regulations

The legal procedures to incorporate the IMO Guidelines into the national regulations were explored with all the participants during the discussions and in particular with the representatives of PSO. It was agreed that usually for recommendation codes and guidelines the level of approval is the Board of Directors of PSO. A more powerful instrument to regulate the ballast water issues could be a decision of the Supreme Council of PSO. If the "decision" involves additional governmental organisations the level of approval raises to the Cabinet and if fines or freedom restrictions are involved the regulations have to be approved by the Parliament.

In the concrete case of IMO Guidelines it was agreed that, due to its inter ministerial character, its adoption as a decision of the Supreme Council of PSO would be the most appropriate solution. If the Department of Environment, which is not a part of the Supreme Council of PSO, will ask, the level of approval might be raised to the Cabinet level.

Although further consultations are expected to take place on this subject it may be concluded that the large majority of the representatives of the governmental bodies involved confirmed their willingness to implement the IMO Guidelines for the control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens.

4.6 BARRIERS TO THE EFFECTIVE IMPLEMENTATION OF BALLAST WATER MANAGEMENT AND CONTROL MEASURES

4.6.1 Legal and institutional barriers

One of the main obstacles mentioned by almost all the interviewees is the non existence of specific regulations regarding the ballast water discharges. Since this is a relatively new topic it has not achieved an institutionalised frame on the national level and therefore the issue is not among the priorities of the Government or of the legislative body. There is a real need for national co-operation; a committee officially appointed to gather the necessary statistics, to prepare the risk analysis and to come up with clear proposals regarding the management and control of ballast water discharges. In these conditions the fact that the guidelines have a voluntary character can be seen as barrier to the implementation process.

The poor co-ordination of PSO with the Ministry of Health and the low interest showed by the later for the ballast water discharges is another barrier for the global process. The transfer of pathogens may pose a major risk on the population and the only governmental organisation with real capabilities in this respect is the Ministry of Health.

4.6.2 Technical and financial barriers

The main technical obstacle which could be identified during the visit relates to sampling procedures and the laboratory analysis of the samples. The sampling technique are complicated and require free access to difficult parts of the ballast tank. Vessels are not technically fitted to permit appropriate sampling and the existing man holes are rusted and difficult to open.

Although the scientific resources are available, the research itself requires financial support. The limited resources of the budget by one side and again the low priority compared with other issues can be seen as an other barrier.

Another technical barrier and probably the most specific one for the Persian Gulf is the fact that approx. 200 vessels enter daily through the Strait of Ormuz and discharge large quantities of ballast. A very sensitive and fragile area, the Gulf receives daily the largest quantities of ballast water in the world.

4.6.3 Other barriers

The poor regional and international co-operation on ballast water discharges may be considered another barrier because ultimately it leaves the whole burden on the country instead of distributing it among the regional participants.

The Regional Organisation for Protection of Marine Environment (ROPME) includes: Arab Emirates, Bahrain, Iraq, Iran, Kuwait, Oman, Quatar and Saudi Arabia. Very little has been done in the organisation and by the individual member states with regard to ballast water discharges. This problem should be raised in the Organisation and a Regional Steering Committee on Ballast Water Issues could substantially improve the situation.

The lack of alternatives to contaminated ballast water discharges, like on board treatment or reception facilities is also seen as a barrier to efficient implementation of new regulations. the high cost involved by such alternatives are not of such a nature to encourage a positive approach in this respect.

4.6.4 Possible strategies for barrier removal

It appears in some cases that the insufficient inter ministerial co-operation regarding the ballast water issues may hinder the implementation of specific regulations. The appointment of a Steering Committee - national co-ordinator seems to be a very advisable step for the Administration. It is believed that in the case of Iran the most appropriate organisation which could assume this responsibility is the Ministry of Roads & Transportation through its Ports & Shipping Organisation. The technical meetings and periodical reports on the development may considerably improve the co-operation during the relevant governmental agencies and speed up the process.

The transfer of harmful aquatic may affect not only the coastal waters of a certain country but the whole ecosystem of the region due to its significant transboundary character. Regional co-operation may be in most of the cases the solution to split the responsibilities and accordingly reduce the pressure on the national budget.

In parallel with the identification of the domestic resources, a thorough evaluation of the international opportunities to tackle the ballast water problems should be considered. Technical co-operation programmes, bilateral arrangements or twining with the advanced countries may significantly ease the implementation process.

4.7 PROPOSED CO-ORDINATING STRUCTURES FOR THE PURPOSE OF THE "BALLAST WATER PROJECT" AND DEMONSTRATION SITE

4.7.1 Regional Steering Committee

The need for a common structure to manage the future developments regarding the ballast water was mentioned by all the representatives of the interested organisations during the discussions. On several occasions it was underlined that such an organism could not only be a forum for future decisions regarding the ballast water, but could also substantially improve the communication among the parties. The Steering Committee was seen as the appropriate structure to co-ordinate the activities of different organisations by periodic meetings. The first meeting took place before the consultant's visit and had a preparatory character. It was suggested to consider the possibility of inviting the representatives of the Ministry of Oil as they play a determinant role in the selected demonstration site.

The main duties and responsibilities of the Steering Committee and its agenda were to be established by further consultations of the interested governmental structures. It may be concluded that the government officials interested in harmful aquatic organisms carried in ballast water have confirmed their willingness to establish the Steering Committee in the near future.

4.7.2 National Focal Point (NFP)

According to the national regulation existing in the Islamic Republic of Iran the most appropriate organisation to ensure the liaison with IMO and other bodies involved in ballast water issue is the Ports & Shipping Organisation. During the discussions support for the nomination of the national focal point by the PSO was expressed in several cases by the participants.

4.7.3 Description of the demonstration site

The purpose to select the oil terminal of Khark Island as a pilot demonstration site seemed to enjoy the support of government officials participating in the discussions. The terminal is the largest one in the Gulf area and enormous quantities of ballast water are currently discharged in its neighbourhood.

T-shaped piled fendered jetty, 1836 m long, connected to the shore by a 1219 m causeway is designed to handle large tankers. Three of its berth can accommodate vessels of 250 000 dwt. The jetty consists of ten berths each one equipped with a chicksan unit with loading arms from 12 - 16 inches in diameter. Vessels can load simultaneously through shore metering system at about 10 000 tons per hour, but under favourable conditions 15 000 t-h can be maintained.

The Sea Island Terminal is located on the West side of the island with two berths for vessels up to 500 000 dwt. The depth alongside these berths is 32.3 m at MLW. The terminal also provides two berths for vessels up to 300 000 dwt with a depth alongside of 29.8 m at MLW.

Darius Terminal is an open unsheltered roadstead situated 1.6 km South of the main loading jetty. Ships are loaded by means of submarine pipelines at a single berth.

Khemco Terminal has one single berth consisting of one main and eight mooring dolphins for the export of crushed sulphur and LPG.

4.7.4 Main reason for selecting the oil terminal of Kharg Island as demonstration site

According to the traffic figures and the description of the terminal, Kharg Island has the characteristics of a loading port. The fact that large quantities of ballast water are currently discharged is of a particular relevance for the purpose of the project.

Some scientific research and laboratory facilities are available on the island from the oil company exploiting the terminal and much more scientific and logistic support can be provided from the port of Busher situated at three hours distance from the island.

In terms of quantity of oil handled, Kharg Island is the largest terminal in the Gulf. Its position on an island may be considered an advantage for the future researches in the area.

Last but not least the Persian Gulf is one of the most sensitive marine areas of the world. Shallow waters, high water temperature, little water exchange through Ormuz Strait and significant agglomeration of ships are some of the characteristics of the Gulf.

4.8 DESCRIPTION OF DEMONSTRATION ACTIVITIES RELATED TO BALLAST WATER CONTROL AND MANAGEMENT AND ESTIMATION OF COSTS

4.8.1 Previous activities related to ballast water control and management

In Iran concerns over the ballast water issues were raised only recently. Although the scientific resources are available, the process is very slow. Some results on the taxonomy of the existing zoo and phytoplankton in the Persian Gulf are available but no information about the potential alien species, settled during the last period, could be identified. A number of studies and projects were conducted in this respect by the Department of Environment. Two oceanographic cruises were organised in 1995 and 1996. The total cost of relevant marine projects in the last decade was approximately 2 million US Dollars, the details of which could be provided if necessary.

The problem of pollution in the Persian Gulf was mentioned by the Fisheries Department among other interested organisations. A selection of their studies which may have direct link with the "Ballast Water Project" includes:

- Studying the pollutants in Genave region and their effects on the aquatic animals.
- Studying the organic pollutants in Busher province waters.
- Hydrological and hydrobilogical study of Chabahar Bay.
- Stock assessment of the benthic fishes in the Persian Gulf waters using swept area method.

The experts of the Fisheries Department estimated the total costs of these studies at the amount of 101.000 USD.

An evaluation of the costs which may be related to ballast water issues like attending the relevant international meeting and conferences, specific training, was provided by the PSO as well. The total amount raises to 145.000 USD.

Table 4.1 provides a rough estimation of the costs incurred by Iran with regard to ballast water control and management.

Table 4.1: Approximated costs of baseline operations concerning the ballast water in Iran

Organisation	Ports & Shipping Organisation	Department of Environment	Fisheries Department	Total
Costs *	145,000	2,000,000	101,000	**2,246,000**

* All costs in USD

4.8.2 Prospective activities related to ballast water control and management

Some new activities envisaged by interested authorities and organisations were mentioned during the visit. Some of them are complementary to what has been done and some are totally new.

Due to the time constraints no relevant information on the incremental costs could be made available during the discussions. The majority of the interviewees were of the view that the concept of incremental costs has a certain degree of complexity and for this reason it requires additional study and more accurate evaluations.

Among the most relevant future activities described by the representatives of the interested organisations were:

- The initiation of the legal process to incorporate the IMO Guidelines and to prepare for the adoption of a new international binding instrument in year 2000.
- The initiation of a sampling programme in Kharg Island area jointly by the interested organisations and the development of relevant studies related thereto.
- The dissemination of the developments regarding the ballast water issue among the other countries from the Gulf area through ROPME.

4.9 CO-ORDINATION WITH UN AND GEF LOCAL REPRESENTATIVES

4.9.1 Co-ordination with Global Environment Facility (GEF) Operational Focal Point

In Iran the GEF Operational Focal point is based in the Ministry of Foreign Affairs. The consultations took place at the Ministry of Foreign Affairs. The particular interest showed to the "Ballast Water Project" was corroborated with the current policy of Iran in the Gulf region. The leading role of the country in approaching the marine environment problem and the fact that Iran acted as "spokman" for the region was underlined during the discussions. Full support was promised for the project since it was found consistent with the policy of the country in the region. As a prerequisite of the issuance of a letter of support for the project, copies of the existing relevant materials were requested from the authorities in charge respectively PSO.

4.9.2 Co-ordination with the United Nations Development Programme (UNDP) Resident Representative

The consultation with the UNDP representatives took place at their premises. During the particularly fruitful discussions the special interest and the intention to support the project were expressed in several occasions. The project was perceived as benefic for the country and for the region and some reference was made to a similar programme (Caspian Environmental Programme) officially launched by the World Bank, European Union and UNDP.

Copies of the relevant documents regarding the "Ballast Water Project" were also requested in order to follow the future developments.

4.10 CONCLUSIONS AND RECOMMENDATIONS

The involvement of all the interested parties is important to the successful implementation of ballast water control and management measures. The problem of alien species transfer has global implications for the society and is not simply an issue for the shipping industry. It is therefore recommended to improve the co-operation between relevant authorities at the national level.

It is also recommended to promote and encourage regional co-operation by expanding the works of the Steering Committee at regional level. The necessity to attend the first meeting of the International Steering Committee was also strongly recommended.

It may be concluded that the relevant authorities confirmed their willingness to implement the IMO Guidelines for control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens. Further consultations with GEF Operational Focal Point and UNDP Office will significantly benefit their endeavours and speed up the whole process.

ANNEX 1

TERMS OF REFERENCE FOR CONSULTANT TO VISIT DEMONSTRATION SITES IN IRAN AND UKRAINE

PROJECT TITLE: **REMOVAL OF BARRIERS TO THE EFFECTIVE IMPLEMENTATION OF BALLAST WATER CONTROL AND MANAGEMENT MEASURES IN DEVELOPING**

PROJECT NO: **T011-GLO/97/G4/A/1G/19**

Background

One of the main objectives of this project is to collect background material for the preparation of a full-scale document to be submitted to the GEF Council in October 1998. In order to collect such material, a mission was undertaken in early 1998 to Bahrain, Brazil, China, India, Poland and South Africa.

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Acting upon the instructions of the Secretary General of IMO or other officials acting on his behalf, the consultant shall, during a two-week period in June 1998, carry out the following tasks:

- undertake a fact-finding mission to Iran and Ukraine to hold discussions with government officials and other parties interested in harmful aquatic organisms carried in ballast water, including maritime, port and health authorities and the shipping industry with a view to identifying ballast water management strategies, barriers to be removed and strategies for barrier removal which confirm with regional characteristics, including oceanographic features, government structure, scientific capacities, economic systems and cultural variables;

- confirm their willingness to implement the IMO guidelines for control and management of ships' ballast water to minimise the transfer of harmful aquatic organisms and pathogens:

- confirm their willingness to: a) select a specific port as demonstration site: b) select a national focal point (NFP) and a Steering Committee including representatives from the region;

- confirm their willingness to carry out, or take part in, specific treatment methods for ballast water;

- define demonstration activities in terms of objectives, outputs and activities and inputs with a costing for each item:

- include consideration of special modalities like manpower surveys, twining with developed countries, use of existing facilities, links to existing (East Asian Seas, Black Sea) where appropriate;

- clearly distinguish between the cost of baseline operations (what is being done now) and incremental costs and benefits (what will be done additionally) using inputs from government, private sector and GEF/UNDP/IMO;

- consultant should be familiar with GEF incremental cost procedures;

- consult with UNDP Resident Representative, GEF operational focal points and other to obtain a letter from GEF operational point to the UNDP Resident Representative with a copy to the GEF Secretariat (Mr. Al Duda) and UNDP Headquarters (Mr. P. Reynolds) in support of the project;

- keep careful records of names, titles, organisations, telephone/fax numbers and E-mail addresses of all persons contacted;

- carry out other relevant duties falling within the scope of his competence;

- visit IMO for one day debriefing;

- submit a report in hard copy and on diskette to IMO by 20 July 1998.

ANNEX 2

ITINERARY AND SCHEDULE OF MEETING

Sunday, 5 July 1998	
A.M. & P.M.	Travel to Odessa, Ukraine Preliminary discussion with the representatives of the Department of Merchant Marine and River Transport
Monday, 6 July 1998	
A.M. & P.M.	Discussion with government officials representing the Ukrainian authorities and other parties interested in harmful aquatic organisms carried in ballast water. Participants :
	- Cpt. Leonid P. Chaikovsky, Deputy Director, Head of Maine State Marine Inspection of Ukraine, Ministry of Transport, State Department of Merchant Marine & River Transport, Odessa tel : + 380482 682784, fax : + 380482 683932, tlx : 380482 232127 DMRTU UX
	- Mr. Vladimir G. Rabotniov, Head of Ecological Division, State Department of Maritime & Inland Water Transport, Marine Administration of Ukraine Odessa tel : + 380482 637387, fax : + 380482 685773, tlx : 380482 232127 DMRTU UX
	- Mr. Sergey P. Limanchuk, Chief Expert, Southern Institute of Merchant Marine, Lanzheronovskaya Str. 15a, 270026 Odessa Ukraine tel : + 380482 200346, fax : + 380482 200256, tel : 380482 239129
	- Prof. Yuvenaly P. Zaitsev, Doctor of Biological Sciences, Full Member of the National Academy of Scinces of Ukraine, Chief Scientist of the Institute of Biology of Southern Seas, Odessa tel : + 380482 250917, e-mail : inbum @ farlep. net
	- Mr. Vladimir Savusin, Deputy Manager, State Inspection for Protection of the Black Sea, Ministry of Environmental Protection and Nuclear Safety of Ukraine, Odessa tel : + 380482 251447, fax : + 380482 251446
	- Mr. Evgeni Patlatiyk, Chief of Section for Analitical Chemistry, State Inspection for Protection of the Black Sea, Ministry of Environmental Protection and Nuclear Safety of Ukraine, Odessa tel : + 380482 253363, fax : + 380482 251446
Tuesday, 7 July 1998	
A.M.	Consultations regarding the "Ballast Water Project" with the Deputy

	Minister of the Environmental Protection and Nuclear safety, Global Environment Facility Operational Focal Point for Ukraine
	- Mr. Vasyl Vasylchenko, Deputy Minister, Kiev tel : + 380482 2287798, fax : + 380482 2298383 Consultation regarding the "Ballast Water Project" with UNDP Resident Representative in Ukraine
	- Mr. P.P. Villanueva, UNDP Resident Representative in Kiev tel : + 380482 2935559 Discussions with the representatives of the Department of Mercahnt Marine & River Transport
P.M.	Discussions with representative of the Ministry of Health
	- Mr. Vladimir P. Sidenko, Chief Member of Staff of Research Institute of Medicine and Transport, Connsellor of the Academy of Engineering of Ukraine tel : + 380482 618291 Visit to the Laboratory of the State Inspection for Protection of the Black Sea
Wednesday, 8 July 1998	
A.M.	Discussion with the other interested parties in the premises of the Department of Merchant Marine & River Transport
	- Mr. Igor S. Borovskiy, Manager of the Environmental Department, Odessa Sea Commercial Port tel : + 380482 294677, fax : + 380482 294627
	- Mr. Anatoly Kudiukin, Head of the Environment Department of the "Black Sea Shipping Company" (BLASKO) tel : + 380482 285314, fax : + 380482 285315
P.M.	Site visit of the Port of Odessa, the selected demonstration site. Discussions with : - Mr. Maxim Bykov, Director of the Odessa Port Reception Facility tel : + 380482 294555, fax : + 380482 285315
Thursday, 9 July 1998	
A.M.	Conclusion session in the Department of Merchant & River Transport
P.M.	Travel to Istanbul (Turkey)
Friday, 10 July 1998	
A.M. & P.M.	Travel to Teheran (Islamic Republic of Iran)
Saturday, 11 July 1998	

A.M. & P.M.	Discussion with government officials representing the Ministry of Roads & Transportation. Participants :
	- Mr. Mohammad Reza Ghaderi, Director General Maritime Affairs, Ports & Shipping Organisation, Teheran tel : + 9821 8808989, fax : + 9821 8811992, tlx : 0212271 BNDR-IR
	- Mr. D. Sharifi, Director General, Specialized Organisations, Ports & Shipping Organisation, Teheran tel : + 9821 8809377, fax : + 9821 8807805
	- Mr. H. Izady, Head of Safety Office, Ports & Shipping Organisation, Teheran tel : + 9821 8808989, fax : + 9821 8811992
	- Mr. H. Mohit, Marine Protection Office, Ports and Shipping Organisation, Teheran tel : + 9821 8809326, fax : + 9821 8811992
	- Mr. Keyvan Rad, Marine Environment Surveyor, Ports & Shipping Organisation, Teheran tel : + 9821 8809280, fax : + 9821 8807805
	- Mr. H. Aligholian, Translation Services, Ports & Shipping Organisation, Teheran tel : + 9821 8807741
Monday, 13 July 1998	
A.M.	Discussions with the representatives of the Department of the Environment. Participants :
	- Mr. M. Saeid Hosseini, Director General, Marine Environmental Research Bureau tel : + 9821 8808776, fax : + 9821 897223, P.O.Box 5181. Nyatolahi. Ave Teheran 15875 I.R. Iran
	- Mr. Omid Sedighi, marine Biologyst, Marine Environment Research Bureau, Teheran tel : + 9821 8808776, fax : + 9821 897223
P.M.	Discussions with the representatives of the Ministry of Health. Participants :
	- Dr. Reza Labbaf Ghassemi, specialist in tropical and infectious deseases, Director General of Deseases Control, Teheran tel : + 9821 8827265, fax : + 9821 830444
	- Dr. Youshia Pireh, Deseases Control, Teheran tel : + 9821 8828433
	- Mr. Manouchehr Alaie, engineer, General Department of Environmental and Occupational Health, Teheran tel : + 9821 8865773, fax : + 9821 8865771
	- Mr. Alireza Alimohammadi, expert, Environmental and Occupational Health Department, Minstry of Health and Medical Education, Teheran

	tel : + 9821 8865774
	- Mr. Seyed E. Asaei, chief expert, General Department of Environmental and Occupational Health, Ministry of Health and Medical Education tel : + 9821 8865774, fax : + 9821 8865771
Tuesday, 14 July 1998	
A.M.	Discussions with representatives of the Ministry of Jehad, Iranian Fisheries Researsch and Training Organisation. Participants :
	- Mr. A. Nikooyan, senior fisheries tel : + 9821 8751498, fax : + 9821 8751495
	- Mr. N. Pourang, marine ecologyst, Marine Ecology Division tel : + 9821 8751495, fax : + 9821 8752870
	Consultations with UNDP Resident Representatives Office in Teheran - Dr. Hamid Reza Ghaffarzadeh, Assistant Resident Representative (Programme) tel : + 9821 8732812, fax : + 9821 8738864, tlx : 212397 UNDP IR, e-mail : hrghaffarzadeh @ hotmail. com
P.M.	Discussions with representatives of National Iranian Tanker Company, Teheran
	- Mr. Arash Salimi, Opeartion Department tel : + 9821 21932206, fax : + 9821 2223011
	- Cpt. H. Yousepour, Operation Department tel : + 9821 21932206, fax : + 9821 2223011
	- Ms. Saina Taaghol, pollution prevention surveyor tel : + 9821 2193323
Wednesday, 15 July 1998	
P.M.	Discussions with reprsentatives of the Ministry of Culture & Hugher Education, , National Oceanographic Commssion. Participants :
	- Prof. Dr. H. Zomorrodian, Director, Iranian National Center for Oceanography, Teheran tel : + 9821 6416556, fax : + 9821 6419978, e-mail : inco @ istn. irost. conr
	- Mr. Omid Haeri Ardakani, sedimentology expert tel : + 9821 6416556
	- Mr. Arash Sharifi, petrologist e-mail arasshgeo @ Khaian. ut. ar. ir.
	- Dr. Hamid Lahijani, sedimentologist tel : + 9821 6416556
	- Mr. Mohammad Reza Shokri, marine biologist tel : + 9821 6416556
	- Mr. Hossein Fazeli, maritime studies
	- Mr. Mohammad Reza Sheikholeslami, marine environmentalist, Head of Marine Environment and Coastal Management Department

	tel : + 9821 6416556
	- Dr. Peyman Eghtesadi Araghi, marine Biochimist tel : + 9821 6419891
	Consultation with GEF Operational Focal Point Office for Iran. Participants :
	- Mr. M. R. Salamat, deputy, Department of International Economic Affairs, Teheran tel : + 9821 3212675, fax : + 9821 674176
	- Mr. Hossein Moeini, Second Secretary, Department for International Economic Affairs, Ministry of Foreign Affairs, Teheran tel : + 9821 3212675, fax : + 9821 674176
P.M.	Conclusion session with the representatives of PSO. Participants : same as for the first day (11 July 1998)
Thursday, 16 July 1998	
A.M. & P.M.	Travel to Bucharest via Istanbul

Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries

prepared by

Dr. Stephan Gollasch

This report is an extract of the main-report entitled: "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" supporting a joint GEF/IMO/UNDP project, initiated by the IMO, with background information. Due to the minimized time available to collect these information the compiled lists claim not to be complete but shall give an overview relevant to the subject.
Please, consult the main-report for further details and given references.

Abbreviations used:

ABWMAC Australian Ballast Water Management Advisory Council
ANS Aquatic Nuisance Species
AQIS Australian Quarantine and Inspection Service
BMB Baltic Marine Biologists
CRIMP Centre for Research on Introduced Marine Pests (Australia)
CSIRO Commonwealth Scientific and Industrial Research Organization (Australia)
CSA Canadian Shipping Act
EEZ Exclusive Economic Zone
FAO Food and Agriculture Organization of the United Nations
FWS Fish and Wildlife Service (USA)
GEF Global Environment Facility
GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (IMO/FAO/UNESCO-IOC/WMO/IAEA/UN/UNEP)
HAB harmful algal bloom
IAEA International Atomic Energy Agency
IBIN Indigenous Peoples Biodiversity Information Network
ICES International Council for the Exploration of the Sea
ICS International Chamber of Shipping
IHS Import Health Standard (New Zealand)
INTERTANKO International Association of Independent Tanker Owners
IPHAB Intergovernmental Panel on Harmful Algal Blooms (IOC)
IMO International Maritime Organization
IOC Intergovernmental Oceanographic Commission
IUCN The World Conservation Union
MEPC Marine Environment Protection Committee (of IMO)
NEMO Non-Indigenous Estuarine and Marine Organisms (BMB Working Group)
NISA National Invasive Species Act (USA)
NOAA National Oceanic and Atmospheric Administration (USA)
SERC Smithsonian Environmental Research Centre (USA)
SGMBIS Study Group on Marine Biocontrol of Invasive Species (ICES)
SGBWS Study Group on Ballast Water and Sediments (ICES/IOC/IMO)
SOLAS International Convention for the Safety of Life at Sea, 1974
UN United Nations
UNDP United Nations Development Programme
UNEP United Nations Environment Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
VPC Vancouver Port Corporation (Canada)
WGITMO Working Group on Introductions and Transfers of Marine Organisms (ICES)
WHO World Health Organization
WMO World Meteorological Organization

1 Introduction

The unintentional introduction of nonindigenous organisms has resulted in the establishment of many species outside their native ranges with the potential to threat native environments and economies.
It is assumed that the main vector concerning transportation of organisms is, beside the introduction of species for aquaculture purposes, the unintentional transport with ships. Since the introduction in the late 19. century of steel hulled vessels ballast water discharges have increased considerably throughout the world and the probability of successful establishment of selfsustaining populations of non-indigenous species increased with greater volumes of ballast water as well as with reduced ship travel times. The first suggestion of an unwanted species introduction was made by Ostenfeld (1908) after a mass occurrence of the Asian phytoplankton algae *Odontella* (*Bidulpphia*) *sinensis* in the North Sea in 1903. Several decades later a survey was carried out by German scientists sampling the Suez Canal flora and fauna. At that time some ships did use ocean water for cleaning purposes pumped on board via segregated pipework. One of the plankton scientists realised that this cleaning water contained organisms and sampled it for his plankton study. This was the preferred way of sampling because the ship was able to continue its voyage without a stop for sampling. But the scientists on board did not realise that in the same way as for cleaning purposes water was pumped on board to fill the ballast tanks and that species may survive this pumping activity as well. The first shipping studies including sampling of ships' ballast water appeared 70 years later by Medcof (1975) followed by those of Carlton (1985, 1987), Hallegraeff & Bolch (1992) and Subba Rao et al. (1994). Rosenthal (1976) reviewed the state of knowledge and the risks associated with the transplantation of non-indigenous species to fisheries and aquaculture, including ballast water as vector. The study concluded that modern aquaculture development in the coastal zone was at high risk of disease transfer from ballast water in cases where aquaculture facilities and areas of fishing were located near shipping routes. The recent worldwide growth of aquaculture along such infrastructure elements amplifies this risk, possibly rendering disease regulations for this industry useless in many areas. An annotated bibliography on transplantation and transfer of aquatic organisms through various means (including ballast water) is presently under preparation, covering more than 10,000 literature entries (Rosenthal 1998, final draft).
After having been made aware of the problems, the International Council for the Exploration of the Sea (ICES) established a working group in the end of the 1970s (Working Group on Introductions and Transfers of Marine Organisms (WGITMO) in order to evaluate quarantine measures dealing with living imports of species for aquaculture and accordingly developed an ICES Code of Practice (Carlton 1992, Sindermann 1992). The ICES WGITMO further emphasised the need to follow the IMO Assembly resolution A.774 (18): "Guidelines for the Control and Management of Ship’s Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens” during preparation of this report resolution A 774 (18) is being replaced by IMO resolution A 868 (20). In addition to the WGITMO ICES, IOC and IMO established in 1997 a joint Study Group on Ballast Water and Sediments (SGBWS). Other regional bodies particularly relevant in this field are a working group of the Baltic Marine Biologists (BMB) on NonIndigenous Estuarine and Marine Organisms (NEMOs), an adhoc group established in 1994 with a term of reference covering 45 years.

Non-indigenous species are not only introduced with ballast water and associated sediments, but also as fouling organisms on the ship´s hull. However, efficient biocidal antifouling paints currently used considerably reduce the number of fouling organisms on ship´s hulls. Accordingly the major problem in transmission of harmful aquatic organisms, therefore, resides with the continued transfer of ballast water of ships, in particular bulk carriers and container ships of different design and dimensions.

It has been estimated that the major 40,000 cargo vessels of the world (Stewart 1991) are transferring 10 billion tonnes of ballast water globally per year indicating a global concern for this problem. Ballast water may be taken in from eutrophicated coastal areas containing hundreds of species which may survive voyages of several months duration. It has been demonstrated that in average 3,000 (Carlton & Geller 1993) to 4,000 species (Gollasch 1996) are transported daily by ships. Species discharged with ballast water into the next port of call may threaten native populations, fishing industries and public health.

The likelihood of an introduced species to settle in new regions and to create problems depends on a number of factors, primarily related to the biological characteristics of the species and the environmental conditions in which the species has been introduced. Additional factors are climate, number of introduced species (size of founder population), native competitors and the availability of food. Species are more likely to establish in environments that are similar to those environment of their origin. Therefore, if the port of loading and port of discharge are ecologically comparable the risk of a species introduction is relatively high.

Some invaders affected native flora and fauna by competing for food, habitat and other recourses. The ecological worst case is the replacement of a native species caused by the exotic invader. This can effect not "only" one single newly extinct species but also any other organism dependent on it as a food source or habitat. As a result the food web structure may intensively change after the introduction of one single species.

It is the aim of this report to summarise ongoing research and to lists national and international regulations on non-indigenous species and / or ballast water. In addition assistance in the effective implementation of guidelines is given.

Need for ballast water management

Since it is well known that eradication of an introduced species which established in a new marine environment will be either very expensive or even impossible. Efforts to prevent or minimize introductions should be given high priority.

Ballast water that is discharged when a ship arrives in most cases has been taken on board in fare away areas. During the intake of the ballast water, organisms and sediment as well as contaminants may have also been taken on board, especially if the area of intake is shallow. If the ballast water is discharged, parts of the sediment and organisms, which survived the voyage also will be discharged. It is impossible to predict the effects which these introductions will cause to the ecology and economy by threatening aquaculture sites, damaging port installations, causing diseases and reducing the aquaculture production.

The great number of nonnative species introduced in several regions all over the world called for the need to develop treatment options in order to minimize the amount of introduced species. The impact of each introduced species is unpredictable because of the extremely high number of connected parameters (Courteney & Taylor 1986). A species showing no negative impact in its area of origin may cause serious damages to economy and ecology to any new locality where it has been intentionally or unintentionally introduced (worst case if these are commercially harvested) (Rosenthal 1980, Williams & Sindermann 1991, Kern 1994, Grosholz & Ruiz 1995, Holmes & Minchin 1995).

Desk studies revealed that 53 nonindigenous species of macro fauna and flora in British waters (England, Scotland and Wales), 24 exotic organisms in Cork Harbour (Ireland) more than 100 in

German waters (North Sea and the Baltic) and about 70 nonnative species have been found along the Swedish coasts. A least half of the species quantity is believed to have been introduced with shipping. More than 145 species are known to have been introduced and established in the Mediterranean Sea. Nearly half of the total number of these nonindigenous species are believed to be introduced by shipping (Ben-Tuvia 1953, Rubinoff 1968, Ben-Eliahu 1972, Walford & Wicklung 1973, Krapp & Sconfietti 1983, Zibrowius 1991, Boudouresque 1994, Galil 1994).

The area which is supposed to be the habitat with the highest numbers of nonnative species in the world is located at the west coast of the USA, the San Francisco Bay. In total 213 exotic species were found in the San Francisco Bay until today (Carlton 1994, 1995). In the Hudson estuary 120 non-indigenous species were found (Swanson 1995) and 139 non-indigenous aquatic species have been recorded from the Great Lakes (Mills et al. 1990). The total number of aquatic non-indigenous North American species was estimated the higher than 250 (Carl & Guiguet 1957, Bousfield & Carlton 1967, Carlton 1985, 1987, Mooney et al. 1986, Smith & Kerr 1992, Mills et al. 1993, Carlton et al. 1995, Grosholz & Ruiz 1995, Smith 1995). In total 103 species are believed to be introduced with ballast water (Carlton et al. 1995).
Vessels calling for Australian ports come from more than 300 ports of 53 counties around the world introducing approx. 121 million tons of ballast water each year (Jones 1991, MEPC35/INF.19). In addition, over 4,000 vessels per year move more than 34 million tonnes of ballast water between Australian ports. In total 172 marine pests had been introduced into Australia’s marine environment (Hoese 1973, Paxton & Hoese 1985, Hutchings et al. 1986, Hutchings 1992, Hallegraeff & Bolch 1991, 1992, Rigby et al. 1993), mostly through ballast water (Thresher pers. comm.) These include molluscs, crustaceans, polychaete worms, seaweeds and toxic phytoplankton species. The species established themselves and some of them even found excellent conditions. Phytoplankton bloomed and entered the food chain via shellfish feeding. The toxins of some phytoplankton species are known as Paralytic Shellfish Poisoning (PSP), which may paralyse or even kill humans who consume affected shellfish. Recent cases of damage resulted in the need to close down all harvesting of shellfish on the River Huon river estuary in Tasmania, in Port Phillippe Bay, Victoria and in Port Jackson, New South Wales, following a bloom of introduced toxic phytoplankton algae (dinoflagellates) in 1993 (Jones 1991, AQIS 1993).

The number of species carried in ballast water is an indicator for the need of treatment. Several studies showed that more than 50.000 zooplankton species may be found in one cubic meter of ballast water. Usual densities of species are around 10.000 specimens per cubic meter of ballast water. Calculations revealed that a total of several 10.000s or even millions of organisms were transported in the ballast water of a single ship (Locke et al. 1991. 1993, Gollasch 1996, Kabler 1996). The German shipping study revealed that in average each vessel calling for a German port contained in its ballast water, tank sediment and on the ships hull in total more than 4 million specimens of macrofauna (ballast water 300,000 specimen from up to 12 different species in one sample, tank sediment 2 million specimens, hull fouling 1,8 million specimens) (Gollasch 1996). The number of phytoplankton species is even several times higher. Lenz et al. (in prep) listed up to 110 million phytoplankton specimen in 1 m³ in ballast water and maximal 150 cysts in 1 cm³ of ballast tank sediments. A Canadian study showed that more than 10 million phytoplankton cells were collected in 1 m³ (Subba Rao et al. 1994) and the content of viable cysts of the dinoflagellate *Alexandrium tamarense* in one ballast tank was estimated to be more than 300 million cysts (Hallegraeff & Bolch 1992). Even up to 22,500 phytoplankton cysts per cm³ were found in tank sediments during Australian studies.). Investigations by Hallegraeff and Bolch between 1989 1991 showed that viable dinoflagellate cysts were found in up to 6 % of the vessels entering Australian ports. The List of organisms reported to have survived ship voyages in the ballast water of vessels is being extended after each sampling programme world-wide (Howarth 1981, Kelly 1992, Locke et al. 1991, Müller & Reynolds 1995, Carlton 1985, 1987, Carlton & Geller 1993, Carlton et al. 1995). Cysts of some phytoplankton species may remain viable under unfavourable conditions for 10 to 20 years (Hallegraeff & Bolch 1992).

The existing potential risk of negative impact of harmful phytoplankton species on marine aquaculture was indicated. In 1988, the total world aquaculture production was estimated at 14 million tons (FAO 1990). Therefore operational and procedural practices dealing with ballast water are necessary to prevent unwanted impacts (Subba Rao et al. 1994). The treatment of ballast water is necessary in the light of increasing risks involved with ballast water releases. Firstly, shipping activities have increased over the past decades with corresponding increases of amounts of transported ballast water. Secondly, the duration of ship voyages has decreased due to technical improvements resulting in faster ships. Reduced duration of species in a ballast tank increases the survival rate. Thirdly, the amount of exotic marine organisms in ballast water seem to be increasing. As example dinoflagellate blooms appear increasing worldwide probably due to changing eutrophic conditions and climate changes. Therefore the probability of an uptake of these species in ballast water is increased. Fourthly, the increase in aquaculture worldwide increases the potential of the unintentional spread of diseases and parasites which after their establishment in a new areas may be distributed further as e.g. larvae in the ballast water of ships (Jones 1991).

Therefore the uncontrolled discharge of untreated ballast water is a major international problem. It is up to governments, environmental agencies and the shipping as well as the fishing industries to make commitments with a view to identifying a solution to this very complex problem. The presence of human disease agents as e.g. Cholerabacteria in ballast underlines the need for ballast water treatment (see below). Ignoring the problems that may be caused by introduced species with ballast water could be analogue to an ecological roulette (Carlton & Geller 1993, Hedgpeth 1993). We cannot estimate any probability (as in a roulette game) due to the great number of parameters involved. In the same way as the ecology, major problems may occur impacting local aquaculture business or other economically important activities.

Inventory of worldwide activities

Several research projects on ballast water or non-indigenous species are currently undertaken or have been finished recently. The involved countries are (in alphabetical order): Australia, Baltic countries, Belgium, Canada, Croatia, Germany, Finland, France, Ireland, Israel, Japan, New Zealand, Norway, Spain, Southafrica, Sweden, The Netherlands, United Kingdom (England**,** Wales and Scotland) and the USA. Summarized results of shipping studies shall give an overview on the variety of species which can be found in the ballast water.

Germany

A shipping study supported by the German Government revealed that in none of the ballast water samples abiotic parameters were estimated to be of lethal nature. However, not all samples contained organisms. Organisms were found in 73.5% of all ballast water samples. Among the factors determining survival in ballast water tanks, tolerance towards changing environmental conditions seems to be the most important factor as evidenced during a voyage on board a container vessel from Singapore to Bremerhaven (Germany). Daily sampling of different ballast tanks revealed dramatically varying temperature and oxygen contents. These are important factors influencing the survival of organisms inside the ballast tanks.

The main phytoplankton groups recorded in ballast water were diatoms, dinoflagellates and Chlorophyceae. All phytoplankton species that were recorded are occurring in a wide range of geographical areas and had probably been spread by earlier transport of ships. Of the total 147 species, 11 nonindigenous phytoplankton species were recorded, 8 diatom species in ballast water, and 3 dinoflagellates in sediment samples. Among the 11 nonindigenous species were 2 dinoflagellate genera (Alexandrium and Gonyaulax) which are known for toxin production.

The zoological results of the ballast water investigation were dominated by Copepoda and Rotatoria, and up to 15 cm long fishes found in ballast water samples. With increasing age of ballast water (time period spent in the tank), the number of species and specimens decreased. Of the 257 species identified, 150 were classified as nonindigenous species to German waters. In general, about 1 animal per 1 l ballast water was recorded. This means an introduction of 69 zooplankton organisms per second or 6 million per day with ballast water from outside Europe. The potential for the establishment of nonindigenous species was classified into three categories according to how the climatic conditions in the area of origin compared to those in German waters (low, medium, and high risk of introduction). Ballast water was estimated as an important vector for future introduction of nonindigenous species in our waters, since most of the species with the highest potential for survival and establishment have been recorded here, and not in sediment and hull samples (Gollasch 1996, Lenz et al. in prep.).

The survival of plankton organisms in ballast water tanks was studied during a voyage of 23 days with a container vessel from Singapore to Bremerhaven (Germany). Previous ballast water investigations during ship voyages showed the decrease of specimens and the reduction of diversity according to the time the ballast water stayed in the ballast tanks. As expected, the number of specimens decreased dramatically in one of the two investigated tanks. In the second tank the number of individuals of one harpacticoid copepod, *Tisbe graciloides*, increased from 11 specimens per 100 litre at the beginning of the investigation to more than 1,000 specimens at the end. An increase of specimens during ship voyages has never been documented before. This new dimension of species transportation in ships ballast tanks shows that ballast tanks may be incubators under special conditions and emphasises the risk of species transport with ships (J. Lenz, H.G. Andres, S. Gollasch & M. Dammer, in prep).

United Kingdom

Biological analyses focused on planktonic organisms, including motile phytoplankton and zooplankton in ballast water, and resting cysts of dinoflagellates in ballast tank sediments. Full resting cysts of dinoflagellates were found in 62% of sediment samples, including cysts belonging to potentially toxic species associated with Paralytic Shellfish Poisoning (PSP). These were partly cysts representing the resting stages of the dinoflagellates Alexandrium minutum and Gymnodinium catenatum, species not currently described from UK waters. 51%of cysts incubated in culture media during preliminary investigations into the viability of cysts hatched into motile dinoflagellate cells, and many phytoplankton species also flourished in sediment slurries incubation experiments. Motile phytoplankton was found in 133 of the 134 ballast water samples. These samples contained a wide range of organisms, reflecting the diversity of their geographic origins and characteristics. Potentially toxic species of diatoms (*Pseudonitzschia* spp.) and dinoflagellates (*Dinophysis* spp. and *Alexandrium* spp.) were observed. The problems of identifying toxic flagellates were outlined. Phytoplankton assemblages taken from ballast tanks prior to and following midwater exchange in the North and Irish Seas were compared. This practise appeared to be less effective at reducing the diversity and abundance of phytoplankton cells than midwater exchange in oceanic waters, and these are important implications for future ballast water management guidelines.

Analyses of zooplankton in ballast tanks showed the great diversity in taxa transported in ballast water, and demonstrated that many organisms appeared to survive the ballasting operations and voyages. Two nonindigenous species of calanoid copepod were observed, and five species (four copepods and one polychaete) only rarely seen in Scottish waters were found. The results showed further that resting cysts of toxic dinoflagellates are a major problem which should be addressed in future ballast water treatment options (Macdonald & Davidson 1997).

Norwegian "Sture" study

Preliminary results of the ballast water samples partly investigated so far showed that live phytoplankton were found in 96 % of the vessels, live copepods were found in 90 % of the vessels, live Cirripedia were found in 80 % of the vessels, live Polychaeta were found in 50 %, and fish eggs in 20 % of vessels. In addition many more taxonomic groups are present in the samples, and live fish and crabs have been observed (Botnen pers. comm.).

USA

Several North American studies were undertaken to sample the ballast water of ocean-going vessels. Main focus of the North American studies was the zooplankton introduced with ballast water (the Australian working groups were concentrated on phytoplankton (see below).
A shipping study revealed that in total 367 different species sampled on 159 vessels calling for the port of Coos Bay, Oregon, USA. The study concentrated on one specific shipping route (Japan to the North American west coast) (Carlton & Geller 1993). An earlier investigation of Carlton et al. (1982) and Carlton (1985) focused on bulk carrier entering North American ports without any cargo but with high loads of ballast water. The predominantly found taxa of all studies belonged to Crustacea, Mollusca and Polychaeta.
An additional sampling programme at the Smithsonian Environmental Research Centre (SERC) revealed the presence of living species in ballast water in 25 of 27 ships entering the Chesapeake Bay (Ruiz pers. comm.). The minimum number of species found in ballast water arriving to the Chesapeake is reported as 221 in (Smith et al. 1996).

Canada

The Canadian study revealed that existing data on pH, temperature, oxygen and salinity of the ballast water does not inhibit a broad range of organisms from surviving. In four ballast samples streptococci were found. The concentration in two samples exceeded the criteria level for public surface water supplies. The maximum number of coliform bacteria (4,600 per 100 ml) were slightly less than the maximum permissible level (5,000 per 100 ml).

In total more than 150 species of phytoplankton were identified. All ballast water samples contained aquatic flora. The macrophyt component consisted of fragments only. In 76 % of the ships in minimum one viable algae had survived the transport in ballast water. Of the eleven major phytoplankton divisions only Chloromonadophyta were absent. 9 species were estimated to have the potential of becoming introduced into the St. Lawrence estuary.

The aquatic fauna (over 56 species) consisted entirely of invertebrate species. Zooplankton represented the majority of animal organisms found in the ballast water samples. 89% of all ships contained at least one viable invertebrate form. The assembly of found species consisted of Protozoa, Rotifera, Nematoda, Mollusca, Annelida, Tardigrada, Acarina, Crustacea and Chaetognatha. Occasionally terrestrial insects were found. Their occurrence in the ballast water was quoted as probably accidental. 9 species of flora and fauna were estimated to have the potential to become introduced into the St. Lawrence estuary (Howarth 1981).
The results of the ballast water sampling of 455 ocean-going vessels entering the St.-Lawrence Seaway carried out by Locke et al. (1991, 1993) revealed 107 taxa. All sampled ballast tanks contained living

zooplankton. Predominately found organisms were copepods, water fleas and rotifers. The maximum number of specimens was comparably high with more than 50,000 species per m³ of ballast water. A sample with the minimum number of specimens contained 21 specimens per m³ (Locke et al. 1991, 1993).
Subba Rao et al. (1994) published a study of exotic phytoplankton species from ballast water and their potential spread and effects on mariculture localities. Ballast water was analysed from 86 foreign vessels that visited the Great Lakes area during 1990 and 1991. In total 102 taxa of 7 taxonomical groups were determined, 69 diatoms and 30 dinoflagellates were collected. Most of the phytoplankton were found in a good condition. In total 21 potentially bloom-forming (red tide) and / or toxin producing phytoplankton species were found in the ballast water samples. Several of the species were found for the first time is this geographical region (Subba Rao et al. 1994).

Australia

A zoological study revealed that in 23 samples of ballast water 67 taxa were determined. Crustacea (mainly Copepoda) and Mollusca were the most abundant taxa found (Williams et al. 1988).

Additional sampling carried out before 1990 showed that in 35 % of 343 samples of ships entering 18 different Australian ports dinoflagellates were found. In total 53 species of planktonic and benthic species of dinoflagellate and diatom were collected. Due to the frequent findings of phytoplankton in ballast tanks it was assumed that the world-wide distribution of some species could be related to the transport in ballast water. The toxic dinoflagellates *Alexandrium catenella*, *A. tamarense* and *Gymnodinium catenatum* were found in samples from 16 vessels (Hallegraeff et al. 1986, Rigby et al. 1993, Hallegraeff & Bolch 1992). It is known that one vessel filled its ballast tank during a phytoplankton bloom of toxic species in the port of Muroran (Japan). After its voyage to Australia the ballast water of this vessel was sampled, revealing more than 300 million cysts of the species *Alexandrium*.

New Zealand

Results of the research programme entitled „Foreign organisms entering NZ coastal waters via discharge of ballast water„ showed that about 80% of tanks sampled contained live phyto- and zooplankton. About half of these tanks were reported to have been exchanged in mid-ocean suggesting that mid-ocean exchanges do not remove coastal marine life. Some zooplankton taxa (e.g. polychaete worms with their tubes still intact) appear to be persistent residents in the tank sediments. Many of the invertebrates found were larvae which hindered taxonomic resolution (Taylor pers. comm.).

The need for standardisation of sampling methods

For all of the above mentioned sampling programmes specific sampling methodologies were used. The development of globally applicable standard sampling methodologies for collecting and analysing ballast water from ships is needed. Sampling methods may vary according to the behaviour and the taxa of species considered to be harmful. It may be necessary to consider different techniques according to the local conditions of each port, country or region. Protocols need to be developed to address these issues.
The IMO / MEPC Ballast Water Working Group considers the development of ballast water management plans identifying the location and suitable points for sampling ballast water or sediment.

This would enable the ship´s crew to provide maximum assistance when port authority inspections require samples of ballast water or sediments.

In cooperation with 5 European countries: Finland, Ireland, Sweden and the United Kingdom (England and Scotland) and Lithuania, Germany is coordinating the Concerted Action programme, launced in January 1998, entitled: "Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters". Several experts from all over the world (e.g. North America, Mediterranean Countries, Australia and Asia) will be participating. This two year Concerted Action was funded by the EU. Various methods of monitoring ballast water species will be studied evaluating qualitatively and quantitatively the fate of exotic species in ballast water. Sediments accumulating in ballast tanks and fouling biota on ship hulls will also be examined. Treatment measures for the control of exotics will be discussed. Assessment of potential risks from hazardous introductions and their control is an increasing problem of importance.

2 Case histories of introduced species and their effects to environment and ecology

The Australian Bio-Economic Risk Assessment report from 1994 estimated that with an application of effective treatment options costs of US $ 292.5 million of damages in regard to domestic and international tourism, public health and aquaculture could be avoided (ECIL Economics 1994). Until today this has been the only report listing costs what may be saved by the implementation of effective ballast water treatment options and the associated minimization of potentially harmful species introductions.

Flora

Toxic algal blooms (harmful algal blooms (HAB))

The potential of ballast water as a vector to introduce phytoplankton species outside their native range was firstly suggested by Ostenfeld (1908) after a phytoplankton bloom of *Odontella sinensis* in the North Sea in 1903. More recent concerns arose after increasing phytoplankton blooms around the world in the 1980s (Smayda 1990, Hallegraeff & Bolch 1992, Rigby et al. 1993). Increasing toxic algal blooms of nonindigenous species in Australian and New Zealandian waters have been associated with ballast water releases. Australian scientists have since intensified their ballast water studies (Hallegraeff & Bolch 1991, 1992, Baldwin 1992).

In 1992 an IOC-FAO Intergovernmental Panel on Harmful Algal Blooms (IPHAB) had its first session focusing meeting on the negative impacts of these blooms on public health and economy. The expansion of these blooms are related (at least at part) to the increasing exploitation of coastal waters (waste disposal, aquaculture, maritime commerce and other anthropogenic influences) as well as to the dispersal and proliferation of such species. It was noted that in order to foster the effective management of, and scientific research on harmful algal blooms to understand their causes, predict their occurrences and mitigate their effects a lack of information exists (IOC-FAO IPHAB 1992, 1993). Outbreakes of Paralytic Shellfish Poisoning (PSP) in Norwegian waters and coastal areas of the United Kingdom cuased by HABs were recorded in the past. *A. minutum* was observed for the first time at the Swedish west coast being abundant during end of June (Lindahl & Edler 1997) it was also present in samples of the North Sea and the Atlantic, the Mediterranean Sea, east coast of the USA, Japan, Australia and New Zealand (ICES WGITMO 1997). In January 1993 the whole New Zealand shellfish industry (export and domestic use) was closed as a result of toxic algal blooms. Knowing that the transport the exotic phytoplankton species in ballast water may result in new phytoplankton blooms after discharge of the ballast water, vessels were requested not to discharge ballast water in any Australian or New Zealandian port or to exchange their ballast water before releasing it in an Australian or New Zealandian port.

Caulerpa taxifolia

The accidental introduction of the alga *Caulerpa taxifolia* into the Mediterranean Sea and its spread through regional shipping and boating had been subject of research by the European Union. The seaweed *Caulerpa taxifolia* was probably introduced into the Mediterranean Sea in the mid 1980s: First records were made in the Monaco area (Meinesz & Hesse 1991, Boudouresque et al. 1992). *Caulerpa* covered in 1984 a surface of 1m². In 1990 it covered 3 ha, in 1991 30 ha, in 1992 427 ha, in 1993 1,300 ha, in 1994 1,500 ha and in 1996 more than 3,000 ha. Today it covers the surface of thousands of hectares along the coasts of France, additional records were documented from Spain (the Balearean islands (21 ha covered)), Italy and Croatia (Adriatic Sea).

Caulerpa replaces the native seagrasses (e.g. *Posidonia oceanica)* limiting the habitat for larval fish and invertebrates. It therefore endangers the continuity of their populations (Meinesz et al. 1997, Ribera pers. comm.).

Fauna

Dreissena polymorpha

The Zebramussel *Dreissena polymorpha*, a pontocaspian species was unintentionally introduced into the Great Lakes (USA). Nowadays it occurs in very high densities. Besides an ecological harm, this species causes economical problems (Roberts 1990, Lodge 1993). The Zebra Mussel has and will in future cause billions of dollars of damage by fouling underwater pipes in the Great Lakes area. The control, repair and actions to remove the introduced Zebra mussel in the Great Lakes costs US$ 4 8 billion in the next 10 years. The mussels are displacing native bivalves, clogging water intakes and fouling vessel hulls, fishing nets and other submerged hard material as port installations, piers and buoys.

Long before this mussel invaded many areas of Europe via shipping or by natural distribution via freshwater waterways and canals as well as by birds. Mass occurrences appeared in 1850s and 1970s in some German rivers and lakes. In recent times unconfirmed records of the mussel were mentioned for the Shannon Estuary (Ireland) and the River Plate (Argentina). In Argentina the new species creates habitats on drain outlets, industrial and drinking water intake pipe systems clogging the flow rate and threatening the water quality.

Crepidula fornicata

This unintentionally introduced species is native to the north American east coast; it presumably arrived as adult species with imported live mussels or as larvae in the ballast water of ships. First records in European waters were made in the 1880s in England (Robson 1915, Nordsieck 1969, Utting & Spencer 1992). In 1934 records were made in Denmark and Germany. Additional findings were noted in France and Ireland (Minchin et al 1993), Sweden (Farnham 1980), Japan (Walford & Wicklund 1973), North American west coast (Carl & Guiguet 1957, Hanna 1966) and the Mediterranean Sea (Zibrowius 1991). The slipper limpet has a negative impact as food competitor on scallop and other shellfish culture in France and Ireland (Campbell 1987, Eno et al. 1997).

Mnemiopsis leidyi

The ctenophore *Mnemiopsis leidyi,* endemic to the North American Atlantic coats is spreading in the Black Sea area. After its first record in the Black Sea in 1982 additional findings were reported in 1986. Nowadays the comb jelly is well established and occurs in masses. It has played a major role in the profound decline of the local anchovy industry. The population of native ctenophores has almost been completely removed. The fishing harvest of the Anchovies fishery in the Black Sea decreased to 10 % compared with fisheries of the times before the comb jelly invaded the Black Sea (Vinogradov et al.1989, Shushkina & Musayeva 1990, Reeve 1993). Proposed predators as carnivorous fish (e.g. cod from the Baltic, butterfly fish or chum salmon from North America) or ctenophore predating other ctenophore; e.g. *Beroe* sp. from Atlantic North America waters could be intentionally introduced into the Black. A GESAMP report issued in 1997 reviews control strategies and possible predators for biocontrol, as well as the viability of other, nonbiocontrol options (Leppäkoski 1994, Harbison 1994, Harbison & Volovik 1994, GESAMP report 1997). By 1992, the species had spread into the Mediterranean Sea (Harbison 1994).

Asterias amurensis

Established populations of the North Pacific Seastar *Asterias amurensis* have been discovered in the cold-temperate waters of Southern Tasmania. The seastar is native to Japanese and Alaskan Waters and has been known from Tasmanian waters since the late 1980s (first records in 1986). The introduction is believed to have occurred with the discharge of ballast water containing the larvae of the species in Australian waters. The impacts of this starfish on e.g. shellfish industries and the marine environment causes concern. The Pacific Starfish threatens the shellfish industry causing damages of US $ 367.5 million by eating mussels. The prognosis for its future potential is not good. It may settle as far as Sydney (New South Wales) since it has an appropriate water temperature tolerance. A status report on *A. amurensis* by the Commonwealth Scientific Industrial Research Organization (CSIRO) in June 1993 concluded that only physical removal seemed to be a viable in reducing starfish numbers. The application of biocontrol methods is expected, but a success is not guaranteed. It is believed that a disease agent could be used to control the population of the starfish. There are several problems in biocontrol, especially the need to test the control measures treatment in regard to a selective effect on the target organisms and no native species. A possible species for biocontrol could be the Japanese ciliate *Orchitophyra* sp.. After infection, this species disables the host's reproduction. Tests, if this species is able to cause problems by infesting native Echinodermata are being carried out (Furlani 1996, Byrne et al. 1997, Thresher and Goggin pers. com., Report of ICES SGMBIS 1997)

Marenzelleria viridis

The Polychaeta *Marenzelleria viridis* after its introduction probably with ballast water in 1982 is spreading rapidly along the German coast. It was first observed in the Ems estuary (Essink & Kleef 1988, 1993). First records in the Baltic were made in 1985 (Laine 1995) often close to ports, indicating a possible introduction via ballast water (Olenin pers. comm.) Now it is occurring in the various brackish waters of the southern shore of the Baltic Sea (e.g. the Boddens) in great numbers. Its extension to the eastern parts of the Baltic seems to continue and specimens have been found in Finnish waters up to Tvärminne (H. Rumohr, Kiel, pers. comm.).

Human disease agents

Pfiesteria piscicida

The Phantom algae *Pfiesteria piscicida* has not yet been found in European waters, but was recently introduced into the Chesapeake Bay region. It is believed that this species may be transported and subsequently introduced via ballast water or tank sediment (Macdonald per. comm.).
P. piscicida is a dinoflagellate that has been made responsible for recent estuarine fish kills on the U.S. eastern seaboard (see below) and has also been reported to be associated with human illness. *Pfiesteria piscicida* is known in 24 different forms and is able to produce dormant cysts that may remain for years. The dinoflagellate feeds on fish body fluid. The waste from fish swimming above resting stages of the dinoflagellate in the sediments makes the cysts change to a toxic life form. These migrate towards the water surface and anaesthetise the fish with their poison and start to feed on the fish fluids from the body tissue after they have bored in. After the fish died, *Pfisteria piscicida* starts to reproduce and the next generation of cysts return to the bottom waiting for their prey.

Thirteen people who worked with dilute toxic cultures of *Pfiesteria* sustained mild to serious adverse health impacts through water contact or by inhaling toxic aerosols from the cultures. The effects include a suite of symptoms such as narcosis (a "drugged" effect), confusion, development of acute skin burning (in areas that directly contact water containing toxic cultures of *P. piscicida*, and also on the chest and face), uniform reddening of the eyes, severe headaches, blurred vision, nausea / vomiting, sustained difficulty breathing (asthma-like effects), kidney and liver dysfunction, acute short-term memory loss, and severe cognitive impairment (= serious difficulty in being able to read, remember one's name, dial a telephone number, headaches, skin rash, eye irritation, upper respiratory irritation, muscle cramps, and gastrointestinal complaints (i.e., nausea, vomiting, diarrhoea, and / or abdominal cramps). Most of the acute symptoms proved reversible over time, provided that the affected people were not allowed near the toxic cultures again. Some of these effects have recurred (relapsed) in people following strenuous exercise, thus far up to six years after exposure to these toxic fish-killing cultures. The first known fish kills in adjacent waters to the Atlantic Ocean caused by *Pfisteria* were documented in 1988 in fish culture sites of North Carolina (USA). Since 1991 a billion fish have been killed by *Pfisteria* in eastern U.S. waters. Most recently un-confirmed findings of Pfiesteria were noted from the Chesapeake Bay region (USA). However, it will not be possible to determine the extent to which people in European estuaries are being affected by *Pfiesteria* toxins, or whether it is safe to consume fish from toxic outbreak areas, until we have a way to diagnose the presence of these toxins.

Lung disease

In Asia a fatal lung disease caused by the parasite *Paragonimus westermani* (Trematoda) results in cough, peritonitis and pneumothorax (Ichiki et al. 1989) such threatening mammals as rats, dogs, pigs and humans (Davis 1986). The life cycle of this parasite includes two intermediate hosts, the gastropod *Thiara granifera* and the crab *Eriocheir* spp. The gastropod was introduced to the USA (Florida and Texas) (Abbott 1950), and the crab as second intermediate host as well (occasional findings in the Great Lake area and established in San Francisco Bay) (Nepszy & Leach 1973, Cohen 1995, Cohen & Carlton 1995). If both the introduced intermediate hosts will spread and become common in overlapping areas this would complete the life cycle of the parasite. Therefore, it could happen that the lung disease will introduce to the USA.

Cholera

A Cholera epidemic (disease agent: *Vibrio cholerae*) commenced in Easern Celebes (Indonesia) during 1961 and finally completed its encirclement of the globe in 1991. In South America the epidemic wave started on the coasts of Peru and was documented later from several ports of Latin America. Therefore, it is believed that the Cholera had been introduced by maritime traffic (Epstein 1993). In November 1991 and June 1992 the USA documented the detection of active Cholera bacteria in ballast water of vessels coming from South America (McCarthy & Khambathy 1994). Therefore Australia introduced a testing programme for cholera in 1992 of all vessels from South America and other ports known for Cholera outbreaks. This programme is continuing. A number of presumptive positive test for cholera were documented. Six vessels that had been taken ballast on board in ports of the Persian Gulf, Singapore and Indochina provided presumptive readings, indicating possible Cholera. On serological testings all were subsequently proven to be negative. Since that time studies are being carried out in order to evaluate the risk of Cholera introductions to Australia via ballast water.

The introduction in coastal waters of Latin America caused a serious threat to thousands of peoples health after consumption of seafood as bivalves (oysters), crustacean and finfish caught in affected areas (Murphree & Tamplin 1992).

Treatment options

Ballast water management procedures have been investigated to a certain extent but insufficient research has been carried out to assess the effectiveness of applicable ballast water treatment techniques.
Shipboard treatment of ballast water is considered preferable to land based reception / treatment facilities. Particular emphasis has therefore been placed on potential options for shipboard treatment.
A quarantine system does not provide an absolute barrier to prevent the introduction of unwanted nonindigenous species (Carlton et al 1995). It is also assumed that no single treatment process was likely to achieve the required inactivation or removal of unwanted organisms. A two stage approach seems to be most likely. After an initial mechanical treatment process followed by disinfection, a physical treatment process or a technique involving manipulation of the environmental conditions within the ballast tank could provide a solution. Thus when considering the options reviewed, it should be assumed that the mechanical options are largely viewed as preliminary treatment method.

At this stage various methods of treatment that have been put forward and are described as a "tool box" from which the most practical (easy and safe to apply, not damaging existing ship installations as ballast tank coating, isolators and sealing rings), cost effective safe and environmentally sound combination should be selected. To date, international guidelines have been adopted as the IMO Assembly Resolution A.868(20).
Several of the listed options are straightforward statements of good practice but in many circumstances the choices available to an operator will be very restricted. There are indeed two different possibilities of using the ballast water treatment options listed below. First of all, the ballast water is treated enroute. Secondly, a treatment of ballast water may take place at the port of destination. In this way only the countries concerned need to invest, ports can maintain the treatment equipment and the operation would meet port quarantine and local environmental protection laws. But, the IMO does not promote regional (different) systems, emphasising that the ballast water problem is a global issue. Using different provisions and options could result in unwanted regional restrictive practices, restraints of trade and competitive advantages.

IMO Recommendations

In proposing the development the control mechanisms for the introduction of the ballast water in the early 1990s. MEPC adopted guidelines by resolution in 1991 and in 1993 these were adopted by the IMO Assembly under resolution A.774 (18) entitled "International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships Ballast Water and Sediment Discharges". In 1997 the IMO Assembly adopted Resolution A.868 (20) "Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens". This IMO Assembly Resolution is extremely important towards the development of provisions in addressing this international, worldwide problem. IMO has put forward these guidelines to limit the movement of organisms by ballast water worldwide which include the informing of ships on areas where ballast water uptake should be avoided due to the presence of harmful algal blooms and known unwanted contaminants, precautionary procedures when taken on ballast water in shallow areas, ballasting with freshwater, discharging ballast water and sediments to onshore facilities (if available) and the exchanging ballast water at sea.

The IMO Assembly Resolution A.868 (20) recommends an exchange of ballast water in open oceans as far as possible from the shore. The midocean exchange of ballast water is believed to be currently the most reliable method in order to minimize the risk of transfer of unwanted organisms. Compared with coastal waters, deep ocean waters contain less organisms and species occurring in open ocean waters very often are not able to survive in coastal zones and vice versa. Where open - ocean - exchange is not possible, requirements developed within regional agreements may be applicable, particularly in areas within 200 nautical miles from shore. If safety permits all of the ballast water should be released until suction is lost. Stripping pumps or eductors should be used if possible. Where the flow- through method is employed in open ocean by pumping ballast water into the tank or hold and allowing the water to overflow, at least three times the tank volume should be pumped through the tank. This method is nonpolluting the environment at discharging and comparable inexpensive. A set of recommended actions have been adopted by IMO in relation to the uptake of ballast water. The taking in of ballast water in shallow habitats, during prevailing turbidity of water, nearby sewage outfalls, when a tidal stream is known to be more turbid, in areas where tidal flushing is known to be poor, during phytoplankton blooms or relevant disease outbreaks and near dredging sites have to be avoided to minimize the risk of up taking species. In addition ballast water should be wherever possible not be taken in darkness (when bottom dwelling organisms may rise up in the water column) and in very shallow waters or when propellers may stir up sediments.

Ballast water uptakes in port areas characterised by slow tidal currents could result in the uptake of ballast water formerly used by another vessel and just released. This scenario could enable some organisms discharged in the ballast water from one vessel to become transported again pumped in with the ballast water of another vessel.

It has been proposed that ballast water may be analysed in a laboratory on board and that the investigation may provide a certificate of cleanness of the ballast water documenting the absence of harmful aquatic organisms. However, this may not be an effective method of risk minimization due to e.g. taxonomically problems regarding the identification of the organism and pathogens.

Another option deals with the fact that populations of species decrease with their increasing stay in the ballast tanks. The absence of light provides an uncomfortable environment for some species. Water that has been located in a ballast tank longer than 100 days provides a small risk discharging unwanted species. Research showed that even after 116 days living macrobenthos organisms were found (Gollasch 1996). In addition, some species, as phytoplankton organisms may form cysts during unfavourable conditions surviving in the sediment of ballast tanks for a long period. Some zooplankton species may form resting stages as well. These cysts may remain active over longer periods of up to several years. In this way e.g. cysts of dinoflagellates may be transported over long distances. After sediment discharges the cysts may hatch in foreign waters. If these dinoflagellates are toxic they may cause harm to local aquaculture. It is assumed that many phytoplankton blooms may be initiated by these discharges (Hallegraeff et al. 1992, Bolch & Hallegraeff 1994).

Effectiveness of the ballast water exchange

A Canadian survey carried out 1990 by Locke et al. (1991) studied the ballast water transported by foreign vessels into the Laurentian Great Lakes and upper St.-Lawrence River in order to monitor the compliance with the Great Lakes Ballast Water Control Guidelines and their effectiveness. The effectiveness of mid-ocean ballast water exchange eliminating living freshwater zooplankton specimens from ships originating in freshwater ports was 67 %. It was noted that live freshwater organisms may still survive a mid-ocean exchange of the ballast water in their dormant stages. Therefore, each vessel which has ever taken on ballast in a freshwater port may pose a risk to the North American Great Lakes, even after a ballast water exchange in marine waters. In addition it was estimated that nearly half of the vessels entering the Great Lakes carried ballast water in previously emptied ballast tanks (remaining water bodies below the level of the ballast pump intakes in the ballast tanks). This “unpumpable” ballast water represents a reservoir of specimens at the tank bottom. These specimens could be discharged after re-filling of the ballast tank followed by ballast water discharges (Locke et al. 1991).

In an Australian study on board of the bulk carrier IRON WHYALLA 95 % of ballast water was discharged at open ocean. In the remaining 5 % of the original ballast water approx. 25 % of the specimens of the previously filled ballast water were found (Rigby & Hallegraeff 1993). The proportion of original plankton and detritus remaining after exchange of ballast water flushing the ballast tanks of two tank volumes while underway was lower. The proportion of living organisms surviving ocean exchange would be significantly less than 10 to 20 %, depending of the species composition (especially the possibility to generate resting stages as cysts) and the change of temperature as well as salinity (MEPC35/INF.19).

A problem in using open – ocean - exchange is the sediment in the ballast tank. Exchanging ballast water at sea does not affect the sediments at the bottom of the ballast tanks. Hallegraeff & Bolch (1992) investigated 32 vessels which had carried out an ballast water exchange. 15 vessels still contained significant amounts of sediment. A method needs to be developed to resuspend the sediments into the ballast water above. They concluded that the midocean exchange was not always an effective method of control for ballast water and sediment on its own. In addition a complete ballast water exchange at sea is unsafe in case of bad weather. A sequential operation of continuous flushing of tanks with ocean water would be a workable option (Rigby & Hallegraeff 1993). The guidelines of the IMO recognized in addition that many aquatic organisms are present in sediments and that all sources of sediment (as e.g. ballast tanks, anchor chains, chain lockers) should be cleaned routinely.

As long as safety permits, open – ocean – exchange should be used as a first step in order to minimize the number of species and specimens unintentionally introduced with ballast water. Every eventuality must be taken into account when deciding as to whether it would be safe to exchange ballast at sea. It is agreed that flushing the ballast tanks three times during voyages in open oceans could extend the efficiency of this method (Rigby & Hallegraeff 1993, 1994, MEPC31/14/1).

The advantage of this method is that it involves no major investment and is thus comparably inexpensive. In addition this method may be carried out in transit without disrupting the vessels schedule.
The IMO guideline in addition lists that a responsible officer should be appointed to maintain appropriate records and to ensure that ballast water management and / or treatment procedures are followed and recorded. It also advises to document during taking on or discharging ballast water dates, geographical locations, ship's tank(s) and cargo holds, ballast water temperature and salinity as well as the amount of ballast water loaded or discharged should be recorded. A suitable form is shown in the annex 1 of the guidelines.

Safety aspects

A study of the "Ship Operational and Safety Aspects of the Ballast Water Exchange at Sea" was carried out by Woodward et al. (1992) who concluded that ballast / deballast operations may be carried out safely if wave heights were below a maximum value. Using hydrostatic data furnished by the ship owners hull bending moments and stabilities are investigated to find the tankemptying operations representing the maximum safety. Atsea analysis for hull bending moment, shear and rate of slamming was carried out using both linear and nonlinear analysis. From the used small sample of three ships (a dry bulk carrier, a tanker and a container ship) it appears that the critical wave height lies between 10 and 20 feet. The sample is to small to support a more definite conclusion on the maximum safe height.

In addition the IMO sub-committee on Ship Design and Equipment prepared a guidance on safety aspects of ballast water exchange considering structural integrity, stability of ships and crew safety and in particular stated (e.g.) to avoid over and under pressurisation of ballast tanks, free surface effects on stability and sloshing loads in tanks that may be slack, admissible weather conditions, maintenance of adequate intact stability in accordance with an approved trim and stability booklet, permissible sea-going strength limits of shear forces and bending moments in accordance with an approved loading manual, torsional forces, minimum / maximum forward and aft draughts, wave induced hull vibration. It was mentioned that the ballast water management plan should include designated control personnel responsible of the ballast water exchange and crew training to familiarisation. Furthermore it was noted that a need exists to evaluate the safety of long term aspects taking into account relevant safety matters, including safety of crews and ships, ship´s position, weather condition, ballast system inspection and maintenance, machinery performance and availability (MEPC39/WP.8, MEPC39/7, MEPC39/7/1, MEPC39/7/4).

Other ballast water treatment options include mechanical removal of species in ballast water (filtration, separation, flowthrough system, sedimentation and flotation, pump velocity), physical removal of species in ballast water (heat treatment, cooling treatment, radiation, ultrasonics, microwave, rapid pressure changes, electrical removal, magnetic fields); chemical removal of species in ballast water (chlorination, metal ions, ozone, hydrogen peroxide, oxygen deprivation (deoxygenation), coagulants, pH adjustment, salinity adjustment, antifouling paints as ballast tank coatings, organic biocides) and biological removal of species in ballast water via bio-control.

Additonal options are to reduce the ballast water amount of ballast water or keep a constant volume of ballast water on board, alternating salinities in ballast water and area of discharge, fresh Water Ballasting and dewatering.-

Summary of treatment options

From the foregoing it is apparent that no single or simple solution presently exists for shipboard treatment to prevent the transfer of viable nonnative organisms in ballast water. None of the listed treatment options seem to be 100 % effective, environmentally sound, cost effective and safe during application. A combination of technologies may however, be at least partially effective and feasible in terms of economic and shipboard constraints. The most promising method seems to be a combination of heat treatment and filtration of ballast water or heat treatment and changing salinities of the ballast water.

Some form of mechanical removal of debris and the larger organisms would appear a prerequisite to any other treatment. This would most likely take the form of straining, microfiltration or even cyclonic separation. As a second step, physical treatment techniques, in particular application of UV radiation or heat treatment, would appear to be more acceptable than chemical options on both environmental and safety grounds. An exception is the ozonization of ballast water. Although ozone leaves no residual environmental polluting components, as it quickly decomposes to oxygen, in the water and it is a considerably more effective biocide as other chemicals than e.g. chlorine.

As regards the chemical disinfection options, most of the traditional biocides produce byproducts which may be environmentally unacceptable and may require specialist operator skills on account of the complexity of ballast systems and problems associated with the application of chemicals. Suitable dispersal mechanisms in the ballast tanks would also need to be addressed, in particular mechanisms for penetrating the sediment layer. In addition, both inorganic and organic biocides would present a range of health and safety problems related to storage of chemicals, compatibility with cargo carried on board as well as direct and indirect handling of chemicals by crew members. Nevertheless the use, for example, of hypochlorite may be useful as an emergency treatment measure.

Of the remaining options reviewed, adjustment of ballast water salinity is clearly a useful technique where supplies of fresh or seawater, as appropriate, are freely available. Indeed this technique is already being used for the treatment of ballast water for ships entering the Great Lakes.
On the basis of the available data, none of the other techniques reviewed appear particularly suitable for shipboard application to ballast water on account of effectiveness, practicality, cost, environmental health and / or safety considerations. As regards those that have been identified as potentially feasible and effective, further research will be needed before firm recommendations for shipboard installation can be made (AQIS 1993, Müller 1995, Müller & Reynolds 1995, Sipes et al. (eds.) 1996).

4 Ballast water regulations and associated guidelines in place and planned

Ballast water management and control regulations and associated implementation guidelines are being developed by IMO. IMO is concerned in regard to uni-lateral actions that have been developed or are considered by port states regarding the control of ballast water discharge in their ports or in areas under their jurisdiction. It should also be noted that the IMO voluntary international ballast water guidelines (resolution A.774 (18), since November 1997 replaced by resolution A.868 (20) have so far been applied in a relatively small number of countries only.

Europe

The IMO Assembly Resolution A.868 (20) will be applied in Sweden in national laws as voluntary guidelines in the near future. Spain, Ireland and the Netherlands consider the implementation of the IMO Assembly Resolution A.868 (20) or other national regulations. Ireland is planning to regulate the ballast water discharge at the oil terminal of Bantry Bay. Authorities in the Netherlands are awaiting results from a research project currently carried out as an initial desk study and probably extended for ship sampling as well as results from a cooperative ship sampling of ships calling for Rotterdam and ports in the Chesapeake Bay region.

United Kingdom

The United Kingdom has some kind of practice in place to minimize the risk of unintentionally introduced species via ship´s ballast water. Compliance with IMO Assembly Resolution A.774 (18) was requested by 10 of 66 ports. A national quarantine procedure in regard to ballast water management is used in 4 of 66 ports (Macdonald 1994).

The United Kingdom has developed management policies on ballast water to protect the marine environment. In Scotland, planning applications associated with he development of coastal activities have brought this issue in the public spotlight. In addition to the introduction of organisms from abroad the marine environment managers are aware of the possibility of secondary transport within the United Kingdom. Various agencies require advice on ballast water management strategies for example in relation to coastal planning applications or in the case of port authorities reviewing or designing ballast water management and treatment options (Macdonald & Davidson 1997).

A questionnaire was sent to 127 ports in England and Wales, 111 (87.4%) of which responded. Ballast water is discharged into just under half (48.7%) of ports in England and Wales. Most ports (79%) have no policy or regulations on management of ballast water discharge. Of the 13 ports which do have regulations, these are mainly related to operational safety. Only five ports request ships to apply IMO Assembly Resolution A.774 (18) on ballast water management now replaced by the IMO Assembly Resolution A.868 (20) (Laing pers. comm.).

Israel

Israel requires, since 1996, that a ship must exchange any ballast water on board which was not pumped on board in open ocean. Ships visiting the port of Eilat must exchange their ballast water outside the Red Sea and those visiting Mediterranean ports of Israel must exchange ballast water in the Atlantic ocean. It was noted that the best way to exchange the ballast water is in the open ocean, beyond any continental shelf or freshwater impact. Vessels failing to comply will not be permitted to exchange ballast water in Israelian waters. It is expected that a record of location, date and time of the ballast water exchange in open ocean waters should be documented in the ship´s log book or other suitable documentation as e.g. an official record book on ballast water operations. Ship masters are requested to complete a ballast water exchange report (State of Israel, Ministry of Transport, Administration of Shipping and Ports, Notice to Mariners No. 4/96, Galil & Hülsmann 1997).

North America

Canada

The Canada Shipping Act (CSA) does currently not include federal regulations concerning the prevention of harmful introductions of non-indigenous species through ballast water or sediment discharges. However, the following guidelines and area specific requirements are currently applied:

- Notices to Mariners #995 has imposed ballast water discharge restrictions for the Grande Entrée Lagoon of the IlesdelaMadeleine to reduce the threat of introduction of toxic phytoplankton to local mussel farming industries since 1982. Discharging of ballast water within 10 nautical miles of the Islands is prohibited unless the ballast water were pumped on board in a designated area off Canada’s east coast at minimum distance of 5 miles from the shore;

- The governments of Canada and the USA signed the Great Lakes Water Quality Agreement in 1987. This agreement was established to co-operate in development and implementation of Remedial Action Plans, Fishery management Plans and lakewide Management plans. The pollution from ships (including ballast water) was addressed in this agreement as well. The goal of the plans is the identification of necessary remedial actions to reduce pollution to the Great lakes; and

- Canadian guidelines for controlling ballast water discharge into the Great Lakes were introduced in 1989 by the Canadian Coast Guard. The Canadian Coast Guard developed these guidelines in full consultation with the U.S. Coast Guard, the Great Lakes Fishery Commission and representatives from commercial fishing. These guidelines apply for all vessels carrying ballast water with an origin from outside the Exclusive Economic Zone (EEZ, beyond 200 nautical miles from the shoreline). The guidelines encourage all vessels transiting the Eastern Canadian Region Vessel Traffic Service Zone inbound for the St. Lawrence River and the Great Lakes to exchange freshwater ballast collected in foreign harbours or near coastal waters for saltwater ballast collected from open ocean. The exchange was to occur far enough from any coastline such that the new ballast water contained few organisms, if any, that could survive in the freshwater of the Great Lakes (MEPC34/INF.22). The exchange of the ballast water has to be carried out if the required port of call lies west of 64□ W longitude (SGBWS 1997). The ballast water exchange has to be carried out at depths greater than 2,000 m. If this is not feasible ships are permitted to exchange their ballast water in a “backup exchange zone” within the Laurentian Trough of the St. Lawrence Estuary east of 64□ W longitude in water depths greater than 300 m. A ballast water exchange form has to be completed listing information on ballast water on board and compliance of the guidelines. A fine of max. CAN$ 50,000 may be imposed for providing false information (Gauthier & Steel 1995, 1996).

In addition, very recently the Vancouver Port Corporation (VPC), B.C. introduced a ballast water exchange programme. Vancouver has become the first Canadian port to make a complete midocean exchange of ballast water of all incoming ships from abroad mandatory. On arrival at the port documentary evidence of the exchange is required via a log entry or any other administrative format. Any vessel unable to provide the information is not permitted to discharge ballast water in the harbour area. These vessels will have to depart and exchange the ballast water in the outgoing current of the Strait of Juan de Fuca. Acceptable reasons for the avoidance of an midocean exchange of the ballast water are stress from weather conditions, stability or hull stresses. Vessels which used bad weather conditions as excuse for no ballast water exchange for numerous visits will be randomly sampled after reporting the midocean exchange was carried out to confirm their announcements. Following the official launch of the programme in March 1997 a nine month reprieve period will be established before the regulation becomes mandatory in January 1998. The VPC announces that the regulation have been well received by the industry as well as the community.

Recently, as a result of the preliminary draft being prepared by the Vancouver Port Co-operation a working group of the Puget Sound - Georgia Basin International Task Force, recommends that other ports in British Columbia follow the regulations of the Vancouver Port Corporation (Kieser pers comm.).

USA

Ballast water management guidelines were established for vessels entering the Great Lakes. These regulations are mandatory and will be incorporated in the Title 33 of Code of Federal Regulations (33CFR).
In 1990, the House Committee on Transportation and Infrastructure approved a proposal to reauthorise the NonIndigenous Aquatic Nuisance Prevention and Control Act. The Control Act established a Aquatic Nuisance Species Task Force responsible for coordinating efforts related to nonindigenous aquatic nuisance species in US waters and is composed of representatives from the National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), Army Corps of Engineers, Department of Agriculture, Department of State, Environmental Protection Agency and the U.S. Coast Guard. The Coastal Waters Project, located at Rockland, Maine is attempting to further the efforts of the Aquatic Nuisance Species Task Force, particularly in the Gulf of Maine region States and North Carolina (Huber pers. comm.). The task force is responsible for developing and implementing an Aquatic Nuisance Species (ANS) Programme to prevent the introduction and dispersal of ANS,

monitor, control and study ANS and disseminate related information. The ANS programme has undergone public review and was submitted to the U.S. Congress in 1993. In early 1994 the U.S. Congress took into account the growing problem of introduced species via ballast water discharge of vessels. The House of Representatives Merchant Marine Subcommittee approved a bill authorising appropriation of US$2 million in 1995 / 1996 to pursue nonindigenous species. In the focus stands the identification and evaluation of ballast water management technologies that could be installed on existing vessels or incorporated in constructions of new designed vessels. These technologies necessarily need to be operational practical, safe in application on board, environmentally sound, effective and of low costs (Crosby 1994, Edwards 1994).

In 1992, The Coast Guard published a notice of proposed rulemaking entitled "Ballast Water Management for Vessels Entering the Great Lakes" in the Federal Register (57 FR 45591). The final regulation implements the regulatory requirements of the NonIndigenous Aquatic Nuisance Prevention and Control Act 1990, Public Law 101646. The Act required the U.S. Coast Guard, in consultation with the Government of Canada, to issue voluntary guidelines to help prevent the additional introduction and spreading of aquatic nuisance species into the Great Lakes through ballast water of vessels, by 1991. The U.S. Guidelines are comparable to those of the Canadian Coast Guard (see above). Including those vessels that only partial exchange, the participation by the commercial shipping industry has been estimated to be 90% of voluntary compliance as monitored through salinity measures of the ballast on board indicating the amount of ballast water exchanged in cases where the last port of call was in brackish or freshwater areas. Currently the U.S. Coast Guard carries out research in regard to a method to assess whether sufficient exchange has occurred in vessels arriving to and from saltwater ports (Carlton & Cangelosi 1997).

In 1993 the U.S. Coast Guard rule requiring Ballast water management practices for vessels entering the Great Lakes after operating on waters beyond the U.S. exclusive economic zone became effective (MEPC34/INF.31).

In 1996 the Act to provide for ballast water management to prevent the introduction and spread on nonindigenous species into the waters of the United States and for other purposes (preferred cited as: National Invasive Species Act of 1996) was established on October 26th 1996 (Public Law 104332Oct.26.,1996).

In addition to previously mentioned aspects, the legislation also mandates the US Maritime Administration to conduct a national ballast water management demonstration programme to test and evaluate the technologies and practices identified. Currently ballast water exchange is voluntary but under the amended act any shipping line failing to exchange its ballast water will be forced to do so in the future. The salinity of ballast water is tested to verify the compliance with the required exchange of ballast water at sea. Vessels would be expected to exchange any ballast water at sea before entering US waters and ports**.** An increase of funding of over US$ 2 Million had been made available to cover costs in relation to compliance procedures, in total US$ 33.17 Million This is an indication of the tremendous costs involved controlling the establishment of nonindigenous species in your waters (Carlton & Cangelosi 1997).

The regulations will replace the voluntary guidelines. The act requires that the regulation apply to vessels that enter a U.S. port of the Great Lakes after operating in waters beyond the Exclusive Economic Zone (EEZ) (in a depth of not less than 2,000 meters). The Act further requires that the regulations shall prohibit the operation of a vessel in the Great Lakes if the master of the vessel has not certified to the Secretary or Secretary's designee, by not later than the vessel's departure from the first lock in the St. Lawrence Seaway, that the vessel has complied with the requirements of the regulations. The Act provides civil and criminal penalties. Any person who violates the regulations shall be liable for a civil penalty not to exceed US$ 25,000**.** The Act provides a three year windowofopportunity for vessels arriving in U.S. ports to exchange their water on the high seas. After this period of time the U.S. Coast Guard will assess the level of compliance with this regulation. If levels are found to be insufficient, ballast exchange will become mandatory.

The currently most practical method to protect the Great Lakes from the introduction of unwanted nonindigenous species may exist in the exchange of ballast water of incoming vessels in the open ocean beyond the continental shelf (depth exceeding 2,000m). If this option is impossible to carry out one of the following actions have to be taken:

return to sea and undergo ballast water operations
retain the vessels ballast on board
use alternative environmentally sound method of ballast water management or under extraordinary conditions (safety, weather conditions or equipment failure) discharge ballast water in designated areas.

Requests of this methods have to be given to the commandant of the U.S. Coast Guard.
discharge ballast water to land based facilities or to reception vessel

In addition:

no sediment should be discharged from tanks or holds containing ballast water unless it is disposed of ashore
ballast water carried in any tank containing oil or any other contaminants must be discharged in accordance with the applicable regulations.

Nothing in this regulation relieves the master of the responsibility for reinsuring the safety and stability of the vessel or the safety of the crew and passengers or any other responsibility (MEPC34/INF.22, Carlton & Cangelosi 1997).

In November 1996, the United State passed the National Invasive Species Act (NISA), which requires that vessels entering US waters from the outside the 200 mile Exclusive Economic Zone (EEZ) must exchange their ballast water before entering the EEZ. The guideline is initially voluntary, but would become mandatory after two years if compliance was recognized as insufficient.

In 1996, reauthorizing legislation expanded that programme to include all US waters and coastlines. The Coast Guard is currently developing its specific regulations pursuant to the latter statute. If they resemble the Great Lakes programme (and this is likely) they will request that vessels entering US waters after operating outside the EEZ undertake highseas ballast exchange or an alternative ballast management measure approved by the Coast Guard which is equally effective or more effective than ballast exchange prior to entering US waters. This leaves the door open to alternate technologies as they are developed. This national protocol will be "voluntary" for at least three years, depending upon compliance under a voluntary regime. If after three years, the Coast Guard determines that compliance is not adequate then the Coast Guard must add an enforcement component to the programme. Thus, industry has the opportunity to police itself. However, if that system fails to achieve adequate participation, then the Coast Guard must undertake the policing role (which it already does for the Great Lakes) (Cangelosi pers. comm.).

Latin America, Panama

Discharges of any kind of ballast water is prohibited in the Panama Canal.

South America

Argentina

Since the beginning of the 1990s, the port authorities of Buenos Aires require a chlorination of ballast water of ships calling for their port. This binding instruction is still in practice. Chlorine is added to the ballast water via ventilation tubes of the tanks. In Argentina, inspection crews are randomly visiting the vessels in order to control the compliance with this instruction (Capt. Rabe, Capt. Katzenbach pers. comm.).

Chile

Unilateral mandatory requirements for preventing introductions of harmful organisms from ballast water are in place, adopted in 1995. The "order for preventive measures to avoid transmission of harmful organisms and epidemics by ballast water" states that any ship coming from zones affected by cholera or a similar contagious epidemic is requested to renew the ballast water at a minimum distance from the coast of 12 nautical miles. The ballast water operation has to be documented in the bridge or engine room logs. In cases where no proof of the ballast water exchange is available chemicals must be added to the ballast water prior deballasting in a port. Per tonne of ballast water 100 grams of powdered sodium hypochloride or 14 grams of powdered calcium hypochloride has to be added allowing in minimum 24 hours to elapse before beginning the emptying process (MEPC/Circ.308, Gauthier & Steel 1996, Sipes et al. (eds.) 1996).

South Africa

Because of the rapid growth of the South African mariculture business serious consideration should be given to instituting a control over ballast water discharge. The need to protect the South African mariculture industry, South Africa is a signatory to the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL). The provisions are enacted into domestic legislation in the forms of the International Convention for the Prevention of Pollution from Ships 2 of 1986. Since it is likely that international legislation to control ballast water discharges will take the form of an Annex to MARPOL, it is important that South Africa recognized the need to give attention to this issue. An additional consideration is that there have been suggestions that ports „exporting" ballast water contaminated with potentially harmful organisms could be held liable for any subsequent damage. While the question regarding liability might be uncertain, South Africa emphasises that there would be no harm in guarding against it (Jackson in prep.).

Australia

In 1990, the Australian Quarantine and Inspection Service (AQIS) introduced voluntary ballast water management guidelines for ships entering Australian waters. These guidelines were formed to minimize the amount of ballast water and sediments discharged in Australian water loaded abroad. The guidelines are based on the IMO international ballast water guidelines of Assembly Resolution A.774 (18).

The Australian Ballast Water Management Advisory Council's (ABWMAC) membership consists of parties of the shipping industry, Australian Maritime Safety Authority, State and Territory Governments, seafood production industries, ports and harbour administration, Australia Quarantine and Inspection Service, research agencies and the Governments environmental management. The Council is responsible in the first instance for the provision of advice to the Minister and all relevant agencies to oversee the administration of its Ballast Water Strategy defined as: "to seek to avoid adverse economic and environmental impact of unwanted aquatic marine organism by minimizing their risk of entry, establishment and spread in Australian marine environment from ballast water and other shipping activities involving international and domestic shipping, whilst not unduly impeding trade" (Hutchings 1992, MEPC37/INF.24;1995)

In 1991/1992 a random sampling programme on ships arriving Australian ports from overseas destinations was carried out. Of about 200 samples only 11 contained toxic dinoflagellates of the *Alexandrium* spp. Most of these samples were taken out of ballast water of Asian origin, mainly from ports in Japan, China and Korea (MEPC33/INF.26).

Australia's International Guidelines for Shipping

Strategies for Minimizing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ship's Ballast water and Sediment Discharges. These guidelines include e.g. ship operational procedures as ensure to load clean ballast, avoid taking on ballast water in shallow areas, areas of dredging, areas with known outbreaks of diseases or phytoplankton blooms. When taking on ballast water records should be made upon date, geographical location, salinity and amount of ballast water taken on board. All sources of sediment on board (e.g. anchors, cables, chain lockers) should be cleaned. In addition, options for ballast water management are listed:

nonrelease of ballast water wherever possible
ballast water exchange and sediment removal in deep ocean areas
produce evidence of the reballasting at sea enroute
if at sea exchange of ballast water is not possible, carry out flow through exchange, designate a responsible officer on board familiar with the procedures which should be included into the ship's operational manual document actions that have been taken

In cases appropriate control actions have not been taken, the vessel is allowed to discharge its ballast water normally based on risk assessment results taken into account the type of vessel, its origin, risk factors at the port of entry including tidal flow and distance to aquaculture facilities or withholding discharge until samples of water / sediments are taken, analysed and fount free of harmful organisms or giving the vessel the option of departing Australian territorial waters to carry our appropriate reballasting. In exceptional circumstances operations may be carried out in Australian territorial waters after agreement with AQIS and after consultation with State and local authorities (MEPC37/INF.24;1995)

Australian Ballast Water Guidelines in Domestic Traffic

The Australian Agricultural Council agreed in 1991 upon a need for coastal and interstate shipping. The Australian Coastal Ballast Water Guidelines were formed. As international guidelines do not provide a satisfactory solution for the majority of domestic coastal vessels, additional guidelines were developed to minimize the spread of harmful exotic marine organisms between ports. A system should be introduced for the management of ballast water that is taken in Tasmanian waters by vessels that afterwards call for other Australian ports. This practice could minimize the translocation of the

Northern Pacific starfish and Undaria seaweed to other Australian ports. The system should also apply immediately to any other port where a toxic algal bloom exists or becomes present.

The guidelines consist of the following options:
port authorities will inform other ports the presence of toxic algal blooms
port authorities are being made responsible for issuing permission to ship's masters for the discharge of any ballast into their ports
use of certification of port contamination / health / clearance from the ballasting port
effective management for the uptake of ballast water in contaminated ports minimize the risk of uptake of this species on board the ballasting vessel
reballast at sea or in defined areas or taking on ballast from "clean areas"
on board intank treatment systems (not currently available)
commitment not to discharge ballast water
discharge ballast in defined areas

Other optional practices include avoiding taking on ballast during toxic algal blooms or in shallow areas, ensurance that ballast water is free from sediment wherever possible, ensurance that ballast tanks are being kept clean, ballasting of freshwater during toxic algal bloom if available (MEPC37/INF.24;1995)

New Zealand

After initial research in 1989 the Cabinet Environment Committee directed officials from the government departments to develop a policy that will minimize the risk of the introduction or establishment of exotic marine organisms through the discharge of overseas ballast water. The New Zealandian Ballast Water Working Group (BWWG) decided in 1991 that in the interim the most practical and effective way to restrict ballast water discharge would be to institute a set of voluntary controls on the discharge of overseas ballast water within New Zealand. Modified guidelines from Australia were used in order to rapidly implement this policy. The guidelines are in place since March 1992. It was recognized that an immediate ban on the discharge of ballast water with overseas origin was not suitable because of safety aspects. As New Zealand is dependent on international shipping and an immediate ban could preclude some vessels visiting the country. The voluntary guidelines contain the following aspects:

Ballast water which had been loaded in the territorial waters of other countries should not be discharged in New Zealand waters without reporting to an inspector (border protection officer, of the Ministry of Agriculture and Fisheries) prior to discharge.

Evidence of the origin of the ballast water to be discharged should be given to the inspector and certification from a government or other approved agency that the water and seabed of the port at which the ballast was loaded has been tested within the previous 6 months and found to be free of toxic dinoflagellates, or documented evidence existed that the ballast water has been exchanged at sea on route to New Zealand, or documented evidence was given that the ballast has been disinfected.

If the vessel cannot provide documented evidence of the origin of ballast water and requires to discharge ballast water in New Zealand waters the ballast water should be discharged into an onshore facility or should be treated prior to discharge, or should allow a representative sample of the water to be taken for testing for the presence of toxic dinoflagellates. A nil result would allow ballast discharge in situ. In addition no sediment or mud from the cleaning of holds, ballast tanks or anchor lockers may be discharged in the sea in New Zealand without the permission of an inspector.

Since March 1992 officers of the Ministry of Agriculture and Fisheries have been monitoring compliance with the voluntary controls and collected data on the ballast discharged. In total 35 % of the vessels comply with the voluntary controls by exchanging their ballast water at sea; 57 % claim to comply by not having to discharge overseas ballast water while in New Zealand waters and 7 % cannot or will not comply. Inbetween the 7 % which did not comply the following reasons for doing so were noted: vessel to old to consider juggling the ballast, controls are voluntary (one master only), not aware of controls, sea conditions to rough for safe ballast exchange at open seas, master believes that ballast water from the Pacific Islands is safe and ship incapable of complying this voyage.

In addition to the Ministry of Agriculture and Fisheries the Department of Conservation has interests in ballast control stemming from two pieces of legislation:
the Conservation Act which is an Act to promote the conservation of New Zealand's natural and historic recourses; and
the Resource Management Act the purpose of which is to promote the sustainable management of natural and physical recourses.

The Ministry for the Environment administers two statutes relevant to the control of ballast water discharge: the Environmental Act of 1986 and the Resource Management Act of 1991 (MEPC34/INF.3)
In 1998, New Zealand plans to formalise its controls through the introduction of an Import Health Standard (IHS) under the Biosecurity Act 1993. An IHS describes the conditions which must be met, in respect of biosecurity risk, before any "risk goods" may be brought into New Zealand. The IHS will be developed in consultation with the shipping industry and other stakeholders. It will outline New Zealand's requirements for ballast water discharge and options to satisfy an Inspector. The desired outcome is that water that does not comply with this standard will not be discharged within New Zealand territorial waters.
An IHS provides the regulatory approach called for by most of the submissions on the 1996 Public Discussion Paper. However, it is not intended to impose sanctions (e.g. fines etc.) immediately, unless a specific organism present in a specified overseas port is considered a risk to New Zealand as is currently the case for northern pacific seastars from Tasmania. These instances will be made known to mariners (Ministry of Fisheries, New Zealand 1997)

5 Further approaches in development

Risk assessment

A structured approach to decision making concerning the risk posed by individual vessels is highly desirable for the effective administration of any country's ballast water management regime. Critical factors can be taken into account concerning the potential risk posed by any vessel voyage and as a consequence the action required of an individual vessel (MEPC40/INF.7).

Decision Support System

As a possible way of minimizing the risk of introducing non-indigenous species with ballast water, Australia has proposed a Decision Support System. This system is designed to evaluate the risk posed by each incoming vessel due to arrive in a given port. The Decision Support System is composed of a risk assessment system and a decision support framework. The risk assessment component takes into account such criteria as the port of uptake of the ballast water (climate and species composition), the treatment of the ballast water enroute, the tolerance of the species which could have been taken onboard with ballast water and transported to the area of planned discharge and the estimated survival rates of the species in the ballast water during its voyage. The estimation of the survival rate is based on results achieved through sampling a ballast tank before departure as well as immediately after the ballast water uptake and further respectively during the voyage. Other factors in this estimation are the length of the journey and the daytime of the ballast water uptake. Several studies sowed that with increasing time in the ballast tank the number of species and specimens decreased dramatically. The importance of the daytime of the ballast water uptake is due to the daily migration of species in the water column.

The volume of water from overseas origin released in Australian waters is an indicator of the potential for further species introductions. The degree of risks depends also on the characteristics of the port of origin and port of arrival. Two very serious introductions to Australia (i.e. the toxic dinoflagellate *Gymnodinium catenatum* and the Japanese kelp *Undaria pinnatifida*) have occurred near the port of Triabunna (Tasmania) despite the fact it receives relatively little ballast water.

Any vessel that is considered to be of high risk might be required to follow a port authority contingency plan. A generic plan has been developed under Australia's strategic ballast water research programme (see above) which gives details for the procedure of safe deballasting in designated areas close to the port of call. The Decision Support Framework is a computerised programme summarising data input from the vessels as ballast water uptake and ship design. The programme is available on an internet server allowing agencies to add and extract data to enable decisions to be made on the potential risk involved. One key advantage is that a decision of the risk involved may be made prior the arrival of the vessel in Australian waters which enables the ships` crew to take action in advance (MEPC40/INF.7).

Port sampling, define hot spot areas

Monitoring species present in port waters could help to assess the risk involved with the uptake of ballast water. Monitoring carried out at least weekly, the ballast water uptake during the presence of phytoplankton bloom or mass occurrences of other (target) species could be avoided especially for ships departing port areas located in the same climate zone as the originating port of the ballast water.

Sampling an board

Ships could carry out sampling and analysis on board and send the results ahead to the port authorities of the next port of call. Each sample would have to represent the abundance of species of the entire ballast tank. In the case of container vessels, even if the crew knows which tank they were going to discharge in the next port of call, 10 different ballast water tanks might necessarily to be sampled.

A good sample would require on board manual to ensure the sample quality. The standardisation of sampling methods and especially marked sampling points for each type of will be needed in order to standardize sampling procedures. A concerning manual will be prepared by the ICS and INTERTANKO listing (e.g.) sampling points on board and procedures for managing ballast on board (MEPC39/7/3). In addition to the location of the sampling points a standardisation of sampling methods, including size and meshsize of the plankton net, number of hauls, depth of the sample, number of samples etc. is needed.

A larger problem will probably shows up after sampling. Each sample should be examined by an trained expert at least in determining its content as compared with a list of chosen target species.

Because the time schedule on board is pressing additional manpower of trained experts as part of the crew in determining species is probably needed.

Target species

Australia

A list of target species representing high risk species, compiled by Australian scientists and authorities is in preparation. At present Australia's target species, recognized as harmful and unwanted, are:

toxic dinoflagellates (e.g. *Gymnodinium catenatum, Alexandrium* spp.)
North Pacific Seastar (*Asterias amurensis*)
Cholera (*Vibrio cholerae*)
Japanese Kelp (*Undaria pinnatifida*)
Giant Fan Worm (*Sabella spallanzani*)
European Shore Crab (*Carcinus maenas*)
fish pathogens

The list will be modified from time to time as additional information is available (Paterson 1996. Lockwood pers. comm.).

From a ballast water management perspective, the capacity to rapidly screen ballast water samples and identify target species is crucial. Delaying the unloading of a vessel while testing is undertaken is likely to be costly to the shipper and may cause major problems of scheduling for port authorities. Ideally therefore, a testing or screening procedures should be: quantitative; suitable for use by non biologists outside a laboratory setting; and rapid (a turn round time of less than 3 hours). Currently there are no screening or testing procedures available that meet these requirements. Scholin *et al.* (1995) reviewed the feasibility of developing a rapid diagnostic test for cyst-forming dinoflagellates in ballast water. They concluded that while tests that met the criteria could be developed within 1–3 years, the costs involved could range as high as US$ 500,000. To date no similar review has been undertaken for other target species. In most cases identification of phyto- and zooplankton species require microscopic identification by specialists in the laboratory and positive identification of pathogens generally requires histological examination and / or laboratory culturing. Such procedures usually have turn-round times of a minimum of several days.

The occurrence of the introduced **North Pacific Seastar** (*Asterias amurensis*) in the Port of Hobart provides an opportunity to assess the effectiveness methods for sampling target species in ballast water and to test the application of rapid genetic screening techniques for the identification of larvae. CRIMP has an ongoing sampling programme for larvae of *Asterias* in the Port of Hobart which provides information on the seasonal abundance of larvae in port waters and earlier this year initiated a project to develop methods to genetically "finger print" *Asterias* larvae using PCR amplification techniques. It is anticipated that this technique will be ready for testing on larvae in ballast water samples soon.

USA

Information on North American target species are available at the internet site of The Nature Conservancy entitled America's Least Wanted: Alien Species Invasions of U.S. Ecosystems (http://www.consci.tnc.org/library/pubs/dd/toc.html). This report entitled "**America's Least Wanted**", focuses on those intruders that threaten our nation's rich natural heritage. The "**Dirty Dozen**" is a gallery representing some of America's least wanted non-indigenous species. Although these 12 intruders differ from each other in many ways, all share a common trait: they spell trouble for our native species and ecosystems. The species profiled here depict an array of different organisms (plants and animals), a variety of ecological systems (terrestrial, freshwater, and marine), and a wide geographical range-from Hawaii to Florida, and Maine to California: Zebra Mussel, Purple Loosestrife, Flathead Catfish, Tamarisk, Rosy Wolfsnail, Leafy Spurge, Green Crab, Hydrilla, Balsam Wooly Adelgid, Miconia, Chinese Tallow and Brown Tree Snake (The Nature Conservancy 1998).

All non-indigenous species are believed to be potentially harmful. Every import should be assumed harmful in the beginning until shown to pose a low risk. Therefore the target list approach of unwanted species needs critical consideration. It was concluded that another list of species listing introduced species with low impacts is needed. Species in this list of low risk introductions should be removed after the first indication of an unexpected impact of the species and further importation should be forbidden (Ruesink et al. 1995, Wade 1995, Simberloff et al. 1997).

Nordic Countries

A finish study on Risk Assessment of Marine Alien Species in Nordic Waters will study beside other items the application of risk assessment models to one or more key / target species. A semi-quantitative model (low - medium - high risk) will be identified and applied to a vector of introduction and a target organism. Relevant parameters should be described, and data needs and availability identified. A tentative list of parameters for ballast water introductions could include, but not be limited to; vessel ballasting characteristics, ballast water treatment applied (if any), characteristics of donor and receiving ports or geographical areas, voyage route and duration, relevant biological information for the key / target species. Information on the key / target species could include, but not be limited to; environmental requirements such as temperature, salinity, and light / energy requirements during different stages of the life cycle (including resting stages), habitat requirements, known biotic interactions

6 Implementation problems / Removal of Barriers

The need to develop ballast water regulations of any kind is being demonstrated by the great number of non-indigenous species that have been intentionally and accidentionally introduced all over the world.
The IMO considered this matter as a global issue, emphasizing further the necessity to find a globally applicable effective, inexpensive and environmentally sound treatment option for ballast water.

Public awareness

In some countries awareness concerning the unintentional introduction of species and their potential harmful and sometimes disastrous impacts are unknown and need to be developed. One step forward would be the distribution of case histories on introduced species. In this way the potential negative impacts of such species introductions can be shown. Beside negative ecological impacts and commercial interests, the human health may be threatened as listed in chapter 2.
After creating awareness relevant to the issue, the next important and possibly most problematic fact would be to solve financial problems in regard to this matter.

Financial problems in relation to the establishment and implementation of ballast water treatment facilities or control measures do occur. The development of an inspection authority for the control of activities to minimize the risk of unwanted species introductions by ballast water is needed. In North America the Canadian and United States Coast Guards, in Australia the AQIS supervises the application of appropriate treatment or management options concerning ballast water on incoming vessels.

It seems to be complicated to develop such institutions, especially in countries which are not financially or politically stabilised. The identification and removal of barriers that permit the implementation of effective guidelines in developing countries is needed.

Financial aspects

The control of un-intentional ballast water imports will probably pay off in the longer run due to the minimization of negative ecological and ecological impacts. Costs for the implementation and control of ballast water treatment options or management strategies will result in benefits in regard to species which have not been able to establish. Especially the mariculture industry, as well as the touristic and other users of the sea will be effected by unintentionally introduced species introduced via shipping. The volume of trade of such businesses can be important to the economy of the entire country itself. In 1988 the world total aquaculture production was estimated to provide 14 million tonnes of food (FAO 1990).

If one of these industries is affected, impacts could results in nation-wide problems as shown in the Black Sea by the decrease in the anchovy fishery after the unintentional introduction of the ctenophore *Mnemiopsis leidyi* (see above). On the other hand, an introduction of a disease agent affecting target aquaculture species would result in a loss of mariculture harvest.

Political aspects

Other reasons to establish ballast water guidelines are the need to reach agreement on options in a region. To solve the problem in a comparable way in order to prevent international trade competition due to different costs involved in carrying out the required regulations. This approach would assist to prevent a decrease of ships calling for ports where the guidelines are implemented on a mandatory basis when at the same time neighbouring countries would not require any ballast water treatment or management control measures.

Organizational aspects

The implementation of a ballast water management programme or guidelines and the assessment of the risk involved in relation to the introduction of unwanted aquatic species needs guidance. Problems in implement guidelines and the control of their compliance may raise through sampling the ballast water and the scientific analysis of the samples.

Responsible personnel of relevant authorities as e.g. Port State Authorities, Coast Guards, quarantine and inspection services has to be educated in the application of standardized sampling methods, data gathering by sampling protocols and the determination of species in ballast water.

In order to assess the risk involved in ballast water discharge, a minimum of aspects need to be taken into account:

- area of origin of the ballast water (comparable climates in uptake and discharge areas increase the risk of the establishment of a non-indigenous species). Define hot spot areas / shipping routes. Therefore a documentation of ballast water operations on board are necessary;
- investigation of ballast water from special origins have to be carried out if the area of origin was estimated as a high risk area for species introductions (target species);
- daytime of ballast water uptake (some species migrate in the water column periodically, times of high concentrations of species should be avoided);
- age of ballast water (increasing duration in the ballast tanks decreased the survival rate of species;

- salinity of ballast water may indicate the survival rate of species after discharge of the ballast water. Minized survival rates are expected if fresh water ballast is released in marine environments and vice versa;
- sampling of ballast water needs standardization; and
- a determination manual for target species has to be developed.

An informal programme has to be developed to spread the information on the applied guidelines, risk assessment, sampling methods of ballast water and control options for the compliance of the implemented ballast water guidelines.

7 Recommendations

All non-native species are potentially harmful unless it is shown that the involved risks are low or the introduction of the species is even beneficial. Therefore it is most wanted to minimize the number of intentionally or unintentionally introduced species and specimens. Knowing that the eradication of introduced species requires great technical and financial efforts and that these activities are believed to be in-effective or impossible in some cases, preventing measures are needed.

As several shipping studies showed, each single vessel has the potential to carry or introduce non-indigenous species. The IMO Assembly resolution represent a method to reduce this potential in removing most of the un-intentionally transported organisms in the ballast water. Mandatory regulations or guidelines minimizing the introduction of non-indigenous species would be of immense help to prevent unwanted introductions of harmful species. Therefore, it is concluded to enforce the application of this guidelines in a global scale.

The IMO Assembly resolution have apparently so far been implemented in some countries and there is need to apply the resolution in a broader scale due to the lack of other effective, technically and environmentally sound and safe treatment options. Therefore every IMO Member State is requested to implement the resolution.

It is concluded that many countries do not consider the ballast water issue as a major problem or danger. Therefore further activities should include the field of raising public awareness.

The importance of ballast water management and control as a means of human intervention to ensure the stability of aquatic ecosystem and biodiversity is not generally appreciated. Press releases could create a more realistic focus on the essential environmental concerns related to ships' ballast water and sediment and hull fouling while highlighting some potential preventive measures in order to minimize risks to changes or loss of biodiversity from transmitted species. In addition the early involvement of all involved authorities, institutions (of the scientific and non-scientific community) and parties is needed to develop and implement guidelines and regulations successfully. The development of ballast water management or control will be most effective at the international level. National approaches of this world-wide problem could end up in intricate regulations resulting in difficulties in compliance. Verification methods for the compliance with the developed guidelines and / or regulations are needed in order to ensure the application of the se methods.

The concern of other working groups and experts, especially in the biodiversity and aquaculture section as well as ship constructors should be raised. Many reports on wastes or discharges from ships list pollutants as exhaust emissions, oil spills, halon, CO_2,, but do not include ballast water and tank sediments. being aware that ballast water and associated sediment discharges are not considered as pollutants as it has to be emphasized that they could cause severe damages to the environment.

Further research is needed in order to evaluate and judge so far empirical developed treatment options. The prediction of future introductions is impossible, until today. The development of new and improved practices dealing with ballast water and the training of ship crews in this field would provide a significant contribution towards the reduction of further species introductions. Studies should include the:
- effectiveness of ballast water treatment options;
- survival rate of organisms during ships voyages;
- effectiveness of risk assessment models;
- prevention of the spread of human diseases (as e.g. Cholera) by ballast water treatment; and
- consideration of financial aspects related to aquaculture.

The unwanted impact of ballast water may be managed through the development of international ballast water guidelines and treatment options as a step towards the adoption of legally binding provisions, taking into account the conditions of donor and recipient region and the survival rates of species in ballast tanks during voyages.

International cooperation is needed, because the problem of introduced species will not stop at borders. Coordinating research in the field of species introductions would help to prevent duplication of work. This should challenge interested working groups to provide information on ongoing and planned research or legislative issues.

There are only a few countries carrying out monitoring programmes in regard to specific non-indigenous species or their presence in special areas. Sampling of ballast water is only undertaken for research purposes and not as standard procedure. Therefore the records listing nonindigenous species occur mostly in the frame of marginal observations during other studies. Regular surveys could document the introduction of non-indigenous species at an early time and therefore help to minimize the further spread of new populations. In order to solve this problem regular coast sampling programmes could be extended in list the present distribution of non-indigenous species.

Warning systems for newly introduced species should be encouraged in order to document their way of spread and possibly to coordinate control measures.

Preparation and implementation of monitoring and risk assessment studies for selected case histories of unintentionally introduced species should be carried out to provide additional information for future considerations of control and prevention methods. Provide the databases as e.g. INFORMIR (USA) and the EU Concerted Action with information about newest aquatic invaders, regulations etc (see main-report for details).

Ship designers and constructors should be made aware of the problem of ballast water in order to take into consideration possibilities of ballast water treatment and their installation on board or differing design of ballast tanks compared to „old fashioned“ ships.

In addition existing treatment methods in regard to ballast tanks including sediments and ship´s hull fouling have to be developed in the near future in order to minimize the risks of unwanted species imports by ships. The ballast water control and treatment is a helpful step towards risk minimization regarding the un-intentional introduction of aquatic species. Several shipping studies have shown that in addition to ballast water, species were also transported in sediments of ballast tanks as well as in the fouling of the ships´ hulls.

It is recommended that hindering governmental structures and problems of in-adequate funding could be solved through relevant information, supported by educational programmes and creating public awareness. Therefore, the spread of information relevant to the subject is an essential topic.

10 Definitions

The following list of definitions follows is based on definitions of the
(1) IMO Assembly Resolution A.868 (20) for the Control and Management of Ships` Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens;
(2) Code of Practice of the International Council for the Exploration of the Sea (ICES), Working Group on Introductions and Transfers of Marine Organisms WGITMO;
(3) draft IUCN Guidelines for the Prevention of Biodiversity Loss due to Biological Invasions
(4) Carlton (1996);
(5) draft Risk Assessment Protocol for the Introduction on NonNative Species of Fish. Regional NonNative Species Introduction Committee, Winnipeg, Manitoba. October 1996;
(6) AQIS report No. 9. Ballast water - Technical overview report (1996); and
(7) Committee on Ships´ Ballast Operations. Marine Board;, Commission on Engeneering & Technical Systems, National Research Council (1996): Stemming the tide: controlling introductions of nonindigenous species by ships´ ballast water.

"**Alien species**" see "Introduced species"
"**Brackish**" water is saline water with salinities lower than ocean water (6)
"**Clean ballast**" is ballast carried in cargo tanks after an intensive cleaning of the cargo department (in contrast to ballast carried in dedicated ballast tanks) (7)
"**Competition**" is a situation in which organisms need the same resources and compete for these (6)
"**Country of origin**" is the country where the species is native (2)
"**Cryptogenic species**" is a species that is not demonstrably native or introduced. (from crypt, Greek, kryptos, secret; genic, New Latin, genic, origin (3)
"**Disease agent**" is understood to mean all organisms, including parasites, that cause disease (2)
"**DWT**" (Dead Weight Tonnage) is the weight in metric tonnes (1,000 kg) of cargo, stores, fuel, crew and passengers carried by a ship when loaded to the maximum level.
"**Established species**". Species occurring as a reproducing, selfsustaining population in an open ecosystem, i.e. in waters where the organisms are able to migrate to other waters (5)
"**Exotic species**" see "Introduced species"
"**GRT**" (Gross Registered Tonnage) is the estimated maximum ship´s carrying capacity, as it is derived from the total volume of enclosed spaces which are available for cargo, stores, crew, passengers etc. within the hull and superstructure.
"**Intentional introduction**" is a deliberately made introduction by humans, involving the purposeful transport of a species or subspecies (or propagules thereof) outside its natural range. Such introductions may be either authorised or unauthorised (3)
"**Introduction**" An introduction of an organism is the dispersal, by human agency, of a living organism outside its historically known range (3)

"**Introduced species**" (= alien species, = exotic species, nonindigenous species) Any species intentionally or accidentally transported and released by humans into an environment outside its present range (2).

"**Member States**" means States that are members of the International Maritime Organization (1).

"**Native species**" is a species, subspecies or lower taxon, occurring within its natural range and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction by humans) (3)

"**Non-indigenous**" see "Introduced species"

"**Organism**" is an individuum of any plant or animal species

"**Pathogens**" are disease causing organisms (6)

"**Plankton**" aquatic, free-drifting organisms suspended in water (plant = phytoplankton, animal = zooplankton)

"**Port State Authority**" means any official or organization by the government of a port state to administer guidelines or enforces standards and regulations relevant to the implementation of national and international shipping control measures (1)

"**Secondary introduction**" is one that takes place as the result of an intentional or unintentional introduction into a new area and the species disperses from that point of entry to other areas that it could not have reached without the initial (primary) human mediated introduction (3)

"**Transferred species**" (= transplanted species) Any species intentionally or accidentally transported and released within its present range (2)

"**Translocation**" Movement of native or introduced species to habitats outside its historically known range (6)

"**Treatment**" means a process or mechanism, physical, chemical or biological method to kill, remove or render imterfile, harmful or potential harmful organisms within ballast water (1)

"**Un-Intentional introduction**" is one made as a result of organisms utilising humans or human transport systems as vector for dispersal into new areas. The introduction is incidental to the main transaction taking place (often trade and in the marine environment aquaculture) (3)

"**unwanted**" (used in the sense of unwanted species or unwanted introductions) Any species which causes relevant changes to native species composition, including economical and ecological harm

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Summary report on:- The removal of barrier to the effective control and management of ships ballast water to minimise the introduction of harmful aquatic organisms, for developing countries.

Project title:	Preparation of a summary report identifying, on a regional basis 1) the most promising ballast water control and management alternative in developing countries, identified in 1.2 and 1.3; 2) the barriers to be removed in order to allow effective implementation of these alternatives; and 3) strategies for removing the barriers identified in each region.
Requested by:	United Nations Development Program
Scope of assignment:	Appraise mission reports by Mr. Dandu Pughiuc/Mr. Zhao Dianrong and desk study by Dr. Stephan Gollasch and prepare a summary report on the most effective means of managing ships ballast water discharges in developing countries.
Duration:	6th April 1998 to 8th May 1998
Funded by:	Global Environment Facility through United Nations Development Program.
Executing agency:	nternational Maritime Organisation (IMO)
Note:	The contents of the report is based on an assembly of the information obtained during the assignment. The interpretation of such information as expressed in the report is entirely the responsibility of the author. The conclusions drawn are entirely those of the author and should not be attributed to the United Nations or to the International Maritime Organisation.
Consultant:	Roger Lankester.

Summary report on:- The removal of barriers to the effective control and management of ships ballast water to minimise the introduction of harmful aquatic organisms, for developing countries.

Executive summary

Several reports in a series sponsored by GEF/UNDP and executed by IMO have been prepared which identify in detail the various aspects of the unintentional introduction of harmful aquatic organisms via discharges of ships ballast water.
The mission report by Mr. Dandu Pughliuc and Mr. Zhao Dianrong, the technical desk study by Dr. Stephan Gollasch and the report on health effects explore this diversity of issues. The summary report brings these together in an overview outlining the matters to be addressed in effectively implementing the pilot projects described in the mission reports prepared by Mr. Dandu Pughluic and Mr. Zhao Dianrong.. Suggestions are made on the legal, technical and administrative issues together with advice on how they relate specifically to the regional pilot projects.

Summary report on:- The removal of barriers to the effective control and management of ships ballast water to minimise the introduction of harmful aquatic organisms, for developing countries.

1. Introduction

1.1. IMO Resolution A.868(20) identifies the practical means by which the accidental introduction of harmful aquatic species from one discrete marine eco-system to another, through the vector of ships ballast water, can be minimised. The vast number of ships now trading worldwide were never designed with the specific intention of achieving these objectives and therefore no ideal technical solution currently exists, such as equipment on board ship which can sterilise the ballast water before discharge into the waters of the receiving port.

1.2. This report will attempt to identify and isolate the best means of implementing effective strategies for developing countries to minimise the introduction of harmful aquatic species from ships ballast water discharges, given the present circumstances and state of knowledge. The UNDP/IMO mission report "Removal of barriers to the effective implementation of ballast water control and management measures in developing countries" by Mr. Pughiuc and Mr. Zhao Dianrong will be drawn on extensively for guidance.

2. Background

2.1. The average number of different species of aquatic organisms to be found in ships ballast water is estimated at between 3000 and 4000. There is general scientific consensus that when such water is discharged from the ships ballast tanks into the receiving waters there is a risk that a harmful organism is present. What the potential threat to the indigenous aquatic eco-system such an event poses is impossible to establish within a realistic time frame given the nature of maritime transport and the rapid turn round in port now required by ships. Principle 15 of the Rio Earth Summit requires the precautionary approach to be the guiding basis for action to protect the marine environment but if control of ballast water discharges were to be applied strictly by quarantine authorities without sufficient forethought the worlds shipping would be unacceptably restricted. The universal fitting of equipment to sterilise ballast water on board prior to discharge is likely to be at least a decade away, despite the promising research currently being undertaken in a number of countries. Therefore a pragmatic approach is essential at this time if any impact on resolving the problem is to be made, especially in developing countries.

2.2. This is likely to require either a targeted approach based on the known risk or the perceived potential risk of importing a species with an identified harmful record at donor or receiving ports, or where uncertainty and risk is high a requirement that all ships should carry out mid ocean exchange procedures given the parameters outlined in the IMO Guidelines. It needs to be appreciated that scientifically the targeted approach is somewhat flawed with the chance that an aquatic species yet to acquire a harmful designation will pass through any quarantine controls established. **All** aquatic organisms contained in ships ballast water have the potential to cause harm to particular aquatic ecological systems, but some organisms may be more harmful than others depending on species, survivability in the new habitat and the morbidity during transportation in the ships ballast tanks and hold.

3. Legal framework

3.1. Perhaps the most commonly reported problem to effective control of ballast water discharges identified in the mission report was the absence of national legislation specifically related to ballast water and non-indigenous aquatic species. Port State officials, Maritime Administrations, Quarantine Inspectors etc., are powerless to act with authority unless their action is backed by a national statute, otherwise such action could result in a legal challenge from ship operators or charterers should delay to a ship occur or other additional costs be incurred by them. Also a legal instrument brings with it the necessary administrative resources to support implementation and create a greater degree of uniformity in application.

3.2. A number of the officials asked said that once an IMO Regulation came into force they were legally required to enforce it under their existing national maritime regulations. This may be both as flag State and port State or as flag State or port State individually. It is therefore clear that the most effective legal instrument likely to result in universal application of ballast water control and management procedures is a new Annex to MARPOL, a convention or some other appropriate IMO Regulation.

3.3. However, until this occurs it is dependant upon individual States to adopt a national legislation based on the IMO Guidelines and the sovereign rights conferred by UNCLOS. The US, Australia, New Zealand, Canada number the states which have already adopted national legally binding measures to control and manage ships ballast water discharges specifically to minimise the introduction of harmful aquatic species. Such legislation may be primary or secondary depending on national preference or practise and the ease of getting through the legislative process.

3.4. Perhaps more effective in terms of implementation is the regional approach applied to discrete areas of sea. A number of regional conventions exist to protect specific areas of the marine environment, some of which are legally binding, others having prescriptive status or the tacit acceptance approach. Regional legally binding measures aimed specifically at the minimisation of the introduction of harmful aquatic species in ships ballast water has the advantage of providing an even baseline for the operation of free market forces of the port industry within that region. Where adjacent ports in different states provide the equivalent services to ships and apply ballast water controls differently the one with the least stringent controls will have an obvious economic advantage. The sea is an integrated whole and current patterns and marine species do not respect national boundaries and harmful organisms released in one port state may easily damage the aquatic resources of another. Such circumstances can lead to conflict between States and legally binding measures, respected and uniformly applied by the contracting parties, can avoid these difficulties and will clearly be far more effective in achieving the desired objective in protecting the marine environment.

3.5. It is worth considering the an overall approach, although it is recognised that this may be the most difficult to bring into force due to its primary and all encompassing nature. A National Invasive Species Act would require all relevant and competent authorities to take action in accordance with the IMO Guidelines within the range of their exclusive jurisdiction. This is a particularly powerful legal instrument and will need appraisal by experts in individual States and regions to see how this approach can be best accommodated. However, unless national and regional regulations have an overall intent certain individual aquatic resources may not acquire the essential legal protection necessary to ensure environmentally sustainable development criteria is attained.

4. Technical Protocols

4.1. In order to make any controls on ballast water discharges effective it is necessary to establish the basic scientific principles which will direct legal instruments and administrative intent.

4.2. The term “harmful” requires to be identified before any targeted controls can be exercised and it may well depend on national and regional priorities which will define appropriate action. Alternatively all species in ballast water may be classed as harmful requiring open ocean exchange by the ship. There are a number of broad categories where ships ballast water discharges may have environmentally damaging effects. Biodiversity (habitats, species & eco-systems), fisheries/aquaculture (food resources & cash crops), public health (disease epidemics), built infrastructure (power plants, drainage, desalination plants, timber marine structures etc.), tourism (amenity beaches, eco-tourism resources for hard currency) are likely to be the main categories where ballast water controls need to be exercised. Specific species contained in ships ballast tanks on arrival in the destination port could have an effect on any or all of these resources. Some will have a known or likely risk others completely unknown. However, there is a growing inventory world wide of aquatic species which should be priority targets for quarantine control, with the ultimate objective of eliminating all harmful organisms discharged with ballast water into the receiving port.

4.3. Perhaps the most obvious species for control is toxic dinoflagellates which can destroy aquaculture resources, have a public health implication etc. Even though a species of dinoflagellate may not be renown for its toxicity strains of it may be and therefore red tides in the ballast water loading port is a clear signal that ships arriving from such areas should be targets for inspection and management action.

4.4. Similarly ships arriving from locations where a human disease epidemic is known should be identified as requiring attention and mitigation action taken. Also aquaculture has been shown to concentrate fish pathogens and parasites with the result that any ballast water taken on by a nearby ship may well contain either the micro-organisms in free suspension or in the larvae in the pelagic stage. Again ships arriving from such places will need to be targeted for controls, especially where there is aquaculture activity close to the port or place of discharge.

4.5. Other introduced species may be voracious predators on indigenous species and habitats, the comb jelly fish and the crown of thorns starfish are typical examples. Such species will destroy indigenous species, compete for habitat space and expand in numbers to epidemic proportions with often catastrophic consequences to aquatic eco-systems and the resources which are dependant upon them.

4.6. Organisms which cause fouling, like the zebra mussel, once accidentally introduced spread with great rapidity and in the US the main effect appears to be the blocking of water intake and discharge pipes etc., with a continuing financial burden to clear the fouling.

4.7. Biodiversity is perhaps the most difficult resource to be protected from the introduction of harmful species. In many cases biological diversity in terms of baseline species profile has yet to be scientifically established for most discrete eco-systems, together with the spatial, temporal and trophic dynamics of the system. Programmes of biological surveys and monitoring are often absent making it impossible to identify what is or what is not a non-indigenous species. In terms of biodiversity any introduced species can be defined as "harmful" if it can survive in its new habitat. The scientific complexity of the subject is very high indeed. GESAMP Report No. 62 "Marine Biodiversity: patterns, threats and conservation needs" gives useful overall advice and an extensive bibliography. Other GESAMP Reports also relevant to the subject are No. 54 "Guidelines for Marine Environmental Assessments" and No. 55 "Biological Indicators and their use in the Measurement of the Condition of the Marine Environment". Where definitive requirements cannot be established it may be that all ships should be required to adopt, where possible the open ocean exchange procedure.

4.8. Further impediments to establishing a coherent scientifically valid protocol for the effective implementation of ballast water control procedures is the current absence of a universally accepted ballast water sampling protocol for the evaluation and identification of harmful aquatic species. Although this will only be of use in a few specialised cases for direct quarantine controls a clearly defined protocol for ballast water sampling and analysis will enable a profile of what specific aquatic organisms are commonly present in ships ballast tanks, can survive the voyage, from where they originate and whether the ships ballast water management procedure has been effective. So far samples can only be taken from a ships ballast tank at the discretion of the master depending on crew availability and access. Samples need to be taken from ALL ballast tanks say at the bottom (to analyse sediments), mid water and surface on a regular basis so that accurate species survey and profile can be provided. Such information will allow the evolution of more precise data on the likely presence of harmful organisms which should permit better identification of those ship voyages which represent a high risk and are therefore prime targets for Port State control and management action. The presence of sewage in ballast water can be detected using the coliphage method and may well offer a quicker quarantine protocol for identifying the presence of pathogens, leading to the need for treatment prior to discharge or a requirement for retention on board or other procedures outlined in the IMO Guidelines.

4.9. There are a number of precautionary practises listed in the IMO Guidelines which should be undertaken by ships. However heavy weather can prevent open ocean exchange of ballast water and alternative discharge zones need to be established if discharge is prohibited within a port area. Therefore a scientific analysis will be required to establish such zones depending on current patterns, proximity of sensitive sites and aquatic resources perceived or known to be at risk from organisms present in the ballast water. It is essential that alternative discharge zones are established if effective control and management is to be implemented and this should take a regional perspective. Also for shallow water voyages where the ship does not pass through waters which can be defined as open ocean risk assessment procedures and alternative discharge zones will be essential.

4.10. Much scientific data exists globally which may not necessarily be directly related to the ballast water issue, for example the introduction of alien species by aquaculture activity and the diseases associated with them and which are already an established aspect of quarantine science. Such data is often held in specialist academic and research institutions and therefore communication vectors networked on a global scale will allow much existing knowledge to be accessed for effective ships ballast water control and management. Scientific specialisation is now very narrowly defined indeed sometimes with individual experts and their institution concentrating on single species or taxonomic group. These may represent the centre of excellence world wide and the depth of knowledge and expertise gained could be invaluable in evaluating the potential harmful effects of a particular or range of aquatic species, which of course includes marine plants. However, for such information to be effective in ballast water control measures it will need to be translated into a form readily accessible to port state officials.

5. Administrative Requirements

5.1. Unless there is a strategic national or regional coherent management structure specifically established to administer controls to minimise the introduction of harmful aquatic species via ships ballast water any individual endeavour will not be effective. Such a structure will need to clearly define the administrative web from the legislative framework to the port state requirements transmitted to individual ships.

5.2. Prior notification by a port state of what ballast water management or control practices (particularly properly completed Ballast Water Reporting forms – see IMO Guidelines) are required by the ship is likely to be the main and paramount administrative objective using the normal communication vectors. Pilot books are a very useful source of such information and will be kept on the ship to advise passage planning prior to departure on the voyage. There is no point in advising the ship on arrival in the destination port that open ocean exchange of its ballast water was required by the port state. The shipping industry has made it quite clear that the requirements of the IMO Guidelines will not be implemented by the ship **unless specifically demanded by the port state authorities.**

5.3. Ships Ballast water controls are likely to focus on several separate existing administrative departments. Port and Maritime Authorities, which also include a public health and quarantine element, are the traditional interface with a ship and these will normally have a direct communication link with it for transmitting and explaining national or regional requirements and how to enforce them. In addition departments of agriculture (aquaculture, capture fisheries, veterinary service), Environmental Protection (biodiversity, nature conservation, infrastructure, tourism), Public Health (human disease epidemic control and prevention) will all have an administrative interest in the ships ballast water issue. Evidence from the mission report suggests that the relationship between these sometimes disparate administrative departments are not always harmonious and both internal and external rivalries can occur. In addition technical support from specialised academic institutions is essential if effective control on ships ballast water discharges is to be realised.

5.4. As the effects of harmful aquatic organisms from ships ballast water will occur largely within the coastal zone, Integrated Coastal Management could well offer the most effective way of co-ordinating and rationalising the complex technical aspects into an accessible data source. A suggested management flow chart is illustrated in appendix 1. There is an ICM computer system called SIMCOAST which could be a useful tool in co-ordinating and rationalising an effective management structure.

5.5. It is unlikely that all the specialist technical expertise will be directly available in developing countries as indeed it could be in developed countries. There is a compelling case to establish a global inventory of specialist experts and institutions accessible via the internet to provide the complex technical support to the administrations in developing countries. This may be equally true in developed countries also. In a number of cases these institutions already exist with a specific ballast water remit. ICES and the IOC-FAO can assist access to data on harmful algal blooms (red tides). Although not specific to ballast water but aquaculture the OIE (Office International Des Epizooties) holds a global database on the location of piscatorial disease epidemics as does WHO for notifiable human diseases.

5.6. There will be numerous other institutions located in various countries which could bring their expertise to bear on the ballast water issue and offer assistance to developing states. Australia has developed, from known quarantine science, a computerised Risk Assessment/ Decision Support System which could be helpful to developing countries in determining priorities for port State administrative action, such as a port area contingency plan specifically focusing on ballast water and harmful aquatic organisms.

5.7. No administrative endeavour will be effective unless it is well co-ordinated with the imperative that the often disparate agencies work well together, freely sharing and exchanging relevant information and expertise. The International Maritime Organization, which has the universal respect of maritime states, could be a valuable resource in unifying and providing a single focus for administrative intent, possibly through a series of regional implementation seminars and the setting up of steering committees.

6. Education and Training

6.1. Unlike oil pollution there are no absolutes in the minimisation of the introduction of harmful organisms in ships ballast water. The technical complexities alone require considerable understanding of what or what is not likely to represent a potential threat severe enough to initiate action by port State authorities, in what form and how to instigate precautionary action. Therefore value judgements backed by sound technical data and the understanding of how to interpret it are essential. This is the sort of expertise which will require possibly novel training programmes in developing countries.

6.2. It is quite likely that considerable administrative capacity already exists within port State and maritime authorities but the specifics of harmful species and ballast water are not. It therefore seems logical to build on the existing capacity by further training and education within the framework of the IMO Guidelines rather than to introduce a whole new element dealing with ballast water as a single issue. Obviously assuming that the specialist technical support is readily available either within the state system or from centres of excellence elsewhere.

6.3. Similarly ships crews, including officers, need to appreciate why they may be required to undertake a somewhat tedious and apparently spurious activity, i.e. open ocean exchange as a standard practise. It is therefore paramount that for effective controls on ballast water to be realised it is crucial that seafarers have relevant and specific training. One hopes that such a programme will inspire and inform those who are ultimately able to actually solve the problem.

6.4. Training and education should aim to create an empathy of trust between the port State and ship. It is equally important that the ship has confidence that officials are exercising their authority from the perspective of informed opinion rather than a slavish compliance with a regulation which, in the case of ballast water and harmful organisms, will often be a matter of individual interpretation in view of the uncertainties of environmental cause and effect. Perhaps elements in the education programme could be undertaken where seafarers and port State officials are trained symbiotically even to the point where port State officials undertake voyages on ships and experience what is involved in open ocean exchange and stress of weather preventing it. A starting point could be the proper completion and interpretation of the ships Ballast Water Reporting Form. Similarly seafarers might be given instruction as to what are the environmental, economic and health consequences of the introduction of a harmful aquatic species. Visual aids will clearly have a major part to play in education and training and the US Coast Guard video “Controlling Exotic Invasions” is an excellent example. Australia also has a ballast water awareness programme which could be useful resource material for informing ships and their operators of port State and regional requirements.

6.5. However, scientific input is absolutely crucial with new knowledge evolving almost on a daily basis, especially once the ballast water monitoring programme gains momentum. It is therefore paramount that close links are established for continuous updating with relevant academic and research institutions.

7. Effective Regional Implementation

7.1. The Pughiuc and Zhao mission report identified a number of existing initiatives which relate to ballast water discharge control by port States. Although not necessarily directly intended as a means of implementing the IMO Guidelines this existing administrative capacity provides a valuable foundation on which to build further capacity and management structure specifically intended to minimise the introduction of harmful aquatic species via ships ballast water discharges.

Brazil

7.1.1. Considerable concern was expressed in the mission report regarding the level of environmental technical capacity in terms of human and material resources. This is clearly a major problem for a country with such an extensive coastline and 46 major ports. However, the petro-chemical company Petrobras has considerable expertise in the field of on board ships ballast water management through their experimental work on the dilution method of treatment. Also Brazil has a very advanced structure and policy for Integrated Coastal Management which perhaps offers the basic potential for developing the ballast water initiative. Whether it is possible to integrate Petrobras, through its "Environmental monitoring of oceanic coastal areas" initiative and the ICM structure is something which could be explored as the nucleus of technical capacity in association with the existing port State and maritime administrations, who already require ballast water treatment, i.e chlorination, prior to discharge for public health reasons. Few if any states, including developed ones, can claim all inclusive technical capacity regarding the ballast water issue and harmful aquatic species. It is through international scientific collaboration that such expertise becomes available. Once the key national interests have been brought together into a coherent management system, probably within ICM, the additional technical capacity can be incorporated on an evolutionary basis.

7.1.2. The absence of the human and material resources may not be such an impediment to action. Once the decision is taken to implement the IMO Guidelines; supported by national or regional legal measures, the technical capacity will grow provided a clear management structure is in place.

South Africa

7.2.1. Again the absence of a legal basis for port State controls aimed at ballast water and harmful species appears to be an impediment to action. There is already a sophisticated range of legislation specific to maritime transport which is administered by the relevant authorities. With such a well established structure it may be more difficult to introduce the necessary legal, technical and administrative network which enables the diversity of interests which must have an input to be involved. Simply modifying the merchant shipping regulations, which would be secondary legislation, may not be enough to encompass the full range of environmental impacts resulting from ships ballast water discharges containing harmful aquatic organisms.

7.2.2. The DOT (Dept. of Transport) administer MARPOL and therefore have the direct communication link with the ship. DEAT (Dept. of Environmental Affairs and Tourism) has some involvement in pollution from shipping although they consider the DOT should be the initiator. This is the sort of administrative anomaly which could lead to a paralysis of action and some rationalisation might be desirable if ballast water controls are to be effective. Clearly the current situation where the DOT is the link with the ship this should remain. However, again it could be that ICM is the focus for bringing together the key technical interests, such as biodiversity/nature conservation, public health, fisheries/aquaculture, built infrastructure and tourism, into say a "harmful aquatic organism advisory group" to advise the port state and maritime administration on the ships/organisms requiring priority attention.

7.2.3. Already there are substantial research programmes underway in academic institutions into subjects of direct relevance to the ships ballast water issue, such as toxic dinoflagellates, including ballast water sampling, and public health. The challenge here seems to be in applying this expertise directly towards minimising the potential risk from the harmful organisms in ballast water at a practical level. This is where the need for a clear management network is paramount to maximise the effectiveness of the available technical capacity. Where there is concern that a serious shortage of trained personnel exists it is the international scientific community which could augment this capacity. Given the complexity of the subject it is doubtful that any State, developing or otherwise, can claim the full spectrum of technical expertise required.

7.2.4. Aquaculture and fisheries, perhaps, exemplifies this, particularly when considering piscatorial pathogens and parasites and other organisms, such as toxic dineflagellates, which threaten these marine resources. South Africa and adjacent states, including Namibia, Angola, Mozambique and Madagasca are highly dependant on such resources which are essentially regional in nature. There are also a number of ports in the region which, it could be argued, are now in competition particularly for the export of minerals. Unless a regional perspective is taken the expansion of the port industry in one State could be at the expense of aquaculture, fisheries or indeed eco-tourism elsewhere, or even vice versa. The threat from ships ballast water discharges is likely to originate from well outside the region and now Southern Africa is emerging from relative isolation, a global perspective is essential if controls are to be effective.

China

7.3.1 Considerable capacity already exists in the administration, such as the Frontier Health and Quarantine Authority and the Plant and animal Authority, and technical support from the Sea Fisheries Research Institute. It is reported that there are well equipped laboratories available undertaking specific research into toxic algal blooms together with a ballast water sampling programme. Also, obviously because of the number of aquaculture interests in the area, there is likely to be substantial experience in the understanding and prevention of piscatorial disease. It was reported that massive losses were experienced in the past in the prawn industry due to a bacterial infection, apparently from an unknown source. This has also been paralleled by the losses due to toxic dinoflagellates. Yet the ships ballast water vector was not considered as a potential cause. This hints at a problem of management co-ordination and intent.

7.3.2 There is clearly a well established maritime and port administration which already takes action to manage ballast water discharges by requiring chemical disinfection prior to discharge for public health reasons. These are backed by the necessary training and education at Dalian Maritime University.

7.3.3 Given the circumstances outlined it is worth considering in this case a pilot project based on a discrete geographical location. The Bohai Sea, into which the river Huang Hu (The Yellow River) flows carries large volumes of nutrient and sediment to sea. This sea is a shelf sea and semi-enclosed with reletively limited tidal interchange, with the Huang Hu delta comprising wetlands, probably mangrove and salt marsh. There are also some coral reefs. Dalian is the major port with a history of substantial ships ballast water discharges with a number of the necessary technical and administrative centres in close proximity. These could be brought together, as before, within an ICM framework, if one exists, to co-ordinate the multi-disciplinary structure essential for effective action to manage ships ballast water specific to the minimisation of introducing harmful organisms. Also the Dalian Maritime University could act as the training centre to upgrade the expertise of mariners and the port state officials specific to ballast water and the minimisation of the introduction of harmful aquatic species.

7.3.4 Specific aspects which the mission report did not identify were whether any initiatives to establish criteria for marine and estuarial biodiversity was in progress. At this time it would seem that little has been done but is crucial to any effective ships ballast water and harmful species identification and subsequent management. A further benefit of locating the pilot project on the Bohai Sea is that it is entirely within China's 200 mile Exclusive Economic Zone or even internal waters. An ICM initiative, which would incorporate "a non-indigenous species unit" comprising the range of specialist experts necessary, could evaluate the target priority species or any prohibited discharge zones for communication to the port state and maritime authority for onward transmission to ships. This, one assumes, would require some form of national legislative measure to back up the administrative action being taken.

India

7.4.1. There are similarities between India and China in terms of capacity. A developed port and maritime administrative infrastructure is clearly in place but not equipped to address ships ballast water and harmful species. There are also laboratories specialising in marine biological research in Mumbai which if appropriately resourced could probably undertake the necessary analysis. However, it is the objectives of the pilot project which need to be clearly identified before finalising the management structure.

7.4.2. The mission report indicated further research into the effects and spread of the fouling mussel mytilopsis sallei which has become established in harbour areas. This is helpful in understanding the epidemiology of this particular organism but any data obtained should be directed towards the potential effects of this and similar fouling type species, especially on infrastructure and mangrove. A further benefit which such a research programme might achieve is the nucleus of technical expertise which could be expanded to handle other species introductions and the minimisation of others. The Dept. of Marine Science at the University of Cochin has already undertaken some work on this species.

7.4.3. The mission report identifies five government departments as being likely to have an involvement to which can be added the Dept. of Ocean resources. As with China, also where a well established administrative infrastructure exists, a means must be found to bring together these diverse interests to focus on ballast water discharges and harmful aquatic species. Again ICM seems to offer the most promising option, especially as India is known to have a comprehensive coastal management policy basis, with a specialist focus group to provide the technical expertise on non-indigenous aquatic species.

7.4.4. The geographical location of the pilot project may well be crucial to the effectiveness of any initiative. India has a massive coastline which straddles two seas, the Arabian Sea and the Bay of Bengal. What aquatic species are defined as harmful will depend on where ballast water is discharged and the aquatic resources which are perceived to be under threat. Although Mumbai is the larger port current patterns suggest good tidal flushing. Calcutta is located in the Ganges Delta and placed in a regional context, adjacent to Bangladesh, which is 80% dependant on fisheries protein for its population. A bilateral ballast water initiative as a component of the Ganges Delta ICM plan offers the opportunity to test transboundary agreements and relationships. India and Bangladesh are predominantly Hindu which may be a signal for equitable collaboration. It is worth noting that voyages which do not involve leaving India's territorial sea, say Mumbai to Calcutta, will cross oceanographic boundaries without passing through open ocean. Also there is a culture of ships flushing ballast tanks offshore to prevent excessive sediment build up.

The Gulf

7.5.1. The arid nature of the surrounding land contrasts with the rich and varied marine eco-system which comprises the Gulf Sea and which is a special area under the MARPOL Convention. Sea grass beds, coral reefs and coastal wetlands provide habitat for varied species of fish and other marine life, many of which are commercially important. This marine area has very limited tidal interchange and any ballast water discharges containing harmful organisms will therefore remain within this discrete eco-system. The high water temperature may well provide favourable conditions for certain imported organisms which could readily reach epidemic proportions.

7.5.2. The Gulf is an integrated whole with the socio-political boundaries meaningless to any harmful aquatic organisms and non-indigenous species, it is therefore clearly arguable that a regional initiative is essential to achieve effectiveness. With the large number of oil tankers arriving to load cargo substantial quantities of ballast water will be discharged from numerous sources, particularly in the waters of the main oil producing States. This will generally be most of the Gulf States but Saudi Arabia, the United Arab Emirates and Kuwait are likely to be the highest.

7.5.3. The mission report focused on Bahrain which clearly has a well co-ordinated maritime, port and public health administration with well equipped laboratories and technical staff available in support. Ballast water discharge controls are backed by a legal provision which although mainly intended to prevent discharge of dirty ballast water, would require little modification to include the harmful species aspect.

7.5.4. However, Bahrain is too localised as the main focus for effective ballast water control and harmful organisms, although it is clearly an important component. Iran has a much larger coastal zone to be protected, but it is the establishment of a co-ordinated and unified regional approach which is the challenge. Although Iran is also an oil exporting country it is probably less important in national terms than the natural coastal marine resources. For Saudi Arabia, Kuwait and the UAE the ability to export oil without hindrance is vital to their economies, this concern was identified as a potential barrier to ballast water controls. A unified regional agreement is clearly an imperitive to effective action. It is worth noting that even the major oil producers are not immune to the effects of harmful species. Much of the fresh water needs of these States is provided by desalination plant with the saline water drawn directly from the sea. Fouling species, like the zebra mussel, could well block the intake pipes and coarse filters with obvious consequences.

7.5.5. The first step is to convene a regional seminar attended by the administrative and technical experts from the various Gulf States to establish a uniform series of protocols, especially legal, followed by a diplomatic regional conference to formalise these arrangements into a regional agreement, possibly called "The Gulf non-indigenous aquatic species protocol". It could be implemented through the tacit agreement principle. Given the political complexities of the region the IMO/UNDP would have a crucial role in bringing the parties together to unify intent and implementation. Only after such a process can the management framework, as outlined previously, have any chance of being effective in protecting the common marine eco-system of the Gulf, from the impact of ships ballast water discharges containing harmful aquatic species. However, although some Gulf States are taking action to improve reception facilities for ships waste under the special area status requirements, the implementation of MARPOL does not have an enviable record in the region.

The Black Sea

7.6.1. The Black Sea is perhaps better known as an example of what happens when a harmful aquatic species is introduced via ships ballast water. The comb jelly fish first appeared there some two decades ago and has now reached epidemic proportions, the most graphic result being the collapse of the anchovy and other capture fisheries. It is fair to say that the eco-system of the Black Sea is in crisis, with obvious damage to biodiversity. The comb jelly fish saga is well document in GESAMP Report No. 58, it is essential reading for anyone who does not believe that the introduction of harmful aquatic organisms by ships ballast water discharges is not a serious environmental issue.

7.6.2. There is an eco-system remediation programme currently under way in the Black Sea sponsored by UNEP (United Nations Environment Programme) and it seems prudent to integrate the IMO/UNDP ballast water pilot project with this to gain advantage of the technical capacity already existing or in the process of being built.

7.6.3. In terms of developing countries the Ukraine and Georgia are likely to the target due to the recent political changes. Whether a residue of maritime and port State administration still remains in a structured form from the previous USSR system is unknown. Also the legal framework backing any port State intervention to manage the impact of shipping may be in the process of transition and needs to be investigated. The rapidly developing oil industry based in the Caspian Sea will clearly lead to a surge in exports either through the Ukraine or Georgia, with an increasing number of ships arriving in ballast to load cargo. Whether the resulting discharges of ballast water including the many non-indigenous species present will make the situation better or worse is a matter for unscientific speculation. There is, perhaps, scope to consider a scheme to prevent the comb jelly fish being exported elsewhere when ballast water is being loaded after the discharge of cargo by creating or identify "clean zones". It emphasises that the environmental problems associated with ballast water and harmful aquatic species can only be overcome if all parties involved, (loading port, discharge port and ship) work together for a common objective.

Conclusions

The accidental release of harmful aquatic species with ships ballast water into the receiving waters of the discharge port or harbour is like no other form of environmental impact. Unlike oil pollution no obvious evidence of the environmental effects can be seen and may not be seen until perhaps years after the event. In some ways this is worse than oil pollution because once the effects become apparent it is too late. No successful examples currently exist of the eradication of a harmful non-indigenous species from an aquatic eco-system once introduced.

Therefore the precautionary approach is paramount. The most obvious action for any port state is to require all ships which carry ballast water to implement one or several of the precautionary practices listed in the IMO Guidelines, known as the tool box of options. The most effective current option is open ocean exchange by the ship.

However, there will be many situations where this option cannot be accomplished due to stress of weather, a shallow water track where the ship does not encounter the open ocean criteria or where for design reasons the ship can only carry out ballast water management practise in port in association with loading and unloading cargo. Appendix 2 of the IMO Guidelines gives clear guidance to ships in this regard, but it is also advisable for port state officials to appreciate these safety parameters in order to confirm the validity of a visiting ship's requirements.

When open ocean exchange is not possible and ballast water must be discharged prior to loading cargo then there is no alternative but to undertake some form of risk assessment procedure before the ship can be allowed to discharge ballast water. Similar procedures may be necessary when selecting alternative discharge zones.

The ballast water reporting form is a crucial link in validating the potential environmental risk posed by individual ships. Particularly when confirming that open ocean exchange has or has not been completed. Further technical validation procedures will be needed when this is being enforced.

Developing countries are more likely to depend on exports of raw materials to obtain hard currency with an obvious incentive to minimise the impact on the efficiency of port operations and therefore the turn round of the ship. This needs to be balanced against the risk of introducing harmful aquatic organisms into the marine eco-system of an individual state or a region with all the environmental damage which could result.

However, doing nothing is no longer an option.

MISSION REPORT

The consequences of ships ballast water transfer of exotic species, with emphasis on health impacts, particularly on women and children in developing countries.

Project title: Preparation of a report summarizing the the issues related to, and more specifically the consequences of, ballast water transfer of exotic species, with an emphasis on health impacts, particularly on women and children.

Requested by: United Nations Development Program

Scope of assignment: Visit a number of research institutions to obtain data on the effects of alien species, including pathogens, on the marine environment and the resources on which humans depend.

Duration: 6th April 1998 to 8th May 1998

Funded by: Global Environment Facility through United Nations Development Program.

Executing agency: International Maritime Organisation (IMO)

Note: The contents of the report is based on an assembly of the information obtained during the assignment. The interpretation of such information as expressed in the report is entirely the responsibility of the author. The conclusions drawn are entirely those of the author and should not be attributed to the United Nations or to the International Maritime Organisation.

Consultant: Roger Lankester.

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Report on:- The consequences of ships ballast water transfer of exotic species, with emphasis on health impacts, particularly on women and children in developing countries.

Executive summary

The transfer and discharge of ships ballast water, containing a range of aquatic organisms, has a potential to impact on human health both directly and indirectly. Direct effects are the inoculation of the receiving waters by human pathogens and toxic dinoflagellates. Indirect effects may be the transfer of fish diseases damaging aquaculture, organisms causing fouling to water intake and discharge pipes etc. The report gives an overview of the range of these potential impacts with estimates of potential risk in broad terms.

Report on: The consequences of ships ballast water transfer of exotic species, with emphasis on health impacts, particularly on women and children in developing countries.

1. Introduction.

1.1.1. This report is part of a number of reports concerning the UNDP/IMO initiative to be submitted to GEF for the purpose of setting up a series of demonstration projects in developing countries to minimise the effects of the transfer of harmful aquatic organisms via the vector of ships ballast water. It should be emphasised that there is consensus that the effects of introduced organisms through ballast water discharges can only be minimised, not completely eliminated unless there is no maritime transportation to the region. Therefore assessment of health effects will need to be considered in this context. In addition there will be indigenous general health implications concerning use by the population in developing countries of their coastal marine resource which are unconnected or only have a tenuous link with ships ballast water discharges. The report will attempt to identify these, but in a number of cases it will be impossible to discriminate between these and other health impacts.

1.1.2. The consequences to public health from ships ballast water is also a matter of potential risk. However, at this time specific scientific analysis related to ballast water and health is extremely sparse and in many cases non-existent and therefore risk can only be attributed in broad terms and somewhat speculative. Therefore "low", "medium" and "high" are the degrees of risk used in this paper and it is hoped that as greater research and experience is obtained, improved data will become available for more precise risk assessment purposes.

2. <u>Background</u>

2.1.1. There are estimated to be approximately 40,000 ships operating world wide which need to take on ballast water [from the sea] as integral to the operation of the ship. The purpose may be to ensure the ship is stable i.e. it does not capsize, trimmed to submerge the propeller and achieve the best attitude of the hull for fuel efficiency and steerage. In addition the use of ballast water to prevent the hull structure being over-stressed is becoming a more prominent feature of ship management, especially because of the vastly increased size and cargo capacity of modern ships.

2.1.2. The types of ship and the volumes of ballast water used are extremely diverse, as indeed may be the location of take up and discharge and the many diverse organisms thereby translocated. A cruise ship will only require to take on a few hundred tonnes of ballast to replace the weight of fuel used during a voyage but could discharge it near to pristine wildlife habitat where passengers normally embark. At the other end of the scale a VLCC (Very Large Crude Carrier) may need to take on 100,000 tonnes of ballast when voyaging to load cargo but will discharge it within a terminal area dedicated to that cargo.

2.1.3. The type of ship and structural form of the hull will determine the ability of the ship to undertake ballast water management practices as prescribed in IMO Resolution A.868(20) “Guidelines for the control and management of ships ballast water to minimise the transfer of harmful aquatic organisms and pathogens”. Some ships, usually container ships, may only be able to redistribute or discharge ballast water in association with loading and unloading containers. Similarly, bulk carriers can be prone to structural overstressing unless considerable care is taken to manage and distribute ballast water appropriately.

2.1.4. Ballast water management both at sea and in port is nearly always a matter of ship safety. Most of the ships currently trading worldwide were never designed with the specific intention of managing their ballast water for the purpose of preventing the translocation of harmful aquatic organisms.

2.1.5. Therefore ship operators will always assume they are free to take up ballast water as necessary and discharge it in the receiving port at their discretion unless precluded from doing so by Port State regulations or where ballast water is contaminated with cargo residues or operational wastes. This will be assumed to be the norm for the purpose of this report although in a few isolated cases Port States require ballast water management or treatment specifically for public health reasons.

3. Distribution Vectors

3.1.1. How harmful aquatic organisms in ballast water represent a public health risk depends largely on a number of factors, mainly related to where the water is taken on and subsequently discharged.

3.1.2. The location of take up may be high in suspended matter, such as in an estuary where many of the worlds major ports are situated, or in areas close to major cities where sewage is discharged without proper treatment into coastal water. Similarly nutrient levels may be high in the water taken up providing any organisms present with a food supply during a voyage. Sediment accumulated in the bottom of the ballast tank or hold can replicate natural habitat conditions assisting aquatic organisms to survive during a voyage and insulate them from decay. Also salinity levels will have a bearing on the potential survival of harmful organisms when discharged into the waters of a receiving port, although it is becoming increasingly clear that using different salinities between the ballast water on the ship and receiving waters as an effective management strategy needs to be applied with considerable caution, particularly when direct effects on public health are being assessed. Water temperature differences or similarities will also have a bearing on the survival and potential development of introduced aquatic species.

3.1.3. Ballast water discharges in port areas are the normal focus of concern but other locations must also be considered. Ship repair and maintenance facilities may be in separate locations to ports with the ships almost always arriving in ballast. This will be discharged before or during slipping or dry docking. To work on the interior of the ship or to carry out a major survey, tanks will need to be cleaned from sediment, possibly releasing a whole range of harmful aquatic species into the surrounding waters.

3.1.4. Ship breaking is also an important economic activity in developing countries, typically in India where a plentiful supply of low cost labour is available. The ship is literally dragged on to a beach by winch and cut up into pieces for transportation elsewhere. Again ballast water and sediment will be discharged with associated environmental effects and subsequent risks to health. In these circumstances quarantine controls and maritime administrations may be poor or non-existent.

4. Specific health issues

4.1.1. The health effects on the human population, especially women and children, in developing countries can be divided broadly into two categories, direct and indirect effects. Direct effects are where the use of coastal marine resources will result in illness or reduction in health of an individual or group of individuals, such as diseases and other related effects. Indirect effects are more likely to impact at a strategic level on health, such as a reduction in foreign exchange which could reduce the acquisition of hard currencies to purchase pharmaceutical products and other medical requirements from developed countries.

4.2. <u>Direct effects</u>

4.2.1. The most obvious is the discharge with ships ballast water of bacteria and viruses which cause severe disease epidemics such as cholera and typhoid. Coastal waters, which include those up river within the tidal regime, may be used for washing for hygiene and laundry purposes, bathing for recreation and leisure and for washing domestic animals. Where contact with contaminated water occurs the risk of disease is present. Other less direct vectors, such as the consumption of fish and shellfish, especially from wild stocks, contaminated with pathogens clearly may result in diseases. Bivalve molluscs, clams, oysters, mussels etc. are particularly prone to such contamination. However, in relative terms it is the more pristine environments where the risk is highest and where such diseases are absent. When coastal waters are heavily contaminated with sewage discharges from land, ballast water will not add substantially to the risk of disease. The risk of human pathogens surviving as free agents in ships ballast water and subsequently infecting individuals using the sea is considered by epidemiologists to be low. However, when carried by a host organism this may be a different matter. For example the cholera pathogen lives on a copepod which itself enhances the chance of survival. This is unlikely to be unique. Other pathogens may survive in the pelagic stage of shellfish larvae settling in their new location and perhaps becoming an opportunistic food resource but with a hidden danger. Literature on this subject is virtually non-existent.

4.2.2. The perception may be that the highest risk from diseases is when the ballast water is loaded in the port of a developing country where, perhaps, sewage treatment infrastructure ashore is poor. Such a perception needs to be considered with caution. Voyages with a ship in ballast are more likely to occur from a developed country to a developing one wishing to export its natural resources, with the return voyage carrying raw materials for manufacture into new products replacing the ballast water. In a number of developed countries the sewerage infrastructure and treatment remains relatively primitive with the release to sea of pathogens. Also, in temperate zones and where rainfall is high pathogens from diffuse sources may contaminate sea water which can be taken on for ballast purposes. Although it is a remote possibility that the most serious diseases will be translocated to developing countries in this way a lower order of infection may do so.

4.2.3. Epidemiological studies for bathing waters in developed countries suggest that the risk of contracting stomach upsets (salmonella/E.Coli), ear, nose and eye infections are increased when swimming in sewage contaminated sea water. A further complication is the acquisition of anti-biotic resistance by certain of these pathogens. These infections are considered minor and non-reportable in developed countries but may cause greater health problems in developing countries where nutrition is poor, especially amongst infants where diseases are more difficult to treat. Again the risk of direct translocation in ballast water is thought to be low but host species could advance the risk to a medium level. Obviously where coastal waters are already contaminated with sewage from land multiple pathogens could be present. In these circumstances ballast water may become a negligible source.

4.2.4. Aquatic parasites are also a risk to human health via the ships ballast water vector. A species of trematode which may result in a fatal lung disease has been identified as being potentially very dangerous. It requires a species of crab and also a gastropod also to be present as intermediate hosts and both these have been translocated through ballast water. Again the literature is non-existent regarding the risk, but where the host species are present at the loading port for the ballast water, the risk must be at least in the medium order until proven otherwise. It seems likely that this may not be the only example of a parasitic organism in ships ballast water having a direct impact on public health, in this regard further research is clearly desirable.

4.2.5. Perhaps the most well documented public health issue connected with ballast water is related to toxic dinoflagellates. A number of dinoflagellate species known under the generic term phytoplankton, produce neurotoxins which may have direct and sometimes severe health effect (paralysis, organ failure, respiratory failure) if ingested, including the consumption of contaminated fish. Other symptoms are eczema type skin rashes and eye irritations which may lead to further infections. The most vulnerable group exposed to such effects are artisanal fishermen, including their children who often go the sea to learn the tradition. Tidal conditions may carry a "red tide" (phytoplankton bloom) up-river affecting a broader spectrum of people.

4.2.6. Obviously attribution to the ballast water vector is only valid if loaded in a port where a red tide has occurred. What has complicated this aspect is that a single species of dinoflagellate may not necessarily be known for its toxicity, but strains of it are, with greater difficulty in identification. This perhaps indicates the complexity of the subject and the importance of specific and detailed scientific research necessary to carry out proper risk assessments. Furthermore red tides have been attributed to natural occurrences due to high nutrient levels in some coastal waters. Although sufficient nutrients are essential for a phytoplankton bloom to occur naturally, the presence of toxic species may not be. Ballast water discharges are becoming an increasingly important part of these effects and are therefore high on the scale of risk associated with health impacts.

4.3. **Indirect effects**

4.3.1. These cover a diverse range of impacts which may be attributed to ships ballast water discharges. Some will be more direct than others but need to be taken in the context of the socio-economic, environmental and political changes which have recently occurred and may occur in the future in developing countries. The Rio Earth Summit concluded that by the year 2025 approximately 75% of the worlds population would live within the coastal zone. Therefore dependency on coastal marine resources is bound to increase, especially as desertification forces the movement of populations away from the interior.

4.3.2. It is estimated that world aquaculture will expand from its present level of production of 15 million tonnes per annum to 40-50 million tonnes by the year 2020. (See appendix 1). Although most of the current production is for cash crops a burgeoning amount is bound to be essential to feed indigenous populations as they increase and migrate towards the coast and as capture fisheries are reduced to curtail over fishing.

4.4. <u>Aquaculture</u>

4.4.1. Again the most well documented effects which connect ships ballast water discharges to aquaculture are subject to toxic dinoflagellates. The fish stock, trapped in cages or ponds, cannot swim away once hostile conditions develop nor can shellfish which are largely static. Once the toxins engulf the area, fish will die or become contaminated making them useless for consumption or sale. One years' harvest of China's shrimp production was lost in this way and recently a major fish kill occurred in Hong Kong. These are yet to be associated with ballast water discharges but the risk is quite clear and should be considered as being high.

4.4.2. Although action is taken by administrations to prevent the consumption of contaminated fish and shellfish, including crustacea, the economic effects are severe. In most developing countries aquaculture products are intended as cash crop export to obtain hard currency. This is used in turn to acquire essential products from developed countries such as pharmaceuticals, medical supplies and training etc. Typical perhaps is Mozambique where around 35%-40% of GNP is from fishing, especially crustacea, in its various forms, mostly for export, and this country has the second highest infant mortality rate requiring urgent attention.

Similar situations are likely to prevail elsewhere, South America, the Pacific basin, Africa, etc. These are all regions which have substantial aquaculture interests that will undoubtedly grow over the future decades for the reasons stated above. Even though the aquaculture may be lagooned in fresh water areas it is not immune from the ballast water influence. Tidal flows may carry toxic dinoflagellates up river where water drawn from the river may damage stocks. The filtration systems necessary to prevent such effects are often not available or ineffective.

4.4.3. Similarly, piscatorial diseases can be transferred from place to place by ships ballast water. There is the general view that direct transfer of fish disease causing viruses and bacteria as free agents in ballast water is low, but in a host species this is a different matter. Aquaculture is normally located in sheltered waters, often where tidal flushing is limited and therefore such areas represent potential hot spots for disease, taking into account the common problem for the many forms for intensive farming where the stock is packed tightly together. Ports are often similarly located and where these are within the same current pattern, may well take up diseased organisms in the pelagic stage. An example, although not at this time related to ballast water, is an out break of yellow-head and white-spot viral infections in the shrimp farms of Asia, which are described as “highly virulent pathogens”. White-spot viral infection caused the loss of 70,000 tonnes of shrimp in Thailand, i.e. 40% of the total production and there has been concern expressed that these diseases may be transferred to South America, typically Ecuador. The ships ballast water vector is thought to be a "serious risk” but difficult to quantify. Obviously, if ballast water is taken up by a ship near to the location of diseased species and then discharged close to aquaculture cages or layings of similar species elsewhere, the risk must be high.

4.4.4. Another major impact is the transfer of fish parasites to aquaculture. Species of fish etc. which are not necessarily indigenous, may be used because higher water temperatures may enhance growth rates which can result in species from temperate zones becoming rapidly marketable with the obvious potential. However, natural parasites which may remain in balance in temperate regions where water temperatures are lower, may reach epidemic proportions in a tropical or semi-tropical location. Only a temperature rise of 3 degrees C can result in such effects. Chilodorella, a cold water parasite, is now commonly found in the tropics. Parasites, such as the salmon louse, a copepod which attaches itself to the surface of the host, consume its skin and flesh, resulting in extensive sores and lesions.

4.4.5. Non-indigenous tropical species are commonly cultivated in temperate zones with the obvious risk of secondary transfer of disease or parasites. It is the market that determines what is cultivated, particularly as aquaculture science is now so sophisticated that management of the stock, if applied correctly, almost guarantees success. However, external influences, such as ballast water discharges could negate such effort. Approximately 2 billion US dollars is lost annually as a result of piscatorial disease and parasites in aquaculture. The sum which can be attributed to ballast water discharges in developing countries has not so far been evaluated. But the economic and subsequently health consequences could be very severe indeed.

4.4.6. Clearly diseases and parasites which affect aquaculture can have a similar impact on wild fish stocks. However, such risk is likely to be lower in free swimming species, but where an introduced disease or parasite becomes established this may preclude the subsequent use of the location for aquaculture purposes. Dependency on the fishery resource for protein is normally much greater in developing countries. Bangladesh, for example, is 80% dependent on this source.

4.4.7. Other forms of marine resources which are of economic value are seaweeds. These may either be directly for human consumption or be used as raw material for the manufacture of other products. Cosmetics and ice cream are just two examples. Seaweed's can be susceptible to disease as can any plant; the ships ballast water vector is clearly a risk as diseased plant matter can be translocated in this way. However, the degree of risk is unknown due to a complete absence of literature on this specific subject, although it is known that in a number of countries quarantine controls exist to prevent the accidental introduction of seaweeds by other means.

4.4.8. A somewhat esoteric aspect which could have a ballast water connection is the cultured pearl industry of the Pacific Islands. Being virtually pristine natural habitats these places need a cash crop which has minimal environmental impact, compared with say aquaculture. The high value product can clearly attract substantial hard currency and provide alternative employment to environmentally unsustainable economic activity. As a rough estimate 60,000 jobs are dependant on the cultured pearl industry and if allowed to flourish could ensure sufficient income to prevent island depopulation and to maintain traditional cultural and social cohesion . The zebra mussel, a well known harmful aquatic organism associated with ballast water transfer, is known to be capable of destroying the oyster stocks necessary for pearl cultivation. Although there are not necessarily major international ports associated with these small islands the coastal ferry service could introduce harmful organisms through a secondary vector by taking on ballast water at the major destination port and discharging it in these coastal locations as cargo and passengers are taken on. Clearly if damage to the oyster stocks occur the result would be substantial unemployment with all the social and health problems known to be the consequence. Especially as no other economic activity may be possible due to the sensitivity of the coastal marine environment.

4.5. Habitats, eco-systems and infrastructure

Biodiversity

4.5.1. The Convention on biological diversity describes it thus:-

"The variability among living organisms from all sources including, *inter alia,* terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part, this includes diversity within species and of ecosystems."

4.5.2. Obviously what is being described is the global biosphere on what all life is ultimately dependant. However, what this means in specific technical terms remains the subject of continuing scientific debate, especially in the marine environment. Different interpretations of what is "natural" and what is the result of human influence create problems in identifying the exact role of ballast water discharges in terms of "harmful" organisms. Some scientists would argue that any non-indigenous species introduction is harmful in terms of biodiversity. Others might concentrate on species which have a clearly identified harmful effect to anthropogenic interests. Typical is the comb jelly fish introduced into the Black Sea by ships ballast water. This has clearly caused extensive damage to the whole eco-system reducing the anchovy fishery to 10% of its original productivity. The zebra mussel in the US and Canada Great Lakes is a further example of eco-system damage with clear implications to biodiversity and the economic use of the aquatic environment. However, in many cases of accidental species introductions the potential ecological consequences are very difficult to assess, as indeed may be the long term health effects on human communities, often because baseline data is absent particularly for the marine environment. Some species introductions could appear to be beneficial to anthropogenic interests in the marine environment, such as a species providing a food resource but which is reducing the intrinsic biological diversity of a discrete aquatic eco-system. Definitive conclusions on such complex issues are therefore way beyond the scope of this report.

Coral Reefs.

4.5.3. These are without doubt the most biologically diverse of discrete marine eco-systems, with a large number to be found in developing countries. Because of the vast number of species which form a coral reef, obviously including the corals themselves, quite what comprises the "natural" ecosystem seems difficult to determine. The literature suggests that a newly discovered species or group of species forming a reef is a scientific discovery adding to the biodiversity of the eco-system. Whether or not such discoveries might be associated with accidental introductions is unclear. What is certain is the damage to a coral reef which can occur as a result of certain marine species.

4.5.4. The most serious, perhaps, is the crown-of-thorns starfish which consumes the coral. It is a well known ballast water introduction in Australia with strictly enforced quarantine controls to prevent further inoculations of their coastal waters. A polychete worm is known to destroy certain species of coral and there will be a range of parasites and diseases which affect the many fish species which live on or around a reef. There is a clear potential risk of these harmful organisms being introduced by the ships ballast water vector and the degree of risk will vary depending on the conditions prevailing in the loading port. Quite clearly the crown-of-thorns starfish represents the highest degree of risk with others yet to be determined.

4.5.5. The indirect health effects on the human population are several. Small tropical islands invariably low lying with the land sometimes only being a few metres above sea level. The fringing coral reef provides attenuation to wave energy protecting the coastline from erosion. Any loss of the coral reef will have obvious consequences especially when combined with sea level rise. The coral structure provides a habitat for many fish species at adult and juvenile stages, some of which are of commercial interest and any damage will have obvious effects. Coral reefs are without doubt the most charismatic of all marine habitats and therefore represent a major eco-tourism resource. Indeed the only reason why small islands and other similar coastal environments can attract the tourism hard currency is because of the coral reefs. Loss of this resource may well result in a reduction in the most lucrative aspect of the tourist market with unemployment leading to the health problems mentioned earlier.

4.5.6. The natural sponge industry can be associated, but not exclusively, with coral reefs and there are aquatic diseases and parasites which may damage this resource. As with any other water borne threat ships ballast water has a potential involvement in creating a pelagic bridge. The risk of harmful introductions is probably in the lower order but obviously where ballast water is taken up in an area known for sponge disease and then discharged close to a sponge bed elsewhere the risk is much increased.

Mangrove

4.5.7. As with coral reefs mangrove or mangals as they are sometimes called are dominant in tropical developing countries. Unlike coral reefs they lack the charisma which makes them a focus of attention for environmental protection, and in the past have been destroyed to make room for fish farms and coastal tourist development. Although lacking the species richness of coral reefs mangrove is an essential component of the coastal marine eco-system. High in nutrients and forming a sheltered environment the mangrove root structure provides habitat vital to many marine species of commercial interest, particularly during the juvenile stage. There is also a symbiotic relationship with coral reefs where species may interchange between habitats during the various stages of their life cycle.

4.5.8. A further and most important aspect of mangrove is as a natural form of coastal defence, binding together otherwise mobile sediments and attenuating wave energy. Developing countries often obtain foreign exchange from mangrove used to manufacture charcoal for the barbecue trade. Although somewhat controversial amongst conservation NGOs it is a chosen industry and is labour intensive often providing family income to augment artisanal fishing.

4.5.9. It is known that the growth of mangrove can be reduced by up to 60% due to the fouling of the roots within the tidal range by marine organisms. There is unequivocal evidence of the transfer of the zebra mussel via ships ballast water and the most prominent effect of its introduction is fouling. Clearly if it is shown that it can affect the root structure of mangrove it would have serious implications to developing countries. Also a mussel (mytilopsis sallei) has been identified in the harbours of India, again this is a fouling organism and a competitor for substrate space. Whether or not it has the potential to spread and reach epidemic proportions, as the zebra mussel in the US, is not known but history records that the unexpected tends to happen in the ballast water saga.

4.5.10. With the zebra mussel now endemic in many of the waterways of the US and Canada and which are navigable by ocean going shipping, transfer of the species to developing countries in ballast water must be high. The full impact on health, related particularly to mangrove, is almost impossible to assess at this time, with no specific scientific studies available. However, it would be ironic indeed if the ships visiting a developing country to pick up a cargo of charcoal were to become the authors of the eventual damage to this important natural resource. No doubt other aquatic species may well have a detrimental effect on mangrove but the example used has perhaps the most likely relationship with ships ballast water.

Infrastructure

4.5.11.Effects of introduced species and the effects on the civil infrastructure are best illustrated by the zebra mussel in the US, where the severe fouling has blocked water intakes and filters to power plants.

4.5.12.In terms of human health the most obvious effect is the fouling of sewage and storm water discharge pipes which become blocked or flow rates reduced to a degree where flooding ashore occurs, with all the disease epidemics associated with such events. Developing countries in the tropics are more prone to extremes of climate, especially rainfall, and the need for efficient and functioning storm water relief systems to overcrowded cities near the coast is clearly critical. Increasingly towns and cities in arid regions, such as the Gulf, obtain their fresh water for drinking, washing and many other domestic requirements by desalination plant. Sea water is drawn into the system and using either the reverse osmosis or electro-dialysis processes extract the contaminating salts. Clearly if fouling of the intake pipes occurs and they become blocked, failure of the fresh water supply will result. Where desalination is used there is usually no long term fresh water storage on land such as lakes or reservoirs, plant malfunction will cause severe water shortage after only a couple of days. To clear the fouling organisms and to re-establish the water supply may take some time with a potentially severe health implication.

4.5.13.Weather conditions, such as severe storms, which require coastal defences, typically Bangladesh, often consist of only earth embankments. Burrowing marine species, such as crabs, can weaken these structures which may well fail resulting in flooding with obvious health consequences. Species of crab are a well known introduction via ships ballast water.

Fouling of aquaculture netting to cages and fish traps have a detrimental effect on fishing effort but perhaps too tenuous to be classed as a health effect.

4.5.14. Boring marine animals, such as the teredo ship worm and the gribble, a crustacean isopod, have the potential for transfer from place to place by ships ballast water. Timber structures, such as jetties and dock piles, can obviously suffer severe damage where these are present. However, translocation on or in timber ships was the more likely vector. Where such species are still unknown timber may well be a viable local material for use in maritime structures and the accidental introduction of wood borers will have substantial economic effect. The health implications are probably direct due to injury should such structures collapse as a result of the wood boring action and general decay. Perhaps more worrying is the potential effects on artisanal fishing craft and other traditional timber boats which are still much used in developing countries for coastal transport, especially between islands. Wood boring marine species will render such craft unseaworthy with a clear risk to life. Although these species have not previously been a problem, history shows that apparently random events may allow such species to become established and become harmful.

Miscellaneous

4.5.15. Other accidental introductions which have been documented as having a ballast water vector are from marine plants. Although toxic dinoflagellates are essentially plants they are planktonic. Seaweeds and marine alga which are static can be transferred via ballast water. Sargassum, which has a reputation for clogging navigable channels and impeding small shipping is typical. Caulerpa taxifolia can carpet the sea bed preventing the development of benthic species. Again this may have the effect of damaging the capture fishery with a consequential loss of a food resource and perhaps aquaculture. Only a small piece of the plant is necessary to commence a colony elsewhere with its foliage being toxic. Health effects are somewhat tenuous in the short term but could become more serious if mitigation action is not taken.

5.0 Conclusions

5.1.1. How serious the potential health effects are to the population of developing countries from ships ballast water, compared to other health risks is difficult to quantify. Where a cholera or typhoid epidemic can be directly related to ballast water then of course the risk is high. However, there are also circumstances of previous health problems associated with the marine environment which have been wrongly attributed to a land based source, such as sewage discharges, or toxic dinoflagellates which are associated with excessive nutrient inputs and termed "natural" in the scientific literature.

5.1.2. The health of human communities, especially in developing countries, is inextricably linked to the health of the natural environment. Statistical evidence shows that dependence on coastal marine eco-systems is likely to increase rapidly in the next two decades, both for a direct food resource and hard currency from tourism and the cash crop of aquaculture.

5.1.3. Ballast water and health needs to be seen in terms of the dramatic political changes which have occurred in the last 5 years or so. The resolution of internal conflict within the countries of Southern Africa are bound to lead to a desire to exploit natural resources resulting in a greater number of ship visits in ballast. Angola is, perhaps, a good example with a burgeoning offshore oil industry. With the dissolution of the USSR it might be argued that a developed country has fragmented into a number of developing ones, each now more dependant on resources within sovereign boundaries than when within the Soviet collective. It seems ironic that a country, like the Ukraine, having achieved independence discovers its coastal aquatic eco-system and the natural fishery resources on which they depend has been so severely impaired by a ballast water introduction, the comb jelly fish, at a time when they are most desperately needed.

5.1.4. The foreign exchange debt of developing countries has been assessed as having implications directly to the health of the population, especially women and children. To repay such debt and to convince the international banking industry that a particular country is a sound investment it is essential to show exploitable resources can provide an appropriate return in hard currencies to service the loan. In cases where a developing country has no minerals or oil reserves the coastal marine resource exploited for aquaculture, capture fisheries or tourism may well be a major consideration. Furthermore should these industries fail, possibly as a result of damage from harmful aquatic organisms, the result could be a national impoverishment and decline to poor community health, especially women and children.

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Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries

prepared by

Dr. Stephan Gollasch

This report presents the results of a desk study carried out in November 1997 in order to support the joint GEF/IMO/UNDP project, initiated by the IMO, entitled: “Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries” with background information. Due to the minimized time available to collect these information the compiled lists claim not to be complete but shall give an overview relevant to the subject.
In addition to this world-wide inventory, Caroline Sutton at CSIRO/CRIMP (Australia) is also doing an international ballast water survey, focused on ballast water sampling methodology and results of shipping studies in the past.

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Abbreviations used:

(see also in the world wide web at: http://www.icc.ie/info/net/acronyms/index.htm)

ABWMAC Australian Ballast Water Management Advisory Council
ACME Advisory Committee on the Marine Environment (ICES)
ANS Aquatic Nuisance Species
APHIS Animal and Plant Health Inspection Service (USA)
AQIS Australian Quarantine and Inspection Service
ASMO Assessment and Monitoring Committee
BALLERINA Baltic Sea Region On-Line Environmental Information Resources for Internet Access
BIONET Biodiversity Action Network
BMB Baltic Marine Biologists
DWT Dead Weight Tonnage
CBD Convention on Biological Diversity
CBIN Canadian Biodiversity Information Network
CFR Code of Federal Regulations (USA)
CIEL Centre for International Environmental Law
CIESM
CITES Convention in Trade on Endangered Species
CRIMP Centre for Research on Introduced Marine Pests (Australia)
CSIRO Commonwealth Scientific and Industrial Research Organization (Australia)
CSA Canadian Shipping Act
EC Environment Committee
EEZ Exclusive Economic Zone
EIFAC European Inland Fisheries Advisory Commission (of the FAO)
ETI Expert Centre for Taxonomic Identification (UNESCO)
FAO Food and Agriculture Organization of the United Nations
FWS Fish and Wildlife Service (USA)
GEF Global Environment Facility
GESAMP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (IMO/FAO/UNESCO-IOC/WMO/IAEA/UN/UNEP)
HAB harmful algal bloom
HEAR Hawaiian Ecosystem at Risk
HELCOM Helsinki Commission (Baltic Marine Environment Protection Commission)
HNIS Harmful Non-Indigenous Species
IAEA International Atomic Energy Agency
IBIN Indigenous Peoples Biodiversity Information Network
ICES International Council for the Exploration of the Sea
ICLARM International Centre for Living Aquatic Resources Management
ICS International Chamber of Shipping
IFREMER Institut Francais de Recherche pour l'Exploration de la Mer
IHS Import Health Standard (New Zealand)
INTERTANKO International Association of Independent Tanker Owners
IPHAB Intergovernmental Panel on Harmful Algal Blooms (IOC)

IMO International Maritime Organization
IOC Intergovernmental Oceanographic Commission
IUCN The World Conservation Union
ISSG Invasive Species Specialist Group (IUCN)
JAMP Joint Assessment and Monitoring Programme
LEML Laboratoire Environment Marine Littoral (Nice)
MARPOL 73/78 International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto
MC Marine Committee
MEPC Marine Environment Protection Committee (of IMO)
NAS Non-Indigenous Aquatic Species (USA)
NEMO Non-Indigenous Estuarine and Marine Organisms (BMB Working Group)
NISA National Invasive Species Act (USA)
NOAA National Oceanic and Atmospheric Administration (USA)
OSPAR Oslo and Paris Conventions for the Prevention of Marine Pollution
RAG Research Advisory Group (Australia)
SCOR Scientific Committee on Oceanic Research
SERC Smithsonian Environmental Research Centre (USA)
SGMBIS Study Group on Marine Biocontrol of Invasive Species (ICES)
SGBWS Study Group on Ballast Water and Sediments (ICES/IOC/IMO)
SOLAS International Convention for the Safety of Life at Sea, 1974
UN United Nations
UNCED United Nations Conference on Environment and Development
UNCLOS United Nations Convention on the Law of the Sea
UNDP United Nations Development Programme
UNEP United Nations Environment Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
USCG United States Coast Guard
USDA United States Department of Agriculture
VPC Vancouver Port Corporation (Canada)
WCMC World Conservation Monitoring Centre
WGITMO Working Group on Introductions and Transfers of Marine Organisms (ICES)
WHO World Health Organization
WMO World Meteorological Organization

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1 Introduction

The unintentional introduction of non-indigenous organisms has resulted in the establishment of many species outside their native ranges with the potential to threat native environments and economies.

It is assumed that the main vector concerning transportation of organisms is, beside the introduction of species for aquaculture purposes, the unintentional transport with ships. Since the introduction in the late 19. century of steel hulled vessels ballast water discharges have increased considerably throughout the world and the probability of successful establishment of self-sustaining populations of non-indigenous species increased with greater volumes of ballast water as well as with reduced ship travel times. The first suggestion of an unwanted species introduction was made by Ostenfeld (1908) after a mass occurrence of the Asian phytoplankton algae *Odontella* (*Bidulpphia*) *sinensis* in the North Sea in 1903. Several decades later a survey was carried out by German scientists sampling the Suez Canal flora and fauna. At that time some ships did use ocean water for cleaning purposes pumped on board via segregated pipework. One of the plankton scientists realised that this cleaning water contained organisms and sampled it for his plankton study. This was the preferred way of sampling because the ship was able to continue its voyage without a stop for sampling. But the scientists on board did not realise that in the same way as for cleaning purposes water was pumped on board to fill the ballast tanks and that species may survive this pumping activity as well. The first shipping studies including sampling of ships' ballast water appeared 70 years later by Medcof (1975) followed by those of Carlton (1985, 1987), Hallegraeff & Bolch (1991) and Subba Rao et al. (1994). Rosenthal (1976) reviewed the state of knowledge and the risks associated with the transplantation of non-indigenous species to fisheries and aquaculture, including ballast water as vector. The study concluded that modern aquaculture development in the coastal zone was at high risk of disease transfer from ballast water in cases where aquaculture facilities and areas of fishing were located near shipping routes. The recent world-wide growth of aquaculture along such infrastructure elements amplifies this risk, possibly rendering disease regulations for this industry useless in many areas. An annotated bibliography on transplantation and transfer of aquatic organisms through various means (including ballast water) is presently under preparation, covering more than 10,000 literature entries (Rosenthal, 1996, final draft).

As example we note that with the import of the Pacific Oyster several non-target species have probably been introduced. Some of them are harmful, such as parasites and competitors with native species. More than 100 species have been documented as being transported with living oysters in the packing material or settling on the oyster shell. These may even include disease agents and parasites located in the tissues of the oysters (Bonnot 1935, Korringa 1951, Edwards 1976, Farnham 1980, 1994, Carlton 1992, Sindermann 1992, Minchin et al. 1993).

After having been made aware of the problems, the International Council for the Exploration of the Sea (ICES) established a working group in the end of the 1970s (Working Group on Introductions and Transfers of Marine Organisms (WGITMO) in order to evaluate quarantine measures dealing with living imports of species for aquaculture and accordingly developed an ICES Code of Practice (Carlton 1992, Sindermann 1992, see attachment). The ICES WGITMO further emphasised the need to follow the IMO Assembly resolution A.774 (18): "Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens" (see below, see attachment) during preparation of this report resolution A 774 (18) is being replaced by IMO resolution A 868 (20). In addition to the WGITMO ICES, IOC and IMO established in 1997 a joint Study Group on Ballast Water and Sediments (SGBWS). At its first meeting the study group concluded that this provided a unique opportunity to exchange information on research activities, sampling methods, management and control options and to consider directions for new research activities.

Other regional bodies particularly relevant in this field are a working group of the Baltic Marine Biologists (BMB) on Non-Indigenous Estuarine and Marine Organisms (NEMOs), an adhoc group established in 1994 with a term of reference covering 4-5 years.

Non-indigenous species are not only introduced with ballast water and associated sediments, but also as fouling organisms on the ship´s hull. However, efficient biocidal

anti-fouling paints currently used considerably reduce the number of fouling organisms on ship´s hulls. Accordingly the major problem in transmission of harmful aquatic organisms, therefore, resides with the continued transfer of ballast water of ships, in particular bulk carriers and container ships of different design and dimensions.
It has been estimated that the major cargo vessels of the world (total number 40,000 [Stewart 1991]) are transferring 10 billion tonnes of ballast water globally per year indicating a global concern for this problem. Ballast water may be taken in from eutrophicated coastal areas containing hundreds of species which may survive voyages of several months duration. It has been demonstrated that in average 3,000 (Carlton & Geller 1993) to 4,000 species (Gollasch 1996) are transported daily by ships of these species only 500 are known today (Carlton et al. 1995). Species discharged with ballast water into the next port of call may threaten native populations, fishing industries and public health.

The likelihood of an introduced species to settle in new regions and to create problems depends on a number of factors, primarily related to the biological characteristics of the species and the environmental conditions in which the species has been introduced. Additional factors are climate, number of introduced species (size of founder population), native competitors and the availability of food. Species are more likely to establish in environments that are similar to those environment of their origin. Therefore, if the port of loading and port of discharge are ecologically comparable the risk of a species introduction is relatively high.
Observations have demonstrated that organisms need not to be harmful pests to cause severe damages. Some invaders affected native flora and fauna by competing for food, habitat and other recourses. The ecological worst case is the replacement of a native species caused by the exotic invader. This can effect not "only" one single newly extinct species but also any other organism dependent on it as a food source or habitat. As a result the food web structure may intensively change after the introduction of one single species.

Carlton (1985) has given a thorough review of the role of ballast water as a mechanism for the dispersal of organisms. Recent invasions and population explosion of non-indigenous species in various parts of the world that are causing ecological and economical damages are described by Carlton & Geller (1993), Hedgpeth (1993) and Gollasch & Mecke (1996).

As early as 1994, it was recommended during a Conference and Workshop on Non-Indigenous Estuarine and Marine Organisms in Seattle, Washington, USA, that educational programmes should be developed to increase overall awareness, list pathways of introductions of species and educate the general public on reporting procedures for new sightings of non-indigenous species (Brown 1994).
It is the aim of this report to summarise ongoing research and to lists national and international regulations on non-indigenous species and / or ballast water. In addition assistance in the effective implementation of guidelines is given.

1.1 What is ballast water

Ballast water has been used since the late 1870s in cases where ships are not fully loaded in order to submerge the propeller and rudder in the water, to operate effectively and to control the trim and increase the stability. Ballast water is usually carried in segregated ballast water tanks or in emptied cargo holds. Ballast water (not bilge water) is marine or fresh water taken on board in ports, waterways and the open ocean (Carlton 1985, 1987, 1994). With the intake of ballast water organisms in the water are pumped on board into the ballast tanks. Sediments suspended in the water may settle to the bottoms of ballast water tanks or cargo holds containing water ballast. Ships are carrying ballast water in a wide variety of shape of ballast tanks and cargo holds. Vessels almost always carry ballast water when they are not carrying cargo. Loaded ships contain ballast water as well, even if they are loaded to the maximum, ballast water is carried (Carlton 1994). Depending on the construction of ballast water tanks and pipework several tonnes of residual water can remain in maximum emptied ballast tanks.

Depending on the economy of a country it is importing cargo (no or less ballast water necessary to be transported in fully loaded vessels) or exporting goods. Countries characterised by an surplus in exporting cargo usually will record empty vessels calling for their ports in order to load a maximum of cargo for their voyage. These vessels will carry high amounts of ballast water, especially if bulk carriers were employed, what has to be discharged in the ports and waterways..

1.2 Ballast tank configurations

The design of ballast tanks of vessels, the pipework and ballast pumps is varying throughout the different types of ships. Modern oil tankers are equipped with a double hull structure used as ballast water tank. On bulk carriers we mostly find double bottom, wing, fore peak and aft peak tanks. In addition to the segregated ballast tanks cargo holds were filled with ballast water during voyages without carrying cargo. Bulk carrier may carry up to 150,000 tonnes of ballast water, in cases where they do not carry cargo. Container vessels are usually equipped with segregated ballast tanks water. Container vessels carry a maximum about 15,000 tonnes compared with bulk carriers this is a low amount. Even less ballast water is transported in cruise liners or ferries.

Most of the ballast tanks are designed with horizontal and vertical frames (double bottom tanks) and additional ceilings (fore peak, aft peak and side tanks) in order to strengthening the construction. The size of the ballast tanks varies due to the size of the vessel and type of tanks. Each ballast tank of a container vessel may contain 500 tonnes of water or more. Side tanks may have a height of more than 15 meters, a length of 10 meters and a depth range of 2 to 3 meters. This size corresponds with a swimming pool of olympic size, installed vertically along the ships hull.

Each ballast tank is connected with the ballast water pump by separated pipework. Most vessels are equipped with at least 2 ballast water pumps to ensure that ballast water operations are carried out even if one ballast pump is out of order. In addition to the pump pipework most of the tanks are provided with an airpipe and sounding pipes, with outlets on the upper deck. The airpipes allow air in the ballast tank to be expelled from the tank during filling processes. Sounding pipes were used in former times to measure the water level in the ballast tanks. Today many ships are equipped with electrical measurements documenting the amount of ballast water in the tanks.

The ballast water intake is often located in sea chests, with an initial coarse grit for preventing the entry of large floating objects as plastics and timber. The intaken ballast water will pass a second filter with openings of 1 to 2 centimetres.

1.3 Need for ballast water management

Since it is well known that eradication of an introduced species which established in a new marine environment will be either very expensive or even impossible. Efforts to prevent or minimize introductions should be given high priority.

Ballast water that is discharged when a ship arrives in most cases has been taken on board in fare away areas. During the intake of the ballast water, organisms and sediment as well as contaminants may have also been taken on board, especially if the area of intake is shallow. If the ballast water is discharged, parts of the sediment and organisms, which survived the voyage also will be discharged. It is impossible to predict the effects which these introductions will cause to the ecology (e.g. competition to and replacement of native species) and economy (e.g. harmful organisms threatening aquaculture sites, damaging port installations, causing diseases, reducing the aquaculture production).

The great number of non-native species introduced in several regions all over the world called for the need to develop treatment options in order to minimize the amount of introduced species. The impact of each introduced species is unpredictable because of the extremely high number of connected parameters (Courteney & Taylor 1986). A species showing no negative impact in its area of origin may cause serious damages to economy and ecology to any new locality where it has been intentionally or unintentionally introduced. Negative effects could be e.g. the limitation of food sources for native species during mass occurrences of the introduced species, unwanted introduction of parasites and disease agents, extinction of native species (worst case if these are commercially harvested) (Rosenthal 1980, Williams & Sindermann 1991, Kern 1994, Grosholz & Ruiz 1995, Holmes & Minchin 1995).

Desk studies revealed that 53 non-indigenous species of macro fauna and flora in British waters (England, Scotland and Wales), 24 exotic organisms in Cork Harbour (Ireland) more than 100 in German waters (North Sea and the Baltic) and about 70 non-native species have been found along the Swedish coasts. A least half of the species quantity is believed to have been introduced with shipping. In Cork harbour, 8 of the 24 species were introduced prior to 1972 and 4 of these are believed to be introduced via ship hull fouling. Antifouling paints of ships generally contain tri-butyl-tinn (TBT) from 1972 onwards and its use has considerably reduced the risk of introduction of fouling organisms. The increase of ballast water discharges in Cork harbour is estimated from less than 20,000 tonnes in 1955 to almost 200,000 tonnes per year since 1970s. The study revealed that the majority of species introduced in Ireland and the British Isles are invertebrates (crustaceans, molluscs and polychaete worms) and algae. The effects of the exotic species on the British marine environment are in general not as harmful as reported from elsewhere in the world. Some of the non-native species are economically important and have been introduced for aquaculture purposes. But some other species, pests and parasites which adversely affect native species by competing for food and space and replace native species in the worst case, have been introduced unintentionally (Farnham 1980, Leppäkoski 1984, 1994, Knudsen 1989, Utting & Spencer 1992, Jansson 1994, Gollasch 1996, Gollasch & Mecke 1996, Eno 1995, Eno et al 1997, Minchin 1997).

More than 145 species are known to have been introduced and established in the Mediterranean Sea. Nearly half of the total number of these non-indigenous species are believed to be introduced by shipping (Ben-Tuvia 1953, Rubinoff 1968, Ben-Eliahu 1972, Walford & Wicklung 1973, Krapp & Sconfietti 1983, Zibrowius 1991, Boudouresque 1994, Galil 1994).

Investigations by Hallegraeff and Bolch between 1989 - 1991 showed that viable toxic dinoflagellate cysts were found in up to 6 % of the vessels entering Australian ports. The List of organisms reported to have survived ship voyages in the ballast water of vessels is being extended after each sampling programme world-wide. Until today it is estimated that about 500 different species are known to have been transported with ballast water (Howarth 1981, Kelly 1992, Locke et al. 1991, Müller 1995, Müller & Reynolds 1995, Gollasch 1996, Gollasch & Dammer 1996, Carlton 1985, 1987, Carlton & Geller 1993, Carlton et al. 1994).

The area which is supposed to be the habitat with the highest numbers of non-native species in the world is located at the west coast of the USA, the San Francisco Bay. In total 213 exotic species were found in the San Francisco Bay until today (Carlton 1994, 1995). In the Hudson estuary 120 non-indigenous species were found (Swanson 1995) and 139 non-indigenous aquatic species have been recorded from the Great Lakes (Mills et al. 1990). In total 103 species are believed to be introduced with ballast water. Nearly 60 of them were introduced with marine ballast water (Carlton et al. 1995). The total number of aquatic non-indigenous North American species was estimated the higher than 250 (Carl & Guiget 1957, Bousfield & Carlton 1967, Carlton 1985, 1987, Mooney et al. 1986, Smith & Kerr 1992, Mills et al. 1993, Grosholz & Ruiz 1995, Smith 1995). In total 74 of the listed species are believed to be introduced by ballast water of ships (Carlton et al. 1995).

Vessels calling for Australian ports come from more than 300 ports of 53 counties around the world introducing approx. 121 million tons of ballast water each year (Jones 1991, MEPC35/INF.19). In addition, over 4,000 vessels per year move more than 34 million tonnes of ballast water between Australian ports.
About 12 million tonnes of ballast water are discharged annually in the major Norwegian oil / gas harbours (Botnen pers. comm.)

In total 172 marine pests had been introduced into Australia's marine environment (Hoese 1973, Paxton & Hoese 1985, Hutchings et al. 1986, Hutchings 1992, Hallegraeff & Bolch 1991, 1992, Rigby et al. 1993), mostly through ballast water (Thresher pers. comm.) These include molluscs, crustaceans, polychaete worms, seaweeds and toxic phytoplankton species. The species established themselves and some of them even found excellent conditions. Phytoplankton bloomed and entered the food chain via shellfish feeding. The toxins of some phytoplankton species are known as Paralytic Shellfish Poisoning (PSP), which may paralyse or even kill humans who consume affected shellfish. Recent cases of damage resulted in the need to close down all harvesting of shellfish on the River Huon river estuary in Tasmania, in Port Phillippe Bay, Victoria and in Port Jackson, New South Wales, following a bloom of introduced toxic phytoplankton algae (dinoflagellates) in 1993 (Jones 1991, AQIS 1994).

The exact number of non-indigenous species in South African waters is not known due to the lack of appropriate studies. Until today different crustaceans, molluscs and phytoplankton species are known to occur (Jackson in prep.)

The number of species carried in ballast water is another indicator for the need of treatment. Several studies showed that more than 50.000 zooplankton species may be found in one cubic meter of ballast water. Usual densities of species are around 10.000 specimens per cubic meter of ballast water. Calculations revealed that a total of several 10.000s or even millions of organisms were transported in the ballast water of a single ship (Locke et al. 1991. 1993, Gollasch 1996, Kabler 1996). The German shipping study revealed that in average each vessel calling for a German port contained in its ballast water, tank sediment and on the ships hull in total more than 4 million specimens of macrofauna (ballast water 300,000 specimen from up to 12 different species in one sample, tank sediment 2 million specimens, hull fouling 1,8 million specimens) (Gollasch 1996).
The number of phytoplankton species is even several times higher. Lenz et al. (in prep) listed up to 110 million phytoplankton specimen in 1 m³ in ballast water and maximal 150 cysts in 1 cm³ of ballast tank sediments. A Canadian study showed that more than 10 million phytoplankton cells were collected in 1 m³ (Subba Rao et al. 1994) and the content of viable cysts of the dinoflagellate *Alexandrium tamarense* in one ballast tank was estimated to be more than 300 million cysts (Hallegraeff & Bolch 1992). Even up to 22,500 phytoplankton cysts per cm³ were found in tank sediments during Australian studies. Cysts of some phytoplankton species may remain viable under unfavourable conditions for 10 to 20 years (Hallegraeff & Bolch 1992).

The existing potential risk of negative impact of harmful phytoplankton species on marine aquaculture was indicated. In 1988, the total world aquaculture production was estimated at 14 million tons (FAO 1990). Therefore operational and procedural practices dealing with ballast water are necessary to prevent unwanted impacts (Subba Rao et al. 1994). The treatment of ballast water is necessary in the light of increasing risks involved with ballast water releases. Firstly, shipping activities have increased over the past decades with corresponding increases of amounts of transported ballast water. Secondly, the duration of ship voyages has decreased due to technical improvements resulting in faster ships. Reduced duration of species in a ballast tank increases the survival rate. Thirdly, the amount of exotic marine organisms in ballast water seem to be increasing. As example dinoflagellate blooms appear increasing world-wide probably due to changing eutrophic conditions and climate changes. Therefore the probability of an uptake of these species in ballast water is increased. Fourthly, the increase in aquaculture world-wide increases the potential of the unintentional spread of diseases and parasites which after their establishment in a new areas may be distributed further as e.g. larvae in the ballast water of ships (Jones 1991).

Therefore the uncontrolled discharge of untreated ballast water is a major international problem. It is up to governments, environmental agencies and the shipping as well as the fishing industries to make commitments with a view to identifying a solution to this very complex problem. The presence of human disease agents as e.g. Cholera-bacteria in ballast underlines the need for ballast water treatment (see below).

Ignoring the problems that may be caused by introduced species with ballast water could be analogue to an ecological roulette (Carlton & Geller 1993, Hedgpeth 1993). We cannot estimate any probability (as in a roulette game) due to the great number of parameters involved. In the same way as the ecology, major problems may occur impacting local aquaculture business or other economically important activities.

1.4 Inventory of world-wide activities

Scientific studies that have previously been carried out demonstrate that a large number of organisms are introduced in coastal waters and port areas around the world with ballast water, tank sediments, and hull fouling. Every vessel from overseas is a potential carrier of organisms in sufficient numbers to establish a new population. Since even a single introduced non-indigenous species may cause severe damage, it is necessary to develop preventive measures. Without special treatment of ballast water further introductions of undesirable species will continue.

1.4.1 European activities

1.4.1.1 Belgium

An investigation entitled ”Study of the Potential Role of Transportation of Ships Ballast Water on the Geographical Extension of Blooms of Toxic Algae” was carried out between 1994 and 1995 by A. Vanden Broeck (Université Libre de Bruxelles). In ballast water samples of 21 ships in total 21 genera of plankton algae have been found. The dominant species collected in the ballast water were dinoflagellates. In the tank sediments very large numbers of their cysts were extracted. Some of the determined genera included toxic species. The main result of the study was that a risk exists concerning the introduction of non-indigenous toxin-producing phytoplankton species into European waters with ballast water or sediment discharges. It is recommended to implement ballast water management guidelines on an international level.

1.4.1.2 Croatia

A shipping study is currently undertaken sampling vessels entering the port of Dubrovnik. Preliminary results of this study are scheduled for late 1998 (Lovric pers. comm.).

1.4.1.3 Germany

A joint research project between the Institut für Meereskunde, Kiel and the Universität Hamburg commissioned by the Umweltbundesamt, Berlin (German Environment Protection Agency), was launched in 1992 to investigate species introductions by international ships traffic. The study aims at a thorough taxonomic assessment of planktonic and benthic organisms found in ballast water, tank sediment and on the ship hulls. During the investigation period from 1992 - 1995 a German shipping study (completed in 1996) revealed samples from 186 ships. The scientific project was financed by the Umweltbundesamt, Berlin. A total of 334 samples were taken from the ballast water, tank sediments and ships` hulls. The vessels investigated were selected according to type of vessel and sea areas covered by their voyages. The majority of samples originated from tropical and warm-temperate regions. The abiotic parameters of the ballast water (temperature, salinity, pH value, and oxygen content) were measured aboard immediately after sampling. In the initial phase of the project a questionnaire was mailed to more than 200 scientist in order to collect information on non-indigenous species in German waters and neighbouring countries. The amount of ballast water discharged in German ports and waterways was estimated during the shipping study based on data from the Verband Deutscher Reeder and records from the crews of sampled ships resulting in 10 million tonnes of annually discharged ballast water of which approx. 2,2 million tonnes are characterised by an origin outside of Europe (Gollasch 1996, Lenz et al. in prep.).

In co-operation with the Smithsonian Environmental Research Centre (SERC), Edgewater, Maryland (USA) several vessels were sampled in the USA before their departure, after their arrival in German ports and vice versa. This sampling design made an estimation of the survival rate of species during inter-oceanic voyages possible. The results clearly demonstrated that either the number of species or the number of specimens in ballast water dramatically decreased with the time spent in the ballast tank. In addition a visit of the German sampling team at SERC offered the opportunity to standardize sampling methods.

Routine monitoring programmes in the North Sea area for water qualities, along the coasts of the German Federal States of Niedersachsen and Schleswig-Holstein, include a warning system for harmful algal blooms. In addition a long term monitoring study, established in 1962, close to the island of Helgoland (sampling site located at Helgoland Roads) includes the occurrence of non-indigenous plankton species. The sampling and taxonomical work is distributed through by the Biologische Anstalt Helgoland.

A documentation on introduced non-indigenous species in coastal and marine waters during a future monitoring programme is being discussed within the programme (Bund-Länder-Meßprogramm / BLMP).

Reise (1991) estimated that the number of non-indigenous species in the German Wadden Sea may be summarised to 5 % to 10 %. Another study of the macrozoobenthos species occurring in German waterways and canals indicates 31 non-indigenous species. The number non-indigenous taxa sampled varied between 6 % to 30 % of all collected fauna. The number of non-indigenous species in northern canals was higher than in other German regions (Tittizer 1996) due to the stronger influence of in northern Germany with the location of important international ports in this area.

Several studies on the introduced polychaete *Marenzelleria viridis* carried out at the University of Rostock and Warnemünde focussed the taxonomy, ecology and development of the species (Bick, Kinzelbach, Zettler pers. comm.).

1.4.1.4 Finland

A co-operational Nordic educational programme brought together experts and students from several countries at the Abo Akademi, University, Finland in 1997. This post-graduate course sponsored by the Nordic Academy for Advanced Study (NorFA) was entitled as “Ecology of Marine Invasions and Introductions”. Focused subjects included: non-indigenous species in the Baltic and other marine or brackish environments, characteristics of invaders (their biology, ecology, invasion history), vectors, relation to native species, habitat modification ability, interspecific and ecosystem impacts, linkages with biodiversity issues, world-wide case studies on ecological and economic impacts of marine introductions, marine biocontrol of introduced species, global issues relative to ballast water: history, science and policy, treatment techniques to reduce the risks arising from ballast water releases, international treaties and instruments to control introductions of non-indigenous species and regional conventions and agreements.

A Nordic Risk Assessment Study, was launched to evaluate as to whether resources were at risk and vulnerable to invasions of non-indigenous species, nordic marine areas were particularly sensitive to the introduction of non-indigenous organisms, organisms or categories of them were particularly potent to cause, large-scale environmental problems (biodiversity in particular) and / or as to whether economic effects, ecosystems and indigenous species were particularly sensitive to the impact of non-indigenous species. A calculation of economic losses due to the impact of non-indigenous species and prerequisites (e.g., salinity and temperature conditions, availability of habitats, turbidity, eutrophication, pollution) will be carried out and probabilities of harbour areas to act as receivers and / or donors will be quantified in relation to survival probabilities of non-native species. Studies of existing vectors in selected, international harbours, including harbour profiles with regard to import / export of ballast water (i.e. a origin / destination profile for imported / exported ballast water) are being undertaken together with suggestions of measures and strategies to be employed with a view to tackling the problem and the need for further research, and suggestions concerning monitoring activities.

The final report will indicate shipping traffic patterns and ballast water dumping in some harbours in the Nordic countries. The harbours selected are Klaipeda (Lithuania), Turku (Finland), Stenungsund (Göteborg, Sweden) and the oil terminal Sture in western Norway. In addition, the physical environment in these harbours was documented (water depth, sediment types, temperature and salinity, and nutrients). These "harbour profiles" indicate risks of introducing unwanted species by ballast water imports.

The results of the project may be used to fulfil commitments within several international conventions / organizations such as HELCOM, OSPARCOM and ICES. A report (in English) from the project, scheduled to be published in late spring of 1998, could be of use for national authorities and international bodies, in contributing to the assessment of the scope of the problem in Nordic marine areas.

Other objectives are:

a) Review of some existing risk assessment (RA) methods applicable to introductions of non-indigenous species, including ecological RA models and models applied to ballast water introductions.

b) Application of such a model to one or more key / target species. A semi-quantitative model (low - medium - high risk) will be identified and applied to a vector of introduction and a target organism. Relevant parameters should be described, and data needs and availability identified. A tentative list of parameters for ballast water introductions could include, but not be limited to; vessel ballasting characteristics, ballast water treatment applied (if any), characteristics of donor and receiving ports or geographical areas, voyage route and duration, relevant biological information for the key / target species. Information on the key / target species could include, but not be limited to; environmental requirements such as temperature, salinity, and light / energy requirements during different stages of the life cycle (including resting stages), habitat requirements, known biotic interactions

In addition another study will focus the assess if the possibility and probability that (toxic strains of) Vibrio cholerae: could become established in Nordic waters, and if so, could be introduced to Nordic waters by way of ballast water, and if so identify the most likely routes and suggest steps for further action, including legislative and / or

treatment options. Assess to what extent the findings on cholera are applicable to other potentially disease-causing micro-organisms that could be transported in ballast water.
Project description:
a) Through literature review assess effect of temperature, salinity, association with copepod and phytoplankton hosts and viruses on the probability of establishment of (toxic strains of) cholera in Nordic waters. Identify historical data, if any, on previous occurrences.
b) Identify possible sources of cholera, and whether there are any direct or indirect links to between Nordic countries / Europe and these sources through shipping.
c) Describe existing techniques / methodologies to monitor and treat (toxic strains of) cholera in ballast water. Identify the existing legislative and administrative framework that could be applied to prevention of cholera infestations through ballast water, and assess whether this provides sufficient means of protection, or if additional (treatment, legislative and or administrative) measures are necessary.

1.4.1.5 France

French scientists are carrying out monitoring programmes on the macroalgae *Caulerpa taxifolia*, *Sargassum muticum* and the Gastropoda *Crepidula fornicata* and the possibly latest macrofauna invader in European waters *Hemigrapsus penicillatus*, a decapod, first recorded at the French coast in 1994 (Meinesz et al. 1997, Noël et al. 1997). The research projects on *Caulerpa taxifolia* and *Crepidula fornicata* focus on the treatment of these unwanted species. Especially the commercial impact of C. fornicata in reducing the harvests of aquaculture mussel farms emphasises the need for a treatment on this species (M. Blanchard, IFREMER).
In the case of *Sargassum muticum* the ecological parameters and methods of spread are investigated (T. Belcher, IFREMER)

A study on the role and impact of ballast water on aquaculture, especially on the potential release of dinoflagellate cysts is planned by Masson & Fouche (Aquaculture

Research Laboratory of IFREMER-URAPC, Unite de Recherches Aquacoles Poitou-Charentes).

1.4.1.6 Ireland

In 1994 / 95 a port area was examined to determine whether there was a potential risk from ship introductions. the chosen port was Cork Harbour on the south east coast of Ireland. Since 1955 estimated ballast water discharges have generally increased from about 50,000 tonnes to about 400,000 tonnes. In the port are 15 un-intentionally introductions are recorded, eight of these may have been imported on the hulls of ships and two were possibly introduced by ballast water. Some cryptogenic species such as the dinoflagellate *Alexandrium tamarense* could have been transferred by ballast water to Cork Harbour from elsewhere. These are presently known to rarely cause toxic phytoplankton blooms in Belfast Lough and Cork Harbour. A desk study involving all 32 Irish ports determined which of these had the greatest relative risk for further un-intentional species introductions. Two port regions, Cork Harbour and the Shannon Estuary appeared to have the greatest risk. The Shannon Estuary is perhaps vulnerable to Baltic species introductions. It was clear that most of the shipping was with European ports and that introductions to Ireland were most likely to be from other areas within Europe where exotic species had already become established. A detailed study of Bantry Bay, a small port on the south west coast, then proceeded to take into account trends in shipping over a number of years, residual flow within the bay and other oceanographic features and how this might influence the risk of species introductions. This port region has had relatively little traffic until the last 100 years when it was a major naval base, more recently most of the shipping consists of fishing vessels, bulk carriers carrying aggregates and oil tankers. This is a bay in which there is also extensive aquaculture and there are concerns by those involved in this industry over possible introductions that may compromize their activities.

More recently, in 1997, at Limerick dock, in the Shannon Estuary, the Zebra Mussel *Dreissena polymorpha* was found and it is thought to have been present there in 1994 or before. The species extends into the freshwater regions of the lower Shannon about

70 km upstream of the dock region. The species has become invasive and already is causing problems for some water abstractors and boat users. There are two possible means by which this species became introduced. Firstly, in ballast water to the Shannon Estuary of vessels carrying timber from the Baltic Sea, these vessels can carry ballast trim, or secondly as fouling organisms on hulls of boats imported on trailers from Britain or both. Zebra Mussels were found on one canal boat imported in 1997.

In an Irish study sampling of ballast water and sediments took place on one vessel in 1996 in Dublin in addition to activities related to the development of port profiles. These profiles consist of an analysis of current and past shipping traffic patterns. Calculations of estimates of ballast water releases were also made. The profiles further took into account a series of factors considered to enhance relative risk such as tidal amplitude and aquaculture activities. As a result of this study two regions were considered to have greater risk: The Shannon Estuary and Cork Harbour. Nevertheless the overall risk to Irish ports, because of the relatively small amounts of ballast releases, was considered to be less than that for other European ports. Species introductions, by means of ballast water, are likely to gain entry to Ireland from populations that have become established in other European ports. The 200,000 tonnes of ballast water discharged annually in Cork harbour are originating from the United Kingdom, Australia, Egypt, French and Spanish Mediterranean regions.

The importance of hull fouling as a vector for dispersal of exotic species still needs to be given serious consideration and may have an affect as significant that related to ballast water discharges, albeit for different suites of species

Special attention was drawn to molluscan parasitology after the unintentional introduction of a bivalve parasite with live oyster imports, probably from France (Minchin, pers. comm.).

1.4.1.7 Norway

In 1996 a project entitled The Sture Project, a four-plus year investigation, was launched including sampling of ballast water of ships calling for the oil terminal Sture north west of Bergen at the Norwegian west coast; the first phase of the study was finished in September 1997. Samples from 30 vessels were collected, including salinity, oxygen, temperature, zooplankton and phytoplankton, as well as samples for the determination of nutrients content in the ballast water. No samples have been collected from ballast tank sediment or from ship hulls. Most ships arriving at Sture depart from harbours in Europe. However, 15 % depart from harbours in North America, and another 5 % depart from harbours in other geographic regions. In total about 360 vessels arrive at Sture each year, and about 8-10 million m^3 of ballast water are released during a year.

In addition, sampling of the water and sediments of waters adjacent to the terminal area shall monitor non-indigenous species that may have been introduced. Monitoring data of benthic and littoral flora and fauna are available from the area before the terminal was opened. Therefore it may be possible to compare the abundance of species before and after the opening of the terminal. First official report is expected in 1997 / 1998 (Botnen pers. comm.)

The Kamtschatka King Crab (*Paralithoides camtschatica*) introduced in Russian waters of the Barents Sea with the purpose of future harvests is in occasionally found in Norwegian waters. Records were made by fishermen mostly close to the northern coasts of Norway. A monitoring programme on this species focuses the range of expansion and distribution in Norwegian waters. The range has expanded to Porsangen in northern Norway and additional findings were documented in a distance of more than 1,000 km, close to Tromsö and Vestfjorden. One crab was found at the west coast of Norway indicating a range expansion of the species. Most of the findings by fishermen were not confirmed by scientists and therefore have to be quoted with care. Research on the environmental impact of the crab will be carried out at the Norwegian Institute of Fisheries and Aquaculture, Tromsö (J. Sundet) and the Institute of Marine Research, Bergen (K. Jörstadt). Other studies will focus on the population density and distribution of the crab in Norwegian waters (Institute of Marine Research, Bergen S. Ohlsen)

Studies on the introduced non-indigenous red algae *Polysiphonia harveyi* in southern Norway will be carried out by J. Rueness, Oslo University.

1.4.1.8 Spain

In spite of the fact that the number of marine non-indigenous species is increasing in Spain, only *Caulerpa taxifolia* is object of a research programme. The first programme on *C. taxifolia* was carried out in 1993-94, supported by the European Union (LIFE, DG XI) entitled "Spreading of the tropical seaweed *Caulerpa taxifolia* in the Mediterranean". In 1994 the "Second International Workshop on *C. taxifolia*" was held in Barcelona involving more than 150 scientists (Ribera et al. (eds.) 1996). An additional research Programme (1996-98) was supported by the EU as well (LIFE, DG XII) entitled "Controle de l'expansion de *Caulerpa taxifolia* en Mediterranee". In September 1997 the Third International Workshop on *Caulerpa taxifolia* was celebrated. Both programmes were focused on monitoring and control of the spread of *Caulerpa taxifolia.* Studies about taxonomy, biology and ecology of *C. taxifolia*, the secondary metabolites of this species and its toxicity effects, impacts of *C. taxifolia* on the Mediterranean communities, eradication methods and a programme of arising public awareness are considered (Ribera pers. comm.)

1.4.1.9 Sweden

Sweden prepared a questionnaire to countries bordering the OSPAR Convention Area (i.e. the NE Atlantic including the North Sea) concerning non-indigenous species in the marine environment. The purpose was to gather relevant national information on non-indigenous species, including, inter alia, information on relevant research activities, strategies for the development of monitoring programmes and sampling techniques (IMPACT95/14/1, §8.7). In total, 12 countries replied to the questionnaire. Additional information was provided by the Helsinki Commission covering the Baltic Sea.
In total 102 non-indigenous species have been reported form waters of the North Sea and the Baltic area. Only one country reported that there were no known non-indigenous species occurring in their waters. It is not clear, if all of the reported species have become established in the long term. The dominant vectors mentioned for species introductions are shipping (unintentional introductions via ballast water, tank sediments and hull fouling) and aquaculture (intentionally introduced non-native target species and unintentionally introduced non-target species). For many species the introducing vector is unknown, but e.g. aquaria and pleasure fishing (bait and gear) are known to have provided additional routes for intentional and unintentional species introductions. After an introduction in one country secondary dispersal (introductions into waters of neighbouring countries) can take place either by natural means as currents or by recreational and commercial coastal ship traffic or with the transfer within Europe of aquaculture species (Jansson 1994, Swedish Environmental Protection Agency 1997)

An estimation of the amount of ballast water discharged in Swedish waters based on data from port authorities and shipping companies revealed 20 million tonnes (Jansson pers. comm.).

The geographical distribution, variation of population and biomass, preference in habitat and substrat as well as associated taxa of *Sargassum muticum* off and along the west coast of Sweden was investigated 1993-1995. In 1996 the sampling sites were investigated again in order to quantify changes in abundance and impacts (J. Karlsson, University of Göteborg).

Infestations of the European Eel *Anguilla anguilla* with the introduced Nematode *Anguillicola crassus* were studied in 1992-1994. The nematode was introduced by live eel imports (J. Thulin, Institute for Marine Research, J. Höglund, National Veterinary Institute).

A pilot project entitled "Risks associated with introduction of non-indigenous organisms to Swedish waters by water / sediment in the ballast tanks of ships" was carried out in 1996. The study included sampling of ballast water of ships. The project also included a regional survey of dinoflagellates along the province of Bohuslan at the Swedish west coast.
The result of this pilot study is focused on phytoplankton in ballast water. Hatching experiments of phytoplankton cysts from sediments of tanks were carried out in order to support the identification of taxa. In addition to the taxonomically work of ballast water and sediment samples, experiments in culturing the found species will be carried out. Although few living cells were observed in the samples, results of the cultures show that there are large numbers of living organisms present in the ballast water and tank sediment. These species might hatch and grow after their discharge in Swedish waters (Persson, Godhe and Wallentinus pers. comm., Swedish Environmental Protection Agency 1997).

In 1997 a risk assessment desk study for the ports in the Stenungssund (Swedish west coast) was carried out by A. Godhe, University of Göteborg.

Associated to the Finish NorFA project Risk Assessment of Marine Alien Species in Nordic Waters (see above, Finish chapter) a desk study entitled as: ”Ballast Water - Transportation Patterns and Volumes” will be carried out under the co-ordination of Kristina Jansson. The Project objective are described as an inventory of volumes and patterns of ballast water is needed for assessing the scope and significance from a regional perspective, and to identify risk areas (donor as well as recipient area) for introductions. The desk study will document main transport routes and volumes of ballast water imported to and from Swedish ports.

1.4.1.10 The Netherlands

In co-operation with the North-Eastern University, Maryland, USA, a shipping study based at the Aquasense (Amsterdam) was carried out sampling ships in ports of the Chesapeake Bay region and in Rotterdam. Three ships were sampled at both sides of the Atlantic ocean and analysed for phyto- and zooplankton content. The sampling design enabled an estimation of the number of species and specimens introduced in both ports. Beside other non-indigenous species toxic phytoplankton species stand into focus. A standardized sampling protocol for testing of phytoplankton and their cysts was developed by both partners of the co-operation (Tripos 1998).
A desk study identifying the need for further research in this field concerning the biological risks for the Dutch coastal waters with respect to ballast water is in preparation. The study was initiated by the Ministry of Transport, Public Works and Water Management, Department North Sea (van Gool pers. comm., Gotje pers. comm.).

1.4.1.11 United Kingdom

Port sampling revealed 2 newly introduced species in the area of Cardiff docks: the decapod *Rhitropanpeus harrisii*, native to The Netherlands, was first found in 1996, and a brackish water zebra mussel *Mytilopsis leucophaeta* (Family Dreissenoidea) was found in 1996 at the Cardiff docks. The species had been described in Belgium (under a different name). It also is present in other European countries, but it is not clear if this species has arrived in Britain from the European continent or its native range in America (ICES WGITMO 1997)

An inventory of non-indigenous species in U.K. waters lists 16 marine algae, 5 diatoms, 1 angiosperm plant and 31 invertebrates. Red algae, polychaetes, crustaceans and molluscs represent the majority of species listed. More than half of the introduced species were believed to be introduced associated with shipping (Eno 1995).

Questionnaire

A questionnaire was sent to 127 ports in **England** and **Wales**, 111 (87.4%) of which responded. Ballast water is discharged into just under half (48.7%) of ports in England and Wales. Few accurate records are kept by these ports but it is possible to gain a general picture of the current situation from the information supplied. To get a more accurate assessment it would be necessary to extract the information from individual ships' log books. It is estimated from the information supplied that there are more than 36,000 ballast water exchange operations annually, so this would be a major and expensive undertaking.

Ports in England and Wales are net importers of bulk cargoes and so ships are more likely to load ballast water than to discharge. Nine ports reported that ballast water exchange involved only loading operations. About 1.6 times more ballast water is loaded compared with the amount of discharge.

An estimated 16.8 million tonnes of ballast water is discharged annually at ports in England and Wales. Oil and gas tankers contribute over 75% of this total. This compares with an estimated 25.7 million tonnes of ballast water discharged at Scottish ports, 90% of which is received by just three ports. In comparison, in England and Wales, ballast water discharge is more frequent and at a greater number of ports, but amounts discharged at individual ports are generally smaller, through the operation of more, smaller vessels.

Ports in Bristol, King's Lynn, Middlesborough, and Milford Haven were the only ones to report discharge of ballast water originating from outside continental Europe. By volume, ballast water from this origin accounted for about 11% of the total for all ports, compared with 47% at ports where discharge originated only from other United Kingdom and Northern European ports. These results must be treated with caution as accurate information on port of origin was not always available and ballast water may have been loaded at a site other than the previous port of call. Overall, the results indicate that the main risk is of further dispersal of unwanted marine organisms that may have been introduced at other UK or European ports.

Sampling of ballast water was carried out at only four ports and only three of the 111 respondents were aware of any problems associated with the discharge of ballast water.

This study was designed to assess the risk of introductions of non-indigenous marine organisms into coastal waters of **England** and **Wales** through discharge of ballast water from ships. Further assessment of the risk will be made by a sampling programme, in which the number and type of viable marine organisms transported in ballast water into the coastal waters of England and Wales will be determined. The strategy for this sampling programme is based on the results of the questionnaire survey.

This project was initiated on behalf of the Ministry of Agriculture, Fisheries and Food as a research project. It started on the 1st July, 1996 and will end on the 30th June, 1999. The research is being carried out at the School of Ocean Sciences, University of Wales, Bangor. The objectives are 1) to establish a sampling strategy for the collection of ballast water and sediment from ships docking at ports around England and Wales, 2) to investigate the range and numbers of organisms present in the ballast tanks of the selected ships, 3) to investigate the changes in the transported organisms with respect to the port of origin and the season in which the transportation occurs and 4) to assess the potential risk of introduced organisms and chemical agents in ballast water and sediment to the coastal waters of **England** and **Wales**.

From information collected in a survey carried out at CEFAS, Conwy, contacts have been established with harbour masters at many major ports in England and Wales where ballast water is discharged, and other contacts have been made with shipping agents and fleet operators. Various ports have been visited, including Liverpool, Immingham, Teeside, Fowey, Milford Haven, Cardiff, Swansea and Southampton. Other ports have been contacted and visits to Bristol, Kings Lynn, London, Ipswich and Felixstowe are planned during the next year. Analysis of samples is underway. Data will be provided for a database to be compiled by SOAEFD for the UK.

The SOAEFD Ballast Water sampling programme has recently started and revealed samples of vessels, ranging from small coasters to oil tankers. Ballast water and sediments were sampled during 128 sampling visits to ships docking in 10 **Scottish** ports. Ballast water originated from over 80 ports spanning 25 countries, mainly from the northern hemisphere. Samples of ballast water and ballast tank sediments were collected for biological and chemical analyses Samples will be taken for zooplankton, phytoplankton and chemical analysis. Another sample is pumped up from as close to the bottom of the ballast tanks as possible in order to collect sediment which is examined for dinoflagellate cysts. Until today 29 phytoplankton species of 12 genera were determined. Experiments in germination of the sampled phytoplankton cysts resulted in 51 % successfully germinated tests. Studies on the effectiveness of a mid-ocean exchange of ballast water in order to minimize the amount of introduced specimens will be undertaken (Macdonald & Davidson 1997, McCollin et al. 1997, Laing pers. comm.).

The distribution and the abundance of the commercially interesting non-indigenous American tingle (*Urosalpinx cinerea*) is studied by the Fisheries Department.

Unsuccessful attempts have previously been made to eradicate the introduced seaweed Sargassum muticum and the slipper limpet *Crepidula fornicata*.

1.4.2 Baltic Sea

A (proposed) Database on Alien Species of the Baltic is under construction. The aims of the database are as follows:

- development of an up-to-date and standardized inventory of non-indigenous species in the Baltic Sea area;
- documentation of effects and impacts (ecological, economic and social) posed by unwanted non-indigenous species and the
- elaboration of schemes for fast dissemination of information on new invasions and introductions within and outside the Baltic Sea region.

Specialists from all countries bordering the Baltic Sea will be involved. At present about 50 scientists dealing with the subject from various parts of the Baltic Sea are involved. The Environment Committee (EC) of the Helsinki Commission requested the HELCOM Contracting Parties to take action in reducing risks associated with intentional introductions and to consider possibilities of monitoring the distribution of already established species within the Baltic Monitoring Programme and Coastal Monitoring Programme.

In the Baltic Sea region Poland, Lithuania, Latvia, Estonia and Russia have established routine monitoring programmes on marine environmental quality since the end of the 1970s. Within these ongoing programmes, biological observations are performed on phytoplankton, zooplankton and macrozoobenthos. These sampling programmes are considered an instrument to reveal non-indigenous species. It was in this way possible to document newly introduced species, e.g. the dinoflagellate *Prorocentrum minimum*, the polychaete *Marenzelleria viridis* and the crustacean *Cercopages pengoi*. The monitoring programmes will be continued (Olenin pers. comm.).

1.4.3 Israelian activities

As mentioned above, scientists from Israel and the United States established a co-operation programme with the Smithsonian Environmental Research Centre (SERC), Edgewater, Maryland (USA) to sample vessels before their departure in the USA and after arrival in Haifa, and vice versa. This sampling design allows an estimation of the survival rate of species during inter-oceanic voyages. The results have clearly shown that either the number of species or the number of specimens in ballast water dramatically decreased with the time spent in ballast tank.

The transport of protists in ballast water was studied by a German expert in co-operation with the Israel Oceanographic and Limnological Research Ltd, Haifa (B. S. Galil). During the survey several ships calling for Israelian Mediterranean ports were sampled at the Mediterranean harbours Haifa and Ashdod. The protist community present in the 17 sampled ballast water tanks was documented. In total 362 records of living protozoan species (in total 198 species) were made. They belong to 82 heterotrophic genera. The maximum number of protists in one ballast water tank was 138 species (!). Most of the ballast tanks examined showed a comparable diversity and were therefore determined as uniformity of protist communities. These enable a classification of protist communities regarding food web interactions in ballast water in a) bacteria-grazing protozoans, predatory protists and more intricate associations including parasites and metazoans (Polychaeta, Cnidaria, Nematoda, Gastrotricha, harpacticoid Copepoda, Rotifera and Turbellaria) (Galil & Hülsmann 1997).

1.4.4 American activities

1.4.4.1 North America

Canada

Various ballast sampling studies have been undertaken by different agencies in different regions of Canada for several years. Testing of ballast water for the presence of zooplankton, bacteriae (Aeterotrophic Picoplankton and Autotrophic Picoplankton is carried out.

In 1980, the Canadian Department of the Environment commissioned a study to assess the effect of ballast water discharges, specifically in regard to ballast water taken on board in foreign ports and discharged into the Great Lakes. Introductions of several new predators of fish into the Great Lakes caused concern in the commercial and pleasure fishing industry. Authorities are examining several prevention options; one likely option being the exchange of ballast water in mid-ocean as it is thought that mid-ocean organisms are less likely to survive in Great Lakes waters. Samples were taken via opened manholes of the ballast tanks and from discharge points at ballast pumps. Sediment was not sampled. In total ballast water from 55 ships, representing 10 different geographic origins were sampled as the vessels entered the St. Lawrence-Great Lake system. One ballast tank contained raw sewage indicating that potential hazards exist if this ballast was discharged. The study concentrated on aquatic flora and fauna (> 80 µm) and the assessment of the potential impact of these species if released into the Great Lakes. Over 150 genera and species of phytoplankton and 56 aquatic invertebrates were determined, many of them found to be non-indigenous to the Great Lakes. In the light of these results it was recommended that an additional study should include sediment samples, focus on ballast origins (shipping routes) that had not been covered in the present study, and take into account ballast water mixing of more than one origin, such referring to the need of a detailed log book documenting the ballast operations.

The study indicated that several marine organisms may provide potential risk in becoming established in the St. Lawrence estuary (Howarth 1981).

Transport Canada has conducted a ballast water sampling study in the Welland Canal and the Science Department of the Department of Fisheries and Oceans has initiated a study to examine the possibility of using organic acids to treat residual ballast water.

An on-going research project, initiated in 1993 by the Department of Fisheries and Oceans aims to assess the risks for the introduction of non-indigenous species through ballast water discharges in the St. Lawrence estuary and Gulf of St. Lawrence. The evaluation of these risks is important in the light of current Canadian regulations and guidelines which allow ballast water exchanges by foreign ships in the Gulf of St. Lawrence in situations where it has not been feasible to exchange ballast water in the Atlantic Ocean (Gauthier & Steel 1995, SGBWS Report 1997).

In 1994 a study was initiated to assess the overall risks for ballast water mediated introductions of non-indigenous marine species in the estuary and gulf of the St. Lawrence. The risk assessment was based on foreign maritime traffic and on surveys of ballast water discharge practices and species diversity in ballast tanks of foreign ships bound for ports of the area. It is estimated, that 12 million tonnes of ballast water are discharged annually in the estuary and Gulf of St. Lawrence. About 1.6 million tonnes originate from the last port of call of regions as Northeast Atlantic, Mediterranean Sea and Black Seas. The results of the study (see below) could be used as a scientific rationale to extend the application of the existing voluntary IMO guidelines to all foreign ships entering the Gulf of St. Lawrence. In addition the results showed that the guidelines (when complied) were effective in reducing the potential risk for ballast water mediated introductions in the marine ecosystem of the St. Lawrence area (Gilbert & Harvey 1997, SGBWS 1997).

During a ballast water study in 1992, 62 % of all 60 ballast water samples taken from ships in the dockyards of Iles-de-la-Madeleine contained four potentially toxic dinoflagellates of the genus *Alexandrium* and three *Dinophysis* spp. (Gosselin et al.

1995) and eight of nine sediment samples of three ships contained resting stages of *Alexandrium* spp. (Roy 1994).

In 1994 Subba Rao et al. published a study of exotic phytoplankton species from ballast water and their potential spread and effects on mariculture localities. Ballast water was analysed from 86 foreign vessels that visited the Great Lakes area during 1990 and 1991. Due to the enormous number of parameters that regulate the successful transport and establishment in non-indigenous areas it is quite uncertain to predict which species may be introduced. The existing potential risk of negative impact of these species on Canada's east coast aquaculture sites was noted. Therefore practices to deal with ballast water are necessary (Subba Rao et al. 1994).

An ongoing research study conducted by the Canadian Coast Guard aims to identify safety aspects related to the mid-ocean exchange of ballast water. Both of the investigated two bulk carriers had not been to follow the advice set out in the voluntary ballast water guidelines to enter the Great Lakes because of bending moment limitations and of shear forces limitations during bad weather situations (Prior 1995).

In-between the timeframe of 1999-2002 different research projects are planned e.g. on the survival of species in ballast water during voyages, ballast water treatment approaches including filtration methods, design criteria for new ship constructions and a ballast water exchange location assessment.

USA

The new National Invasive Species Act of 1996 (see below) authorises the U.S. Coast Guard to sample vessels regularly in selected U.S. ports, such as San Francisco Bay, the Gulf of Mexico and Honolulu Harbour. No routine monitoring programme in the USA focuses the arrival of marine organisms in ballast water or sediments. The law requires regularly vessel sampling in order to determine if and to what extent ballast exchange occurs. This requirement reflects the U.S. decision to seek protection from all types of foreign organisms (Carlton & Cangelosi 1997).

The investigations in 1982 and 1985 (Carlton et al. 1982, Carlton 1985) focused on bulk carriers entering North American ports without any cargo but with high loads of ballast water. Most of the sampled vessels filled in addition to ballast tanks cargo holds with ballast water (Carlton & Geller 1993). Shipping studies revealed that in total 367 different species were sampled on 159 vessels calling for the port of Coos Bay, Oregon, USA. The study concentrated on one specific shipping route (Japan to the North American west coast) (Carlton & Geller 1993). It is estimated that every hour an average of almost two and 1,900 tonnes of foreign ballast water will be released in U.S. waters (Carlton et al. 1995).

CHESAPEAKE BAY AREA

Smithsonian Environmental Research Center (SERC), Edgewater, Maryland USA Co-operating Institutions Williams College-Mystic Seaport Maritime Studies Programme, Mystic, Connecticut USA and Marine Sciences Center, Northeastern University, Nahant, Massachusetts

Projects:

NATIONAL BIOLOGICAL INVASIONS SHIPPING STUDY (NABISS). Biological Invasions by Non-Indigenous Species in United States Waters: Quantifying the Role of Ballast Water and Sediments [in Chesapeake Bay]. The project was funded by the National Sea Grant / U.S. Coast Guard 1993-1995. This work has been completed and the final report submitted in 1996 to the United States Coast Guard. Year 2 / Part II involved sampling 70 vessels in Chesapeake Bay. A manuscript is now in preparation (L.D. Smith, senior author) for publication. The final report to the USCG is as follows: L. David Smith, Marjorie J. Wonham, Linda D. McCann, Donald M. Reid, Gregory M. Ruiz, and James T. Carlton. 1996. Shipping Study II. Biological Invasions by Non-Indigenous Species in United States Waters: Quantifying the Role of Ballast Water and Sediments, Parts I and II. The National Sea Grant College Programme / Connecticut Sea Grant Project R/ES-6. Prepared for U.S. Coast Guard Research and Development Center, Groton CT and United States Coast Guard Marine Safety and Environmental

Protection, Washington, D.C. Report No. CG-D-02-97, Government Accession No. AD-A321543, xxv + 97 pp. + Appendices A-M. (Final Report July 1996).

BIOLOGICAL INVASIONS OF THE CHESAPEAKE BAY BY NON-INDIGENOUS SPECIES: THE RELATIVE CONTRIBUTION OF BALLAST AND FOULING ASSEMBLAGES TRANSPORTED BY U. S. NAVY VESSELS. Funded by: Department of Defence, Legacy Programme, 1994-1997. This work is in progress. It involves both directly sampling of U.S. navy vessels and experimental studies, the latter both in U.S. naval bases in Spain and in the United States. No published results are available as yet (Carlton pers. comm.).

THE RELATIVE IMPORTANCE OF BALLAST WATER FROM DOMESTIC SHIP TRAFFIC IN TRANSLOCATION OF NONINDIGENOUS SPECIES AMONG U.S. PORTS. Funded by the National Sea Grant Programme this project (commenced in 1997-1998), will sample ballast water being moved along the Atlantic coast of the United States.

Smithsonian Environmental Research Centre (SERC)

SERC is located on Chesapeake Bay, near the middle of the U.S. Atlantic coast, and we have focused much of our attention to date on the Chesapeake as a model system to examine patterns and mechanisms of invasion. A core group of approximately 15 researchers is based in the region, and we have many collaborators outside of the region who participate in the Chesapeake-based research.

Over the past 7 years a collaborative research programme at the Smithsonian Environmental Research Center (SERC) was developed to address a broad range of issues in marine and estuarine invasion biology. The overall goal of the programme was to:

<u>measure patterns of non-indigenous species transfer, invasion, and impact</u>;

<u>test specific and general mechanisms that underlie these patterns</u>;

<u>assess the efficacy of management strategies</u> to limit the spread and impact of non-indigenous species.

Although the research is focused on non-indigenous species (NIS) invasions, SERC was also interested in the unique opportunities that invasions offer to understand fundamental processes in population, community, and evolutionary ecology (e.g. patterns of dispersal, dynamics and genetics of small populations, ecological and evolutionary responses of invading and resident populations to species interactions, effects of species insertions on community structure).

The programme in addition included research at an increasing number of sites outside of the Chesapeake Bay region to measure variation among sites and test for generalities in invasion processes. Within the U.S., research projects in Alaska, California, Florida, and Massachusetts primarily, and this work often involves collaboration with scientists based outside of the Chesapeake region. Furthermore contacts to collaborative overseas research institutions in Australia, Germany, Israel, Italy, Netherlands, and New Zealand were established.

The current research at the SERC is focused on a variety of implemented research projects that examine patterns of NIS transfer, invasion, and impact, and that begin to assess the effect of some control measures. A large component of our research on transfer examines the volume, content, dynamics, and management of ballast water.

Ballast Water Management and Delivery Patterns

SERC invasion / ballast water biologists continue to sample ballast water and sediments in ships coming into Chesapeake Bay on an "as needed" basis to obtain organisms for experimental studies and to continue selected monitoring programs. The most extensive surveys related to the transport of marine and estuarine organisms via shipping are being conducted during the ongoing ballast water research programme of the SERC. International vessels are being sampled at the ports of Norfolk (lower bay, marine waters) and Baltimore (upper bay, oligohaline to freshwater). Sampling programmes revealed the presence of living species in ballast water of 25 of 27 ships entering the Chesapeake Bay.

Additional experimental studies are being carried out on vessels including one experimental voyage conducted in 1996 between Israel and the Chesapeake Bay.

- Characterised the cumulative volume, source regions, and ballast exchange rates for commercial vessels arriving to Chesapeake Bay (1993-1997)

- Characterised the cumulative volume, source regions, and ballast management practices for U.S. Navy vessels arriving to Chesapeake Bay (1995-1997)
- Initiating programme with U.S. Coast Guard to measure frequency of ballast water exchange on commercial vessels arriving from overseas to ports throughout the U.S. (1997-2001)

Ballast Water Content

- Measured physical attributes and biological (esp. plankton) content of ballast water of approximately 150 commercial ships arriving to Chesapeake Bay (1993-1997)
- Measured physical attributes and biological (esp. plankton) content of ballast water of approximately 30 U.S. Navy vessels arriving to Chesapeake Bay (1995-1997)
- Measured microbial (esp. bacterial and viral) attributes of ballast water for a subset of these same vessels (1996-1997)
- Initiating programme to measure content of ballast water of oil tankers arriving to Port Valdez, Alaska from domestic and foreign sources (1997-1999)
- Initiating programme to measure density and dynamics of microbial organisms, especially *Vibrio* bacteria, arriving to Chesapeake Bay from foreign sources (1997-1999)
- Initiating programme to measure the relative importance of domestic ballast water as a transfer mechanism of non-indigenous species to Chesapeake Bay (1997-1999)

Survival Patterns of Organisms in Ballast Tanks (Transit Success)

- Measured survival of organisms, comparing initial versus final densities, in ballast water on commercial and military vessels (n=15) arriving to Chesapeake Bay from Germany, Israel, Italy, Netherlands, Spain and from domestic ports (1995-1997)
- Initiating measurements of survival during transit for organisms in ballast tanks of vessels arriving to Alaska (1997-1999)

Condition of Organisms arriving in Ballast Water

- Tested ability of organisms arriving in ballast water from foreign ports to survive and reproduce in laboratory conditions (temperature and salinity) that mimic local field conditions of Chesapeake Bay (1994-1997)
- Initiating measurements of viability and tolerance of organisms exposed to local field conditions upon arrival to Port Valdez, Alaska in ballast water of oil tankers (1997-1999)

Efficacy of Ballast Water Exchange

- Tested the efficiency of ballast water exchange in removing entrained plankton and introduced tracers from ballast tanks on commercial and military vessels arriving to Chesapeake Bay (n=6) (1996-1997)
- Initiating tests to measure the efficiency of ballast water exchange (especially variation in exchange effort) in removing plankton and tracers from ballast water or oil tankers arriving to Port Valdez, Alaska (1997-1999)

Patterns of NIS Invasion

- Documenting the history and mechanisms of NIS invasion for the Chesapeake Bay to include all major taxonomic groups that includes creation of detailed relational database on the biology, distribution, ecology, and impact of each species (see attached) (1995-1997)
- Documenting the history and mechanisms of NIS invasion for the Indian River Lagoon (Florida) that includes these same elements (1996-1997)
- Measuring current distribution of NIS and rate of new NIS arrivals across environmental gradients in Chesapeake Bay (1994-1997)
- Measuring rates of geographic spread and population dynamics for selected NIS in Chesapeake Bay and California (1994-1997)
- Initiating comparisons of temporal and spatial patterns of invasion in Alaska, California, and Florida to test specific hypotheses about associations with various factors (e.g., transfer patterns, environmental conditions, etc.) (1996-1999)

Effects of NIS Invasions

- Quantifying ecological effects of selected NIS invasions on resident populations and communities in the U.S. (Chesapeake Bay, California, Massachusetts) and Australia; selected NIS to date include species of crabs, bivalves, hydroids, barnacles, and bacteria (1994-1997)
- Testing predictability and variability of invasion effects among multiple communities; current focus has been measuring impact(s) and population characteristics of a single invader in California, Massachusetts, and Australia (1995-1998).
- Testing the effects of *Vibrio* bacteria on the survival and demography of planktonic organisms

Future Directions

Although a large component of the research will continue to examine the invasion processes discussed above, this research is increasingly done in a comparative and collaborative context to measure (in parallel) patterns of NIS transfer, invasion, and impact among sites. A limited scale including both national and international sites to measure variation in invasion processes on various spatial scales was established. Only this broad and co-ordinated approach will sufficiently describe key patterns, effects, and mechanisms of invasion that extend beyond single estuaries or regions.

To achieve this comparative perspective on invasion processes, two elements will play an especially critical role, and were describe below:

National Ballast Information Clearinghouse

One key element in this programmatic approach is the development of the National Ballast Information Clearinghouse at SERC as part of the National Invasive Species Act of 1996 (NISA). NISA requests that all ships arriving to U.S. ports from overseas follow voluntary guidelines for ballast water exchange to minimize the transfer of non-indigenous species (see below). The Clearinghouse was established to track the effectiveness of these NISA guidelines in (a) increasing the rate of ballast water exchange, (b) changing overall the rate and patterns of ballast water delivery, and (c) reducing the rate of ballast-mediated invasions. At present, the Clearinghouse is implementing a nation-wide programme with U.S. Coast Guard to measure ballast management practices and delivery patterns of all vessels that arrive to the U.S. from foreign ports. The Clearinghouse is responsible for the management and timely statistical analysis of the extensive data collected under this programme, and is assisting in the development and implementation of appropriate data collection techniques and selective ”ground-truthing”. This programme will result in a comprehensive biennial report to the U.S. Congress on ballast water management and delivery patterns.

Additional goals of the Clearinghouse include a similar synthesis and analysis of national data on invasion patterns. These data will be used to (a) assess the effectiveness of NISA in reducing invasion rates and (b) create a national resource centre (i.e., *Information Clearinghouse*) and database for current, comprehensive information on both ballast water and marine invasions.

The combined synthesis of data on ballast water exchange and delivery patterns with data on invasion rates is necessary to assess the effectiveness of management practices in reducing invasions, as relevant to NISA goals. These data will also address broader issues on spatial variation in both ballast water supply and ballast-mediated invasion across the

U.S., allowing us to compare general patterns of invasion as a function of ballast water supply, latitude or coastal region, and various environmental characteristics.

Marine and Estuarine Non-Indigenous Species Database (see below)

Another key element in the approach includes the use of a relational database on non-indigenous species that provides a powerful framework for standardized and formal comparisons that we plan to use for regional-, national-, and international-scale analyses of invasion patterns by taxonomic group, organism traits, environmental characteristics, etc.

The development and maintenance of a relational database for each non-indigenous species of Chesapeake Bay at the SERC includes extensive details of taxonomy, distribution, life history, reproductive and population biology, environmental tolerances, habitat distribution and ecology by life-stage, and documented economic and ecological impacts. Recently the SERC begun to expand the database to include similar records for all non-indigenous marine and estuarine species in the Indian River (Florida) and Prince William Sound (Alaska). The long-term goal is to expand this database to include non-indigenous marine species from many additional sites in the U.S. and overseas through collaboration with other research groups. We have already begun this process for a number of national and international sites, using our format as a standard approach. Through this work, we are establishing a formal network of sites to document both the patterns of invasion and the attributes and impacts on non-indigenous species among regions (Ruiz & Hines 1997).

ALASKA

PRELIMINARY STUDIES ON BALLAST WATER BIOLOGY IN TANKER VESSEL TRAFFIC [not the formal title]. The study was funded by Prince William Sound Regional Citizens' Advisory Council, Valdez, Alaska and began in 1997. No results are yet available.

Involved institutions are the Smithsonian Environmental Research Center (SERC), Edgewater, Maryland USA, Marine Sciences Center, Oregon State University, Newport, Oregon USA, Williams College-Mystic Seaport Maritime Studies Programme, Mystic, Connecticut USA (Carlton pers. comm.).

NORTH CAROLINA

A study at the University of North Carolina at Wilmington entitled MOLECULAR STRATEGIES TO CHARACTERIZE MICROBIAL DIVERSITY AND PATHOGENS IN MARINE BALLAST WATER was funded by the National Sea Grant. This work will commence in 1997-1998 (Carlton pers. comm.).

Ballast water Management practices are in place for Cholera detection.

GREAT LAKES

The ALGONORTH Experiment

This is the major filtration experiment now in progress using the M/V ALGONORTH, funded by the Great Lakes Protection Fund. Involved institutions are Northeast Midwest Institute, Lake Carriers Association. The first season of sampling was completed in November 1997. Initial results are scheduled for publication in spring 1998. The purpose of the experiment is to determine the biological and mechanical efficiency of various levels of filtration, testing of mechanical devices and the biological efficiency of filter systems. For the biological experiment, two matched upper wing tanks have been isolated for use as test and control tanks. Water from the sea is drawn from an ballast tank, sent through the filter and discharged into the test tank. Water discharged into the control tank bypasses the filter system. The experimental design involves sampling both tanks for phytoplankton and zooplankton and comparing size, abundance and condition of organisms from major taxa. Since this is not a taxonomic survey, but a filter effectiveness test, the major salt and fresh water taxa were determined representing size and morphological categories of organisms. Taxa include diatoms, dinoflagellates, eggs, rotifers by genus, cladocerans, copepods (harpactacoids separately), bivalve veligers, copepodites, and nauplii).

In addition microbial taxa are investigated. The ballast residuals in fully-loaded incoming vessels into the Great Lakes system were studied with molecular detection analysis for viruses and bacteria with pathogenic potential. The filtration system will be tested for its effectiveness at screening the microbial taxa (Cangelosi pers. comm.).

HAWAII

Williams College-Mystic Seaport Maritime Studies Programme, Mystic, Connecticut USA and Hawaiian institutions commenced a study in 1997 - 1998, entitled MARINE

NONINDINGEOUS SPECIES IN HAWAIIAN HARBORS AND BALLAST WATER STUDIES [not the formal title]. The funding source is: Packard Foundation and Dingell-Johnson funds. No preliminary data available (Carlton pers. comm.).

1.4.4.2 South America

It was noticed during several personal communications that in some regions of Brazil and Chile local regulations dealing with ballast water of non-indigenous origin have been discussed (see 5.2.5).

1.4.5 Australian activities

Australia recognized the potential of ballast water to create problems since the late1970s but it was only in recent times that the matter has become a mean issue. Early studies in New South Wales in 1973 gave warning that non-indigenous fish species were introduced.

In 1986 two cases of paralytic shellfish poisoning occurred in Tasmania. In 1989 the Australian Quarantine and Inspection Service (AQIS) became involved in the ballast water issue. Introduced marine pests posed a greater threat to the Australian environment than oil spills, land degradation, and rabbits warned the AQIS. Australian scientists were among the first to realise the risk of unintentionally species introductions with ballast water. Early studies in New South Wales reported and warned that exotic fishes had been introduced (Jones 1991). In addition several studies dealing with non-indigenous species and their introductions with ships were carried out in the past, are ongoing or are planned for the future. Research is being carried out and organized by the Australian Quarantine Inspection Service (AQIS) and the Australian Centre for Research on Introduced Marine Pests (CRIMP). The objectives of CRIMP are to develop and promote the application of tools for an earlier warning, more precisely prediction and more effective assessment of risks and costs of marine pest species introduced to Australia, as well as the development of new methods or improvement of existing measures to control the spread and to minimize the impacts of

introduced marine species. In the three years since its inception, CRIMP has expanded from two part-time positions to twelve permanent staff members and international researchers and students. CRIMP is organized in three groups: Invasion Process, Impacts and Demographics as well as Pest Management and in addition a small administrative group managing the centre (Thresher 1997).
The estimated cost of US$ 5 billion will be spent over this decade to control species introduced in Australian waters (Jones 1991).

Australian studies of ballast water were focused on phytoplankton species and their resting stages (Williams et al. 1982, 1988, Pollard & Hutchings 1990, Hallegraeff & Bolch 1991, Rigby et al. 1993, Kerr 1994). A phytoplankton shipping study carried out between 1987 and 1989 revealed several species sampled from the ballast water of 200 ballast tanks (Hallegraeff & Bolch 1991). Until 1990in total 343 ships were sampled in 18 different Australian ports. In addition to ballast tanks, cargo holds filled with ballast water were sampled as well by several hauls with the plankton net (Hallegraeff & Bolch 1992).

A zoological study involving in total 23 samples of ballast water and 9 sediment samples resulted in the determination of 67 taxa. Crustacea (mainly Copepoda) and Mollusca were the most abundant taxa found (Williams et a. 1988).

Several of the key projects (MSC/Circ.625/Add.3) are summarized as follows:
A study reviewing the current scientific results on introduced and established harmful species threatening the marine environment, commercial fisheries and human health was completed in 1991 (Manning et al. 1996).
A study on ballast water treatment for the removal of marine organisms considered three ballast water treatment options: ship board treatment, port treatment and land based treatment. Shore based treatment of ballast water was the preferred method (completed in 1992) (AQIS 1993, Manning et al. 1996).
A study completed in 1992 investigated the possibility of exchanging ballast water in open seas / mid ocean (re-ballasting studies). Trials on large bulk carriers showed some

of the practical aspects and assessed the effectiveness of the method of exchanging ballast water, sediments and associated organisms (Manning et al. 1996).

Ballast water management options were reviewed according to type of vessel. Recommended appropriate practical management procedures and practices to minimize or eliminate the uptake of exotic organisms with ballast water were listed (completed in 1993) (Thomson Clarke Shipping Pty Ltd et al. 1993, Manning et al. 1996).

A port and shipping study (completed in 1993) reported the amount and origin of ballast water entering Australian waters. The receiving tonnage of ballast water from each particular Australian port and country of origin as well as the number of ship visits by port and country of origin was listed (Kerr 1994, Manning et al. 1996).

An epidemiological review of possible fin fish and shell fish diseases which may result from ballast water and sediment discharges in Australian waters lists the pathogens of concern by region of origin and seriousness of threat. The report was completed in 1993; it lists pathogens of concern by area of origin and hazards involved if the species will establish (MEPC35/INF.19, Munday et al. 1994, Manning et al. 1996).

A ports and disease study, completed in 1993, identifies and ranks Australian ports according their risks of receiving infected ballast water as well as the countries or regions of threat as donor of contaminated ballast water and exotic diseases. There were ranked according to the threat that they pose to Australian aquaculture and wild fisheries (Herfort & Kerr 1995, MEPC35/INF.19).

A pilot study on the potential application methods of heat treatment in order to inactivate potentially harmful organisms present in ballast water was carried out. The heat treatment trials showed that treatment with 40 to 45 °C on the IRON WHYALLA effectively killed both phytoplankton and zooplankton (MEPC35/INF.19, Rigby & Hallegraeff 1993, Manning et al. 1996).

A dye-staining diagnostic test for the detection of the presence of dinoflagellates, their cysts and other harmful organisms in ballast water was cancelled (Manning et al. 1996).

The port water sampling programmes determined the presence or absence of potentially harmful organisms that could be transmitted to other Australian ports via ships` ballast water in order to minimize the risk of the transport of harmful species. The study covers selected Australian ports (Manning et al. 1996).

The development of standards for re-ballasting guidelines using the results of the IRON WHYALLA trials and the ballast water management report (in progress).

To enforce public awareness brochures and videos will be produced to educate governments, industry and the public about the ballast water problem, current research activities and possible solutions (temporarily suspended) (Manning et al. 1996).

It has been planned to determine the capacities and limitations of the port of Newcastle in supporting a ballast water treatment plant and evaluate the gross dimensions as well as the capacities of such a plant, but the project was cancelled (Manning et al. 1996).

Reviews of the introduced Pacific Starfish *Asterias amurensis* and the seaweed *Undaria pinnatifida* summarised information on their introduction, growth and effects on native environments (Munday et al. 1994). A preliminary trial with 9 herbicides showed limited success against the sporophytes. Another trial has commissioned in order to treat the gametophytes with other herbicides (ICES WGITMO 1997).

A technical overview report listed conclusions and recommendations of the completed ballast water reports (Manning et al. 1996).

A bio-economic risk assessment compiled information on risks and costs, both biological and economic, concerning the treatment of ballast water. Thus was published as Report No. 6 of the AQIS Ballast water research series (ACIL Economics 1994, Manning et al. 1996).

A project regarding the development of standardized re-ballasting guidelines (based on e.g. the results from the IRON WHYALLA trials) were presented by Rigby and Taylor (Manning et al. 1996). The study concluded that the decision whether to exchange ballast water and by which method must rest by the ship´s Master. It was noted that for some ships a complete exchange of ballast water was unsafe and that in the cases the flow through method (or continuos flushing method) should be used (Manning et al. 1996, Sipes et al. (eds.) 1996).

Future action will cover the monitoring of non-indigenous species and in particular toxic dinoflagellates and continue with port testing studies. The development of a national strategy for ballast water management will be enforced.

A hull fouling study shall compile information via literature search on the organisms likely to be introduced into Australian waters by hull fouling (Manning et al. 1996).

A strategy dealing with vessels that have been confirmed carrying Cholera bacteria is being developed.
The infected case study will examine the ship management on ballasting practices of a vessel that has been re-infected after cleaning of ballast water and sediment from its ballast tanks. The study is still in progress (Manning et al. 1996).
Australia further identified a short list of target species that could be of major threat to Australian waters. In addition Cholera testing of ballast water has been commenced.

In summary, Australia sees the implementation of the IMO Guidelines as just the first step in overcoming this major problem (MEPC35/INF.19)
Community based coastal monitoring as a joint effort between CRIMP, the Australian Department of the Environment, Australian Ballast Water Management Advisory Council (ABWMAC) and fisheries including the development of a national network of regional co-ordinators will link scientific and management agencies to local community groups for rapid detection of new introductions. A national "incursion response" plan was established to deal quickly and effectively with new invasions or range extensions.
A general risk assessment framework for ballast water introductions is being developed as a joint CRIMP and ABWMAC initiative. It is using port survey information, data on ballast water tank configurations and management as well as biological data on pest species to calculate for each vessel and voyage the risk of introducing a new pest species. The risk assessment will be used in order to determine the level of management action required for each vessel (Thresher 1997).
Ballast water management practices are in place for Cholera detection and the indication of toxic dinoflagellates. A feasibility study of a rapid diagnostic test to prove the presence of toxic dinoflagellates in ballast water was approved as high priority (Scholin et al. 1995, Manning et al. 1996).

A desk study on the Mediterranean polychaete *Sabella spallanzani* introduced and spreading in Australia was carried out to reveal natural enemies for use as biocontrol agents. Further investigations are needed in order to evaluate the specificity of these agents and to prevent damages to native polychaete populations or other species.

Die-backs in different places in Australia were noted in 1996 without knowing the causative agent (ICES WGITMO 1997).
Another non-indigenous invader that has been requested to treat with biocontrol is the European Shore Crab (*Carcinus maenas*). A desk study indicated that natural enemies such as *Sacculina carcini* (Cirripedia), ciliates, parasitic dinoflagellates (*Hematodinum* spp.) and viruses may be worthwhile to investigate (ICES WGITMO 1997).
Within a joint CRIMP and ABWMAC project the distribution of planktonic organisms in ballast water tanks is being examined. Sampling methods obtaining representative samples will be tested in order to demonstrate their effectiveness in detecting target organisms of known densities in the ballast uptake. On board trials are ongoing and should be completed in 1997.
Another group of experts is involved in a study to test the effectiveness of ballast water heat treatment, hull fouling as a transport vector across the Tasman Sea and the ability of organisms to survive in ballast tanks. Major studies on the effects of port management techniques on the progress of colonization, and the role of hull fouling as a transport vector are scheduled to start in 1997 / 1998 (Thresher 1997).

At the CSIRO/CRIMP an international ballast water survey, focused on sampling methodology of world-wide relevant projects was initiated. Results of this study will be published in 1998 (Sutton, Martin pers. comm.).

1.4.6 New Zealand's activities

In late 1988 a group so called the Ballast Water Working Group (BWWG) was particularly concerned about toxic dinoflagellates which cause Paralytic Shellfish Poisoning. This had so far not been recorded to occur in New Zealandian waters (MEPC34/INF.3).

In addition, a research programme entitled "Foreign Organisms entering NZ Coastal Waters via Discharge of Ballast Water" was carried out by the Cawthron Institute in 1996 / 1997. The goal of this research project concerns the international problem of translocating non-indigenous marine life in ships ballast tanks. In this context it quantifies the diversity and the abundance of foreign marine species entering NZ waters. By sampling the ballast tanks of a representative range of ships, the study aims to identify potentially invasive species, with the view to assessing the risk of their introduction. In addition the study considers methodologies for sampling ballast tanks, relates the analyses of ballast water samples to such variables as water origin, containment time, ship and tank types and effectiveness of mid-ocean exchange, considers the design of a computerised data base to store and export ship and sample related data for statistical analysis and provides suggestions for assessing the risk of introducing foreign marine life to NZ via ballast water discharge.

A practical, reliable and consistent method of obtaining quantitative water and sediment samples from all types of ballast tanks via sounding pipes, manholes, and from ballast holds was developed. This procedure is independent of ships personnel and causes no inconvenience to cargo handling. Measurements of water quality (e.g. salinity) and of phytoplankton and zooplankton diversity and abundance were made both at dock-side and in the laboratory. Together with the history (e.g. origin and containment time) of the water in the ballast tanks, tank capacities, ship statistics (e.g. registration, DWT) and details about mid-ocean exchange, all data were entered into a customized computer data base. Until now 161 ballast tanks from 75 vessels were sampled from a wide range of ship types but mainly container ships, using a sounding pipe sampling method.

The sampling method via sounding pipes has shown to be of significant advance, and is consistent with requests to develop a practical, representative sampling procedure. The method permits sampling of all vessels with sounding pipes; i.e. at least 90% of ships plying NZ trade-routes. Recently this method has been adopted by two other research agencies (Ministry of Fisheries Policy 1997, Taylor pers. comm.).

1.4.7 Southafrican activities

Information of ballast water discharges have been collected from several ports. The available information was limited to a short period of time and a selection of port authorities. The amount of ballast water discharged was estimated as 20 million tonnes annually (Jackson in prep.).

Currently a sampling study of ships is carried out. The pilot study at the Sea Fisheries Research Institute investigates the possibility of introduction of non-indigenous phytoplankton species (especially toxic forms) into South African waters at Saldanha Bay on the Cape West Coast. Saldanha Bay is South Africas second busiest port and is destined to become the busiest port when the facilities for additional export of iron ore are completed. The project was commenced as a pilot study in 1996. One of our major problems was the access to sample ballast water. In addition to the ship sampling 4 monitoring stations in Saldanha Bay are sampled so as to be able to get base line data on what phytoplankton occurs in Saldanha Bay, both in the water and in the sediments. Preliminary results are not available (Jackson, Pienaar pers. comm.)

1.4.8 Japanese activities

The Japanese Ship-owners Association completed in 1995 on board experiments using the ore carrier Ondo Maru (56.062 Gross Tonnage, LOA 245m, B 41.8m, D 21m) to develop effective methodologies on how treat marine organisms in ballast water. The study was concentrated on the treatment of phytoplankton in the ballast water, but zooplankton was investigated as well. The heat exchanging unit from the cooling circuit of the main engine of this vessel was modified in order to lead the heated water into the studied ballast tank. Before the experiments were carried out a feasibility study had been conducted to investigate as to whether a heating unit as planned will be able to solve the problem. It was believed that the ballast water temperature has to be heated up to 45 □C. Using the planned heat treatment would heat up the ballast water up to 46 □C with a flow rate of 100 tonnes / h. One single ballast tank was used in this investigation. The studied ballast tank (sidetank No.4) is characterised by a surface area in contact with the atmosphere of 456 m^2, seawater covered surface of 642 m^2 and area touching holds 693 m^2. The results showed that the quantity of species in the ballast water was effectively reduced by the heat treatment.

For future investigations it was noted that firstly, the temperature of the ballast water was not uniform in the whole tank, secondly that during the mid-ocean exchange of ballast water additional species of plankton were taken on board and thirdly that all living phytoplankton species were not able to survive the 24 day voyage due to the lack of light. In this connection it was documented, that 7 different phytoplankton species were found in total. After the mid-ocean exchange of the ballast water the *Thalassiosira* sp. was not found anymore, but all other species that had been determined prior to the ballast water exchange and in addition *Thalassiothrix* sp.

Summarising these facts, Fukuyo et al. (1995) recommend to develop new methods of ballast water treatment suggesting the application of new electrolysis technologies (MEPC36/18/2, Fukuyo et al. 1995).

1.5 Results of ship sampling studies

In this chapter the results of a selected number of shipping studies are presented. The incomplete list shall give an overview on the variety of species which can be found in the ballast water, ballast tank sediments and as fouling on the ships hull.

1.5.1 Ballast water

1.5.1.1 Germany

A shipping study supported by the German Government revealed that in none of the ballast water samples abiotic parameters were estimated to be of lethal nature. However, not all samples contained organisms. Organisms were found in 73.5% of all ballast water samples. Among the factors determining survival in ballast water tanks, tolerance towards changing environmental conditions seems to be the most important factor as evidenced during a voyage on board a container vessel from Singapore to Bremerhaven (Germany). Daily sampling of different ballast tanks revealed dramatically varying temperature and oxygen contents. These are important factors influencing the survival of organisms inside the ballast tanks.

The main phytoplankton groups recorded in ballast water were diatoms, dinoflagellates and Chlorophyceae. All phytoplankton species that were recorded are occurring in a wide range of geographical areas and had probably been spread by earlier transport of ships. Of the total 147 species, 11 non-indigenous phytoplankton species were recorded, 8 diatom species in ballast water, and 3 dinoflagellates in sediment samples. Among the 11 non-indigenous species were 2 dinoflagellate genera (Alexandrium and Gonyaulax) which are known for toxin production.

The zoological results of the ballast water investigation were dominated by Copepoda and Rotatoria, and up to 20 cm long fishes found in ballast water samples. The maximum number of different species in one sample was 12. With increasing age of ballast water (time period spent in the tank), the number of species and specimens decreased. Of the 257 species identified, 150 were classified as non-indigenous species to German waters. 37 of these were found in ballast water, 60 in sediment, and 83 in hull samples.

In general, about 1 animal per 1 l ballast water was recorded. This means an introduction of 69 organisms per second or 6 million per day with ballast water from outside Europe. A maximum of 110,000 unicellular algae were recorded from 1 l of ballast water and 300 empty cysts per 1 ml sediment

The potential for the establishment of non-indigenous species was classified into three categories according to how the climatic conditions in the area of origin compared to those in German waters (low, medium, and high risk of introduction). Ballast water was estimated as an important vector for future introduction of non-indigenous species in our waters, since most of the species with the highest potential for survival and establishment have been recorded here, and not in sediment and hull samples (Gollasch 1996, Lenz et al. in prep.).

The survival of plankton organisms in ballast water tanks was studied during a voyage of 23 days with a container vessel from Singapore to Bremerhaven (Germany). Previous ballast water investigations during ship voyages showed the decrease of specimens and the reduction of diversity according to the time the ballast water stayed in the ballast tanks. As expected, the number of specimens decreased dramatically in one of the two investigated tanks. In the second tank the number of individuals of one harpacticoid copepod, *Tisbe graciloides*, increased from 11 specimens per 100 litre at the beginning of the investigation to more than 1,000 specimens at the end. An increase of specimens during ship voyages has never been documented before. This new dimension of species transportation in ships ballast tanks shows that ballast tanks may be incubators under special conditions and emphasises the risk of species transport with ships (, J. Lenz, H.-G. Andres, S. Gollasch & M. Dammer, in prep).

1.5.1.2 United Kingdom

Biological analyses focused on planktonic organisms, including motile phytoplankton and zooplankton in ballast water, and resting cysts of dinoflagellates in ballast tank sediments. Full resting cysts of dinoflagellates were found in 62% of sediment samples, including cysts belonging to potentially toxic species associated with Paralytic Shellfish Poisoning (PSP). These were partly cysts representing the resting stages of the dinoflagellates Alexandrium minutum and Gymnodinium catenatum, species not currently described from UK waters. 51%of cysts incubated in culture media during preliminary investigations into the viability of cysts hatched into motile dinoflagellate cells, and many phytoplankton species also flourished in sediment slurries incubation experiments. Motile phytoplankton was found in 133 of the 134 ballast water samples. These samples contained a wide range of organisms, reflecting the diversity of their geographic origins and characteristics. Potentially toxic species of diatoms (Pseudonitzschia spp.) and dinoflagellates (Dinophysis spp. and Alexandrium spp.) were observed. The problems of identifying toxic flagellates were outlined. Phytoplankton assemblages taken from ballast tanks prior to and following mid-water exchange in the North and Irish Seas were compared. This practise appeared to be less effective at reducing the diversity and abundance of phytoplankton cells than mid-water exchange in oceanic waters, and these are important implications for future ballast water management guidelines.

Analyses of zooplankton in ballast tanks showed the great diversity in taxa transported in ballast water, and demonstrated that many organisms appeared to survive the ballasting operations and voyages. Two non-indigenous species of calanoid copepod were observed, and five species (four copepods and one polychaete) only rarely seen in Scottish waters were found. The results showed further that resting cysts of toxic dinoflagellates are a major problem which should be addressed in future ballast water treatment options (Macdonald & Davidson 1997).

1.5.1.3 Norwegian “Sture“ study

Preliminary results of the ballast water samples partly investigated so far showed that live phytoplankton were found in 96 % of the vessels, live copepods were found in 90 % of the vessels, live Cirripedia were found in 80 % of the vessels, live Polychaeta were found in 50 %, and fish eggs in 20 % of vessels. In addition many more taxonomic groups are present in the samples, and live fish and crabs have been observed (Botnen pers. comm.).

1.5.1.4 USA

Several North American studies were undertaken to sample the ballast water of ocean-going vessels. Main focus of the North American studies was the zooplankton introduced with ballast water (the Australian working groups were concentrated on phytoplankton (see below).

A shipping study revealed that in total 367 different species sampled on 159 vessels calling for the port of Coos Bay, Oregon, USA. The study concentrated on one specific shipping route (Japan to the North American west coast) (Carlton & Geller 1993). An earlier investigation of Carlton et al. (1982) and Carlton (1985) focused on bulk carrier entering North American ports without any cargo but with high loads of ballast water. The predominantly found taxa of all studies belonged to Crustacea, Mollusca and Polychaeta.

An additional sampling programme at the Smithsonian Environmental Research Centre (SERC) revealed the presence of living species in ballast water in 25 of 27 ships entering the Chesapeake Bay (Ruiz pers. comm.). The minimum number of species found in ballast water arriving to the Chesapeake is reported as 221 in (Smith et al. 1996).

1.5.1.5 Canada

The Canadian study revealed that existing data on pH, temperature, oxygen and salinity of the ballast water does not inhibit a broad range of organisms from surviving.

In four ballast samples streptococci were found. The concentration in two samples exceeded the criteria level for public surface water supplies. The maximum number of coliform bacteria (4,600 per 100 ml) were slightly less than the maximum permissible level (5,000 per 100 ml).
In total more than 150 species of phytoplankton were identified. All ballast water samples contained aquatic flora. The macrophyt component consisted of fragments only. In 76 % of the ships in minimum one viable algae had survived the transport in ballast water. Of the eleven major phytoplankton divisions only Chloromonadophyta were absent. 9 species were estimated to have the potential of becoming introduced into the St. Lawrence estuary.
The aquatic fauna (over 56 species) consisted entirely of invertebrate species. Zooplankton represented the majority of animal organisms found in the ballast water samples. 89% of all ships contained at least one viable invertebrate form. The assembly of found species consisted of Protozoans, Rotifera, Nematoda, Mollusca, Annelida, Tardigrada, Acarina, Cladocera, Ostracoda, Copepoda, Cirripedia, Mysidacea, Isopoda, Amphipoda, Diptera, Decapoda, Chaetognatha. Occasionally terrestrial insects were found. Their occurrence in the ballast water was quoted as probably accidental. 9 species of flora and fauna were estimated to have the potential to become introduced into the St. Lawrence estuary (Howarth 1981).

The results of the ballast water sampling of 455 ocean-going vessels entering the St.-Lawrence Seaway carried out by Locke et al. (1991, 1993) revealed 107 taxa. All sampled ballast tanks contained living zooplankton. Predominately found organisms were copepods, water fleas and rotifers. The maximum number of specimens was comparably high with more than 50,000 species per m³ of ballast water. A sample with the minimum number of specimens contained 21 specimens per m³ (Locke et al. 1991, 1993).

Subba Rao et al. (1994) published a study of exotic phytoplankton species from ballast water and their potential spread and effects on mariculture localities. Ballast water was analysed from 86 foreign vessels that visited the Great Lakes area during 1990 and 1991. In total 102 taxa of 7 taxonomical groups were determined, 69 diatoms and 30 dinoflagellates were collected. Most of the phytoplankton were found in a good condition. Culture experiments were carried out. In total 21 potentially bloom-forming (red tide) and / or toxin producing phytoplankton species were found in the ballast water samples. Several of the species were found for the first time is this geographical region (Subba Rao et al. 1994).

Additional sampling on 94 ships revealed at least 106 different zooplankton species in the ballast water. 25 species had never been reported from the St. Lawrence region. The number of species ranged from 5,000 to 8,000 per m³ depending on the season. The number of species ranged from 11 to 24 on average per sample. The results of the study could be used as a scientific rationale to extend the application of the existing guidelines to all foreign ships entering the Gulf of St. Lawrence. In addition the results showed that the guidelines (when complied with) are effective in reducing the potential for ballast water mediated introduction in the marine ecosystem of the St. Lawrence area (Gilbert & Harvey 1997, SGBWS 1997).

1.5.1.6 Australia

A zoological study revealed that in 23 samples of ballast water 67 taxa were determined. Crustacea (mainly Copepoda) and Mollusca were the most abundant taxa found (Williams et a. 1988).

Additional sampling carried out before 1990 showed that in 35 % of 343 samples of ships entering 18 different Australian ports dinoflagellates were found. In total 53 species of planktonic and benthic species of dinoflagellate and diatom were collected. Due to the frequent findings of phytoplankton in ballast tanks it was assumed that the world-wide distribution of some species could be related to the transport in ballast water. The toxic dinoflagellates *Alexandrium catenella*, *A. tamarense* and *Gymnodinium catenatum* were found in samples from 16 vessels (Hallegraeff et al. 1986, Rigby et al. 1991, Hallegraeff & Bolch 1992). It is known that one vessel filled its ballast tank during a phytoplankton bloom of toxic species in the port of Muroran

(Japan). After its voyage to Australia the ballast water of this vessel was sampled, revealing more than 300 million cysts of the species *Alexandrium*.

1.5.1.7 New Zealand

Results of the research programme entitled “Foreign organisms entering NZ coastal waters via discharge of ballast water“ showed that about 80% of tanks sampled contained live phyto- and zooplankton. About half of these tanks were reported to have been exchanged in mid-ocean suggesting that mid-ocean exchanges do not remove coastal marine life. Some zooplankton taxa (e.g. polychaete worms with their tubes still intact) appear to be persistent residents in the tank sediments. Many of the invertebrates found were larvae which hindered taxonomic resolution (Taylor pers. comm.).

1.5.2 Tank sediments

1.5.2.1 Germany

As early as 1933 Peters noted the presence of the Chinese Mitten Crab (Eriocheir sinensis) and of an amphipod after the investigation of the bottom of a vessels ballast tank. The investigation was carried out in 1932 and documented the possibility of successful species introductions into German waters (the Chinese Mitten Crab was first recorded in 1912).

Samples of the sediment inside ballast tanks were difficult to collect due to safety provisions. Rotting material could have produced bad air conditions with limited oxygen content. Therefore, during the German shipping study, sampling was only possible after intensive tank ventilation. Inspection of the ballast tanks could be carried out 71 times, nearly half as much as for ballast water and hull samples. 74.6% of the sampled sediments contained living organisms: diatoms, dinoflagellates and their cysts as well as Chlorophyceae. Bivalvia and Cirripedia were the most common animals found in sediment samples. The maximum number of species in one sample was 25, more than twice as much as in the ballast water (Gollasch 1996, Lenz et al. in prep.).

1.5.2.2 Australia

In 1975 a report documented the presence of live invertebrates in ballast water and sediment in a ship arriving at Twofold Bay Eden (New South Wales) from Japan (MEPC35/INF.19) and therefore proved the presence of living organisms in ballast water of ocean -going vessels after its intercontinental voyage (Medcof 1975).

A zoological study revealed in total 9 samples of ballast tank sediments. Crustacea (mainly Copepoda) and Mollusca were the most abundant taxa found (Williams et a. 1988).

Additional sampling until 1990 revealed 343 samples of ships entering 18 different Australian ports In about 35 % of all ballast tank samples cysts of dinoflagellates were found. In total 53 species were determined. Due to the frequent findings of phytoplankton in ballast tanks it was assumed that the world-wide distribution of some species could be related to the transport in ballast water. The toxic dinoflagellates *Alexandrium catenella*, *A. tamarense* and *Gymnodinium catenatum* were found in samples from 16 vessels (Hallegraeff et al. 1986, Hallegraeff & Bolch 1992).

1.5.3 Hull fouling

Further development of the toxic components of anti-fouling paints improved the effectiveness of this hull paints tremendously (MEPC/38/INF.9).
During the German shipping investigations access to ship hulls was only permitted in dry docks, most of the vessels investigated entered the dock in order to renew their anti-fouling paints after several years. Therefore nearly all samples (98.5%) of the hull fouling contained organisms. Hull samples investigated for macroalgae revealed mainly widespread green algae of the genus *Enteromorpha* and brown algae of the

genus *Ectocarpus* were found. Non-indigenous algae to German waters were not found. All species of macroalgae that were found are spread over a wide range of geographical areas.

Bivalvia and Cirripedia represent the dominant fauna in the hull samples as well as in the sediment samples. The highest species number per sample was 15, less than in sediment samples but 20 % higher than in samples of the ballast water. Hull fouling contained a higher number of non-indigenous species than ballast water and tank sediments. Most of the 83 non-indigenous species are distributed over a wide geographical range possibly spread by hull fouling during earlier shipping (Gollasch 1996, Lenz et al. in prep.). Even a species unknown to science was found in one sample. This turbellarian species was named after the site of its first finding *Cryptostylochus hullensis* (Faubel & Gollasch 1996).

1.5.4 The need for standardisation of sampling methods

For all of the above mentioned sampling programmes specific sampling methodologies were used. The development of globally applicable standard sampling methodologies for collecting and analysing ballast water from ships is needed. Sampling methods may vary according to the behaviour and the taxa of species considered to be harmful. It may be necessary to consider different techniques according to the local conditions of each port, country or region. Protocols need to be developed to address these issues.

1.5.4.1 IMO / MEPC sampling plan

The IMO / MEPC Ballast Water Working Group considers the development of ballast water management plans identifying the location and suitable points for sampling ballast water or sediment. This would enable the ship´s crew to provide maximum assistance when port authority inspections require samples of ballast water or sediments.

1.5.4.2 EU Concerted Action

In co-operation with 5 European countries: Finland, Ireland, Sweden and the United Kingdom (England and Scotland) and Lithuania, Germany is co-ordinating the Concerted Action programme entitled: "Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters". Several experts from all over the world (e.g. North America, Mediterranean Countries, Australia and Asia) will be participating. This two year Concerted Action (starting early 1998) was recently funded by the EU. Various methods of monitoring ballast water species will be studied evaluating qualitatively and quantitatively the fate of exotic species in ballast water. Sediments accumulating in ballast tanks and fouling biota on ship hulls will also be examined. Treatment measures for the control of exotics will be discussed. Assessment of potential risks from hazardous introductions and their control is an increasing problem of importance.

The main objectives of the Concerted Action include state of the art of ballast water studies (case histories), evaluation of the various sampling methods presently used for ballast water studies in selected EU member countries, validation of the reliability of sampling methodologies (through intercalibration workshops, also on board of ocean-going ships) to assess in-transit survival capabilities, standardisation of sampling methods and development of intercalibrated monitoring systems for use by EU countries and by inter-governmental bodies such as ICES, BMB (Baltic Marine Biologists), IOC and IMO. In addition interested institutions (National Governmental Organizations) from other countries will be invited as guests for specific tasks.

1.6 International Network for Marine Invasion Research (INFORMIR)

International co-operation is necessary in order to co-ordinate scientific studies avoiding double work to standardize sampling methods for international comparison of results and to develop measures to deal with ballast water.

Over the past decade research on aquatic non-indigenous species has increased all over the world, resulting in several studies carried out in many different countries (see above). The development of management strategies on non-indigenous species and ballast water depends on the understanding of both generalities and sources of variation. The development of a co-ordinated effort is underway for ballast water management including treatment options implemented by the IMO. As a result of meetings of several expert groups dealing with the ballast water issues first steps are being developed to co-ordinate activities around the world and to increase the effectiveness of e.g. research, to develop standards and to promote comparisons. An International Network for Marine Invasion Research (INFORMIR) is under construction to derive comparative approaches due to summarising the individual studies carried out. Beside IMO, the IOC of the UNESCO and the ICES are working in the field covering aspects that fall within their mandates, i.e. IOC in relation to research on harmful algal blooms (see section 2.1), and ICES concerning the introduction of species and their effects on aquaculture.

In contrast, co-ordinated research on patterns and impacts of non-indigenous marine and estuarine species marine lags far behind. Missing data include the abundance, distribution and impacts within regions (national and international). It is suggested that a strong benefit would result from establishing an International Network for Marine Invasion Research what may be used to comparative and collaborative research in this field.

2 Case histories of introduced species and their effects to environment and ecology

The Australian Bio-Economic Risk Assessment report from 1994 estimated that with an application of effective treatment options costs of US $ 292.5 million of damages in regard to domestic and international tourism, public health and aquaculture could be avoided (ECIL Economics 1994). Until today this has been the only report listing costs what may be saved by the implementation of effective ballast water treatment options and the associated minimization of potentially harmful species introductions.

Selected examples of unwanted introduced species and their ecological and economical impacts are listed in the following section:

2.1 Flora

Toxic algal blooms (harmful algal blooms (HAB))

The potential of ballast water as a vector to introduce phytoplankton species outside their native range was firstly suggested by Ostenfeld (1908) after a phytoplankton bloom of *Odontella sinensis* in the North Sea in 1903. More recent concerns arose after increasing phytoplankton blooms around the world in the 1980s (Smayda 1990, Hallegraeff & Bolch 1992, Rigby et al. 1993). Increasing toxic algal blooms of non-indigenous species in Australian and New Zealandian waters have been associated with ballast water releases. Australian scientists have since intensified their ballast water studies (Hallegraeff & Bolch 1991, 1992, Baldwin 1992).

In 1992 an IOC-FAO Intergovernmental Panel on Harmful Algal Blooms (IPHAB) had its first session focusing meeting on the negative impacts of these blooms on public health and economy. The expansion of these blooms are related (at least at part) to the increasing exploitation of coastal waters (waste disposal, aquaculture, maritime commerce and other anthropogenic influences) as well as to the dispersal and proliferation of such species. It was noted that in order to foster the effective management of, and scientific research on harmful algal blooms to understand their causes, predict their occurrences and mitigate their effects a lack of information exists.

Several international institutions were interested in harmful algal blooms as e.g. UNEP, EEC, ICES and SCOR and formed the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms. The IPHAB organized discussion / expert groups, training programmes on the taxonomy of harmful phytoplankton, design and implementation of monitoring programmes, funding research and forming an information network starting with the first issue of a newsletter Harmful Algal News published in 1992. The panel recognized in its1993 report that the problem of the transport of harmful algal blooms via ballast water was of major concern (IOC-FAO IPHAB 1992, 1993).

Particularly in regard to toxic marine phytoplankton species such as *Alexandrium minutum*, *Gymnodinium tamarense*, *G. catenatum* and *Gyrodinium aureolum* which are known to have occurred in blooms all over the worlds oceans.

Alexandrium species have caused outbreakes of Paralytic Shellfish Poisoning (PSP) in Norwegian waters and coastal areas of the United Kingdom. *A. minutum* was observed for the first time at the Swedish west coast (Skagerrak) being abundant during end of June (Lindahl & Edler 1997) it was also present in samples of the North Sea and the Atlantic, the Mediterranean Sea, east coast of the USA, Japan, Australia and New Zealand (ICES WGITMO 1997).

Gyrodinium aureolum has caused fish kills in the British Channel, western areas of United Kingdom, Danish, Norwegian and Swedish waters (Swedish Environmental Protection Agency 1997).

In January 1993 the whole New Zealand shellfish industry (export and domestic use) was closed as a result of toxic algal blooms. Knowing that the transport the exotic phytoplankton species in ballast water may result in new phytoplankton blooms after discharge of the ballast water, vessels were requested not to discharge ballast water in any Australian or New Zealandian port or to exchange their ballast water before releasing it in an Australian or New Zealandian port.

Caulerpa taxifolia

The accidental introduction of the alga *Caulerpa taxifolia* into the Mediterranean Sea and its spread through regional shipping and boating had been subject of research by the European Union. The seaweed *Caulerpa taxifolia* was probably introduced into the

Mediterranean Sea in the mid 1980s: First records were made in the Monaco area (Meinesz & Hesse 1991). *Caulerpa* covered in 1984 a surface of 1m². In 1990 it covered 3 ha, in 1991 30 ha, in 1992 427 ha, in 1993 1,300 ha, in 1994 1,500 ha and in 1996 more than 3,000 ha. Today it covers the surface of thousands of hectares along the coasts of France, additional records were documented from Spain (the Balearean islands (21 ha covered)), Italy and Croatia (Adriatic Sea).

Caulerpa replaces the native seagrasses (e.g. *Posidonia oceanica)* limiting the habitat for larval fish and invertebrates. It therefore endangers the continuity of their populations (Meinesz et al. 1997, Ribera pers. comm.).

In 1992 an international programme was launched to combat the further spread of the algae (Nolan 1994, UNEP(OCA)/MED WG.89/Inf.9 1995, Ribera et al. (eds.) 1996).

Undaria pinnatifida

The Japanese Brown Kelp *Undaria pinnatifida* is believed to have been introduced in Australia in a similar way as the North Pacific Seastar *Asterias amurensis* (see below) and has negatively effected fishing stocks in Tasmania. In 1988 it was first recorded, but it is known to have become established at sites of France as well as in New Zealand before 1988 (Byrne et al. 1997). By 1991 the temperate algae had spread over an area of 16 kilometres. It is likely to continue its spread as its spores are easily dispersed by currents and at this stage an eradication seems impossible. Based on temperature tolerances it may potentially survive from Cape Leeuwin (Western Australia) to Wollongong (New South Wales). The kelp has had already a detrimental impact on the abalone industry, as it attaches to rocks that are abalone feeding sites. It also makes the abalone extremely difficult to harvest. The kelp will have an even greater impact when it reaches oyster and other mussel farms and settles on racks, lines and other culturing material (MEPC33/INF.26). Physical removal of *U. pinnatifida* from a marine reserve area was undertaken. The success of this action is not yet known (ICES WGITMO 1997).

In 1991 a proposal reached the European Commission requesting financial support for the introduction of the kelp (*Undaria* spp.) to the French coast of the Channel area for commercial exploitation. The proposal has been supported and ”justified” by the planned provision of employment and the use of this additional food sources (Nolan 1994).

Sargassum muticum

Unintentionally introduced in France as packaging materials or as fouling species on imported oysters from Japan in the 1970s. This large brown algae is now being found along the coasts of Portugal, Spain (Atlantic coast), France (Atlantic coast), United Kingdom, The Netherlands, Germany (North Sea) Denmark (North Sea), Norway and Sweden (west coast). Negative effects to native species are the competition with native species and a negative impact concerning light-penetration and water exchange, as well as the hindering of local fisheries (Swedish Environmental Protection Agency 1997).

2.2 Fauna

Dreissena polymorpha

The Zebramussel *Dreissena polymorpha*, a pontocaspian element was unintentionally introduced into the Great Lakes (USA). Nowadays it occurs in very high densities. Besides an ecological harm, this species causes economical problems. Water supplies of power plants are densely clogged by this species and have to be cleaned by man (Roberts 1990, Lodge 1993).

The pontocaspian Zebra Mussel has and will in future cause billions of dollars of damage by fouling underwater pipes in the Great Lakes area. The control, repair and actions to remove the introduced Zebra mussel in the Great Lakes costs US$ 4 - 8 billion in the next 10 years. The mussels are displacing native bivalves, clogging water intakes and fouling vessel hulls, fishing nets and other submerged hard material as port installations, piers and buoys.

Long before this mussel invaded many areas of Europe via shipping or by natural distribution via freshwater waterways and canals as well as by birds. Mass occurrences appeared in 1850s and 1970s in some German rivers and lakes.

In recent times un-confirmed records of the mussel were mentioned for the Shannon Estuary (Ireland) and the River Plate (Argentina). In Argentina the new species creates habitats on drain outlets, industrial and drinking water intake pipe systems clogging the flow rate and threatening the water quality.

Eriocheir sinensis

The first introduction into European waters occurred probably early this century. First European findings were recorded from the German river Aller in 1912 (Schnakenbeck 1924, Peters 1933, Panning 1938, a, Anger 1990, Reise 1991, Zibrowius 1991, Michaelis & Reise 1994). Marquard (1926) found some specimens in empty "shells" of cirripeds on a ships hull. Another vector for the introduction is probably the ballast water of ships (Peters 1933, Jazdzewski 1980, Howarth 1981, Carlton 1985). After multiple introductions *E. sinensis* was able to establish with a self-reproducing population 7(Panning 1938, b) and spreading throughout Europe (Pax 1929, Boettger 1933, Panning 1937 a, b, 1950). This happened probably by the active migration of the species via rivers and canals (Arndt 1931, Boettger 1933, Luther 1934, Rosenthal 1980, Nyman 1993). Specimens were found 700 km upstream the river Elbe (Kaestner 1970) in many estuaries at the German North Sea coast and in 1924 in the Tegeler Lake (Berlin, Germany) (Sukopp & Brande 1984).

After its introduction a further spread to many different areas was documented in rivers up to Prague (Czechoslovakia) (Marquard 1926, Gruner et al. 1993), spread into the Baltic Sea probably via the Kiel Canal. First finding in the Baltic Sea (German coast) 1926. Occurrence in Lakes of the former Eastern-Germany (state Mecklenburg-Vorpommern) in 1931 / 32 (Boettger 1933). Findings outside Germany were noted in The Netherlands, Denmark, western Baltic Sea up to the Finnish coasts in the 1920s and 1930s (Rosenthal 1980, Jansson 1985), United Kingdom in 1935 (Ingle 1986), Hawaii in the 1950s (Edmondson 1959), Mediterranean Sea (Zibrowius 1991), North-America, Detroit River 1965 (Gruner et al. 1993) and Great Lakes 1973 (Nepszy & Leach 1973) without establishing (Hebert et al. 1989). It is not clear if the introduced specimens came from Europe or China (Carlton 1985).

The area of origin are waters in temperate and tropical regions between Wladiwostock and South-China (Peters 1933, Panning 1938, a), including Japan and Taiwan. The main area of distribution is the Yellow Sea (temperate regions of North-China) (Panning 1952, Kaestner 1970, Anger 1990).

During mass occurrence damages on dikes, other coast protection and harbour installations were observed because of *E. sinensis´* burrowing activities. In addition feeding on fishes in nets reduced the harvest of the river fishing industry. Therefore some controlling mechanisms (e.g. selective fishing, traps) had been introduced however, with little success (Panning & Peters 1932, Peters et al. 1936, Leppäkoski 1991, Gruner et al. 1993).

Increasing water pollution in German rivers resulted in a decrease of the number of specimens due to the decrease of the population density of its food-organisms. Now, where the condition of the rivers become better and better (Reincke 1993), the population density of *E. sinensis* is increasing again (Pfeiffer pers. comm.)

Crepidula fornicata

This unintentionally introduced species is native to the north American east coast; it presumably arrived as adult species with imported live mussels or as larvae in the ballast water of ships. First records in European waters were made in the 1880s in England (Robson 1915, Nordsieck 1969, Utting & Spencer 1992). In 1934 records were made in Denmark and Germany. Additional findings were noted in France and Ireland (Minchin et al 1993), Sweden (Farnham 1980), Japan (Walford & Wicklund 1973), North American west coast (Carl & Guiget 1957, Hanna 1966) and the Mediterranean Sea (Zibrowius 1991).

The slipper limpet has a negative impact as food competitor on scallop and other shellfish culture in France and Ireland (Campbell 1987, Eno et al. 1997).

Bythotrephes cederstroemi

Introduced to the Great Lakes from Europe the Cladocera *Bythotrephes cederstroemi* threatens native fish stocks as a food competitor (Sprules et al. 1990, Berg 1991; Mills et al. 1993).

Mnemiopsis leidyi

The ctenophore *Mnemiopsis leidyi,* endemic to the North American Atlantic coats is spreading in the Black Sea area. After its first record in the Black Sea in 1982 additional findings were reported in 1986. Nowadays the comb jelly is well established and occurs in masses. It has played a major role in the profound decline of the local anchovy industry. The population of native ctenophores has almost been completely removed by the American Comb Jelly *Mnemiopsis leidyi*. The fishing harvest of the Anchovies fishery in the Black Sea decreased to 10 % compared with fisheries of the times before the comb jelly invaded the Black Sea (Vinogradov et al.1989, Shushkina & Musayeva 1990, Reeve 1993). Proposed predators as carnivorous fish (e.g. cod from the Baltic, butterfly fish or chum salmon from North America) or ctenophore predating other ctenophore; e.g. *Beroe* sp. from Atlantic North America waters could be intentionally introduced into the Black. A GESAMP report issued in 1997 reviews control strategies and possible predators for biocontrol, as well as the viability of other, non-biocontrol options (Leppäkoski 1994, Harbison 1994, Harbison & Volovik 1994, GESAMP report 1997). By 1992, the species had spread into the Mediterranean Sea (Harbison 1994).

Sabella spallanzani

The giant Mediterranean Fan Worm *Sabella spallanzani* and the Northern Pacific Sea Star (see below) are threatening aquaculture and fishing industry in Australian waters. This species is characterised by its rapid growth of up to 10 cm annually. The first Australian record was made in early 1980s. Die-backs of the polychaete were reported from different areas without knowing the causative agent (Furlani 1996).

Asterias amurensis

Established populations of the North Pacific Seastar *Asterias amurensis* have been discovered in the cool temperate waters of Southern Tasmania. The seastar is native to Japanese and Alaskan Waters and has been known from Tasmanian waters since the late 1980s (first records in 1986). The introduction is believed to have occurred with the discharge of ballast water containing the larvae of the species in Australian waters. The impacts of this starfish on e.g. shellfish industries and the marine environment causes concern. The Pacific Starfish threatens the shellfish industry causing damages of US $ 367.5 million by eating mussels. The prognosis for its future potential is not good. It may settle as far as Sydney (New South Wales) since it has an appropriate water temperature tolerance. A status report on *A. amurensis* by the Commonwealth Scientific Industrial Research Organization (CSIRO) in June 1993 concluded that only physical removal seemed to be a viable in reducing starfish numbers. The application of biocontrol methods is expected, but a success is not guaranteed. It is believed that a disease agent could be used to control the population of the starfish. There are several problems in biocontrol, especially the need to test the control measures treatment in regard to a selective effect on the target organisms and no native species. A possible species for biocontrol could be the Japanese ciliate *Orchitophyra* sp.. After infection, this species disables the host's reproduction. Tests, if this species is able to cause problems by infesting native Echinodermata are being carried out (Furlani 1996, Thresher and Goggin pers. com., Report of ICES SGMBIS 1997)

Carcinus maenas

The European shore crab was introduced at several places around the world presumably with the discharge of ballast water or sediments from ballast tanks. *Carcinus maenas* was probably introduced to Hawaii (Alcock 1899) [uncertain], the North-Americas west coast (Alcock 1899, McDermott 1991, Hedgpeth 1993), Bay of Panama (Alcock 1899) North-Americas east coast (Vermeij 1982), Brazil (Alcock 1899) [uncertain], South.-Africa (Joska & Branch 1986, Jackson 1993), Madagascar (Christiansen 1969), Red Sea, India (Alcock 1899) Burma (Boschma 1972) as well as to the coast of Australia and Tasmania (Bourne 1990, Pollard & Hutchings 1990). The crab was first found in Australia in the late 19th century. At this time the ballast of ships were predominantly sand and rocks. It is believed that this species is robust enough to survive a several week long voyage from Europe to Australia with this solid ballast. It has been discovered only within the last decade in Tasmania. C. maenas is a omnivorous species what may have negative predatory impacts on the shellfish industry. A possible biocontrol of this species is considered using parasites selectively hosting in *C. maenas*. Such parasite is the rhizocephalan cirripede *Sacullina carcini*. Australian studies are ongoing to determine the specification of the parasite. Trials with native decapods will show if the parasite is able to host and threat native species.

Anguillicola crassa

Anguillicola crassa (Nematoda), first recorded in German waters in the 1970s (Koops & Hartmann 1989) was introduced with imported eels for aquaculture (Williams & Sindermann 1991). It now occurs in all waters of Germany and is increasingly affecting eel populations. In the river Elbe an infestation rate of nearly 100% is reported and similarly high infestation rates are occurring in other river systems.

In many lakes of the German state Schleswig-Holstein, the ruffe seems to be an important carrier of the swimbladder nematode. A study on its prevalence in other fish species has recently started. Scientific discussions on management options regarding the control of the parasite include suggestions to increase fishing of ruffe and to ongrow juvenile eels to larger sizes before stocking them into natural waters (Rosenthal pers. comm.).

Marenzelleria viridis

The Polychaeta *Marenzelleria viridis* after its introduction probably with ballast water in 1982 is spreading rapidly along the German coast. It was first observed in the Ems estuary (Essink & Kleef 1988, 1993). First records in the Baltic were made in 1985 (Laine 1995) often close to ports, indicating a possible introduction via ballast water (Olenin pers. comm.) Now it is occurring in the various brackish waters of the southern shore of the Baltic Sea (e.g. the Boddens) in great numbers. Its extension to the eastern parts of the Baltic seems to continue and specimens have been found in Finnish waters up to Tvärminne (H. Rumohr, Kiel, pers. comm.).

The occurrence of the American polychaete has initiated a number of studies on ecology, distribution and reproduction of the species in German coastal areas and in coastal waters of neighbouring countries.

Ensis americanus (=E. directus)

This bivalve species is suspected to compete with native molluscs for food and space resulting in suppressing native species. Potential positive effects of this unintentionally introduced species are reported, such as additional food source for native species or even human consumption (Cosel et al. 1982, Essink 1984, 1986, Carlton & Geller 1993).

2.3 Human disease agents

Pfiesteria piscicida

The Phantom algae *Pfiesteria piscicida* has not yet been found in European waters, but was recently introduced into the Chesapeake Bay. It is believed that this species may be transported and subsequently introduced via ballast water or tank sediment (Macdonald per. comm.).

P. piscicida and are dinoflagellates that have been made responsible for recent estuarine fish kills on the U.S. eastern seaboard (see below) and have also been reported to be associated with human illness. These dinoflagellates appear similar under light microscopy and require scanning electron microscopy for definitive identification. *Pfiesteria piscicida* is known in 24 different forms and is able to produce dormant cysts that may remain for years. The dinoflagellate feeds on fish body fluid. The waste from fish swimming above resting stages of the dinoflagellate in the sediments makes the cysts change to a toxic life form. These migrate towards the water surface and anaesthetise the fish with their poison and start to feed on the fish fluids from the body tissue after the have bored in. After the fish died, *Pfisteria piscicida* starts to reproduce and the next generation of cysts return to the bottom waiting for their prey.

Human Health Impacts

Thirteen people who worked with dilute toxic cultures of *Pfiesteria* sustained mild to serious adverse health impacts through water contact or by inhaling toxic aerosols from the cultures. These people generally worked with the toxic cultures for 1-2 hours per day over a 5-6 week period. The effects include a suite of symptoms such as narcosis (a "drugged" effect), confusion, development of acute skin burning (in areas that directly contact water containing toxic cultures of *P. piscicida*, and also on the chest and face), uniform reddening of the eyes, severe headaches, blurred vision, nausea / vomiting, sustained difficulty breathing (asthma-like effects), kidney and liver dysfunction, acute short-term memory loss, and severe cognitive impairment (= serious difficulty in being able to read, remember one's name, dial a telephone number, headaches, skin rash, eye irritation, upper respiratory irritation, muscle cramps, and gastrointestinal complaints (i.e., nausea, vomiting, diarrhoea, and / or abdominal cramps).

Most of the acute symptoms proved reversible over time, provided that the affected people were not allowed near the toxic cultures again. Some of these effects have recurred (relapsed) in people following strenuous exercise, thus far up to six years after exposure to these toxic fish-killing cultures. The first known fish kills in adjacent waters to the Atlantic Ocean caused by *Pfisteria* were documented in 1988 in fish culture sites of North Carolina (USA). Fish kills and fish disease events linked to *Pfiesteria* can extend for 6-8 weeks in North Carolina's estuaries (Pamlico Sound region), thus potentially providing the circumstances for humans in field settings to be hurt due to this dinoflagellate toxins. Since 1991 a billion fish have been killed by Pfisteria in eastern U.S. waters. Most recently un-confirmed findings of Pfiesteria were noted from the Chesapeake Bay region (USA). However, it will not be possible to determine the extent to which people in European estuaries are being affected by *Pfiesteria* toxins, or whether it is safe to consume fish from toxic outbreak areas, until we have a way to diagnose the presence of these toxins. That will require identification of the chemical toxins produced by *Pfiesteria*, which is the subject of intensive research.

Lung disease

In Asia a fatal lung disease caused by the parasite *Paragonimus westermani* (Trematoda) results in cough, peritonitis and pneumothorax (Ichicki 1989) such threatening mammals as rats, dogs, pigs and humans (Davis 1986). The life cycle of this parasite includes two intermediate hosts, the gastropod *Thiara granifera* and the crab Eriocheir spp. The gastropod was introduced to the USA (Florida and Texas)(Abbott 1950), and the crab as second intermediate host as well (occasional findings in the Great Lake area and established in San Francisco Bay) (Nepszy & Leach 1973, Cohen 1995, Cohen & Carlton 1997). If both the introduced intermediate hosts will spread and become common in overlapping areas this would complete the life cycle of the parasite. Therefore, it could happen that the lung disease will introduce to the USA.

Cholera

A Cholera epidemic (disease agent: *Vibrio cholerae*) commenced in Easern Celebes (Indonesia) during 1961 and finally completed its encirclement of the globe in 1991. In

South America the epidemic wave started on the coasts of Peru and was documented later from several ports of Latin America. Therefore, it is believed that the Cholera had been introduced by maritime traffic (Epstein 1993). In November 1991 and June 1992 the USA documented the detection of active Cholera bacteria in ballast water of vessels coming from South America (McCarthy & Khambathy 1994). Therefore Australia introduced a testing programme for cholera in 1992 of all vessels from South America and other ports known for Cholera outbreaks. This programme is continuing. A number of presumptive positive test for cholera were documented. Six vessels that had been taken ballast on board in ports of the Persian Gulf, Singapore and Indochina provided presumptive readings, indicating possible Cholera. On serological testings all were subsequently proven to be negative. Since that time studies are being carried out in order to evaluate the risk of Cholera introductions to Australia via ballast water.

The introduction in coastal waters of Latin America caused a serious threat to thousands of peoples health after consumption of seafood as bivalves (oysters), crustacean and finfish caught in affected areas (Murphree & Tamlin 1992).

3 Treatment options

It has so far been concluded that no single or simple solution exists for shipboard treatment of ballast water. However, a combination of techniques might at least be partially effective and feasible in terms of economic and shipboard constraints. These would most likely comprise of some form of mechanical removal of organisms followed by a physical or chemical treatment method.

Ballast water management procedures have been investigated to a certain extent but insufficient research has been carried out to assess the effectiveness of applicable ballast water treatment techniques.

Shipboard treatment of ballast water is considered preferable to land based reception / treatment facilities. Particular emphasis has therefore been placed on potential options for shipboard treatment.

A quarantine system does not provide an absolute barrier to prevent the introduction of unwanted non-indigenous species (Carlton et al 1995). It is also assumed that no single treatment process was likely to achieve the required inactivation or removal of unwanted organisms. A two stage approach seems to be most likely. After an initial mechanical treatment process followed by disinfection, a physical treatment process or a technique involving manipulation of the environmental conditions within the ballast tank could provide a solution. Thus when considering the options reviewed, it should be assumed that the mechanical options are largely viewed as preliminary treatment method.

At this stage various methods of treatment that have been put forward and are described as a "tool box" from which the most practical (easy and safe to apply, not damaging existing ship installations as ballast tank coating, isolators and sealing rings), cost effective safe and environmentally sound combination should be selected. To date, international guidelines have been adopted as the IMO Assembly Resolution A.868(20) (see attachment).

Several of the listed options are straightforward statements of good practice but in many circumstances the choices available to an operator will be very restricted. There are indeed two different possibilities of using the ballast water treatment options listed below. First of all, the ballast water is treated en-route. Secondly, a treatment of ballast water may take place at the port of destination. In this way only the countries concerned need to invest, ports can maintain the treatment equipment and the operation would meet port quarantine and local environmental protection laws. But, the IMO does not promote regional (different) systems, emphasising that the ballast water problem is a global issue. Using different provisions and options could result in unwanted regional restrictive practices, restraints of trade and competitive advantages.

The following list gives an overview on the amount of ballast water introduced into the waters of several countries. Estimated by scientists and technicians the amount of annually transported ballast water has been summarises world-wide to 10 billion tonnes (Gerlach 1992, Bettelhäuser & Ullrich 1993, Rigby & Taylor 1995).
No country seems to keep records or statistical data on the release of ballast water in their waters. The volume of the water of overseas origin released in territorial waters of a country would be only an indicator of the potential for further species introductions. The degree of risk depends also on the characteristics of the port of origin and port of arrival. In addition, several shipping studies showed, that one single vessel is able to introduce an unwanted species by discharging its ballast water.
The quantitative data on ballast water discharges have to be gathered from individual ports respectively through port authorities or the shipping industry. Therefore the mentioned data are estimated amounts of ballast water discharged. The reason for mentioning these data here is to demonstrate which amounts of ballast water could have to be treated in order to minimize the risk of introduced species.

Europe
Ballast water discharges per year in English and Welsh ports amount to 16.8 million tonnes (Laing 1995) and in Scottish ports to 25.7 million tonnes (Macdonald 1994). About 10 - 15 % of the discharged ballast water originated from outside Europe. In Ireland less than 2 million were discharged, most of it from Europe (Minchin & Sheehan 1996). The estimations of the amount of ballast water in German ports and waterways varied from 8 to 38 million tonnes. The non-European origin was estimated to range from 1.4 to 7 million tonnes (Golchert, pers. comm., Gollasch 1996). Data from Norway are available from one port only: 8 - 10 million tonnes, 15 % of non-European origin (Swedish Environmental Protection Agency 1997)

North America

In all 226 US ports (including Great Lakes) in total 79 million tonnes of ballast water were dumped from vessels from abroad. (Carlton 1995, Carlton et al. 1995).

Gauthier and Steel (1995) estimated that 62 million tonnes of ballast water were discharged.

South Africa

Information on ballast water discharges were collected from several ports around the South African coastline. The estimation summarised relevant data to more than 12 million tonnes (based on data from 1991 / 1992). Data from some ports are missing until today. It is likely that one of these, e.g. Port Elisabeth, does receive about 20 million tonnes of ballast water each year. Roughly a third of these ballast waters are from Far East. Remarkable is that a relatively high percentage of the water was exchanged en route. It is assumed that this is the result of controls introduced in many ports of the world (Jackson in prep.).

Australia

Vessels calling for Australian ports are discharging approx. 121 million tonnes of ballast water each year (Jones 1991, Mills 1992, O´Reilly 1992, Paterson 1992, Kerr 1994, MEPC35/INF.19). In addition over 4,000 vessels per year move more than 34 million tonnes of ballast water between Australian ports.

New Zealand

The total amount of discharged ballast water, mostly of Asian origin, was estimated as 4.5 to 4.7 million tonnes each year (Hayden 1995).

IMO Recommendations

A set of recommended actions have been adopted by IMO in relation to the uptake of ballast water. The taking in of ballast water in shallow habitats, during prevailing turbidity of water, nearby sewage outfalls, when a tidal stream is known to be more turbid, in areas where tidal flushing is known to be poor, during phytoplankton blooms or relevant disease outbreaks and near dredging sites have to be avoided to minimize the risk of up taking species. In addition ballast water should be wherever possible not be taken in darkness (when bottom dwelling organisms may rise up in the water column) and in very shallow waters or when propellers may stir up sediments.

Ballast water uptakes in port areas characterised by slow tidal currents could result in the uptake of ballast water formerly used by another vessel and just released. This scenario could enable some organisms discharged in the ballast water from one vessel to become transported again pumped in with the ballast water of another vessel.

It has been proposed that ballast water may be analysed in a laboratory on board and that the investigation may provide a certificate of cleanness of the ballast water documenting the absence of harmful aquatic organisms. However, this may not be an effective method of risk minimization due to e.g. taxonomically problems regarding the identification of the organism and pathogens.

Another option deals with the fact that populations of species decrease with their increasing stay in the ballast tanks. The absence of light provides an uncomfortable environment for some species. Water that has been located in a ballast tank longer than 100 days provides a small risk discharging unwanted species. Research showed that even after 116 days living macrobenthos organisms were found (Gollasch 1996). In addition, some species, as phytoplankton organisms may form cysts during unfavourable conditions surviving in the sediment of ballast tanks for a long period. Some zooplankton species may form resting stages as well. These cysts may remain active over longer periods of up to several years. In this way e.g. cysts of dinoflagellates may be transported over long distances. After sediment discharges the cysts may hatch in foreign waters. If these dinoflagellates are toxic they may cause harm to local aquaculture. It is assumed that many phytoplankton blooms may be initiated by these discharges (Hallegraeff et al. 1992, Bolch & Hallegraeff 1994).

3.1 Mechanical removal of species in ballast water

3.1.1 Filtration

Filtration of ballast water seems to be the most environmentally sound method, but the amounts of ballast water that has to be treated are immense. Ultra-filtration methods have not yet been tested or proven with large volumes of ballast water and high loads of sediments, which can occur in ballast water even if ballast water uptake in water with high sediment loads should be avoided (Sipes et al. (eds.) 1996, IMO Assembly Resolution A.868 (20)).

The efficacy of removing particles larger than the meshsize of these filter units is with 95 - 98 % very effective. In addition some percentage of the smaller particles may be removed. Another advantage of this method is the use during ballast water intake. Therefore the backwashing (filter cleaning) water may be returned immediately to the port water from which the ballast water was taken without any treatment. The use of vacuum filtration to treat ballast water was listed by AQIS (1993).

3.1.1.1 Self cleaning filter system ("The ALGONORTH experiment")

Located in the Great Lakes a joint U.S. / Canada project will test one potential technique to control the spread of unwanted organisms. An US$ 1.3 million filtering unit, testing laboratory and peripheral equipment were installed on the Canadian Algoma Central Marine`s bulk carrier ALGONORTH in 1996. The filter unit is containersized and located on deck. This first-of-its-kind-experiment will get underway to measure the effectiveness of filtration as a means to control the spread of unwanted organisms with ballast water. Filtration was identified by the U.S. National Research Council's Marine Board as one of the most promising technologies for ballast water treatment, offering several advantages:

- enhancement of the number of secondary treatment options such as ultraviolet light, chemicals and heat;

- it represents a preventive measure and as such is carried out when at the port ballast is taken on board. The waste of the self cleaning filter unit can be backwashed to the port before the vessel departs; and
- it addresses safety concerns associated with the ballast water exchange at open seas since the system would be operated at a port and not in high seas.

In the beginning of the project the filtration unit will treat the ballast water of one wing tank with a capacity of 225 tonnes may be accessed through manholes on the deck. The multi-level filter technique designed by Ontario Hydro is operated by a diesel-powered pump with a 6 tonnes per minute capacity.

The project involves both, biological and mechanical testing protocols. Biological tests will be carried out with samples for the identification of zooplankton, phytoplankton, bacteria and for water chemistry. The mechanical protocols will take into account the filters efficiency over time and frequency of backwash required. Both kinds of test will be carried out in fresh water an the marine environment in each of the seasons of the year during which the vessel operates using up to 5 different filtration levels (Changeless 1997).

3.1.1.2 "Microfiltration"

Ballast water systems generally incorporate coarse and fine screens with openings in the region of 80 µm and 10 µm, respectively. Particles down to the size of seaweeds and large zooplankton species could be removed by reducing the opening size further or incorporating additional smaller mesh sizes. However, removal of smaller organisms would be poor. Fine mesh screens are used extensively in the offshore oil industry and are capable of handling 5,000 m^3 per hour. With mesh sizes of 500 µm and 50 µm filter surfaces require spaces of approximately 3 and 4 m^2. An automatic back-washing facility, utilising a sensor for monitoring pressure differential, may be incorporated (AQIS 1993).

A related system of ‘microfiltration’ installed downline of the ballast pumps has also been proposed as an option for reducing marine organisms (Carlton et al. 1993). This would consist of two or more ‘coarse’ filters (300 mm mesh) followed by two or more ‘fine’ filters (25 mm mesh). Woven mesh filters, made from synthetic fibres, are available as automatically self-cleaning units. They could potentially be retro-fitted to existing ships or incorporated into the design of new vessels. Automatic cleaning of the filters could be programmed either for specific time intervals or at specific pressure differences across the filters. This would involve stainless steel brush and suction scanner filter mechanisms for ‘coarse’ and ‘fine’ filters, respectively. Disposal of the collected residues would occur at the location of ballasting rather than at the destination port, thereby avoiding the transfer of non-native species. It is claimed that the ‘coarse’ filters would remove most of the larger zooplankton whilst the second in-line ‘fine’ filters would remove most of the smaller zooplankton and much of the large and medium sized phytoplankton. Filter capacities of 1,000 m^3 per hour are possible at both the 300 mm and 25 mm filter mesh size. As most pump capacities are below this figure filtration would not slow the ballasting or de-ballasting operations. However, resizing of the pumps may be required to cope with the increased filter resistance. Alternatively, with no modification, a reduction in pump capacity and concomitant increase in ballasting time would result.

3.1.1.3 Granular filtration

The ballast water could pass a granular filtration unit before the microfiltration. Granular filtration will remove larger particles. It is supposed that a land-based unit equipped with sand and anthracite media could be effective. In cases of clogging a backwashing procedure can be applied to remove the clogging material (AQIS 1993).

3.1.2 Separation unit ("The Norway-Model")

Cyclonic separation has been proposed as a relatively simple and inexpensive way of removing larger particles and organisms from ballast water.

Liquids / particulates enter a separation unit tangentially, thus setting up a circular flow. The liquids / particulates are then drawn through tangential slots and accelerated into the separation chamber. Centrifugal action tosses particles heavier than the liquid to the perimeter of the separation chamber. The solids gently drop along the perimeter and end up in the calm collection chamber of the separator. The liquid freed from or reduced in particulates is drawn to the vortex and up through the outlet of the separator. Solids may be periodically purged or continuously bled from the separator. A flow rate of up to about 2,900 m^3 per hour may be achieved by a unit weighing 3,000 kg. The resistance of this separator is not thought to be significant, so that the pumps already present on the ships should be sufficient.

It seems feasible that this system could be used on board ship by incorporating the separator in a ballast tank recirculation system. The separated particulates would have to be collected or drained overboard in open ocean waters. Since the flow rate achievable by the larger separator is comparable to that of ballasting pumps on ships, it may also be possible to use cyclonic separation during ballasting / deballasting.

Cyclonic separation of organisms with a specific gravity similar to that of sea water as sea water (as jellyfish, chaetognaths) is limited (Armstrong 1997).

Norway has put forward a solution model based on the technique previously used in offshore oil production. Over a period of 20 years of time it was found that injections of large volumes of water into offshore wells to enhance the production increased the growth of bacteria.

The method consist of a low-pressure / high capacity centrifugal device to remove suspended solids, followed by a UV (ultra violet) -light unit. Although the UV dose delivered is sufficient to produce sterile water but should not be considered as providing a complete sterilisation. Firstly neither the tanks nor tubes would be sterile in a new-built ship, and secondly it practically would be impossible to ensure that no contaminated water enters the tubes and tanks after treatment.

Using this method a high proportion of the multicelled animals and plants, as well as eggs, larvae and seeds (possibly including the resting spores of harmful algae, which tends to follow the sediment) were destroyed, harmful e.g. pathogenic bacteria in the bulk of the water would be killed. In addition, a large fraction of the sediment usually deposited in the ballast water tanks could be removed.

There are several options for the application of this method, each with their own advantages and disadvantages.

Treatment at ballasting port. This means that one can potentially reduce the problem of sediment deposition in the ballast tanks substantially. By removing the sediment and removing a large fraction on the carbon ("bacterial food"), from the tanks, the anoxic corrosion in ballast tanks may be reduced or even eliminated. A small risk for regrowth of harmful bacteria exists. Studies should be carried out to quantify this risk.

Treatment on board. Essentially the same effects could be accomplished as above. The installation and operational costs and eventual space problems would determine as to whether this could be an attractive solution.

Treatment at deballasting port. The positive effect with respect to sediment removal would be lost. However, as the effluent water would be effectively sterilized, this option would probably be the safest from a biological point of view.

The optimal solution would be to treat ballast water at BOTH ballasting and deballasting ports (Jelmert pers. comm.).

3.1.3 Flow-through system

A continuous flow through system that is a continuous sea-to-sea circulation of ballast water while the ballast tanks remain filled, would enable a permanent ballast water exchange at sea via continuos pumping. This flushing method would turn over the complete ballast water, but requires a especially designed piping system. The water flow could be realised by using the present ballast water pumps or using the vessels`s momentum to create a flow through system from the bow to the stern.

In contrast to ballast water exchange at high seas at bad weather the continuous flow through system does not impose excessive bending moments or shearing forces and minimizes stability problems.

Rigby & Hallegraeff (1993) demonstrated that by emptying certain ballast tanks on the bulk carrier IRON WHYALLA the still water bending moment may be much higher than the maximum allowable value. This fact, in combination with the high number of specimens in the remaining water bodies in the ballast tank after emptying (see below) made the flow through option favourable.

Methylene blue dye dispersed in the ballast water was used in order to examine the necessary time for a complete exchange of the ballast water by an ongoing sea water flow through the ballast tanks. After an exchange of 3 times the volume of the ballast water tank only 5 % of the previously containing ballast water was present. After exchange of 4 times the volume of the ballast tank 98.2 % of the previously taken ballast water was exchanged. Accordingly IMO in 1993 when adopting ballast water guidelines recommended an exchange of ballast water in open seas of at least three times of the volume of the ballast tanks wherever possible.

Armstrong (1997) calculated for the 190,000 DWT bulk carrier ORMOND that the complete ballast water exchange (ballast water capacity max. 81.379 m^3 including a cargo hold) with the ballast pump on board (pump capacity of 2.500 m^3 per hour) of all ballast tanks and possibly filled cargo holds would take 4.07 days. A container vessel as the JERVIS BAY with a capacity of 4,000 TEU and a length of 292.2 m with a maximum ballast water capacity of 16.613 m^3 it will take 4.15 days for a complete exchange (pump capacity 500m^3 per hour). Cruise ships usually carry comparably little amounts of ballast water. The GRAND PRINCESS (242m LBP) has a ballast water capacity of 4.345 m^3. A complete exchange would take 2.17 days using the pump with a capacity of 250 m^3 per hour (Rigby et al. 1994, Paterson 1996, Armstrong 1997).

This method may have limited application possibilities for existing vessels. The current design of pipes and tanks in some cases are limiting such operations.

3.1.4 Sedimentation and flotation

Other mechanical treatment processes such as sedimentation and flotation have also been discussed in terms of their application to ballast water treatment. The former essentially entails the settling of material from the water column under gravitational forces, with or without the use of coagulant chemicals to assist sedimentation. The latter also entails the use of coagulants and the injection of fine air bubbles into a 'flotation tank'. The bubbles attach themselves to coagulated organisms or particulates and float them to the surface.

Although some consideration has been given to a design of ship that would allow ballast tanks to be used as sedimentation tanks, it is unlikely that either of these techniques would be suitable for shipboard application. They could, however, form a useful component in a land based treatment system (Müller 1995, Müller & Reynolds 1995, AQIS 1993).

3.1.5 Pump velocity

The increase of the water flow rate has been proposed to mechanically destroy organisms (Carlton et al. 1995). The use of a high velocity ballast water pump during ballast water intake and discharge could minimize the survival rate of macro-organisms due to their mechanical damage (Woodward 1990).

The installation of additional units in order to create high velocity jets of water in ballast tanks or pipework would involve high costs. Data on the efficacy of this method are not available (Carlton et al. 1995).

3.1.6 Ballast water exchange in open ocean IMO Assembly Resolution Guidelines

3.1.6.1 IMO Assembly Resolution Guidelines

The International Maritime Organization’s (IMO) Marine Environment Protection Committee (MEPC) had a specific interest in the field of unwanted introduced species by ballast water as demonstrated in 1973 when the International Conference on Marine Pollution adopted resolution 18, drawing attention to the transport of aquatic organisms and pathogens around the world in ships ballast tanks.

Australia was the first country to bring the ballast water problem into focus and has played a key part in proposing the development the control mechanisms for the introduction of the ballast water in the early 1990s. MEPC adopted guidelines by resolution in 1991 and in 1993 these were adopted by the IMO Assembly under resolution A.774 (18) entitled "International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships Ballast Water and Sediment Discharges". In 1997 the IMO Assembly adopted Resolution A.868 (20) "Guidelines for the Control and Management of Ship’s Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens" (see attachment). This IMO Assembly Resolution is extremely important towards the development of provisions in addressing this international, world-wide problem. IMO has put forward these guidelines to limit the movement of organisms by ballast water world-wide which include the informing of ships on areas where ballast water uptake should be avoided due to the presence of harmful algal blooms and known unwanted contaminants, precautionary procedures when taken on ballast water in shallow areas, ballasting with freshwater, discharging ballast water and sediments to on-shore facilities (if available) and the exchanging ballast water at sea.

The IMO Assembly Resolution A.868 (20) recommends an exchange of ballast water in open oceans as far as possible from the shore. The mid-ocean exchange of ballast water is believed to be currently the most reliable method in order to minimize the risk of transfer of unwanted organisms. Compared with coastal waters, deep ocean waters contain less organisms and species occurring in open ocean waters very often are not able to survive in coastal zones and vice versa. Where open - ocean - exchange is not possible, requirements developed within regional agreements may be applicable, particularly in areas within 200 nautical miles from shore. If safety permits all of the ballast water should be released until suction is lost. Stripping pumps or eductors should be used if possible. Where the flow- through method is employed (see below) in open ocean by pumping ballast water into the tank or hold and allowing the water to overflow, at least three times the tank volume should be pumped through the tank. This method is non-polluting the environment at discharging and comparable in-expensive.

3.1.6.3 Effectiveness of the ballast water exchange

A Canadian survey carried out 1990 by Locke et al. (1991) studied the ballast water transported by foreign vessels into the Laurentian Great Lakes and upper St.-Lawrence River in order to monitor the compliance with the Great Lakes Ballast Water Control Guidelines and their effectiveness. The effectiveness of mid-ocean ballast water exchange eliminating living freshwater zooplankton specimens from ships originating in freshwater ports was 67 %. It was noted that live freshwater organisms may still survive a mid-ocean exchange of the ballast water in their dormant stages. Therefore, each vessel which has ever taken on ballast in a freshwater port may pose a risk to the North American Great Lakes, even after a ballast water exchange in marine waters. In addition it was estimated that nearly half of the vessels entering the Great Lakes carried ballast water in previously emptied ballast tanks (remaining water bodies below the level of the ballast pump intakes in the ballast tanks). This ”unpumpable” ballast water represents a reservoir of specimens at the tank bottom. These specimens could be discharged after re-filling of the ballast tank followed by ballast water discharges (Locke et al. 1991).

In an Australian study on board of the bulk carrier IRON WHYALLA 95 % of ballast water was discharged at open ocean. In the remaining 5 % of the original ballast water approx. 25 % of the specimens of the previously filled ballast water were found (Rigby & Hallegraeff 1993). The proportion of original plankton and detritus remaining after exchange of ballast water flushing the ballast tanks of two tank volumes while underway was lower. The proportion of living organisms surviving ocean exchange would be significantly less than 10 to 20 %, depending of the species composition (especially the possibility to generate resting stages as cysts) and the change of temperature as well as salinity (MEPC35/INF.19).

A problem in using open – ocean - exchange is the sediment in the ballast tank. Exchanging ballast water at sea does not affect the sediments at the bottom of the ballast tanks. Hallegraeff & Bolch (1992) investigated 32 vessels which had carried out an ballast water exchange. 15 vessels still contained significant amounts of sediment. A method needs to be developed to re-suspend the sediments into the ballast water above. They concluded that the mid-ocean exchange was not always an effective method of control for ballast water and sediment on its own. In addition a complete ballast water exchange at sea is unsafe in case of bad weather. A sequential operation of continuous flushing of tanks with ocean water would be a workable option (Rigby & Hallegraeff 1993). The guidelines of the IMO recognized in addition that many aquatic organisms are present in sediments and that all sources of sediment (as e.g. ballast tanks, anchor chains, chain lockers) should be cleaned routinely.

As long as safety permits, open – ocean – exchange should be used as a first step in order to minimize the number of species and specimens unintentionally introduced with ballast water. Every eventuality must be taken into account when deciding as to whether it would be safe to exchange ballast at sea. It is agreed that flushing the ballast tanks three times during voyages in open oceans could extend the efficiency of this method (Rigby & Hallegraeff 1993, 1994, MEPC31/14/1).
The advantage of this method is that it involves no major investment and is thus comparably in-expensive. In addition this method may be carried out in transit without disrupting the vessels schedule.

The IMO guideline in addition lists that a responsible officer should be appointed to maintain appropriate records and to ensure that ballast water management and / or treatment procedures are followed and recorded. It also advises to document during taking on or discharging ballast water dates, geographical locations, ship's tank(s) and cargo holds, ballast water temperature and salinity as well as the amount of ballast water loaded or discharged should be recorded. A suitable form is shown in the annex 1 of the guidelines (see attachment).

3.1.6.3 Safety aspects

A study of the "Ship Operational and Safety Aspects of the Ballast Water Exchange at Sea" was carried out by Woodward et al (1992) who concluded that ballast / deballast operations may be carried out safely if wave heights were below a maximum value. Using hydrostatic data furnished by the ship owners hull bending moments and stabilities are investigated to find the tank-emptying operations representing the maximum safety. At-sea analysis for hull bending moment, shear and rate of slamming was carried out using both linear and non-linear analysis. From the used small sample of three ships (a dry bulk carrier, a tanker and a container ship) it appears that the critical wave height lies between 10 and 20 feet. The sample is to small to support a more definite conclusion on the maximum safe height.

In addition the IMO sub-committee on Ship Design and Equipment prepared a guidance on safety aspects of ballast water exchange considering structural integrity, stability of ships and crew safety and in particular stated (e.g.) to avoid over and under pressurisation of ballast tanks, free surface effects on stability and sloshing loads in tanks that may be slack, admissible weather conditions, maintenance of adequate intact stability in accordance with an approved trim and stability booklet, permissible sea-going strength limits of shear forces and bending moments in accordance with an approved loading manual, torsional forces, minimum / maximum forward and aft draughts, wave induced hull vibration. It was mentioned that the ballast water management plan should include designated control personnel responsible of the ballast water exchange and crew training to familiarisation. Furthermore it was noted that a need exists to evaluate the safety of long term aspects taking into account relevant safety matters, including safety of crews and ships, ship´s position, weather condition, ballast system inspection and maintenance, machinery performance and availability (MEPC39/WP.8, MEPC39/7, MEPC39/7/1, MEPC39/7/4).

3.2 Physical removal of species in ballast water

3.2.1 Heat treatment

Temperatures below 60□C will inactivate organisms often present in ballast water. It has been proposed as an appropriate target temperature to kill most toxic marine organisms (AQIS 1993). For example, exposure to temperatures of 36 to 38□C over a period of 2 to 6 hours were sufficient to kill zebra mussels in pipes.

Heat treatment using excess engine heat or the exhaust from the engine cooling unit is supposed to be the most promising treatment option but would be unfeasible for ships with several 10,000 tonnes of ballast water. The minimum temperature needed is over 40 □C to kill the target species. The temperatures and dwell times sufficient for eradicating the marine lifeforms in the ballast water have been obtained from scientific studies. In a laboratory study Bolch and Hallegraeff (1993) demonstrated that short-term (30 to 90 seconds) exposure to temperatures above 40□C were effective in killing dinoflagellate cysts of Gymnodinium catenatum and Alexandrium tamarense. They subsequently confirmed their findings in an experiment on board ship, which was retro-fitted to enable heat exchange between the ballast water and the main engine cooling circuit. At a flow rate of 500 m^3 per hour the ballast water was heated to above 40□C for about 8 minutes within the heat exchange unit. Subsequent sampling revealed that this exposure had been lethal to all organisms.

Initial suggested temperatures of 40 - 45 □C for 30 seconds would be sufficient. Recent data show that 35 - 38 □C exposed for a period of 4 - 5 hours effectively kills cysts and vegetative cells of toxic and non-toxic dinoflagellates (Bolch 1997).

Ballast water containing very resistant algal cysts can only be treated effectively with higher temperature as 50 □C and more. These temperatures have to last over a period of several hours up to days (Bolch & Hallegraeff 1991). An 8 minute exposure of water heated to 40 □C was lethal to many organisms.

Effective temperature to kill organisms in ballast water are listed as 50 □C ("instant" death), 45 □C for 30 sec, 43 □C for 60 sec or 40 □C for 90 sec (Bolch & Hallegraeff 1994).

The temperature of ballast water may be raised by:

(1) connecting the ballast water with the engine cooling circuit

(2) heating by a repeated passage of the ballast water through the cooling system; and

(3) generating additional heat

All of these possibilities would generally require the retro-fitting of pipework. The first option would require pipework to re-route the ballast water to the engine room, so that the ballast water becomes part of the main engine cooling water system. This concept may not be viable due to the size and hence heat producing capacity of particular main engines. A 'once-through' passage of ballast water through the cooling system may not sufficiently elevate the temperature of the water, or maintain it. Utilisation of other sources of heat to be installed on board ships would also require installation of heated pipelines on most ships.

There are numerous difficulties that are likely to be encountered with the thermal treatment of ballast water. In particular, thermal stresses to the vessel would have to be considered. Little information exists with regard to the thermodynamic heat transfer of large volumes of water on board of vessels not primarily designed for the carriage of hot liquids. Conversely, heat loss may be rapid as ballast tank walls are of situated near the hull of the vessel. Many ballast tanks are, by virtue of design, irregularly shaped, and this would create problems when trying to establish an homogenous temperature throughout the body of water to be treated. Furthermore, such treatment would unlikely be suitable in those situations where cargo tanks are used for ballasting a vessel. Dependent on the temperature involved thermal treatment may have adverse effects on pipework, pumps or coatings.

Generally, it has to be ensured that the heating up process does not take longer than the actual voyage. For existing vessels economic considerations are likely to be the overriding factor against thermal treatment because of the high costs of retro-fitting pipes. Energy requirements of 45 MW on top of the 20 MW of waste heat from the ship's main engines have been quoted for a ship carrying 45,000 tonnes of ballast water (Bolch & Hallegraeff 1993). It has also been pointed out that more power would be required to reach the desired temperatures in the ballast water in colder waters such as the North Sea. Rather than heating all the ballast water simultaneously, it has been suggested to apply the heat sequentially to individual ballast tanks, or to pump the ballast water during ballasting or deballasting through an on-deck heat exchanger and a

smaller well-insulated tank. It has been estimated that this system could reduce the consumption of heat energy for this purpose by 5 - 10 %. Research into the feasibility of thermal treatment is being continued in Australia.
On health and safety grounds thermal treatment is likely to be acceptable, although the subsequent discharge of heated water to some open waters may be undesirable on environmental grounds.

Two different systems, a shore based portable and one on board system, could be used. A seagoing trial of ballast water treatment with heated clean water had been conducted successfully on a small bulk carrier in Australia. The temperature of the untreated ballast water was 15 °C. After pre-heating the temperature reached 32 °C leaving the heating unit. Afterwards the incoming water passes the main engine heat exchanger. The water temperature leaving this unit is heated to 50 °C and is collected in an hold tank on board where it is held at that temperature for treatment. The water retains its heat until returning to the pre-heater, where it loses approx. 50 % of its temperature by pre-heating the ballast water pumped aside for treatment.
The shore-based system is designed of several heat exchangers, a holding tank and a heat source. It could have a treatment capacity of 1,000 tonnes per hour of ballast water, raising the temperature to 50 °C and cooling it down to within 2 °C of the starting temperature. Additional heat exchangers could attain up to 80 °C (Bolch & Hallegraeff 1991).

It has since been suggested that it may even be sufficient to kill organisms simply by raising the temperature of the ballast water by between 2° and 5°C above its original temperature (Anderson 1993) at least with dinoflagellate cysts.

The following disadvantages of the heat treatment have to be considered:
1) Increasing temperatures of ballast water in single ballast tanks could bring up structural stresses to ships due to expanding metal. In addition damages to the tank coating could occur (Yount 1990, Armstrong 1997).
2) It is likely, that higher temperatures would be required to deal with thermophilic (heat loving) organisms or more resistant forms such as bacterial spores. It has to be

taken into account that temperature between 30 and 40 °C would support the growth of bacteria as e.g. *Vibrio cholerae* (!).

3.2.2 Cooling treatment

In order to retard (bacterial) biofouling of reverse osmosis membranes of industrial water systems beside biocides (see below) the possible use of freezing was mentioned in order to remove the bacterial biofilm (Mittelman 1991). The application of ethylene glycol at - 12 °C destabilises the biofilm matrix and detaches it. Practical experiments were not reported (Costerton 1983, Flemming 1991). A reduction of the temperature of the ballast water to the freezing point requires e.g. a cooling unit, additional pipework, and power. Further studies to evaluate the feasibility should take into account the temperature related impact on the pipework and ballast tank as well as trials on the treatment effectiveness on ballast water organisms.

3.2.3 Ultraviolet radiation

Ultraviolet (UV) radiation is commonly used for sterilising potable or waste water and for the purification in aquaculture and fisheries. UV radiation operates by causing photochemical reactions of biological components such as nucleic acid (DNA and RNA) and proteins. The lower UV wavelengths are generally more effective. However, radiation at these wavelengths shows a lower transmission in water. Due to a higher concentration of inorganic solutes, the transmission in seawater is slightly less than in freshwater. It may further be affected by organic solutes, particulates or bubbles. For practical reasons, UV radiation is commonly divided into three wavelength ranges: UV-A (400-320 nm), UV-B (320-280 nm) and UV-C (280-200 nm).

The effectiveness of UV treatment depends largely upon the size and morphology of organisms. Those with a smaller surface / volume ratio tend to be less susceptible to the radiation. In relation to the shape of the bacteria capsules, bacteria with more resistant capsules that can be stained (Gram positive strains as e.g. streptococci) are more resistant to UV than Gram negative strains (e.g. coliform bacteriae, salmonellae).

Viruses require similar dosages to bacteria. Algae require larger dosages than bacteria due to their size and their pigmentation. Blue green algae have shown to be particularly resistant to UV radiation and radiation values of 2 to 3 orders of magnitude greater than that used to kill bacteria have been quoted (Meulemans 1987). It has been postulated that this was due to the fact that they evolved during a geological time when the Earth had only little protection against UV radiation. Preliminary data with different stages of the zebra mussel *Dreissena polymorpha* suggest that a low pressure lamp is only partially effective in inducing mortality. In contrast, a medium pressure lamp caused 100 % kill of all stages except the adults where mortality was reduced, presumably due to their opaque shells.

A bactericidal curve shows that the mortality is most effective in the UV-B and UV-C range with a peak at a wavelength of around 265 nm. Until recently, low pressure mercury lamps have predominantly been used, which emit radiation at 253.7 nm, i.e. close to that peak. However, they are now increasingly replaced by broad spectrum medium pressure mercury lamps, which cover a wavelength range of about 200 to 400 nm, claiming to combine high biological effectiveness with good water transmittance.

The biological effectiveness of UV treatment is not necessarily a simple function of irradiance and exposure time. Experiments with a phytoplankton species showed that a short exposure at high irradiance was found to be more effective than long exposure at low irradiance (Cullen & Lesser 1991). Montani et al. (1995) have shown that the germination of cysts of *Alexandrium*, *Gymnodinium*, *Protoperidinium*, *Scrippsiella* and *Gyrodinium* occurred after exposure to UV radiation. It has been suggested that some organisms have a repair mechanisms which may enable them to recover from the UV treatment provided their exposure does not exceed a certain time. Similar observations were made with bacteria and other phytoplankton species, demonstrating the importance of specifying exposure time as well as irradiance level.

Volumetric flows greater than those necessary for most ballast water systems are treated with UV radiation in municipal treatment plants as a postchlorination treatment (Carlton et al. 1993). It has been reported that a UV plant to treat 4,000 m^3 per hour would require an area of 10 x 5 meters and consequently space may be a limiting factor on existing ships (AQIS 1993). In-line flow treatment would appear feasible and the

most practical option for retro-fitting a UV treatment system on ships. Treatment could take place at the time of ballasting or de-ballasting. However, greater effectiveness is likely to be achieved if the water was treated on de-ballasting to avoid any recontamination of the water after it entered the ballast tanks. This method is likely to be practicable and environmentally sound (no toxic side effects) and no adverse effects in pipework pumps, sealing rings or coating are known (Müller 1995, Müller & Reynolds 1995).
No specific health, safety or environmental concerns appeared to be associated with the use of UV systems on board ship, however, the possibility exists that UV radiation might cause mutation of genetic material in the organisms treated. Capital and running costs for suitable systems were likely to be significant, suggesting that regulatory pressure or financial incentive would be required before UV treatment of ballast water on board ship would be considered seriously (Müller 1995, Müller & Reynolds 1995).
Disadvantaging is the effect that some smaller organisms could pass the UV unit in the shadow of larger organisms without any treatment (Armstrong 1997) and the reduced penetration of UV-radiation in turbid waters (Rigby et al. 1993).

As part of its contribution to the discussion at IMO on the transfer of unwanted organisms in ballast water, the UK Marine Safety Agency initiated a study to undertake a programme of research aimed at evaluating disinfection options for ballast water. This provided information whether the Cu / Ag electrode system (see below) and UV method were, in principle, effective for ballast water disinfection. Dosing requirements were also evaluated under relatively defined and reproducible conditions. Laboratory based experiments aimed to simulate shipboard applications as far as was possible.

UV radiation appeared to significantly reduce the viability of the bacterial, phytoplankton and zooplankton species tested. However, there was some evidence for recovery of the phytoplankton following exposure to UV radiation. Effects on dinoflagellate cysts and diatom resting stages were unclear on account of the experimental design and the analytical process for determining the viability of test organisms which did not allow the unambiguous interpretation of results.

Analysis of the feasibility of employing UV treatment on board ship suggests that few problems would be encountered in installing suitable systems on board new ships. However, retrofitting systems on existing ships would be problematic and the feasibility would need to be examined on a case by case basis. On the basis of the experimental results, UV appeared promising for the treatment of ballast water.

3.2.4 Gamma radiation

Beside the UV-radiation the use of the highly penetrating gamma rays (wave length < 0.1 nm) was listed as possible ballast water treatment techniques. The application of gamma rays is relatively new and was developed for waste water pasteurisation (AQIS 1993).

3.2.5 Ultrasonics

The use of ultrasonics for controlling hull fouling dates back to the 1950's, however, its potential application for ballast water treatment purposes remains largely uninvestigated (Subklew 1963, Müller 1995, Müller & Reynolds 1995). The action or ultrasound is thought to be mediated through various responses that may be fatal to marine organisms. These are heat generation, pressure wave deflections, cavitation and possibly the degassing effect of ultrasound causing removal of much of the oxygen. Cavitation, the formation of gas cavities within liquids, is affected by the frequency of the ultrasonics, power level, volume of water, temperature of the water and the concentration of dissolved matter and gases. Higher frequencies, warmer temperatures and lower concentrations of dissolved matter have been found to increase the effect of ultrasound pulses. Plankton mortality has also been observed in the presence of ultrasound and is considered in part to be attributable to the cavitation process. The application of sonic disruption as treatment to the ballast water was so far not been tested (Armstrong 1997).

Effects range from simple 'shock' to extensive physical tissue disruption. In at least one case it has been reported to kill bacteria. Varying degrees of mortality have been achieved for zebra mussel larvae with exposure times of under 10 seconds (Carlton et al. 1993). In the ballast water context the effectiveness of this method can also be related to the exposure time, the pipe diameter and the effective pipe length.

The implementation of ultrasonics would require the installation of in-line transducers because ultrasound is unlikely to penetrate sediments. The relatively high exposure time for significant mortality may require the installation of parallel piping systems to avoid a decrease in pumping rate. In addition, colder water requires greater power levels for the cavitation process to be effective. Reliable cost estimates for the installation of ultrasonic treatment systems do not appear to be available.

With respect to health and safety aspects, problems may arise with noise from some transducer types. There may also be some as yet unknown implications for the ship's structural integrity and health of personnel following repeated exposure to ultrasound. Additionally, reducing concentrations of dissolved oxygen would enhance metal corrosion. It has also been suggested that the cavitation process could cause physical damage to tank coatings or structures. Such reservations would suggest that ultrasound was an unlikely proposition for ballast water treatment purposes (Müller 1995, Müller & Reynolds 1995).

3.2.6 Microwave

Beside the use of ultrasonics the application of microwaves (wave length 0.1 - 1 nm) for ballast water treatment has been listed. The application of microwaves is relatively new but has been developed to treat waste waters (AQIS 1993).
The size and costs of a microwave unit would prohibitively high as a 50 kW microwave generator costs about US$ 2 million and a unit like this would even be too small to microwave one large ballast tank (Carlton et al. 1995).

3.2.7 Rapid pressure changes

A comparable effect to ultrasonics might be reached through rapid pressure changes produced by e.g. an airgun, as used for seismic investigations. Both methods would probably damage many species but involved disadvantages such as noise from the transducers could affect the health of shipping crews and cause physical damage to tank coatings or structures (Müller 1995, Müller & Reynolds 1995) .

3.2.8 Electrical removal of species in ballast water

Ballast water treatment with electrical currents may cause serious damage to macro-organisms (Woodward 1990). The inactivation of dinoflagellate cysts had been readily achieved by the use of an electric chock during the exposure to 100V for 5 sec (Montani et al. 1995).

The installation of an electronic unit in the sea chest of the vessel near the ballast water intake could during the intake of the ballast water in addition chase away macro-organisms. Comparable units were used in intake areas of power plants to prevent the unwanted impact of macro-organisms.

3.2.9 Magnetic fields

Water what has to be treated could pass a strong magnetic field generated by ferromagnetic or electromagnetic devices. The biological and chemical impact of magnetic systems are not well understood. It is supposed that the organic and inorganic components of living specimens in the water could be modified by strong magnetic fields. magnetic water treatment under laboratory conditions has been effectively used in the treatment of e.g. fresh water bivalves. The method was not applied for salt water treatment (Sipes et al. (eds.) 1996).

3.3 Chemical removal of species in ballast water

A large number of chemical disinfectants are commercially available. These have been used successfully for many years in land-based potable and wastewater treatment applications. Target organisms include protozoa, vegetative and resting cells of bacteria and algae, and viruses. Bolch & Hallegraeff (1994) noted that copper sulphate and high or low pH values are completely ineffective to treat phytoplankton cysts.

A number of other inorganic biocides are used for water treatment purposes. These include bromine, potassium permanganate and hydrogen peroxide. However, their use is generally restricted to small scale and / or specific applications. Moreover, high costs suggest that their use for the treatment of ballast water was unlikely on economic grounds (Müller 1995, Müller & Reynolds 1995).

It has to be considered that despite the costs, the storage of the chemicals on board could be impracticable. Several tonnes were needed to treat the large amounts of ballast water on a bulk carrier calling for a port area without any cargo.

In addition, both inorganic and organic biocides would present a range of health and safety problems related to the storage and handling of chemicals, their compatibility with cargoes carried on board ships, as well as those related to the direct and indirect handling of chemicals by crew members.

As regards the chemical disinfection options, most of the traditional biocides produce by-products which are likely to be environmentally unacceptable and / or might require specialist operator skills. Suitable dispersal mechanisms in the ballast tanks would also need to be addressed, in particular mechanisms for penetrating the sediment layer. In addition in cases where ballast water in cargo holds would be treated with chemicals, these tanks would have to be cleaned intensively before cargo could be loaded in the same tanks (Carlton et al. 1995).

3.3.1 Chlorination

Study of Lloyds Register Engineering Services

Chlorine is a strong oxidising agent. The precise mechanism by which chlorine kills aquatic organisms is not known (Twort et al. 1985, Sterritt & Lester 1988), however, it is assumed that this occurs due to the destruction of the cell wall or channels in the cell membrane.

The effectiveness of chlorine as a disinfectant is dependent on temperature and contact time. Organism mortality rate varies with changes in temperature between 2°C and 20°C. Kills have been substantially reduced with lowering of temperatures (Tebbutt 1983). Chlorine effectiveness is further reduced with increasing pH. At pH values up to 6.7, more than 90 % of ”free chlorine” comes from HOCl, when ammonia is not present. With increasing pH dissociation favours production of OCL^- ions so that only 4.5 % of the ”free chlorine” is present as HOCl at pH 9.

Chlorine could easily been added to ballast water via a chlorinator installed in-line. However, the significant amounts of organic material and sediment in ballast water will exert a high chlorine demand. This material may also act as a shield to some organisms and compromize the effectiveness of the chlorine.

Dosage rates between 100 and 500 mg per litre have been quoted for ballast water disinfection (AQIS 1993). Such high dosage rates may create a storage problem. For dosing with chlorine following a filtration step, low concentrations of around 5 mg per litre may be possible. Improved filtration however, is likely to entail additional modification, significant costs and increased space requirements.

The use of chlorine as a disinfectant and the use of electrochlorination as a means of preventing marine growth are well known. In principle these could be applied to ballast water treatment, however, the effectiveness of chlorine treatment in the marine environment is difficult to predict in all circumstances (Armstrong 1997). Reactions with ammonia, organic material, iron and magnesium may minimize the wanted effect as well as the influence of temperature, pH level and time of exposure. The application of chlorine must be carried out during ballast water uptake with an injection because the effective addition of chlorine to filled ballast tanks is almost impossible. Sounding pipes may be used to add chlorine but one cannot actively homogenise the chlorine content thorough the ballast water. In order to guarantee a disinfection the chlorine application has to be calculated in an overdose resulting in negative effects for the receiving environment in relation to the discharge of the chlorinated ballast water.

Therefore, prior to discharge of the ballast water it would be necessary to remove the free excess chlorine through dechlorination achieved by injection of sulphur dioxide which reacts with residual chlorine to form chloride. Dechlorination involves the use of a similar apparatus to the chlorinator. At the concentrations proposed, chlorine is unlikely to have any adverse effects on pipework or pumps. However, effects on tank coatings may require consultation with producers or possibly further investigation by experimentation.

It is unlikely that the use of chlorine as a biocide would be widely adopted due to health and safety concerns with respect to the use of chlorine in a gaseous form causing problems associated with storage as the liquefied gas under pressure. Additional problems may arise from the venting of ballast tanks. There may also be environmental risks associated with the discharge of ballast that has not been dechlorinated. In addition, research has demonstrated that the reaction of chlorine with organic compounds can produce a number of chlorinated organic compounds, some of which are known or suspected carcinogens. This has led to the re-evaluation of chlorine in existing treatment processes (Smethurst 1988).

Chlorine dioxide (ClO_2)

Chlorine dioxide has a bactericidal efficiency that is comparable with, and possibly greater than, that of free chlorine, although its viricidal efficiency has not been extensively investigated (Twort et al. 1985). Ridgway & Safarik (1991) are listing typical concentrations of 0.5 - 2 mg / l. It is suggested that ClO_2 has a number of advantages over chlorine (Sterritt & Lester 1988, Smethurst 1988). Most importantly ClO_2 does not react with ammonia and thus application of large doses to produce sufficient ‘free chlorine’ is avoided. In addition, disinfection is more effective than for chlorination at high pH values, significant chlorinated by-products, such as trihalomethanes, are not produces and a relatively stable disinfectant residual is produced.

ClO_2 is usually produced by adding chlorinated water to sodium chlorite solution and is generally applied at concentrations between 0.1 and 0.5 mg per litre. Costs of sodium chlorite are very high and on a per unit weight basis ClO_2 is more expensive than chlorine.

Chlorinated water is produced from chlorine which is then added to the sodium chlorite solution via a chlorinator. Health and safety problems associated with chlorine would therefore still apply. As ballast water is likely to have a high chlorine demand because of the presence of ammonia, organics and manganese and iron in solution, ClO_2 is likely to perform superior disinfection at less cost. If excessive doses of ClO_2 are applied sulphur dioxide may be used for dechlorination as for chlorine. Effects on coatings, pumps and pipework are likely to be similar to chlorine (Müller 1995, Müller & Reynolds 1995). Disadvantaging are safety problems due to the explosive character of the gas and toxic by-products (Flemming 1991).

Chloramines (NH_2Cl)

Chloramination, also known as the ammonia-chlorine process, is a form of chlorination. Involving the deliberate formation of monochloramine by the addition of ammonia to water followed by chlorination. The ratio of ammonia to chlorine is usually in the range of 1:3 to 1:4 (Twort et al. 1985) and has to be controlled to prevent the formation of di- and tri-chloramine. As an alternative to controlling the ammonia / chorine ratio, performed monochloramine has at times been used. Inorganic chloramines have found to be less effective disinfectants than free chlorine in laboratory studies (Smethurst 1988).

At higher pH values (8.5-9.0) chloramines have been found to be a better disinfectant than free available chorine. Chloramine treatment is said to have a low overall cost of application and systems maintenance and it is less expensive than other alternative disinfection methods including ozone and chlorine dioxide. The chloramine residual is longer lasting than free chlorine. For shipboard use the biggest problem is likely to arise from maintaining the correct ammonia-chlorine ratio.

As chloramination is a form of chlorination, chlorine would have to be carried onboard ship. Consequently associated health, safety and environmental considerations would need to be taken into account (Müller 1995, Müller & Reynolds 1995). Disadvantaging is the resistance of micro-organisms (bacteria) against chloramine treatment (Flemming 1991).-

Sodium / calcium hypochlorite (Na ClO / $Ca(ClO))^2$

Sodium hypochlorite solution is freely available as an ordinary household disinfectant, containing 1 to 15 % of available chlorine. The solution rapidly loses strength upon exposure to atmosphere or sunlight and consequently is typically supplied in small containers so that the contents may be used quickly. Larger quantities may be available in carboys which require return to the manufacturer for filling. Dosage would need to be carried out by a simple chemical feeder based on hydraulic control of a solution to provide a constant rate of discharge regardless of the level in the storage container.

A less expensive alternative might be the electrolytic generation of hypochlorite onboard ship using seawater as the source of chloride. This could possibly be a cost-effective way of pursuing this option. A brine solution is often used in preference to seawater because the latter would require filtering before use. The presence of manganese in solution in seawater will impair electrode efficiency. However, hydrogen gas also produced by this process would have serious implications for health and safety, particularly for tankers and this does need careful consideration. Solutions with 8g or more of chlorine per litre may be produced with electrical power consumption of 5-6 kWh/kg of chlorine (Twort et al. 1985).

In order to kill *Gymnodinium catenatum* cysts amounts of free chlorine levels as high as 500 ppm have been quoted. This would require approximately 400 tonnes of an industrial solution of 12.5 % NaClO to treat 50,000 tonnes of ballast water. Consequently, economic as well as health and safety considerations are likely to prohibit the use of NaClO for ballast water disinfection.

A study of the Japanese Association for the Prevention of Marine Accidents documented that even a solution of 1 ppm of hypochlorous acid (CLO^-) only was sufficient to kill unwanted aquatic organisms (Fukuyo et al. 1995).

As an alternative, hypochlorite is available in a granular form as calcium hypochlorite (Ca(ClO)2) which contains between 65 and 68 % by weight of chlorine. The product is generally supplied in 45-50 kg plastic lined drums. Granules are readily soluble and may be dosed directly to the water or made up as standard strength solutions. Dosing would be by a simple hydraulic feeder as for sodium hypochlorite. Although Ca(ClO)2 granules are substantially cheaper than the equivalent NaClO solution economic reasons are again likely to prohibit the use of Ca(ClO)2 for ballast water disinfection (Müller 1995, Müller & Reynolds 1995).

Flemming (1991) underlined the low costs and effectiveness of this chemical, but noted disadvantaging toxic by-products and corrosive effects.

Additional studies revealed that free chlorine peroxide killed cysts e.g. *G. catenatum* , but high dose rates make use of the chemicals expensive and high organic sediment loads of ballast water limit the effectiveness of chlorine and hydrogen peroxide (Bolch & Hallegraeff 1993).

3.3.2 Metal ions

Electrolytically generated copper (Cu) and silver (Ag) ions are being successfully used in the treatment of freshwater, particularly potable water and swimming pools. Although the efficiency of the various systems that are commercially available does vary, the effectiveness of electrolytically generated copper and silver ions has to be found superior to chlorination for the inactivation of various bacterial strains (Landeen et al. 1989).

Although most organisms have requirements for small concentrations of Cu and Ag and both metals have important biochemical functions, excessive concentrations are toxic to most organisms. This is largely mediated through the inactivation of enzymes and other biological components by substitution of the metals in reactive sites (Tebbutt 1983).

The disinfecting capacities of Cu and Ag are dependent upon the type of organisms treated. Simple, single-celled organisms are usually more susceptible than larger higher organisms. Different stages in the life-cycles of organisms will vary in their susceptibility, with resting stages generally being more resistant. Environmental conditions might also play a part, particularly in the case of pH and viral susceptibility to metal ions (Thurman & Gerba 1989). Although high concentrations of Cu and Ag ions may not have a lethal effect on exposed organisms, they may prevent successful reproduction and would thus serve the purpose of preventing the establishment of non-native organisms in new areas.

Unlike many other disinfectants, however, chemical and behavioural mechanisms exist which provide tolerance for some organisms to elevated copper and silver concentrations. For example, in situations of high environmental copper concentrations some barnacles are able to bind copper within an organic complex resulting in ‘copper granules’ (Walker 1977). Similar phenomena have been observed in crayfish, isopods and scallops. In addition a direct behavioural response is exhibited by bivalves which rapidly close their shell when exposed to unacceptable high copper concentrations (Powell & White 1989).

There is less data at hand on the effect of silver, but its toxicity is considered to be superseded only by mercury. Bioaccumulation of silver, mostly in form of the very stable silver sulphide, has been recorded for young oysters in response to experimentally induced elevated silver concentrations (Martoja et al. 1988). There appears to be little or no data on the complementary or synergistic effect of copper and silver on the mortality of organisms.
Despite the various metal ion tolerance mechanisms apparent in marine organisms, the use of copper and silver ions for disinfection of ballast water may still be worthy of consideration, since many of the tolerance mechanisms are associated with larger organisms: there could however, be removed by preliminary mechanical treatment processes (section 4.1).

At the present time, there is a lack of data regarding application of copper / silver ion disinfection systems to seawater, although such systems have been used in aquaria and dolphinaria. Trials are also underway for aquacultural and fisheries purposes (Rosenthal pers. comm.).

Concerns over the precipitation of Cu or Ag salts in seawater appear unfounded. Calculations suggest that even the low solubility of the silver chloride salt would not result in precipitation at the silver ion concentrations likely to be required for ballast water disinfection purposes. Moreover the suitability of eletrolytically generated Cu and Ag ions in seawater is understood to be superior as compared with ions deriving from the metal salts.

Application of this technique to ballast water has so far not been tried in practice. It is proposed that the treatment of ballast water could take place during the ship's passage by continuously recirculating water from a ballast tank through an electrolytic cell. Copper / silver alloy electrodes with a copper:silver ratio of around 10 : 1 should be used. The overall size of the system would relate to the required release rate for the metal ions. This, in turn would be dependent upon the volume and characteristics of the water to be treated. The level of organic material present would be of particular importance since complexing of metal ions by organic ligands will reduce the proportion of free metal ions available for disinfection purposes (Müller 1995, Müller & Reynolds 1995).

In contrast to traditional chemical disinfection agents, the use of electrolytically generated copper (Cu) and silver (Ag) ions would be unlikely to pose comparable levels of health and safety concerns since the carriage and handling of chemicals on board would be avoided. Environmental concerns over the discharge of Cu and Ag enriched waters and dispersion of Cu and Ag ions in the ballast tanks would, however, still need to be addressed. The environmental impact is less certain and would largely be dependent upon the copper and silver ion concentrations required for effective kills and metal ion dispersion characteristics at the point of ballast water discharge (Müller 1995, Müller & Reynolds 1995).

There was some evidence that the copper / silver electrode system might have affected the viability of both the zooplankton and the dinoflagellate cysts, although not the diatom resting stages. This was somewhat surprising considering that zooplankton and dinoflagellate cysts would anticipated to be more resistant than either bacteria or phytoplankton to adverse conditions. Whilst it could not entirely be ruled out that the copper / silver electrode system would have an impact on these organisms under normal operating conditions, it is more likely that the effects observed were due to the inordinately high concentrations of copper to which these organisms were exposed, either during the treatment process itself or during the viability analyses. In contrast, silver concentrations were always below the detection limit of the analytical method (10 to 100 $\mu g.litre^{-1}$) and Cu : Ag ratios were in excess of 96 : 4.

The copper / silver electrode system as tested within this project appeared far less promising than the additional tested UV-treatment (see above) of ballast water. Neither bacterial nor phytoplankton viability appeared to be significantly affected by the copper / silver treatment process. The results of the bacterial trials may, however, have been influenced by the high DOC content of the test media which may in turn have reduced the effective toxicity of the metal ions in the test system. However, the DOC concentrations recorded were consistent with those encountered in natural environments (Müller 1995, Müller & Reynolds 1995).

3.3.3 Ozone

Ozone is a fairly powerful but unstable, oxidising agent which rapidly destroys viruses and bacteria, including spores, when used as a disinfectant in conventional water treatment (Reynolds et al. 1989). O_3 quickly decomposes to oxygen, with a half life in water at 20°C of less than 30 minutes. The process is dependent on the production of O_3 on-site, by passing high tension, high frequency electrical discharges through dry air.

Effects of O_3 are rapid, with contact times of 5 to 10 minutes at a dosage of 1-2 mg per litre. Where water was of poor quality much larger concentrations have to be applied. Over a range of pH between 6.5-8.0 the reactivity of O_3 is constant unless colour present in the water was due to reactions with fulvic and humic acids. High pH will lead to slowing down of the kill rate.

Ozone gas is highly toxic and has an odour detection threshold of about 0.01 ppm. A high level of safety measures, including monitoring of carbon scrubbed vented gas, therefore has to be adopted with its use. Although O_3 leaves no residual in the water, it may cause precipitation of manganese and iron and is not suitable for water with high turbidity. In addition to the associated high costs of this treatment it is possible that O_3 may be a potentially corrosive agent in ballast systems (Flemming 1991, Carlton et al. 1993).

3.3.4 Hydrogen peroxide

The use of hydrogen peroxide (H_2O_2) is common for control of fouling in water cooling systems. Cysts of phytoplankton as e.g. *Gymnodinium catenatum* can be destroyed at minimum concentrations of 1 % (Rigby et al. 1994). Typical concentrations are listed with 0.1 - 2 g/l (Ridgway & Safarik 1991).

The major advantage over other chemicals is the effect that residual amounts decompose readily to water and oxygen and are therefore environmentally sound. One potential disadvantage is that applied to ballast water with high loads of organic material the effectiveness decreased due to oxidation of this material. From a practical point of view, a bulk carrier with 50,000 tonnes of ballast water would require 1,000 tonnes of hydrogen peroxide. Lower concentrations would require longer exposure periods of time (Rigby et al. 1994).

Hydrogen peroxide killed cysts e.g. *G. catenatum* , but the dose rates make its use expensive. In addition, the high organic sediment load of ballast water limits the effectiveness of hydrogen peroxide (Bolch & Hallegraeff 1993).
It has been assumed that in combination with other options (as UV-treatment) low concentrations of hydrogen peroxide could be effective (Müller 1995, Müller & Reynolds 1995).

The German chemical company DEGUSSA AG, Frankfurt is testing several mixtures of the peroxigene based fluid “Degaclean” for ballast water treatment. Until today, it was mentioned that the advantage of this new treatment chemical (based on several components) is the comparably low costs involved and that remaining decomposits of the chemical have non polluting impacts to the environment. First preliminary results of trials on the effectiveness are scheduled for 1998 (Huss pers. comm.).

3.3.5 Oxygen deprivation (de-oxygenation)

Reducing agents, such as sulphur dioxide or sodium sulphite may be used to de-oxygenate water creating anaerobic conditions which may effect the viability of marine organisms. However, de-oxygenation is thought to have little effect on algae, anaerobic bacteria, possibly viruses, and resting stages of algae and bacteria (AQIS 1993). Full de-oxygenation would be difficult to achieve in unsealed tanks. Treatment would therefore be only partial and a number of problems would be associated with this approach. In particular, hydrogen sulphide and other sulphur compounds would accumulate leading to potential corrosion problems. The discharge of anoxic, sulphur rich water would also likely to be environmentally unacceptable (Müller 1995, Müller & Reynolds 1995, Sipes et al. (eds.) 1996).

3.3.6 Coagulants

Coagulants were discussed to increase the effectiveness of filtration and gravity (sedimentation / flotation) process. Coagulants are charged ions which destabilise the counter charges on suspended colloidal material and allow the formation of larger particles in the water due to agglomeration. These larger particles could be removed by filters or extracted by floatation methods. In drinking water treatments coagulants were used (aluminium and ferric sulphate, ferric and poly aluminium chloride as well as cationic polymers). Useful application doses and chemicals need to be studied under sea water conditions (AQIS 1993).

3.3.7 pH adjustment

The likely sensitivity of some organisms to pH change, especially large short term variations in pH, has led to investigations of the suitability of this option for ballast water treatment (Müller 1995, Müller & Reynolds 1995). The pH value could be adjusted by the addition of lime (AQIS 1993).

Bolch & Hallegraeff (1994) believe that treatment with pH adjustment was not effective in the wide range of 2 to 10.2. In contrast, Ridgway & Safarik (1991) are listing useful pH values with 2 - 12. Impacts of ballast water discharged with even higher or lower pH values would be absolutely not acceptable for the environment.

Lowering of pH is generally undesirable because of corrosion problems. Temporarily raising the pH to around 12 by the addition of an alkali has been suggested as an alternative; however, such high pH conditions may well result in alkaline attack of pipework, coatings, ballast tanks and so on.

Little real data currently exist with respect to the efficiency and effectiveness of pH adjustment. Inactivation of viruses by pH elevation has been demonstrated (Sproul 1980). However, exposure of dinoflagellate Gymnodinium catenatum cysts to a pH range of 2 to 10 was unsuccessful in preventing germination. On account of the foregoing, adjustment of pH is unlikely to be a suitable option for ship-board treatment of ballast water. Moreover, health and safety concerns would accompany the storage and handling of large quantities of the alkali required for raising pH and acid needed for pH restoration prior to discharge of the water (Müller 1995, Müller & Reynolds 1995).

3.3.8 Salinity adjustment

In the simplest cases this would entail the addition of fresh water to salt water or salt water to fresh water in order to disturb the osmoregulatory processes of the salt or fresh water organisms which were present in the raw ballast water. This method is known not to effect all types of organisms.

The high saline exhaust of an on board desalination unit mixed with the ballast water could have an sterilising effect. This method would probably harm organisms in the area of discharge, if large volumes of high saline water are released. It is believed that this method could be useful for ships carrying very small amounts of ballast water, as e.g. cruise liners. This method has to be tested.

3.3.9 Antifouling paints as ballast tank coatings

The use of anti-fouling pollutants in the inside ballast tank coating could help to minimize fouling (Woodward 1990, Carlton et al. 1995). However, inside tank fouling is not occurring frequently as shown during shipping studies (Gollasch 1996, Lenz et al. in prep.).

Optimal treatment by anti-fouling paints is only given during water movements. High wind forces during the voyage of a vessel can result in water movements in ballast tanks, especially if the tanks are not filled completely. Calm seas and completely filled ballast tanks prevent water motion inside the tanks and therefore would reduce the effectiveness of the anti-fouling paint.

However, the use of poisonous wall coatings could not be applied for cargo holds (Carlton et al. 1995). In addition, the discharge of ballast water contaminated by these toxins would affect the receiving ecosystems.

3.3.10 Organic biocides

There are a number of commercially available organic biocides, however, their overall effectiveness on marine organism mortality is virtually unknown and costs are likely to be prohibitive. Moreover, a dose at 30 times the recommended rate of one particular biocide was found to be completely ineffective against dinoflagellate cysts (Bolch & Hallegraeff 1993). To ensure that active biocide or decay products did not enter the receiving waters the application of a detoxification agent would almost certainly be required (Bolch & Hallegraeff 1994, Müller 1995, Müller & Reynolds 1995). For some of the listed chemicals no detoxification products are known and therefore the use is environmentally unsafe and not recommended.

3-trifluoromethyl-4-nitophenol

The sea lamprey, introduced to the North American Great Lakes caused serious losses in the harvest of local fisheries. The lamprey was treated effectively with biocides. After a trial testing of more than 6,000 chemicals, a chemical (3-trifluoromethyl-4-nitophenol) was found causing damages to the larvae of the lamprey with minimum effects to most of the other species present. Since the first application in 1960 the population of the sea lamprey decreased to 5 % of the population in 1960 (Morse 1990). Each year chemicals are being applied in order to prevent an increase of this unwanted species (Cangelosi pers. comm.).

The following list of chemicals was mentioned by Flemming (1991), Mittelman (1991), Ridgway & Safarik (1991) and references, as well as by AQIS (1993), as possible treatment biocides in order to retard (bacterial) biofouling of reverse osmosis membranes of industrial water systems:

Bromine

The application of this chemical seems to be very effective against a broad microbial spectrum. Unwanted effects are toxic by-products and the development of resistance.

Formaldehyde

The mentioned typical concentrations were 1 % (treatment duration 2-3 h). The low costs involved, the broad treatable antimicrobial spectrum, stability and the easy handling during application was listed as advantage. Disadvantaging and restrictions in use are the resistance of some organisms, toxicity, suspect to promote human cancer disease.

Glutaraldehyde

Glutaraldehyde is an effective toxin even at low concentrations (5 - 25 g/l). The chemical is in-expensive, non-oxidising and non-corrosive.

Isothiazolone,

Recommended typical concentrations of this toxin are 0.1 - 5 g/l. It is therefore effective in low concentrations and a wide spectrum of micro-organisms may be treated. Disadvantaging is the effect of inactivation by primary amines.

Quaternary ammonia compounds

Typical concentrations are between 0.1 - 5 g/l. Disadvantaging is the inactivation by low pH, Ca^{2+}, Mg^{2+} and the development of resistance.

Sodium amines and **EDTA**

Sodium amines and EDTA were typically concentrated in low doses (0.1 - 5 g/l).

Peracetic acid

Peracetic acid is very effective, even in small concentrations (0.1 - 2 g/l). The treatment of a broad spectrum of bacteria, including spores. No toxic by-products known. Disadvantaging are instability and corrosive impacts.

Bisulfite

Typical concentrations for effective applications with bisulfite are between 10 - 100 mg/l.

Iodine (periodate)

The lowest concentrations of all listed chemical with 0.1 - 2 mg/l were effective.

In addition the use of bacterial **pyrogens** (**endotoxins**) has been discussed. Other mentioned biocide treatments in the aquatic habitats is the use of the organic algaecide Kathon WT (a chemical containing Isothiazolone) (Ridgway & Safarik 1991, Bolch & Hallegraeff 1994).

3.4 Constant volume of ballast water

Another option is the carriage of a constant volume of ballast water on board without any discharges or uptakes of additional water. This option seems to be applicable on a very little number of vessels. Ships which usually carry very little amounts of ballast water as e.g. cruise liners, could minimize their ballast water discharge to a minimum or even could prevent any discharge by pumping the ballast on board from one tank into another (Gollasch 1995).

Due to the constant volume of ballast water the time the ballast water remains on board would considerably increase as compared with current practices. Scientific ballast water studies showed that with increasing duration the number of species and specimens in the ballast water is decreasing for many organisms (Williams et al. 1988, Gollasch 1995). Therefore Carlton et al. (1995) pointed out that the increased length of voyages (increased time of ballast water on board) would reduce the number of introduced species by ballast water discharge. However, resting stages, especially from phytoplankton species, can remain viable for several years in the tank sediments (Carlton et al. 1995).

3.5 Alternating salinities in ballast water and area of discharge

Wherever possible alternating salinities of ballast water and area of discharge of this ballast water could be used. Firstly, to discharge marine ballast water in freshwater areas (e.g. The North American Great Lakes, freshwater ports) and secondly, to discharge freshwater ballast in marine ports could help to minimize the survival of organisms after discharge into a new aquatic habitat. It is believed that most of the freshwater organisms cannot survive marine water conditions and vice versa. Knowing that there are exceptions of this rule, this option could be used to minimize the risk but cannot exclude further species introductions.

The North American approach of vessels entering the Great lakes took into account that the survival of most marine organisms in the freshwater of the Great Lakes is limited (see below).

In addition there are many trading routes in the world where ships do not have the opportunity to take freshwater ballast on board. The use of an on board desalination unit for this purpose is probably extremely time consuming and associated with enormous need of energy. The additional air pollution caused by running the desalination unit has to be taken into account.

(see also Treatment option "Salinity adjustment")

3.6 Fresh Water Ballasting

Providing ships with city treated fresh water appears to be a useful option in unique circumstances, as e.g. regional shipping routes serving determined cities. Specific arrangements need to be made with port authorities involved (Carlton et al. 1995).

An International Seminar on Fresh Water Ballasting in 1983 discussed the use of fresh water ballast for oil carriers. One issue listed was that the oil carrier could load fresh water instead of cruising back to the oil exporting country without any cargo. Many of the oil exporting countries are located in arid or semi-arid climates where rainfall is scarce. The agriculture of some countries could benefit from this fresh water for irrigation supplied by incoming vessels. The use of the fresh water ballast for agricultural use could help to protect natural fresh water resources.

A number of investigations have been undertaken dealing with the economic feasibility and the tolerance of agriculture to oil contaminated water (Meyer 1983).

Fresh water transported in cargo holds of oil carriers can contain on discharge 1 to 5 ppm of oil. These amounts may be removed at land-based facilities (Leitner 1983).

Short term (3 years) plant tests showed that the content of naphtalenes and phenantrenes varied (7 - 140 μm) according to different agricultural techniques. These contents may not represent health hazardous levels (Persson 1983). Other experiments showed that the effects of oil contaminated water on seed germination and seedling growth was in maximum 25 % of the tested seeds if the contamination was little. Inhibiting of seed germination increases with the cruide oil concentration (Ben Hamieda & Elmehrik 1983).

But using untreated lightly contaminated fresh water from these tanks one will probably enrich the oil content on the agricultural site and pollute the ground water. Using the brackish water from the donating country without desalination an increasing salinity of the agricultural site cannot be avoided.

The benefits of this method could be the minimization of discharging oil polluted ballast water in the marine environment (in countries where land based reception facilities are not available) and cost savings in areas where desalinated water have to be used for agricultural purposes (Meyer 1983). In addition the contaminants (chemicals and biological e.g. pathogens and disease agents) of the water (Maramorosch 1983), as well as costs for water at source and delays during loading and unloading, have to be taken into account (Sadler 1983).

It is supposed that the costs for cleaning and installations are to high for economic feasibility of this method. Today, in addition to the economical point of view, water is a limited source in some countries. Therefore, the applicability of this option is limited to very special circumstances on certain trading routes.

3.7 Biological removal of species in ballast water

Biocontrol methods to remove organisms has been practiced at several occasions in regard to terrestrial habitats after an unwanted species introduction for hundreds of years. The use of imported predators, parasites and diseases is very risky due to the impact of the intentionally introduced species on native species (Center et al. 1997).

Until today no species was intentionally released into the wild in the marine environment following this purpose. A new Study Group on Marine Biocontrol of Invasive Species (SGMBIS) was established in 1997 under the chairmanship of Prof. Dr. J. T. Carlton. The working group will focus their activities on the risk assessment of potential biocontrol species in order to control unwanted non-indigenous species as e.g. *Caulerpa taxifolia* in the Mediterranean Sea, *Mnemiopsis leidyi* in the Black Sea and *Carcinus maenas* in Australian waters (Report of the SGMBIS 1997). A parasite, native to Europe (*Sacculina carcini*, Cirripedia) is affecting *Carcinus maenas* in its native European range. If currently undertaken intensive studies showed that *Sacculina carcini* will only affect the introduced European Shore Crab in Australian waters this species may be introduced to control the population of the European Shore Crab. The second example in this field is the planned introduction of the exotic herbivorous sea slug feeding on the introduced *Caulerpa taxifolia* in the Mediterranean Sea. The sea slug will not feed exclusively on the introduced Caulerpa but as well on the native *Caulerpa* species, but it may be assumed that the introduced *Caulerpa* could remove the native species of *Caulerpa* taking into account its tremendous growth rate.

No current activities or studies exist in order to remove species in ballast water by biocontrol.

3.8 Dewatering

The objective of dewatering is to produce an analogous substance to water that may be easily handled, transported, stored and disposed. Typical dewatering is carried out by the addition of solid material (up to 40 %). The added material may be extracted by using vacuum filtration or centrifugal separation (AQIS 1993).

3.9 Land-based facilities

The possibility of land-based facilities has not been ruled out for the treatment of smaller volumes of ballast water. The reception facility has to be placed in certain areas of ports taken into account quarantine regulations. Land-based reception facilities for ballast water discharge could provide an acceptable means of control, but seemed to be unfavourable due to the costs involved e.g. for pipework of enormous dimensions.

3.10 Shipboard treatment of ballast water

3.10.1 Commercial vessels

If the treatment units may be installed as small scale facilities as e.g. container size, a shipboard use is possible (AQIS 1993). Safety on board as well as additional manpower for the ship crew for the ballast water treatment have to be taken into account.

3.10.2 Treatment vessels

In order to reduce costs for the pipework an especially designed tanker could act as reception facility for ballast water. The ballast water to be discharged could be pumped to this vessel located along side the discharging vessel (AQIS 1993).

It has further been estimated that several land-based treatment plants (connected to the vessels by pipework or serviced by barges which collect the ballast water from the vessels discharging it later to the treatment plant on land) and treatment vessels were needed (AQIS 1993).

3.11 Summary of treatment options

From the foregoing it is apparent that no single or simple solution presently exists for shipboard treatment to prevent the transfer of viable non-native organisms in ballast water. None of the listed treatment options seem to be 100 % effective, environmentally sound, cost effective and safe during application. A combination of technologies may however, be at least partially effective and feasible in terms of economic and shipboard constraints. The most promising method seems to be a combination of heat treatment and filtration of ballast water or heat treatment and changing salinities of the ballast water.

Some form of mechanical removal of debris and the larger organisms would appear a prerequisite to any other treatment. This would most likely take the form of straining, microfiltration or even cyclonic separation.

As a second step, physical treatment techniques, in particular application of UV radiation or heat treatment, would appear to be more acceptable than chemical options on both environmental and safety grounds. An exception is the ozonization of ballast water. Although ozone leaves no residual environmental polluting components, as it quickly decomposes to oxygen, in the water and it is a considerably more effective biocide as other chemicals than e.g. chlorine.

However, environmental concerns will still exist with respect to genetic mutation and discharge of warm water respectively.

As regards the chemical disinfection options, most of the traditional biocides produce by-products which may be environmentally unacceptable and may require specialist operator skills on account of the complexity of ballast systems and problems associated with the application of chemicals. Suitable dispersal mechanisms in the ballast tanks would also need to be addressed, in particular mechanisms for penetrating the sediment layer. In addition, both inorganic and organic biocides would present a range of health and safety problems related to storage of chemicals, compatibility with cargo carried on board as well as direct and indirect handling of chemicals by crew members. Nevertheless the use, for example, of hypochlorite may be useful as an emergency treatment measure.

In contrast to the traditional chemical disinfection agents, the electrolytic generation of copper and silver ions would be unlikely to pose the same level of health and safety concerns since the carriage and handling of chemical on board would be avoided. Environmental concerns may however, be expressed over the discharge of copper and silver enriched waters and dispersion mechanisms would still need to be addressed. Nevertheless, this technique is considered worth of further investigation.

Of the remaining options reviewed, adjustment of ballast water salinity is clearly a useful technique where supplies of fresh or seawater, as appropriate, are freely available. Indeed this technique is already being used for the treatment of ballast water for ships entering the Great Lakes.

On the basis of the available data, none of the other techniques reviewed appear particularly suitable for shipboard application to ballast water on account of effectiveness, practicality, cost, environmental health and / or safety considerations. As regards those that have been identified as potentially feasible and effective, further research will be needed before firm recommendations for shipboard installation can be made (AQIS 1993, Müller 1995, Müller & Reynolds 1995, Sipes et al. (eds.) 1996).

4 Costs of treatment options

The costs involved in the application of the various treatment options were only calculated for very few methods:

4.1 Filtration

Data on the costs of running a self cleaning filtration treatment on board the ALGONORTH in the Great Lakes will not be available at this time.

(AQIS 1993) estimated the costs and applicability for filtration with higher meshsize compared to the ALGONORTH experiment. Filter units are simple to operate and do not require a large amount of additional space. If the treatment units may be installed in small scale facilities as e.g. container size, a shipboard use is possible. Safety on board as well as additional manpower for the ship crew for the ballast water treatment have to be taken into account. The estimated capital costs to install e.g. a filtration unit for ballast water treatment are US \$ 2.9 million, running the unit was estimated as US \$ 117.6 per 1,000 m^3. Total costs summarise to US \$ 1000 per 1,000 m^3. The estimated costs for 50 µm and 500 µm strainers appear to be prohibitively high at US \$ 2.4 million and US \$ 1.6 million. Filtration unit with a larger meshsize of 2,000 µm is estimated to cost US \$ 0.9 million for units capable to handle 4,000 m^3 per hour and of 0,5 million m^3 of ballast water what has to be treated per annum (AQIS 1993).

Woven mesh filters with smaller meshsize (300 and 25 µm) have a larger filter surface area than screening systems. Space requirements for each filter having a capacity of 1,000 m^3 per hour would be in the region of 2.8 m high by 1.7 m wide. Capital costs were quoted as US \$ 16,000 per ‘coarse’ filter and US \$ 20,400 for the ‘fine’ filter (Carlton et al. 1989). However, when compared to the high capital cost of the fine screening devices, it must be assumed that these costs either do not relate to provision of the entire system or the estimated costs for the fine screening system are inordinately high. Maintenance costs for the microfiltration system are reportedly low, with screen replacement required every few years. However, this system would not be suitable where gravitation is used for ballasting (Müller 1995, Müller & Reynolds 1995).

4.2 Ballast water exchange in open ocean

Costs for an mid-ocean exchange of ballast water determined in 1990 by Canadian officials (including the costs of diesel, power generating costs to operate pumps) are approx. US$ 900 per vessel with 7,000 to 10,000 tonnes of ballast on board, as usual for a vessel calling for Great Lakes ports. In this year 455 ocean going vessels entered the St. Lawrence River. Of these 198 or 44 % carried ballast water. Reporting and record keeping costs will probably add US$ 35 per vessel. Calculating the costs until the year 2000 (including inflation rate compensation of 4%) will summarise in US$ 2,112,744 (if number of vessels would not change per year. The Coast Guard experts emphasise that the cost for consumers would be minimal. Assuming that all costs will be passed on to the customer the costs per ton of cargo on vessels subject to the regulations has increased to US$ 0.099 calculated for 1993. The exchange of ballast water in open ocean areas prior to entering the great Lakes and discharging ballast water in the Great Lakes would help to prevent additional introductions of unwanted non-indigenous species (MEPC34/INF.22).

The costs for the installation of additional pipeworks and valves to allow a flow through exchange of ballast water, including remote operation, on a bulk carrier as the investigated ORMOND (190,000 DWT) or a suezmax tanker raises up to US $ 860,000; for a container vessel (e.g. the P & O Jervis Bay with a capacity of 4,000 TEU and length of 292.2 m) with a maximum ballast water capacity of 16,613 m^3: US $ 532,200. The cruise liner P & O GRAND PRINCESS (242m LBP) has a ballast water capacity of 4,345 m^3. A complete exchange will take 2.17 days using the pump with a capacity of 250 m^3/h. Costs in total would be US $ 277,700 (Armstrong 1997).

The Australian Bureau of Transport and Communication Economics estimated that the costs for reballasting at sea (during transit) was between 17 and 30 A cents (and 0.6 to 3.0 cents in a safe haven) per tonne of cargo, depending on the type and size of vessel (MEPC31/14, 1991). The total dry bulk export cargo in Australia in 1989 was 244 million tonnes. The total cost for this treatment would have been between US $ 60.3 million and US $ 107.3 million For the vessel IRON WHYALLA complete ballast water exchange using the flushing method replacing 3 ballast water volumes would require approximately 3 days. The fuel costs were estimated as US $ 3,380 (Rigby et al. 1994).

The IMO Assembly Resolution A.868 (20) advises that a responsible officer should be appointed to maintain appropriate records and to ensure that ballast water management and / or treatment procedures are followed and recorded. It also advises to document as minimum during taking on or discharging ballast water the dates, geographical locations, ship's tank(s) and cargo holds, ballast water temperature and salinity as well as the amount of ballast water loaded or discharged. These costs for documentation seemed to be very little.

4.3 Heat treatment

To improve the heat exchanger utilising heat from engine cooling water costs about US $ 94,000 per vessel. The costs for additional pipework were estimated for a 147,000 metric ton bulk carrier at US$ 50,000. A re-design of the vessel is needed (Bolch & Hallegraeff 1994). Running the unit would be comparable in-expensive and depend on several parameters (as e.g. required temperature, amount of ballast water what has to be treated, location of ballast tank, route of the vessel etc.).

The engine room equipment would have to consisting of an additional heat exchange, hold tank, instruments controlling the water temperature and piping.
A comparable heat system was successfully used on a trial basis on board the 4,226 gt bulk carrier SANDRA MARIE during a voyage from Sidney to Hobart in May 1997. The modification of the vessel was approved by Lloyd’s Register and the Australian Maritime Safety Authority. The system was based around the existing jacket cooling water heat exchanger with a minimum of additional pipe work. The usual seawater cooling circuit was by-passed and replaced by water drawn from the ballast tank and returned to the ballast tank after heating. As every ship is different the on board heating system has to be designed individually. The constructing company Hi-Tech Marine, who designed the unit and installation used during this trial, estimates the costs for a

system designed to treat 500t/h at around US$ 350,000 (Müller 1995, Müller & Reynolds 1995).

4.4 Ultraviolet radiation (UV)

For the treatment of most bacteria the capital costs for three to four units capable of treating 1,000 m^3 per hour are currently in the range of US $ 98,000 to US $ 130,400. In order to treat the more UV-resistant blue-green algae the cost could be tenfold. Power requirements are typically between 10 and 20 Wh m^3, with a large plant in the former USSR reporting the treatment of 3,000 m^3 per day of surface water at an average electrical consumption of 10-16 Wh m^3 (Twort et al. 1985). Other than the input of electricity the ongoing costs would also include replacement of UV lamps every 4,000 hours and quartz sleeves at intervals of approximately two years. Costs for each of these items are approximately US $ 500. The application of UV radiation for the treatment of seawater has so far not been widespread. However, it could be an effective and environmentally acceptable ballast water treatment option once the larger organisms have been removed by mechanical processes (e. g. filtration). The technique is likely to be acceptable on health and safety grounds and is unlikely to have any adverse effects on pipework, pumps or coatings. There are no known toxic by-products, although it is has not been ruled out that the alteration of genetic material and the generation of new characteristics in lower organisms may occur as a result of non-lethal doses of UV (AQIS 1993). Since UV radiation catalyses the oxidation reactions with ozone or hydrogen peroxide, a combination of UV treatment with low concentrations of these biocides may also be worth exploring (Müller 1995, Müller & Reynolds 1995).

4.5 Chlorination

Costs for dosing with low concentrations of chlorine at 5 mg/1 have been quoted as approximately US $ 4:9 per 1,000 tonnes of water. Larger amounts of chlorine would be required for ballast water disinfection at the higher dosage rates and consequently costs will be in the order of 20 to 100 times higher for the same volume of water. Between 4 and 20 tonnes of chlorine would be required for the treatment of 40,000 tonnes of ballast water. In co-operation with a filtration method the chlorine requirement would be reduced to 200 kilograms for the same volume of water. At these lower application rates chlorine would be a relatively inexpensive option (Müller 1995, Müller & Reynolds 1995, Rabe & Katzenbach pers. comm.).

AQIS (1993) estimated the costs of a system that may be used to treat 4,000 m^3/h with 2 mg/l chlorine on less than US $ 376;500.

The needed concentration of free chlorine was estimated as 500 ppm for 24 hours. Approximately 30 % of the initial free chlorine remains after 24 hours application. It was calculated that 2.4 t of 12.5 % NaHOCl per 50,000 t vessel would be needed per voyage. The costs involved were estimated as US $ 294,000 per treatment. It has to be taken into account that the effectiveness of chlorination is decreased in cases of high organic loads of the ballast water (Bolch & Hallegraeff 1994). Lower dosages (e.g. 50 ppm) could be acceptable if one is willing to tolerate a small fraction of residual cysts. In order to prevent environmentally un-sound ballast water discharges after chlorination treatment a neutralisation with an additional chemical (e.g. sodium metabisulphite) is necessary and brings additional costs (Rigby et al. 1994).

4.6 Metal ions

For the use of electrolytically generated copper and silver ions estimated space requirements for a system suitable for treating 20,000 tonnes of ballast water has been given as 3 x 2 x 2 m. An equally tentative capital cost estimate of $100,000 has also been provided. Running costs largely relate to electrical power consumption and periodic electrode replacement (Müller 1995, Müller & Reynolds 1995).

4.7 Ozonation

Ozone gas is highly toxic and has an odour detection threshold of about 0.01 ppm. A high level of safety measures and related costs, including monitoring of carbon scrubbed vented gas, therefore have to be adopted with its use. Capital costs of O_3 generation units are high when compared to chlorine systems. Equipment for the generation of O_3 to treat 4,000 m³ per hour is likely to cost in excess of US $ 2;9 million, whilst a chlorine dosing plant for the same treatment volume is less than US $ 376,500 (AQIS 1993). Operation and maintenance costs are very much higher than for chlorine (Reynolds et al. 1989). In addition to the associated high costs of this treatment it has been assumed that O_3 may be a potentially corrosive agent in ballast systems (Flemming 1991, Carlton et al. 1993).

4.8 Hydrogen peroxide

A concentration of 5,000 ppm for 24 hours application is needed. It is estimated that 150 tonnes of 35 % hydrogen peroxide are needed to treat the ballast water of a 50,000 t vessel. The costs involved were summarised as $A 2 million per treatment. Not only the high costs involved make this option un-acceptable, but it was documented that during high organic load of the ballast water the effectiveness is decreasing (Bolch & Hallegraeff 1994).

In another example costs are calculated for a bulk carrier containing 50,000 tonnes of ballast water requiring 1,000 tonnes of hydrogen peroxide (as an industrial 50 % aqueous solution costing approx. US $ 2,940 per tonne) resulting in US $ 2;9 million per voyage. Lower concentrations may be acceptable for some cysts or for extended periods of time. But even concentrations of 50 ppm seem to be very expensive (US $ 14,700 for 50,000 tonnes of ballast water) (Rigby et al. 1994).

4.9 Salinity adjustment

To treat the ballast water with an adjustment of salinity enormous volumes of NaCL are needed. For a small vessel 210 tonnes. The treatment material is high corrosive (Bolch & Hallegraeff 1994) and may damage ballast tanks, holds or pipework. Additional costs result in delays during loading 210 tonnes bulk material and storage on board

4.10 Organic biocides

The costs involved concerning biocide treatment are known in two cases: the bacterial treatment on Norwegian oil drilling platforms and the treatment of the introduced Sea Lamprey in the Great Lakes.

4.10.1 Bacterial treatment

Treatment of the injection water of Norwegian drilling platforms in the North Sea started two decades ago. The price per treated tonne injection water was in the 1970s approximately US$ 0.12. The price was reduced to US$ 0.0184 per ton today. The sixfold price reduction was possible by the use of alternative chemicals. Monitoring in addition had made a more optimal dosage possible (Jelmert pers. comm.).

4.10.2 Sea Lamprey

Introduced into the Great Lake system the sea lamprey has to be controlled each year by the application of chemicals to treat their larvae (Morse 1990). Costs involved in the chemical control and habitat modification summarised to more than US$ 100 million in 1993 (Leach 1995, Cangelosi pers. comm.).

4.11 Land-based facilities

The calculation of the costs was based on the need of 11,5 million m³ of ballast water that has to be treated per year. The equipment costs (including tanks, filtration units, UV-system, chemical application system, residual treatment and control) were estimated for a 52,000 m³ treatment plant to US $ 13;2 million up to US $ 27;9 million The operational costs per 1,000 m³ of ballast water were estimated as US $ 132 (including chemicals, electric power, maintenance, manpower, testing and residual disposal). Total costs were estimated as US $ 500 - 900 per 1,000 m³ of ballast water (AQIS 1993).

4.12 Shipboard treatment

The calculation of costs was based on the need of 0,5 million tonnes of ballast water that has to be treated per annum (in average one vessel per month).

4.12.1 Commercial vessels

The estimated capital costs to install e.g. a filtration unit (see below) for ballast water treatment are extremely high and therefore this method will probably not be established (AQIS 1993).

4.12.2 Treatment vessels

The costs involved for the floating treatment facilities were estimated as US $ 30;9 million based on a treatment capacity of 4,000 m³/h. This estimation includes purchase of the vessel (second hand), ship modifications and installation of (several) treatment units as well as additional pipework and power supply. Costs to operate the ship-based treatment were estimated as US $ 400 per 1,000 m³ and total costs summarise to US $ 790 per 1,000 m³ (AQIS 1993).

It has further been estimated that several land-based treatment plants (connected to the vessels by pipework or serviced by barges which collect the ballast water from the vessels discharging it later to the treatment plant on land) and treatment vessels were needed. The total costs to install treatment facilities (land-based and ship-based) in major Australian ports was estimated as US $ 470.4 million (AQIS 1993).

5 Ballast water regulations and associated guidelines in place and planned

Ballast water management and control regulations and associated implementation guidelines are being developed by IMO. IMO is concerned in regard to uni-lateral actions that have been developed or are considered by port states regarding the control of ballast water discharge in their ports or in areas under their jurisdiction. Currently there is no cost effective, technically sound, safe and environmentally safe treatment method for ballast water available. It should also be noted that the IMO voluntary international ballast water guidelines (resolution A.774 (18), since November 1997 replaced by resolution A.868 (20) have so far been applied in a relatively small number of countries only.

5.1 Intergovernmental requirements to deal with ballast water and / or non-indigenous species

In fact there are a number of recommendations and guidelines in place or under consideration in various regions dealing with non-indigenous species:

To regulate the working with non-indigenous species internationally several international working groups were formed. The first initiative which was supported 1969 of the American Fisheries Society and the Society Of Ichthyologists And Herpetologists was the Invitational Conference On Exotic Fishes And Related problem (Lachner et al. 1970, Kohler & Courtenay 1986). Several quarantine methods for the import of exotic species were developed.

An increasing number of countries have become aware of non-indigenous species and their potential threats posed to the environment, human health and economy as shown. The need to take common action has been recognized with several taxa, e.g. at the expert workshop on introduced species organized by DG XII and CIESM in Monaco 1993 (European Commission 1994). At the International Council for the Exploration of the Sea (ICES) Annual Science Conference at Aalborg, Denmark in 1995 the ballast water issue was the opening theme session and documenting the international interest and importance of this issue. ICES´ Advisory Committee on the Marine Environment (ACME) identifies introductions and transfers of non-indigenous organisms as one of the six major environmental issues within the ICES area over the next decade (ICES 1995).

Risks in relation to transfers of harmful species by aquaculture in ICES member countries are now considerably reduced because deliberate introductions of species should follow the 1994 ICES Code of Practice (see attachment). As to minimize the risk of negative effects of introductions through aquaculture, six countries (Ireland, Island, Norway, Spain, The Netherlands and the United Kingdom) reported that the ICES Code of Practice is applied. Germany and Sweden are well aware of the Code of Practice, but the extent of this application is uncertain.

Among most of the following regulations marine introductions are largely ignored. This points out the need for an international and effective regulation to deal with non-indigenous species introduced by shipping as one of the most important factors for unintentional introduction into aquatic environments.

HELCOM

The Helsinki Commission which administrates the Convention on the Protection of the Marine Environment of the Baltic Sea Area, at its 16th meeting in 1995 considered the issue of unwanted organisms in ballast water as a matter of highest priority of Helcom Activities (item 15).

EC, Environment Committee, Marine Committee (MC) (MC 21/15)

Paragraph 5.1 The Committee noted document MC 21/5/1, submitted by Russia, concerning the proposal for a Baltic Strategy related to harmful marine organisms in Ballast waters.

Paragraph 5.3 Furthermore, the Committee encouraged the Contracting Parties to apply the IMO Assembly Resolution A.774 (18) for preventing the introduction of unwanted aquatic organisms and pathogens from ship´s ballast water and sediment discharges (Assembly Resolution A.774(18)) and to submit information on experiences in their application to the next meeting of the Committee.

OSPAR

The OSPAR commissions responsible for the administration of the Oslo and Paris Conventions for the Prevention of Marine Pollution concerned the hazards caused by non-indigenous species on the agenda of the Working Group on Impacts on the Marine Environment (IMPACT). At IMPACT 1996, Sweden presented an overview on national activities concerning non-indigenous species in the Convention Area. IMPACT 1996 made a number of proposals concerning non-indigenous species to its parent committee ASMO (Assessment and Monitoring Committee) e.g.: a report on non-indigenous species should be updated and included into the Quality Status Report of the Convention Area prepared for the year 2000. The monitoring of non-indigenous species will also be included in the Commissions Joint Assessment and Monitoring Programme (JAMP) and ICES has been requested to consider a reporting format for non-indigenous species.

EIFAC

The EIFAC (European Inland Fisheries Advisory Commission of the Food and Agricultural Organization of the United Nations) Code of Practice was adopted in 1987 dealing with quarantine measures of intentionally introduced species.

ICES

In 1991 the ICES (International Council for the Exploration of the Sea) Code of Practice to reduce the risks of adverse effects arising from introductions and transfers of marine organisms was prepared by the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) (see above and attachment).

IMO

A first guideline for Preventing the Introduction of unwanted Aquatic Organisms and Pathogens from Ship´s Ballast Water was adopted in 1991 by the Marine Environment Protection Committee (MEPC) of IMO. The Ballast Water Working Group prepared new guidelines which were adopted by the IMO Assembly in 1997 (see below and attachment).

Bern Convention - Convention on the Conservation of European Wildlife and Natural Habitats, 1979, requires that parties shall undertake to strictly control the introduction of non-native species, Article 11.2.

Council Directive 79/43/EEC of 2nd April 1979 on the Conservation of Wild Birds
Member States shall observe that any introduction of bird which does not occur naturally in the wild state in the European territory of the Member States does not prejudice the local flora and fauna.

United Nations Convention on the Law of the Sea, 1982
Article 196 provides that States shall take all measures necessary to prevent, reduce and control the intentional or accidental introduction of non-indigenous species, or new, to a particular part of the marine environment, which may cause significant and harmful changed thereto.

Bonn Convention - Convention on Nature Conservation and Landscape Protection, 1982
States have to prevent, control or eliminate non-indigenous species that are detrimental to the migratory species of wild animals (Article III.4 and Annex I, Article V.4)

Benelux Convention on Nature Conservation and Landscape Protection, 1982
The Benelux Convention provides that Benelux governments prohibit introduction of non-native species into the wild without authorisation (Article 11)

Barcelona Convention 1982
The Convention addresses the subject non-indigenous species and associated impacts in respect of protected areas. The protocol concerning the Mediterranean Sea as a specially protected area obliges Parties to take measures in order to protect these areas. The measures may include the prohibition of the introduction of exotic species and the regulation of the introduction of zoological and botanical species in protected areas.

The Recommendation No. R(84) of the Council of Europe. Ministers of the Member States Concerning the Introduction of Non-Indigenous Species did not focused especially on the aquatic environment.

EC Council Directive 91/67/EEC

All EU member countries have to comply with the EC Council Directive concerning health requirements for the translocation of aquaculture concerning the animal health conditions governing the placing on the market of aquaculture animals and products). The directive allows the free movement of live fish and shellfish across national borders between cultivation units and zones of similar health status.

Convention on Biological Diversity, 1992

In the Convention on Biological Diversity (Article 8.h.) Parties undertake to "prevent the introduction of, control or eradicate those non-indigenous species which threaten ecosystems, habitats or species" as far as possible and appropriate. This convention has been ratified by 148 States and the European Community (1996) and offers therefore an opportunity to approach globally the issue of intentional and unintentional introductions of non-indigenous species and their eradication and control (Glowka & de Klemm 1996).

Council Directive 92/43/EEC of 21st May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora

Member States shall ensure that deliberate introduction of any non-indigenous species into the wild is regulated so as not to prejudice natural habitats within their natural range or the wild native fauna and flora and, if they consider it necessary, prohibit such introduction (Article 22.b).

Agenda 21

In 1992 the United Nations Conference on Environment and Development (UNCED) provided in Agenda 21, Chapter 17 on the Protection of the Oceans and All Kinds of Seas that IMO consider "the adoption of appropriate rules on ballast water discharge to prevent the spread of non-indigenous organisms".

The Recommendation No. 45 of the Council of Europe on controlling proliferation of *Caulerpa taxifolia* in the Mediterranean Sea. The recommendation was adopted in 1995. It was recommended e.g. to control *C. taxifolias* spread by routine exploration, eradication of colonies and spread the information in countries not Party of the Bern Convention.

EC Regulation No. 338/97

The new EC regulation on the protection of species and wild fauna and flora by regulating trade therein - CITES (The Convention on Trade in Endangered Species) - 338/97, contains specific reference to the control of non-indigenous species. Article 3(2)(d) States that Annex B shall contain "species in relation to which it has been established that the introduction of live specimens into the natural habitat of the Community would constitute an ecological threat to wild species of fauna and flora indigenous to the Community". Such species will therefore require import and export permits (Article 4(2)(a)) and impose restrictions on countries of origin (Article 4(6)(d)). To date the only species added to Annex B specifically for this purpose are the American Bullfrog and the red-eared terrapin, both traded by the pet shop trade with invasive capacities (seen in the UK).

IUCN

In 1987 a Position Statement on Translocation of Living Organisms was compiled for the International Union for Conservation of Natural Resources (IUCN) this organization prepared a updated position statement on trade in non-indigenous species for the CITES Conference of the parties in June 1997, supporting a proposal by the USA and New Zealand encouraging CITES to: "recognize that non-indigenous species can pose significant threats to biodiversity...; recognize that CITES may play a significant role in this issue; and other recommendations... including implementation of IUCN´s Invasive Species Specialist Group guidelines for the prevention of biodiversity loss due to biological invasions (Report of the ICES WGITMO, La Tremblade, France 1997).

5.2 National regulations in place

In addition to the listed guidelines, regulations and requirements for the control and management of ships` ballast water some countries have established ballast water regulations:

5.2.1 Europe

The IMO Assembly Resolution A.868 (20) is to be applied in Sweden in national law as voluntary guidelines. Spain, Ireland and the Netherlands consider the implementation of the IMO Assembly Resolution A.868 (20) or any national regulations. Ireland is planning to regulate the ballast water discharge at the oil terminal of Bantry Bay. Authorities in the Netherlands are awaiting results from a research project currently carried out as an initial desk study (see above) and probably extended for ship sampling as well as results from a co-operative ship sampling of ships calling for Rotterdam and ports in the Chesapeake Bay region.

United Kingdom

The United Kingdom has some kind of practice in place to minimize the risk of unintentionally introduced species via ship´s ballast water. Compliance with IMO Assembly Resolution A.774 (18) was requested by 10 of 66 ports. A national quarantine procedure in regard to ballast water management is used in 4 of 66 ports (Macdonald 1994).

At the time of these surveys the ports applying procedures in compliance with IMO Assembly Resolution A.774 (18) were Flotta, Glensanda, Hound Point, Nigg, Sullom Voe, Barry, Berwick, Cardiff, Fowey and Milford Haven, i.e. 10 ports of the 66 (UK total) where ballast water is discharged.

The United Kingdom has developed management policies on ballast water to protect the marine environment. In Scotland, planning applications associated with he development of coastal activities have brought this issue in the public spotlight. In addition to the introduction of organisms from abroad the marine environment managers are aware of the possibility of secondary transport within the United

Kingdom. Various agencies require advice on ballast water management strategies for example in relation to coastal planning applications or in the case of port authorities reviewing or designing ballast water management and treatment options (Macdonald & Davidson 1997).

A questionnaire was sent to 127 ports in England and Wales, 111 (87.4%) of which responded. Ballast water is discharged into just under half (48.7%) of ports in England and Wales. Most ports (79%) have no policy or regulations on management of ballast water discharge. Of the 13 ports which do have regulations, these are mainly related to operational safety. Only five ports request ships to apply IMO Assembly Resolution A.774 (18) on ballast water management now replaced by the IMO Assembly Resolution A.868 (20) (Laing pers. comm.).

5.2.2 Israel

Israel requires, since 1996, that a ship must exchange any ballast water on board which was not pumped on board in open ocean. Ships visiting the port of Eilat must exchange their ballast water outside the Red Sea and those visiting Mediterranean ports of Israel must exchange ballast water in the Atlantic ocean. It was noted that the best way to exchange the ballast water is in the open ocean, beyond any continental shelf or freshwater impact. Vessels failing to comply will not be permitted to exchange ballast water in Israelian waters. It is expected that a record of location, date and time of the ballast water exchange in open ocean waters should be documented in the ship´s log book or other suitable documentation as e.g. an official record book on ballast water operations. Ship masters are requested to complete a ballast water exchange report (State of Israel, Ministry of Transport, Administration of Shipping and Ports, Notice to Mariners No. 4/96, Galil & Hülsmann 1997).

5.2.3 North America

Canada and the USA applied the IMO Assembly Resolution A.774(18).

5.2.3.1 Canada

The Canada Shipping Act (CSA) does currently not include federal regulations concerning the prevention of harmful introductions of non-indigenous species through ballast water or sediment discharges. However, the following guidelines and area specific requirements are currently applied:

- Notices to Mariners #995 has imposed ballast water discharge restrictions for the Grande Entrée Lagoon of the Iles-de-la-Madeleine to reduce the threat of introduction of toxic phytoplankton to local mussel farming industries since 1982. Discharging of ballast water within 10 nautical miles of the Islands is prohibited unless the ballast water were pumped on board in a designated area off Canada's east coast at minimum distance of 5 miles from the shore;
- The governments of Canada and the USA signed the Great Lakes Water Quality Agreement in 1987. This agreement was established to co-operate in development and implementation of Remedial Action Plans, Fishery management Plans and lakewide Management plans. The pollution from ships (including ballast water) was addressed in this agreement as well. The goal of the plans is the identification of necessary remedial actions to reduce pollution to the Great lakes; and
- Canadian guidelines for controlling ballast water discharge into the Great Lakes were introduced in 1989 by the Canadian Coast Guard. The Canadian Coast Guard developed these guidelines in full consultation with the U.S. Coast Guard, the Great Lakes Fishery Commission and representatives from commercial fishing. These guidelines apply for all vessels carrying ballast water with an origin from outside the Exclusive Economic Zone (EEZ, beyond 200 nautical miles from the shoreline). The guidelines encourage all vessels transiting the Eastern Canadian Region Vessel Traffic Service Zone inbound for the St. Lawrence River and the Great Lakes to exchange freshwater ballast collected in foreign harbours or near coastal waters for saltwater ballast collected from open ocean. The exchange was to occur far enough from any coastline such that the new ballast water contained few organisms, if any, that could survive in the freshwater of the Great Lakes (MEPC34/INF.22). The exchange of the ballast water has to be carried out if the required port of call lies west of 64° W longitude (SGBWS 1997). The ballast water exchange has to be carried out at depths

greater than 2,000 m. If this is not feasible ships are permitted to exchange their ballast water in a ”backup exchange zone” within the Laurentian Trough of the St. Lawrence Estuary east of 64° W longitude in water depths greater than 300 m. A ballast water exchange form has to be completed listing information on ballast water on board and compliance of the guidelines. A fine of max. CAN$ 50,000 may be imposed for providing false information (Gauthier & Steel 1996, Hartwig et al. 1996).

In addition, very recently the Vancouver Port Corporation (VPC), B.C. introduced a ballast water exchange programme. Vancouver has become the first Canadian port to make a complete midocean exchange of ballast water of all incoming ships from abroad mandatory. On arrival at the port documentary evidence of the exchange is required via a log entry or any other administrative format. Any vessel unable to provide the information is not permitted to discharge ballast water in the harbour area. These vessels will have to depart and exchange the ballast water in the outgoing current of the Strait of Juan de Fuca. Acceptable reasons for the avoidance of an midocean exchange of the ballast water are stress from weather conditions, stability or hull stresses. Vessels which used bad weather conditions as excuse for no ballast water exchange for numerous visits will be randomly sampled after reporting the midocean exchange was carried out to confirm their announcements. Following the official launch of the programme in March 1997 a nine month reprieve period will be established before the regulation becomes mandatory in January 1998. The VPC announces that the regulation have been well received by the industry as well as the community.

Recently, as a result of the preliminary draft being prepared by the Vancouver Port Co-operation a working group of the Puget Sound - Georgia Basin International Task Force, recommends that other ports in British Columbia follow the regulations of the Vancouver Port Corporation (Kieser pers comm.).

5.2.3.2 USA

Ballast water management guidelines were established for vessels entering the Great Lakes. These regulations are mandatory and will be incorporated in the Title 33 of Code of Federal Regulations (33CFR).

In 1990, the House Committee on Transportation and Infrastructure approved a proposal to re-authorise the Non-Indigenous Aquatic Nuisance Prevention and Control Act. The control act established a Aquatic Nuisance Species Task Force responsible for co-ordinating efforts related to non-indigenous aquatic nuisance species in US waters and is composed of representatives from the National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), Army Corps of Engineers, Department of Agriculture, Department of State, Environmental Protection Agency and the U.S. Coast Guard. The Coastal Waters Project, located at Rockland, Maine is attempting to further the efforts of the Aquatic Nuisance Species Task Force, particularly in the Gulf of Maine region States and North Carolina (Huber pers. comm.). The task force is responsible for developing and implementing an Aquatic Nuisance Species (ANS) Programme to prevent the introduction and dispersal of ANS, monitor, control and study ANS and disseminate related information. The ANS programme has undergone public review and was submitted to the U.S. Congress in 1993. In early 1994 the U.S. Congress has taken into account the growing problem of introduced species via ballast water discharge of vessels. The House of Representatives Merchant Marine Subcommittee approved a bill authorising appropriation of US$2 million in 1995 / 1996 to pursue non-indigenous species. In the focus stands the identification and evaluation of ballast water management technologies that could be installed on existing vessels or incorporated in constructions of new designed vessels. These technologies necessarily need to be operational practical, safe in application on board, environmentally sound, effective and of low costs (Crosby 1994, Edwards 1994).

In 1996 the Act to provide for ballast water management to prevent the introduction and spread on non-indigenous species into the waters of the United States and for other purposes (preferred cited as: National Invasive Species Act of 1996) was established on October 26th 1996 (Public Law 104-332-Oct.26.,1996).

In addition to previously mentioned aspects, the legislation also mandates the US Maritime Administration to conduct a national ballast water management demonstration programme to test and evaluate the technologies and practices identified. Currently ballast water exchange is voluntary but under the amended act any shipping line failing to exchange its ballast water will be forced to do so in the future. The salinity of ballast water is tested to verify the compliance with the required exchange of ballast water at sea. Vessels would be expected to exchange any ballast water at sea before entering US waters and ports**.** An increase of funding of over US$ 2 Million had been made available to cover costs in relation to compliance procedures, in total US$ 33.17 Million This is an indication of the tremendous costs involved controlling the establishment of non-indigenous species in your waters.

In 1992, The Coast Guard published a notice of proposed rulemaking entitled "Ballast Water Management for Vessels Entering the Great Lakes" in the Federal Register (57 FR 45591). The final regulation implements the regulatory requirements of the Non-Indigenous Aquatic Nuisance Prevention and Control Act 1990, Public Law 101-646. The Act required the U.S. Coast Guard, in consultation with the Government of Canada, to issue voluntary guidelines to help prevent the additional introduction and spreading of aquatic nuisance species into the Great Lakes through ballast water of vessels, by 1991. The U.S. Guidelines are comparable to those of the Canadian Coast Guard (see above). Including those vessels that only partial exchange, the participation by the commercial shipping industry has been estimated to be 90% of voluntary compliance as monitored through salinity measures of the ballast on board indicating the amount of ballast water exchanged in cases where the last port of call was in brackish or freshwater areas. Currently the U.S. Coast Guard carries out research in regard to a method to assess whether sufficient exchange has occurred in vessels arriving to and from saltwater ports (Carlton & Cangelosi 1997).
The regulations will replace the voluntary guidelines. The act requires that the regulation apply to vessels that enter a U.S. port of the Great Lakes after operating in waters beyond the Exclusive Economic Zone (EEZ) (in a depth of not less than 2,000 meters). The Act further requires that the regulations shall prohibit the operation of a vessel in the Great Lakes if the master of the vessel has not certified to the Secretary or Secretary's designee, by not later than the vessel's departure from the first lock in the St. Lawrence Seaway, that the vessel has complied with the requirements of the regulations. The Act provides civil and criminal penalties. Any person who violates the regulations shall be liable for a civil penalty not to exceed US$ 25,000**.** The Act provides a three year window-of-opportunity for vessels arriving in U.S. ports to exchange their water on the high seas. After this period of time the U.S. Coast Guard

will assess the level of compliance with this regulation. If levels are found to be insufficient, ballast exchange will become mandatory.

The currently most practical method to protect the Great Lakes from the introduction of unwanted non-indigenous species may exist in the exchange of ballast water of incoming vessels in the open ocean beyond the continental shelf (depth exceeding 2,000m). If this option is impossible to carry out one of the following actions have to be taken:

- return to sea and undergo ballast water operations
- retain the vessels ballast on board
- use alternative environmentally sound method of ballast water management or under extraordinary conditions (safety, weather conditions or equipment failure) discharge ballast water in designated areas. Requests of this methods have to be given to the commandant of the U.S. Coast Guard.
- discharge ballast water to land based facilities or to reception vessel

In addition:

- no sediment should be discharged from tanks or holds containing ballast water unless it is disposed of ashore
- ballast water carried in any tank containing oil or any other contaminants must be discharged in accordance with the applicable regulations.

Nothing in this regulation relieves the master of the responsibility for reinsuring the safety and stability of the vessel or the safety of the crew and passengers or any other responsibility (MEPC34/INF.22, Carlton & Cangelosi 1997).

In 1993 the U.S. Coast Guard rule requiring Ballast water management practices for vessels entering the Great Lakes after operating on waters beyond the U.S. exclusive economic zone became effective (MEPC34/INF.31).

In November 1996, the United State passed the National Invasive Species Act (NISA), which requires that vessels entering US waters from the outside the 200 mile Exclusive Economic Zone (EEZ) must exchange their ballast water before entering the EEZ. The guideline is initially voluntary, but would become mandatory after two years if compliance was recognized as insufficient.

In 1996, reauthorizing legislation expanded that programme to include all US waters and coastlines. The Coast Guard is currently developing its specific regulations pursuant to the latter statute. If they resemble the Great Lakes programme (and this is likely) they will request that vessels entering US waters after operating outside the EEZ undertake high-seas ballast exchange or an alternative ballast management measure approved by the Coast Guard which is equally effective or more effective than ballast exchange prior to entering US waters. This leaves the door open to alternate technologies as they are developed. This national protocol will be "voluntary" for at least three years, depending upon compliance under a voluntary regime. If after three years, the Coast Guard determines that compliance is not adequate then the Coast Guard must add an enforcement component to the programme. Thus, industry has the opportunity to police itself. However, if that system fails to achieve adequate participation, then the Coast Guard must undertake the policing role (which it already does for the Great Lakes) (Cangelosi pers. comm.).

5.2.4 Latin America

Panama

Discharges of any kind of ballast water is prohibited in the Panama Canal.

5.2.5 South America

Argentina

Since the beginning of the 1990s, the port authorities of Buenos Aires require a chlorination of ballast water of ships calling for their port. This binding instruction is still in practice. Chlorine is added to the ballast water via ventilation tubes of the tanks. In Argentina, inspection crews are randomly visiting the vessels in order to control the compliance with this instruction (Capt. Rabe, Capt. Katzenbach pers. comm.).

Chile

Unilateral mandatory requirements for preventing introductions of harmful organisms from ballast water are in place, adopted in 1995. The ”order for preventive measures to avoid transmission of harmful organisms and epidemics by ballast water” States that any ship from abroad is requested to renew the ballast water at a minimum distance from the coast of 12 nautical miles (Gauthier & Steel 1996, Sipes et al. (eds.) 1996).

5.2.6 South Africa

A number of exotic marine species have already become established in South African waters resulting in potential negative impacts as shown by the occurrence of the toxic dinoflagellate *Gymnodinium* sp. Because of the rapid growth of the South African mariculture business serious consideration should be given to instituting a control over ballast water discharge.

The need to protect the South African mariculture industry, South Africa is a signatory to the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL). The provisions are enacted into domestic legislation in the forms of the International Convention for the Prevention of Pollution from Ships 2 of 1986. Since it is likely that international legislation to control ballast water discharges will take the form of an Annex to MARPOL, it is important that South Africa recognized the need to give attention to this issue. An additional consideration is that there have been suggestions that ports “exporting” ballast water contaminated with potentially harmful organisms could be held liable for any subsequent damage. While the question regarding liability might be uncertain, South Africa emphasises that there would be no harm in guarding against it (Jackson in prep.).

5.2.7 Australia

In 1990, the Australian Quarantine and Inspection Service (AQIS) introduced voluntary ballast water management guidelines for ships entering Australian waters. These guidelines were formed to minimize the amount of ballast water and sediments discharged in Australian water loaded abroad. The guidelines are based on the IMO international ballast water guidelines of Assembly Resolution A.774 (18).

The Australian Ballast Water Management Advisory Council's (ABWMAC) membership consists of parties of the shipping industry, Australian Maritime Safety Authority, State and Territory Governments, seafood production industries, ports and harbour administration, Australia Quarantine and Inspection Service, research agencies and the Governments environmental management. The Council is responsible in the first instance for the provision of advice to the Minister and all relevant agencies to oversee the administration of its Ballast Water Strategy defined as: "to seek to avoid adverse economic and environmental impact of unwanted aquatic marine organism by minimizing their risk of entry, establishment and spread in Australian marine environment from ballast water and other shipping activities involving international and domestic shipping, whilst not unduly impeding trade" (Hutchings 1992, MEPC37/INF.24;1995)

P&O bulk carrier serving regularly between Australia and Japan exchange their ballast water in open ocean, during calm weather conditions where ballast water exchange places no stress on the ship and poses no threat to safety on the crew. Compliance with the guidelines is monitored by AQIS staff members. About 80 % of the ships entering Australian ports in the beginning of the 1990s reported compliance with the guidelines (Jones 1991) and 90 % of all Australian shipping industries has either entered into compliance with the arrangements of the AQIS or were in the progress of doing so in the near future. Overall 65 % of vessels claimed to re-ballast at sea and 13 % undertook not to release ballast water in Australian waters. The major non-compliers are the general cargoes and tankers with 76 % of these vessels not complying the guidelines (MEPC33/INF.26). Possibly this could reflect the fear of the Masters concern of structural stresses to the hull during mid-ocean exchange of ballast water.

Bulk carriers have a high level of compliance with the guidelines as shown by 83 %. Container vessels also have a high level of compliance with 89 %.

In 1991/1992 a random sampling programme on ships arriving Australian ports from overseas destinations was carried out. Of about 200 samples only 11 contained toxic dinoflagellates of the Alexandrium spp. Most of these samples were taken out of ballast water of Asian origin, mainly from ports in Japan, China and Korea (MEPC33/INF.26).

5.2.7.1 Australia's International Guidelines for Shipping

Strategies for Minimizing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ship's Ballast water and Sediment Discharges

These guidelines include e.g. ship operational procedures as ensure to load clean ballast, avoid taking on ballast water in shallow areas, areas of dredging, areas with known outbreaks of diseases or phytoplankton blooms. When taking on ballast water records should be made upon date, geographical location, salinity and amount of ballast water taken on board. All sources of sediment on board (e.g. anchors, cables, chain lockers) should be cleaned. In addition, options for ballast water management are listed:

- non-release of ballast water wherever possible
- ballast water exchange and sediment removal in deep ocean areas
- produce evidence of the re-ballasting at sea en-route
- if at sea exchange of ballast water is not possible, carry out flow through exchange
- designate a responsible officer on board familiar with the procedures which should be included into the ship's operational manual.
- document actions that have been taken

In cases appropriate control actions have not been taken, the vessel is allowed to discharge its ballast water normally based on risk assessment results taken into account the type of vessel, its origin, risk factors at the port of entry including tidal flow and distance to aquaculture facilities or withholding discharge until samples of water / sediments are taken, analysed and fount free of harmful organisms or giving the vessel the option of departing Australian territorial waters to carry our appropriate re-ballasting. In exceptional circumstances operations may be carried out in Australian territorial waters after agreement with AQIS and after consultation with State and local authorities (MEPC37/INF.24;1995)

5.2.7.2 Australian Coastal Ballast Water Guidelines

The Australian Agricultural Council agreed in 1991 upon a need for coastal and interstate shipping. The Australian Coastal Ballast Water Guidelines were formed.

As international guidelines do not provide a satisfactory solution for the majority of domestic coastal vessels, additional guidelines were developed to minimize the spread of harmful exotic marine organisms between ports. A system should be introduced for the management of ballast water that is taken in Tasmanian waters by vessels that afterwards call for other Australian ports. This practice could minimize the translocation of the Northern Pacific starfish and Undaria seaweed to other Australian ports. The system should also apply immediately to any other port where a toxic algal bloom exists or becomes present.

The guidelines consist of the following options:

- port authorities will inform other ports the presence of toxic algal blooms
- port authorities are being made responsible for issuing permission to ship's masters for the discharge of any ballast into their ports
- use of certification of port contamination / health / clearance from the ballasting port
- effective management for the uptake of ballast water in contaminated ports minimize the risk of uptake of this species on board the ballasting vessel
- re-ballast at sea or in defined areas or taking on ballast from "clean areas"
- on board in-tank treatment systems (not currently available)
- commitment not to discharge ballast water
- discharge ballast in defined areas

Other optional practices include avoiding taking on ballast during toxic algal blooms or in shallow areas, ensurance that ballast water is free from sediment wherever possible, ensurance that ballast tanks are being kept clean, ballasting of freshwater during toxic algal bloom if available (MEPC37/INF.24;1995)

5.2.8 New Zealand

After initial research in 1989 the Cabinet Environment Committee directed officials from the government departments to develop a policy that will minimize the risk of the introduction or establishment of exotic marine organisms through the discharge of overseas ballast water. The New Zealandian Ballast Water Working Group (BWWG) decided in 1991 that in the interim the most practical and effective way to restrict ballast water discharge would be to institute a set of voluntary controls on the discharge of overseas ballast water within New Zealand. Modified guidelines from Australia were used in order to rapidly implement this policy. The guidelines are in place since March 1992. The purpose of the guidelines was to:

- reduce of the amount of overseas ballast water discharged in New Zealand;
- collect information from vessels that would outline the scope of the problem; and
- inform the international shipping community on New Zealand views on the issue of ballast water discharge.

It was recognized that an immediate ban on the discharge of ballast water with overseas origin was not suitable because of safety aspects. As New Zealand is dependent on international shipping and an immediate ban could preclude some vessels visiting the country.

The voluntary guidelines contain the following aspects:

Ballast water which had been loaded in the territorial waters of other countries should not be discharged in New Zealand waters without reporting to an inspector (border protection officer, of the Ministry of Agriculture and Fisheries) prior to discharge.

Evidence of the origin of the ballast water to be discharged should be given to the inspector and certification from a government or other approved agency that the water and seabed of the port at which the ballast was loaded has been tested within the previous 6 months and found to be free of toxic dinoflagellates, or documented evidence existed that the ballast water has been exchanged at sea on route to New Zealand, or documented evidence was given that the ballast has been disinfected.

If the vessel cannot provide documented evidence of the origin of ballast water and requires to discharge ballast water in New Zealand waters the ballast water should be discharged into an onshore facility or should be treated prior to discharge, or should allow a representative sample of the water to be taken for testing for the presence of

toxic dinoflagellates. A nil result would allow ballast discharge in situ. In addition no sediment or mud from the cleaning of holds, ballast tanks or anchor lockers may be discharged in the sea in New Zealand without the permission of an inspector.
Since March 1992 officers of the Ministry of Agriculture and Fisheries have been monitoring compliance with the voluntary controls and collected data on the ballast discharged. In total 35 % of the vessels comply with the voluntary controls by exchanging their ballast water at sea; 57 % claim to comply by not having to discharge overseas ballast water while in New Zealand waters and 7 % cannot or will not comply. In-between the 7 % which did not comply the following reasons for doing so were noted: vessel to old to consider juggling the ballast, controls are voluntary (one master only), not aware of controls, sea conditions to rough for safe ballast exchange at open seas, master believes that ballast water from the Pacific Islands is safe and ship incapable of complying this voyage.
In addition to the Ministry of Agriculture and Fisheries the Department of Conservation has interests in ballast control stemming from two pieces of legislation:
- the Conservation Act which is an Act to promote the conservation of New Zealand's natural and historic recourses; and
- the Resource Management Act the purpose of which is to promote the sustainable management of natural and physical recourses.
The Ministry for the Environment administers two statutes relevant to the control of ballast water discharge: the Environmental Act of 1986 and the Resource Management Act of 1991 (MEPC34/INF.3)

Controls are voluntary, i.e. there is no regulatory obligation to comply. However, where a specific biosecurity risk is identified, controls may be enforced. For example, following the discovery of the Pacific Seastar in Tasmania, the New Zealand imposed mandatory controls on discharge of ballast water from Tasmania. Controls on the discharge of sediment from overseas vessels are also mandatory. Sediment from the cleaning of holds, ballast tanks, or anchor chains can only be disposed of in a landfill approved by a New Zealand border official.

In 1998, New Zealand plans to formalise its controls through the introduction of an Import Health Standard (IHS) under the Biosecurity Act 1993. An IHS describes the conditions which must be met, in respect of biosecurity risk, before any "risk goods" may be brought into New Zealand. The IHS will be developed in consultation with the shipping industry and other stakeholders. It will outline New Zealand's requirements for ballast water discharge and options to satisfy an Inspector. The desired outcome is that water that does not comply with this standard will not be discharged within New Zealand territorial waters.

An IHS provides the regulatory approach called for by most of the submissions on the 1996 Public Discussion Paper. However, it is not intended to impose sanctions (e.g. fines etc.) immediately, unless a specific organism present in a specified overseas port is considered a risk to New Zealand as is currently the case for northern pacific seastars from Tasmania. These instances will be made known to mariners (Ministry of Fisheries, New Zealand 1997)

6 Further approaches in development

6.1 Risk assessment

A structured approach to decision making concerning the risk posed by individual vessels is highly desirable for the effective administration of any country's ballast water management regime. Critical factors can be taken into account concerning the potential risk posed by any vessel voyage and as a consequence the action required of an individual vessel (MEPC40/INF.7).

6.1.1 Decision Support System

As a possible way of minimizing the risk of introducing non-indigenous species with ballast water, Australia has proposed a Decision Support System. This system is designed to evaluate the risk posed by each incoming vessel due to arrive in a given port. The Decision Support System is composed of a risk assessment system and a decision support framework. The risk assessment component takes into account such criteria as the port of uptake of the ballast water (climate and species composition), the treatment of the ballast water en-route, the tolerance of the species which could have been taken onboard with ballast water and transported to the area of planned discharge and the estimated survival rates of the species in the ballast water during its voyage. The estimation of the survival rate is based on results achieved through sampling a ballast tank before departure as well as immediately after the ballast water uptake and further respectively during the voyage. Other factors in this estimation are the length of the journey and the daytime of the ballast water uptake. Several studies sowed that with increasing time in the ballast tank the number of species and specimens decreased dramatically. The importance of the daytime of the ballast water uptake is due to the daily migration of species in the water column.

Vessels calling for Australian ports may come from more than 300 ports of 53 counties around the world introducing approx. 121 million tons of ballast water each year (Jones 1991, MEPC35/INF.19). In addition over 4,000 vessels per year move more than 34 Million tonnes of ballast water between Australian ports. The volume of water from overseas origin released in Australian waters is an indicator of the potential for further species introductions. The degree of risks depends also on the characteristics of the port of origin and port of arrival. Two very serious introductions to Australia (i.e. the toxic dinoflagellate *Gymnodinium catenatum* and the Japanese kelp *Undaria pinnatifida*) have occurred near the port of Triabunna (Tasmania) despite the fact it receives relatively little ballast water.

Any vessel that is considered to be of high risk might be required to follow a port authority contingency plan. A generic plan has been developed under Australia's strategic ballast water research programme (see above) which gives details for the procedure of safe de-ballasting in designated areas close to the port of call. The Decision Support Framework is a computerised programme summarising data input from the vessels as ballast water uptake and ship design. The programme is available on an internet server allowing agencies to add and extract data to enable decisions to be made on the potential risk involved. One key advantage is that a decision of the risk involved may be made prior the arrival of the vessel in Australian waters which enables the ships` crew to take action in advance (MEPC40/INF.7).

6.1.2 Port sampling, define hot spot areas

Monitoring species present in port waters could help to assess the risk involved with the uptake of ballast water. Monitoring carried out at least weekly, the ballast water uptake during the presence of phytoplankton bloom or mass occurrences of other (target) species could be avoided especially for ships departing port areas located in the same climate zone as the originating port of the ballast water.

6.1.3 Sampling an board

Ships could carry out sampling and analysis on board and send the results ahead to the port authorities of the next port of call. Each sample would have to represent the abundance of species of the entire ballast tank. In the case of container vessels, even if the crew knows which tank they were going to discharge in the next port of call, 10 different ballast water tanks might necessarily to be sampled.

A good sample would require on board manual to ensure the sample quality. The standardisation of sampling methods and especially marked sampling points for each type of ship **or preferred each single vessel** will be needed in order to standardize sampling procedures. A concerning manual will be prepared by the ICS and INTERTANKO listing (e.g.) sampling points on board and procedures for managing ballast on board (MEPC39/7/3).

In addition to the location of the sampling points a standardisation of sampling methods, including size and meshsize of the plankton net, number of hauls, depth of the sample, number of samples etc. is needed.

A larger problem will probably shows up after sampling. Each sample should be examined by an trained expert at least in determining its content as compared with a list of chosen target species. Because the time schedule on board is pressing additional manpower of trained experts as part of the crew in determining species is probably needed.

6.1.4 Target species

6.1.4.1 Australia

A list of target species representing high risk species, compiled by Australian scientists and authorities is in preparation. At present Australia's target species, recognized as harmful and unwanted, are:

- toxic dinoflagellates (e.g. *Gymnodinium catenatum, Alexandrium* spp.)
- North Pacific Seastar (*Asterias amurensis*)
- Cholera (*Vibrio cholerae*)
- Japanese Kelp (*Undaria pinnatifida*)

- Giant Fan Worm (*Sabella spallanzani*)
- European Shore Crab (*Carcinus maenas*)
- fish pathogens

The list will be modified from time to time as additional information is available (Paterson 1996. Lockwood pers. comm.).

From a ballast water management perspective, the capacity to rapidly screen ballast water samples and identify target species is crucial. Delaying the unloading of a vessel while testing is undertaken is likely to be costly to the shipper and may cause major problems of scheduling for port authorities. Ideally therefore, a testing or screening procedures should be: quantitative; suitable for use by non biologists outside a laboratory setting; and rapid (a turn round time of less than 3 hours). Currently there are no screening or testing procedures available that meet these requirements. Scholin *et al.* (1995) reviewed the feasibility of developing a rapid diagnostic test for cyst-forming dinoflagellates in ballast water. They concluded that while tests that met the criteria could be developed within 1–3 years, the costs involved could range as high as US$ 500,000. To date no similar review has been undertaken for other target species. In most cases identification of phyto- and zooplankton species require microscopic identification by specialists in the laboratory and positive identification of pathogens generally requires histological examination and / or laboratory culturing. Such procedures usually have turn-round times of a minimum of several days.

The occurrence of the introduced **North Pacific Seastar** (*Asterias amurensis*) in the Port of Hobart provides an opportunity to assess the effectiveness methods for sampling target species in ballast water and to test the application of rapid genetic screening techniques for the identification of larvae. CRIMP has an ongoing sampling programme for larvae of *Asterias* in the Port of Hobart which provides information on the seasonal abundance of larvae in port waters and earlier this year initiated a project to develop methods to genetically "finger print" *Asterias* larvae using PCR amplification techniques. It is anticipated that this technique will be ready for testing on larvae in ballast water samples soon.

Larvae in the Derwent Estuary reach peak concentrations in excess of 300 / cu. m and ballast loaded in the port during this period is almost certain to contain seastar larvae. Selected vessels will be sampled following ballasting in the port to establish concentrations of seastar larvae in ballast loaded at different times throughout the breeding season. If possible larvae will be resampled in deballasting ports to provide some initial data on the survival of *Asterias* larvae in ballast tanks. As this component will commence before sampling protocols have been fully assessed, standard water column sampling methods (nets or pumps) will be used for initial sampling. Material for genetic screening will be fixed in alcohol for PCR amplification and mDNA analysis. The possibility that this sampling programme will form part of a collaborative project with New Zealand agencies (Sutton, Martin pers. comm.).

6.1.4.2 USA

Information on North American target species are available at the internet site of The Nature Conservancy entitled America's Least Wanted: Alien Species Invasions of U.S. Ecosystems (http://www.consci.tnc.org/library/pubs/dd/toc.html).

Biological pollution, in the form of exotic species, is now one of the leading threats to the ecological integrity of our forests, grasslands, and waterways. Surprisingly, these exotic species often strike at the heart of those natural lands and waters that we most cherish-our national parks and nature preserves. They also are pushing many of our rarest plants and animals even further toward the brink of extinction.

These non-indigenous species arrive here in many ways. Some are the product of misguided efforts to correct other environmental problems. Many non-native fish species were introduced for sport or recreation. Many more, however, end up here as accidental stowaways, having hitched a ride in mail, cargo, ballast water, or even by slithering into aircraft landing gear. With expanding global travel and trade, opportunities for such unwanted guests are only increasing. The Congressional Office of Technology Assessment found that about 15 percent of non-native species do cause severe harm to our economy or ecology. This report entitled ”America's Least Wanted”, focuses on those intruders that threaten our nation's rich natural heritage.

The economic and ecological consequences of surrendering our shores to these foreign invaders make controlling them a national imperative. Safeguarding the United States' natural heritage from harmful non-indigenous species requires work on four fronts:

1. Prevention of Additional Introductions. The best and most cost-effective solution is to prevent the arrival of new non-indigenous pests in the first place. Once exotic species gain a foothold in a new area, they often are capable of spreading with breathtaking speed, making eradication and control efforts difficult or impossible-and almost always costly. One way to prevent the spread and introduction of fouling species (as e.g. Zebra Mussels or Hydrilla) is to clean boats and boating equipment before transporting them from one water body to another. Leave behind unused bait and bucket water. Clean your boots and camping gear before setting out for other regions or countries, and again before returning home. On horse-packing voyages, make sure that feed is certified weed-free.
2. Early Detection and Eradication of New Pests. Finding new outbreaks early, together with aggressive eradication campaigns, is the next best solution. Attacking the problem while it is still small and limited in range offers the prospect of total elimination, saving both money and natural resources.
3. Control and Management of Established Problem Species. If the invaders cannot be eradicated, or already are established, containing their spread and controlling their numbers can help minimize their effects on natural systems and biological diversity. Control efforts can vary enormously, relying on mechanical, chemical, or biological means, or employing environmental management strategies. Fighting exotic species within natural areas or around endangered species, however, presents special challenges to ensure that the control measures do not inadvertently cause further harm to these sensitive species or systems.
4. Protection and Recovery of Native Species and Ecosystems. Controlling problem species is not enough; the affected native species and ecosystems also must be restored and protected. Simply removing non-indigenous species without working to repair or restore the ecosystem conditions often leaves natural areas susceptible to re-invasion by the same or other pests.

The "**Dirty Dozen**" is a gallery representing some of America's least wanted non-indigenous species. Although these 12 intruders differ from each other in many ways, all share a common trait: they spell trouble for our native species and ecosystems. The "Dirty Dozen" were chosen for this dubious distinction because they exemplify the worst of a bad lot. The species profiled here depict an array of different organisms (plants and animals), a variety of ecological systems (terrestrial, freshwater, and marine), and a wide geographical range-from Hawaii to Florida, and Maine to California:
Zebra Mussel, Purple Loosestrife, Flathead Catfish, Tamarisk, Rosy Wolfsnail, Leafy Spurge, Green Crab, Hydrilla, Balsam Wooly Adelgid, Miconia, Chinese Tallow and Brown Tree Snake (The Nature Conservancy 1998).

6.1.4.3 Nordic Countries

The finish study on Risk Assessment of Marine Alien Species in Nordic Waters will study beside other items (see above) the application of risk assessment models to one or more key / target species. A semi-quantitative model (low - medium - high risk) will be identified and applied to a vector of introduction and a target organism. Relevant parameters should be described, and data needs and availability identified. A tentative list of parameters for ballast water introductions could include, but not be limited to; vessel ballasting characteristics, ballast water treatment applied (if any), characteristics of donor and receiving ports or geographical areas, voyage route and duration, relevant biological information for the key / target species. Information on the key / target species could include, but not be limited to; environmental requirements such as temperature, salinity, and light / energy requirements during different stages of the life cycle (including resting stages), habitat requirements, known biotic interactions

7 Implementation problems / Removal of Barriers

The need to develop ballast water regulations of any kind is being demonstrated by the great number of non-indigenous species that have been intentionally and accidentionally introduced all over the world.

The IMO considered this matter as a global issue, emphasizing further the necessity to find a globally applicable effective, inexpensive and environmentally sound treatment option for ballast water.

7. 1 Public awareness

In some countries awareness concerning the unintentional introduction of species and their potential harmful and sometimes disastrous impacts are unknown and need to be developed. One step forward would be the distribution of case histories on introduced species. In this way the potential negative impacts of such species introductions can be shown. Beside negative ecological impacts and commercial interests, the human health may be threatened as listed in chapter 2.

After creating awareness relevant to the issue, the next important and possibly most problematic fact would be to solve financial problems in regard to this matter.

Financial problems in relation to the establishment and implementation of ballast water treatment facilities or control measures do occur. The development of an inspection authority for the control of activities to minimize the risk of unwanted species introductions by ballast water is needed. In North America the Canadian and United States Coast Guards, in Australia the AQIS supervises the application of appropriate treatment or management options concerning ballast water on incoming vessels.

It seems to be complicated to develop such institutions, especially in countries which are not financially or politically stabilised. The identification and removal of barriers that permit the implementation of effective guidelines in developing countries is needed.

7.2 Financial aspects

The control of un-intentional ballast water imports will probably pay off in the longer run due to the minimization of negative ecological and ecological impacts. Costs for the implementation and control of ballast water treatment options or management strategies will result in benefits in regard to species which have not been able to establish. Especially the mariculture industry, as well as the touristic and other users of the sea will be effected by unintentionally introduced species introduced via shipping. The volume of trade of such businesses can be important to the economy of the entire country itself. In 1988 the world total aquaculture production was estimated to provide 14 million tonnes of food (FAO 1990).

If one of these industries is affected, impacts could results in nation-wide problems as shown in the Black Sea by the decrease in the anchovy fishery after the unintentional introduction of the ctenophore *Mnemiopsis leidyi* (see above). On the other hand, an introduction of a disease agent affecting target aquaculture species would result in a loss of mariculture harvest.

7.3 Political aspects

Other reasons to establish ballast water guidelines are the need to reach agreement on options in a region. To solve the problem in a comparable way in order to prevent international trade competition due to different costs involved in carrying out the required regulations. This approach would assist to prevent a decrease of ships calling for ports where the guidelines are implemented on a mandatory basis when at the same time neighbouring countries would not require any ballast water treatment or management control measures.

8 Recommendations

All non-native species are potentially harmful unless it is shown that the involved risks are low or the introduction of the species is even beneficial. Therefore it is most wanted to minimize the number of intentionally or unintentionally introduced species and specimens. Knowing that the eradication of introduced species requires great technical and financial efforts and that these activities are believed to be in-effective or impossible in some cases, preventing measures are needed.

As several shipping studies showed, each single vessel has the potential to carry or introduce non-indigenous species. The IMO guidelines represent a method to reduce this potential in removing most of the un-intentionally transported organisms in the ballast water. Mandatory regulations or guidelines minimizing the introduction of non-indigenous species would be of immense help to prevent unwanted introductions of harmful species. Therefore, it is concluded to enforce the application of this guidelines in a global scale.

The IMO guidelines have apparently so far been implemented in some countries and there is need to apply the guidelines in a broader scale due to the lack of other effective, technically and environmentally sound and safe treatment options. Therefore every IMO Member State is requested to implement the Guidelines.

It is concluded that many countries do not consider the ballast water issue as a major problem / danger. Therefore further activities should include the field of raising public awareness.

The importance of ballast water management and control as a means of human intervention to ensure the stability of aquatic ecosystem and biodiversity is not generally appreciated. Press releases could create a more realistic focus on the essential environmental concerns related to ships' ballast water and sediment and hull fouling while highlighting some potential preventive measures in order to minimize risks to changes or loss of biodiversity from transmitted species. In addition the early involvement of all involved authorities, institutions (of the scientific and non-scientific community) and parties is needed to develop and implement guidelines and regulations successfully. The development of ballast water management or control will be most effective at the international level. National approaches of this world-wide problem could end up in intricate regulations resulting in difficulties in compliance. Verification methods for the compliance with the developed guidelines and / or regulations are needed in order to ensure the application of the se methods.

The concern of other working groups and experts, especially in the biodiversity and aquaculture section as well as ship constructors should be raised. Many reports on wastes or discharges from ships list pollutants as exhaust emissions, oil spills, halon, $CO_{2,}$, but do not include ballast water and tank sediments. being aware that ballast water and associated sediment discharges are not considered as pollutants as it has to be emphasized that they could cause severe damages to the environment.

Further research is needed in order to evaluate and judge so far empirical developed treatment options. The prediction of future introductions is impossible, until today. The development of new and improved practices dealing with ballast water and the training of ship crews in this field would provide a significant contribution towards the reduction of further species introductions. Studies should include the:

- effectiveness of ballast water treatment options;
- survival rate of organisms during ships voyages;
- effectiveness of risk assessment models;
- prevention of the spread of human diseases (as e.g. Cholera) by ballast water treatment; and
- consideration of financial aspects related to aquaculture.

The unwanted impact of ballast water may be managed through the development of international ballast water guidelines and treatment options as a step towards the adoption of legally binding provisions, taking into account the conditions of donor and recipient region and the survival rates of species in ballast tanks during voyages.

International co-operation is needed, because the problem of introduced species will not stop at borders. Co-ordinating research in the field of species introductions would help to prevent duplication of work. This should challenge interested working groups to provide information on ongoing and planned research or legislative issues.

There are only a few countries carrying out monitoring programmes in regard to specific non-indigenous species or their presence in special areas. Sampling of ballast water is only undertaken for research purposes and not as standard procedure. Therefore the records listing non-indigenous species occur mostly in the frame of marginal observations during other studies. Regular surveys could document the introduction of non-indigenous species at an early time and therefore help to minimize the further spread of new populations. In order to solve this problem regular coast sampling programmes could be extended in list the present distribution of non-indigenous species.

Warning systems for newly introduced species should be encouraged in order to document their way of spread and possibly to co-ordinate control measures.
Preparation and implementation of monitoring and risk assessment studies for selected case histories of unintentionally introduced species should be carried out to provide additional information for future considerations of control and prevention methods.
Provide the databases as e.g. INFORMIR (USA) and the Concerted Action Partners with information about newest aquatic invaders, regulations etc.

Ship designers and constructors should be made aware of the problem of ballast water in order to take into consideration possibilities of ballast water treatment and their installation on board or differing design of ballast tanks compared to “old fashioned” ships.

In addition existing treatment methods in regard to ballast tanks including sediments and ship´s hull fouling has to be developed in the near future in order to minimize the risks of unwanted species imports by ships. The ballast water control and treatment is a helpful step towards risk minimization regarding the un-intentional introduction of aquatic species. Several shipping studies have shown that in addition to ballast water, species were also transported in sediments of ballast tanks as well as in the fouling of the ships´ hulls.

It is recommended that hindering governmental structures and problems of in-adequate funding could be solved through relevant information, supported by educational programmes and creating public awareness. Therefore, the spread of information relevant to the subject is an essential topic.

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10 Definitions

The following list of definitions follows is based on definitions of the
(1) IMO Assembly Resolution A.774 (18) for the Control and Management of Ships` Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens;
(2) Code of Practice of the International Council for the Exploration of the Sea (ICES), Working Group on Introductions and Transfers of Marine Organisms WGITMO;
(3) draft IUCN Guidelines for the Prevention of Biodiversity Loss due to Biological Invasions
(4) Carlton (1996);
(5) draft Risk Assessment Protocol for the Introduction on Non-Native Species of Fish. Regional Non-Native Species Introduction Committee, Winnipeg, Manitoba. October 1996;
(6) AQIS report No. 9. Ballast water - Technical overview report (1996); and
(7) Committee on Ships´ Ballast Operations. Marine Board;, Commission on Engeneering & Technical Systems, National Research Council (1996): Stemming the tide: controlling introductions of nonindigenous species by ships´ ballast water.

"**Alien species**" see "Introduced species"

"**Brackish**" water is saline water with salinities lower than ocean water (6)

"**Clean ballast**" is ballast carried in cargo tanks after an intensive cleaning of the cargo department (in contrast to ballast carried in dedicated ballast tanks) (7)

"**Competition**" is a situation in which organisms need the same resources and compete for these (6)

"**Country of origin**" is the country where the species is native (2)

"**Cryptogenic species**" is a species that is not demonstrably native or introduced. (from crypt-, Greek, kryptos, secret; -genic, New Latin, genic, origin (3)

"**Disease agent**" is understood to mean all organisms, including parasites, that cause disease (2)

"**DWT**" (Dead Weight Tonnage) is the weight in metric tonnes (1,000 kg) of cargo, stores, fuel, crew and passengers carried by a ship when loaded to the maximum level.

"**Established species**". Species occurring as a reproducing, self-sustaining population in an open ecosystem, i.e. in waters where the organisms are able to migrate to other waters (5)

"**Exotic species**" see "Introduced species"

"**GRT**" (Gross Registered Tonnage) is the estimated maximum ship´s carrying capacity, as it is derived from the total volume of enclosed spaces which are available for cargo, stores, crew, passengers etc. within the hull and superstructure.

"**Intentional introduction**" is a deliberately made introduction by humans, involving the purposeful transport of a species or subspecies (or propagules thereof) outside its natural range. Such introductions may be either authorised or unauthorised (3)

"**Introduction**" An introduction of an organism is the dispersal, by human agency, of a living organism outside its historically known range (3)

"**Introduced species**" (= alien species, = exotic species, non-indigenous species) Any species intentionally or accidentally transported and released by humans into an environment outside its present range (2).

"**Member States**" means States that are members of the International Maritime Organization (1).

"**Native species**" is a species, subspecies or lower taxon, occurring within its natural range and dispersal potential (i.e. within the range it occupies naturally or could occupy without direct or indirect introduction by humans) (3)
"**Non-indigenous**" see "Introduced species"

"**Organism**" is an individuum of any plant or animal species

"**Pathogens**" are disease causing organisms (6)

"**Plankton**" aquatic, free-drifting organisms suspended in water (plant = phytoplankton, animal = zooplankton)

"**Port State Authority**" means any official or organization by the government of a port state to administer guidelines or enforces standards and regulations relevant to the implementation of national and international shipping control measures (1)

"**Secondary introduction**" is one that takes place as the result of an intentional or unintentional introduction into a new area and the species disperses from that point of entry to other areas that it could not have reached without the initial (primary) human mediated introduction (3)

"**Transferred species**" (= transplanted species) Any species intentionally or accidentally transported and released within its present range (2)

"**Translocation**" Movement of native or introduced species to habitats outside its historically known range (6)

"**Treatment**" means a process or mechanism, physical, chemical or biological method to kill, remove or render imterfile, harmful or potential harmful organisms within ballast water (1)

"**Un-Intentional introduction**" is one made as a result of organisms utilising humans or human transport systems as vector for dispersal into new areas. The introduction is incidental to the main transaction taking place (often trade and in the marine environment aquaculture) (3)

"**unwanted**" (used in the sense of unwanted species or unwanted introductions)
Any species which causes relevant changes to native species composition, including economical and ecological harm

11 Relevant internet locations

In response to the recent call for information from subscribers to the BIODIV-CONV listserver (see below), we received a number of references to homepages on the world-wide web. Given the present and future value of the web as a medium of information, we will begin to post regular updates of web sites relating to biodiversity policy and law, along with our other information postings (calendar of events and recent publications).

Most of the listed information below were selected from a report prepared for ICES/IOC/IMO Study Group on Ballast Water and Sediments ICES Working Group on Introductions and Transfers of Marine Organisms, La Tremblade, France, 21-25 April, 1997 by Kristina Jansson, SWEDEN and the IMO Library Information Services, IMO Library Directory of sites of interest on internet.

It has to be considered that the internet is an continuously changing instrument. Therefore, all listed addresses could have been changed after printing of this report in 1998.

Please not that if an error as e.g. "URL (location of web site) wrong" or "unable to locate server, server has no DNS" the page or server you are looking for could have been removed from the web (temporarily). Sometimes it helps to type in the Server name in capital letters. If even this is hopeless, type in the first part of the address (as: http://www.aquasense.com) and try to locate the relevant page on your own.

11.1 home pages, information on the INTERNET (World Wide Web)

Listed in alphabetical order:

Abbreviations
http://www.icc.ie/info/net/acronyms/index.htm

Alien species of crayfish in Europe (University of Firence, Italy):
http://www.unifi.it/ (select “EVENTI“)

Aquasense
http://www.aquasense.com/species/newspec.htm
http://www.aquasense.com/about/welcome.htm

Australia
- CBD Clearinghouse Mechanism Homepage
http://www.erin.gov.au/life/chm/chm2.html
- Environmental Resources Information Network
http://kaos.erin.gov.au/general/erin_info/intro.html
- Development of a nation-wide system of marine protected areas
http://kaos.erin.gov.au/general_info/bodiv_debate/Marine2.html
- Australian Nature Conservation Agency
http://www.anca.gov.au
- *Australia - AQIS Ballast Water Programme*
"The Australian Quarantine and Inspection Service (AQIS) is the lead Commonwealth Agency for the management of ballast water issues, including policy development, implementation of a strategic research plan and quarantine operations. The Ballast Water Programme which includes and Australian Ballast Water Management Advisory Council (ABWMAC) and its Research Advisory Group (RAG) is administered by AQIS in Canberra."
Available topics include: - Australian Ballast Water Bulletins, - Australian Ballast Water Management Strategy, - Australian Ballast Water R&D Programme and - Australian Ballast Water Guidelines
http://www.dpie.gov.au/aqis/homepage/imadvice/ballast.html
CRIMP - Centre for Research on Introduced Marine Pests (Australia)
Many links to related sites! (type in CRIMP in capital letters)
http://www.marine.csiro.au/CRIMP/
Portfolio Marine and Coastal Environment Strategies - An Overview
http://www.erin.gov.au/portfolio/dest/env_strat/marine.html#HDR1

BALLERINA - Baltic Sea Region On-Line Environmental Information Resources for Internet Access
"BALLERINA is the place to go when you seek information on the Baltic Sea Region, have information to provide, or wish to communicate with others in the region. BALLERINA is a virtual meeting place, providing an opportunity for persons and institutions to find like-minded in the Baltic Sea Region. BALLERINA is the result of a co-operative effort to provide comprehensive information about issues on environment, natural resources and sustainable development relating to the transboundary Baltic Sea Region."
The information gateway to the Baltic is available at (type in BALTIC in capital letters):
http://www.BALTIC-region.net/
New Species in the Gulf of Finland and the Gulf of Bothnia
http://www2.fimr.fi/algaline/arc95/newspec.htm
Baltic Marine Environment Bibliography
http://www.otatrip.hut.fi/vtt/baltic/intro.html
BMB WORKING GROUP 30
Home page of the BMB Working Group 30 on NEMOs. The webside includes information and first entries of the Klaipeda database on non-indigenous species of the Baltic.
http://www.ku.lt/nemo/mainemo.htm
http://www.ku.lt/ (select: projects --> NEMO in the Baltic)

Bern Convention (Council of Europe)
http://www.coe.fr/eng/legaltxt/104e.htm
http://www.coe.fr/eng/legaltxt/treaties.htm

Biodiversity Action Network (BIONET)
http://www.igc.org/bionet

Biodiversity Data Management Homepage, Costa Rica
http://www.inbio.ac.cr/~bdm/home.html

BIOPOLICY: ONLINE JOURNAL (began 1996)
http://www.bdt.org.br/bioline/py

BIOSIS; Taxonomy & Nomenclature
http://www.york.biosis.org/zrdocs/tax_nom.htm

Canada
Canadian Biodiversity Information Network (CBIN)
http://www.doe.ca/ecs/biodiv/biodiv.html
Canadian website on ballast water. Includes information on Commercial Ships & Shipping, Aquatic Nuisance Species, Guidelines & Legislation and other References & Resources
http://www.renc.igs.net/~jdesigns/ccg/
THE STATE OF CANADA'S ENVIRONMENT: 1996 Edition. Government of Canada. Includes information from the past five years on every aspect of Canadian environment complied by a contributing staff of over 200 leading Canadian scientists.
http://www.doe.ca
Exotic Phytoplankton from Ships´ Ballast Water. Risk of Potential Spread to Mariculture Sites on Canada's East Coast. A summary of Canadian activities, some case histories of introduced species and shipping studies is included at:
http://www.maritimes.dfo.ca/science/mesd/he/ballast.html
Canadian CD on Ballast Water - A Vector for Introduction of Aquatic Nuisance Species which was distributed at the ballast water working group at MEPC 40
http://www.renc.igs.net/~jdesigns/ccg/bw_index.html)
The Canada Shipping Act (CSA)
There are over 100 regulations which have been promulgated under the Act. The CSA and its associated regulations may be found on the internet at:
http://www.tc.gc.ca/actsregs/CSA/TOCcsa.htm
Canadian Coast Guard
http://www.ccg.org

Caulerpa taxifolia at Laboratoire Evironnement Marin Littoral (LEML), Université de Nice-Sophia Antipolis. Photographs, maps, references etc.
http://www.unice.fr/LEML
http://com.univ-mrs.fr/gisposi/gisposi.htm
The GIS Posidonie bibliographic database on the spread of the tropical algae Caulerpa taxifolia in the Mediterranean Sea is now available at the following web address:
http://www.com.univ-mrs.fr/basecaul [in French]

For the latest news on the distribution of *Caulerpa taxifolia* in the Mediterranean Sea choose ”Pour avoir les dernieres nouvelles sur la Caulerpa” on the home page.

CBD - Convention on Biological Diversity (UNEP)
http://www.unep.ch/biodiv.html

CBD Clearinghouse Mechanism Site
Official CBD Clearinghouse Mechanism (CHM) Pilot Phase
http://www.biodiv.org/chm

CBD Clearinghouse Mechanism Homepage, Belgium
http://www.kbinirsnb.be/bch-cbd/homepage.htm

CBD Clearinghouse Mechanism Homepage, Mexico
http://www.conabio.gob.mx/

CIEL - Centre for International Environmental Law
http://www.econet.apc.org/ciel/

CITES/Washington Convention
http://www.unep.ch/cites.html

Commission on Sustainable Development
CSD-5/UNGASS
- CSD Country Profiles
http://www.un.org/DPCSD/dsd
- Earth Summit +5
http://www.un.org/dpcsd/earthsummit
- Linkages & ENB
http://www.iisd.ca/linkages/csd/

Environmental and Natural Resources Law Center, Costa Rica
http://www.inbio.ac.cr/~bdm/info_inst/cedarena.html

ETI - Expert Center for Taxonomic Identification (UNESCO)
http://145.18.162.199/default.shtml

European Environment Agency Homepage
http://www.eea.dk/

FAO - Food and Agriculture Organization; International Agreements etc.
http://www.fao.org/waicent/faoinfo/fishery/agreem/agreem.htm
http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm
FAO's Domestic Animal Diversity Information System (DAD-IS)
http://www.fao.org/waicent/faoInfo/agricult/AGA/AGAP/Default.htm

Fifth North Sea Conference; Intermediate Ministerial Meeting 1997, Assessment Report
http://odin.dep.no/md/publ/conf/report.html

FishBase (ICLARM, Philippines)
http://161.76.121.2:80/fish-bin/fishfam.p

Fourth World Documentation Project
http://www.halcyon.com/FWDP/fwdp.html

Germany
- German CBD Clearinghouse Mechanism Homepage
http://www.dainet.de/bmu-cbd/homepage.htm
- German shipping study on non-indigenous species transported via international shipping
Abstract of German shipping study, Institut für Meereskunde, Kiel
http://www.ifm.uni-kiel.de/pl/transpor/default.htm

Global Biodiversity
http://www.ecomall.com/class/bio.htm

Global Environment Facility (GEF)
http://www.worldbank.org/html/gef/gateway/gefrelat.htm

GLODIR - Global Directory of Marine Scientists (!), a database "containing information on scientists and their scientific interests" at
http://www.unesco.org/ioc/isisdb/html/habd.htm

Greenpeace international Environmental Conventions
http://www.greenpeace.org:80/~intlaw/

HELSINKI COMISSION - Baltic Marine Environment Protection Commission
http://www.helcom.fi/

ICES - International Council for the Exploration of the Sea
http://www.ices.dk/
Information on the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO)

ICLARM - International Center for Living Aquatic Resources Management
http://www.cgiar.org/iclarm/

IFREMER - Institut Français de Recherche pour l'Exploitation de la Mer
http://www.ifremer.fr

IMO - International Maritime Organization
IMO homepage (http://www.imo.org)
http://www.imo.org/imo/welcome.htm

Indigenous Peoples Biodiversity Information Network (IBIN)
http://www.ibin.org

Inter-Links
http://www.nova.edu/Inter-Links/

Introductions of non-native genotypes of plants
http://www.naturebureau.co.uk/pages/floraloc/floraloc.htm#index

IOC - Intergovernmental Oceanographic Commission
http://www.unesco.org/ioc/iochome.htm
IOC - Intergovernmental Oceanographic Commission; Harmful Algal Blooms
Via IOC's Home Page you can find information on IOC's Harmful Algal Blooms Programme (HAB) and the IOC Science and Communication Centre on Harmful Algae (http://www.unesco.org/ioc/oslr/oslr.htm, http://www.unesco.org/ioc/oslr/hab.htm). Electronically available documents include reports from meetings and workshops, the newsletter Harmful Algae News, and access to IOC's databases, e.g.
HABDIR - IOC Harmful Algae Bloom Expert Directory at
http://www.unesco.org/ioc/infserv/director/habdir.htm
http://www.unesco.org/ioc/iochome.htm

IUCN - World Conservation Union
http://www.iucn.org/index.html

Linguistic & biological diversity--Terralingua Conference
http://cougar.ucdavis.edu/nas/terralin/english.html
http://ucjeps.berkeley.edu/Endangered_Lang_Conf/Endangered_L
ang.html

Lloyd's Register
http://www.lr.org/news

MEPC, a list of 50 ecological journals
http://www.ng.hik.se/~nmato

Natural Resources Research Information Pages
http://sfbox.vt.edu:10021/Y/yfleung/nrrips.html

Netcoast, guide to integrated coastal zone management
http://www.minvenw.nl/projects/netcoast/index.htm

North East Atlantic Taxa (Tjarno MBL, Sweden)
http://130.241.163.21/TMBL/taxon/taxa

OECD publications, coastal zone management
http://www.oecd.org/publications/catalog/97/97_93_03_1.html

OSPAR - The Oslo and Paris Commissions and the OSPAR Convention for the Protection of the Marine Environment of the North-east Atlantic
http://ourworld.compuserve.com/homepages/ospar/homepage.htm

Ozone Secretariat, contact address (UNEP) http://www.unep.ch/ozone/contact.htm

Pfiesteria piscicida
General information (including pictures) of the Phantom Algae were given on:
http://www2.ncsu.edu/unity/lockers/project/aquatic_botany/pfiest.html
http://www.cdc.gov/nceh/press/1997/970929pf.htm
http://www.epa.gov/OWOW/estuaries/pfiesteria/hilite.html

RAFI Communique
http://www.rafi.ca/communique/

Seaweed (University College, Galway, Ireland)
http://www.seaweed.ucg.ie/seaweed.html

Third World Network
http://www.twnside.org.sg/souths/twn/twn.htm

Treaty Summaries from 1933 (!) to 1993(do NOT type in "www.")
http://sedac.ciesin.org/pibd/summaries-menu.html
very useful (!); access failed sometimes, therefore try alternatively:
http://sedac.ciesin.org/ (select "ENTRI" -->"summaries of some of the treaties in the ENTRI collection " (right column, close to the bottom) --> "chronological list" gets you to the list of treaties as: international conventions for prevention of pollution from ships, nature protection and wildlife preservation...)

Tropical Coasts - newsletter for policy makers, environmental managers, scientists and resource users. "Marine updates" sponsored by GEF/UNDP/IMO
http://www.skynet.net/users/imo

UN
http://www.unsystem.org/

UNEP; Trade and Environment
http://www.unep.ch/trade.html

UNESCO
http://www.unesco.org/mab/collab/diver1.htm

UNESCO-IOC Register of Marine Organisms (UNESCO)
http://145.18.162.199/database/urmo/default.shtml

United Kingdom
Aquaculture, fisheries and natural resources, *Fishing for Information Home Page: Guide to online resources in aquaculture, fisheries and aquatic science*
http://www.stir.ac.uk/aqua/fishing/
HM Coastguard
http://www.netlink.co.uk/users/coasties/hmcg.html

USA

Alien species invasions of U.S. Ecosystems (with links to other organizations involved)
http://www.consci.tnc.org/library/pubs/dd/toc.html
American Association of Port Authorities
http://www.coe.fr/eng/legaltxt/104e.htm
aapa-ports.org
Coastal Resource Centre, University of Rhode Island
http://www.brooktrout.gso.uri.edu/index.html
http://www.bdt.org.br/bioline/py
Great Lakes, Exotic species in the Great lakes
http://www.great-lakes.net/
NOAA; Environmental Research Laboratories
http://www.erl.noaa.gov/
Non-indigenous aquatic species:
http://www.nas.nfrcg.gov/nas.htm
Live Marine Specimens (Woods Hole MBL, U.S.)
http://www.mbl.edu/html/MRC/specimens.html
Multilaterals (Tufts University, Mass., U.S.)
"The Multilaterals Project, begun in 1992, it is an ongoing project at the Fletcher School of Law & Diplomacy, Tufts University, Medford, Massachusetts to make available the texts of international multilateral conventions and other instruments. Although the project was initiated to improve public access to environmental agreements, the collection today also includes treaties in the fields of human rights, commerce and trade, laws of war and arms control, and other areas. Although the vast majority of texts date from the second half of this century, the collection also includes historical texts, from the 1648 Treaty of Westphalia to the Covenant of the League of Nations." (and also including full text versions of e.g. UNCLOS - United Nations Convention on Law of the Sea)
http://www.tufts.edu/fletcher/multilaterals.html
NAS – Non-indigenous Aquatic Species (U.S.)
http://www.nfrcg.gov/nas/nas.htm
National Sea Grant; Non-indigenous Species Research and Outreach (U.S.)
http://mdsg.umd.edu/NSGO/research/nonindigenous/
Ocean planet - Smithsonian Institution
http://www.seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTM/peril_alien_species.htm
Office of Technology Assessment (U.S. Congress). Carries the OTA 1993 report "Harmful Non-Indigenous Species in the United States" in pdf.-format)
http://www.ota.nap.edu/pdf/1993idx.html
Ohio Sea Grant: Aquatic Nuisances (U.S.)
http://www.osc.edu/OhioSeagrant/osgrant/com/nuisances/nuisances.html
U.S.C.G. - Marine Safety Newsletter
http://www.dot.gov/dotinfo/uscg/hq/g-m/gmhome.htm
U.S. EPA
http://www.epa.gov/
Western Zebra Mussel Task Force Home Page (U.S.)
http://www.usbr.gov/zebra/wzmtf.html
Woodshole Oceanographic Institution
http://www.whoi.edu/
Woodshole Oceanographic Institution lists a page on harmful algae:
http://habserv1.whoi.edu/hab/

Zebra Mussel links
http://www.science.wayne.edu/~jram/zmlinks.htm
Zebra Mussel resources
http://www.nfrcg.gov/zebra.mussel/

WCMC - World Conservation Monitoring Centre
http://www.wcmc.org.uk/index.html
WCMC - Protected Areas Virtual Library
http://www.wcmc.org.uk/protected_areas/data/pavl.html

11.2 Mailing lists

11.2.1 Marine-Pests (CSIRO/CRIMP)

CSIRO Centre for Research on Introduced Marine Pests (CRIMP), Hobart, Tasmania, Australia
"This is a public mailing list co-ordinated and owned by the CSIRO Centre for Research on Introduced Marine Pests (CRIMP). Despite the list name, we are more generally interested in introduced species, not just those introductions that attain pest status. It is intended that this list will serve to increase communication in the growing international community of researchers concerned with various aspects of biological invasions in the marine environment. We hope that we will attract and encompass people generally interested in biological invasions in all environments, not just marine. The sort of postings we anticipate include:
- upcoming events related to species introductions such as meetings and symposia related to biological invasions, biological control or eradication techniques
- new websites, newsgroups or mailing lists which might be of interest to the general discussion group
- general information concerning new invasion research groups or projects information (or alternatively questions) about suspected introduced species."
In order to get more information use *majordomo@ml.csiro.au*
Do not type in any text in the subject field and type in as message: “help“ - and nothing else. The return mail will provide information on the system, how to subscribe, how it is organized etc.
In order to subscribe send a mail and type in as message:
subscribe marine-pests
On the next line type in “end“ or ensure that there is no text which will follow the above command by switching off your signature.
The mailing list will provide you with information about new human mediated intentionally and accidentally introduced non-indigenous species, upcoming events on species introductions as meetings and symposia related to biological invasions, their control and a general discussion group, information on new web sides.

11.2.2 Invasive Species Listserver ALIENS-L (ISSG/IUCN)

Department of Conservation, Auckland, New Zealand
"ALIENS-L - listserver of the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission - has been established. ISSG aims to "reduce the threats

posed by invasive species to natural ecosystems and their native species, through increasing awareness of invasive species and means of controlling or eradicating them". This listserver is a contribution to that mission. It allows users to freely seek and share information on invasive species and the threats which they pose to the biodiversity of our planet. This listserver is not limited to members of ISSG but is available to all who might be interested in the invasive species subject."
The listserver of the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission may be subscribed at *majordomo@ns.planet.gen.nz*
In order to subscribe do not type in any text in the subject field and type in as message: “subscribe ALIEN-L“ - and nothing else.
On the next line type in “end“ or ensure that there is no text which will follow the above command by switching off your signature.
The ISSG aims to reduce the threads by invasive species by increasing the awareness in this field and the spread of information on methods for control and eradication.

11.2.3 WEEDS

WEEDS to encourage idea sharing on noxious weeds that impact on U.S. agriculture. They hope to hear from weed specialists, the nursery industry, environmental and natural resources organizations, agronomists, farmers, scientists in academia and the government sector, and regulatory officials in the plant health arena. Sponsored by and housed at the headquarters offices of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) in Riverdale, Maryland, U.S.A. Address a message to *majordomo@info.aphis.usda.gov*. In the body of the message type *subscribe WEEDS*. Type nothing else in the message. Switch off your automatic signature.

11.2.4 WWD-L

WWD-L is a discussion group on a database of weeds of the world (agricultural and environmental) Address a message to MAISER@PLANTS.OX.AC.UK In the body of the message type SUBSCRIBE WWD-L Type nothing else in the message. Switch off your automatic signature.

11.2.5 INFOTERRA

INFOTERRA is intended for exchanging information on environmental topics; posing queries to the Infoterra network; requesting information from the United Nations Environment Programme and raising environmental awareness in general. Address a message to MAJORDOMO@ CEDAR.UNIVIE.AC.AT. In the body of the message type SUBSCRIBE INFOTERRA YOUR@EMAIL ADDRESS. Type nothing else in the message. Switch off your automatic signature.

11.2.6 BIODIV-CONV

BIODIV-CONV is devoted specifically to the Convention on Biological Diversity and its effective implementation. Address a message to MAJORDOMO@IGC.APC.ORG In the body of the message type SUBSCRIBE BIODIV-CONV YOUREMAILADDRESS Type nothing else in the message. Switch off your automatic signature.

BENE is designed to foster enhanced communications and collaborations among those interested in biodiversity conservation and ecosystem protection, restoration and management. Address a message to LISTPROC@STRAYLIGHT.TAMU.EDU In the body of the message type SUBSCRIBE BENE YOURNAME Type nothing else in the message. Switch off your automatic signature.

Introduction to the BIODIV-CONV Listserver (BIODIVERSITY - BIODIV-CONV)

TO: All parties interested in effective implementation of the Convention on Biological Diversity (CBD)

FROM: Sheldon Cohen & Stas Burgiel, Biodiversity Action Network (BIONET)

SUBJECT: ANNOUNCING A NEW INTERNET "LIST-SERVER" FOR DISTRIBUTING INFORMATION RELATED TO THE CONVENTION ON BIOLOGICAL DIVERSITY (CBD) (DATE: 7 May 1996)

INTRODUCTION

We are pleased to announce the establishment of a special "list-server" (or electronic mailing list) on the Internet devoted specifically to the Convention on Biological Diversity (CBD) and its effective implementation. It is entitled BIODIV-CONV. A list-server is simply an automated mechanism that uses e-mail addresses to disseminate information over the Internet to large numbers of people throughout the world.

First off, for your information, BIONET is an NGO (National Governmental Organization) network working to strengthen biodiversity policy and law, with a sharp focus on promoting effective implementation of the CBD. Over the past few months, we have consulted with BIONET member organizations and other partners concerning the establishment of such a list-server. Based on these consultations, and related research, we have identified a clear need for this type of Internet information tool.

The CBD implementation phase is moving forward rapidly:

- Over 170 governments have now signed the CBD, and over 140 have ratified (and are referred to as Parties).
- The CBD Secretariat has been permanently established in Montreal, headed by Dr. Calestous Juma.
- Two meetings of the CBD's governing body, or Conference of the Parties (COP), have already been held, and have resulted in a number of substantive decisions.
- The "Jakarta Mandate on Marine and Coastal Biodiversity" was adopted by the COP last November.
- The COP-3 meeting is scheduled for 4 - 15 November 1996 (Buenos Aires), and will address several important substantive issues.
- The first meeting to negotiate a CBD protocol on biosafety is scheduled for 22-26 July in Denmark.
- The Global Environment Facility (operating the CBD's financial mechanism on an interim basis) has begun to disburse grants to support CBD implementation in developing countries.
- A growing number of CBD Parties have already developed, or are in the process of developing, their national biodiversity strategies and action plans.

Successful implementation of the CBD will require broad and active participation of a wide range of stakeholders committed to translating the legally-binding obligations under the CBD into action that produces meaningful, on-the-ground results. These stakeholders will require a growing amount of solid and timely information. This list-server is intended to help provide such information and to help mobilise world-wide support for effective CBD implementation.

We are establishing this list-server with an initial e-mail distribution list of about 1,000 individuals representing: non-governmental organizations (NGOs), intergovernmental organizations (IGOs) such as U.N. agencies and international treaty secretariats, governments, private foundations, the private sector and others who have been participating actively in the CBD process or have shown a strong interest in this general area. For example, our distribution list includes most of the NGO and IGO participants in the most recent CBD intergovernmental meeting (COP-2), held in November 1995 in Jakarta. The list also includes many of the individuals designated as the CBD "focal points" within governments. And in the coming months, we will include additional e-mail addresses of these and other key CBD stakeholder groups.

This is an "open access" list and any individuals or organizations are welcome to join. (As such, particularly sensitive and confidential information will not be posted.) We expect the distribution list to grow rapidly in the months ahead. In this regard, we need your help to identify others who would be interested in being on the list. strongly encourage you to alert your colleagues to its existence.

To help save you time and on-line charges, we will include in the subject line for each posted document a KEYWORD (to describe the topic of the document) and the page length. By doing this, you will be able to delete any messages that are not of interest. We are aware that some of you on select APC "nodes" will be incurring extra gateway charges. If this is the case and it becomes cost-prohibitive, please contact us and we can discuss alternative transmission options.

TYPES OF INFORMATION THAT WILL BE POSTED

The list-server will provide diverse information to help promote effective implementation of the CBD, including action at the international, national and sub-national levels. The list-server, which will be moderated by the BIONET Secretariat office, will include:

- information about CBD intergovernmental meetings and other activities related to these meetings;
- information on CBD Secretariat activities;
- information produced by the CBD Secretariat appropriate for general circulation;
- reports and analyses of CBD meetings;
- timely alerts about other particularly relevant upcoming meetings (e.g., Global Biodiversity Forum, UN Commission on Sustainable Development, Global Environment Facility);
- reports on recent events/processes (e.g., conferences, workshops, Global Environment Facility, CSD Intergovernmental Panel on Forests, etc.);
- issue-specific reports, position papers and other materials by NGOs, IGOs, governments, industry, etc.;
- pre-print versions of the BIODIVERSITY BULLETIN newsletter;
- periodic calendars of biodiversity events;
- lists of key contacts;
- lists of recent publications; and
- information on biodiversity-related internet sites.

IF YOU WOULD LIKE INFORMATION POSTED TO THE LIST-SERVER

To make this list-server useful, we are counting on you and others to provide us with relevant announcements and information that you would like posted. Posted documents will automatically be circulated to the entire distribution list of over 1,000 persons. While we expect that nearly all requests falling within the scope of this list-server will be posted, some may be rejected for pertinent reasons. We are in the process of developing criteria in this regard, and will circulate them for comment.

The list-server could function not only as a general information clearinghouse on the CBD implementation process and related issues, but also could become a forum for publicising new initiatives and successful programs, and for presenting proposals for needed action. In addition, it could serve as a vehicle for facilitating contacts, partnerships and collaboration.

ACCOMPANYING ELECTRONIC CONFERENCE

Accompanying the list-server is an electronic conference (biodiv.conv) containing a comprehensive, virtual archive of all the documents ever posted to the list-server. As people subscribe to the list-server, this will become a useful, maintenance-free, vehicle to quickly review past issues and information, and to download those documents of interest. It should be noted, however, that the conference can only be accessed if you subscribe to a computer network that is a member of the Association of Progressive Communications (APC), such as: Econet (US), Greennet (UK), Pegasus (Australia), Glasnet (CIS), Alternex (Brazil), and Nicarao (Nicaragua). The conference should be accessible under the conferences section of your APC node, under the title <biodiv.conv>.

HOW TO CONTACT

We welcome any suggestions you might have concerning the above information and ways that this list server may be most useful. To communicate with us in this regard, or for further information, please contact:

Sheldon Cohen or Stas Burgiel
Biodiversity Action Network (BIONET)
1400 16th Street NW, Suite 502, Washington, DC 20036, USA
Telephone: ++1.202.547.8902, Fax: ++1.202.265.0222
E-mail: bionet@igc.apc.org
http://www.igc.agc.org/bionet
http://www.access.digex.net/~bionet

11.2.7 Biological Control Discussion List (biocontrol-L)

"This discussion list is directed to scientists, educators, students, legislators, extension specialists and practitioners of biocontrol of pests around the world. Technical discussions, queries and news on this area of interest are welcome. The list should not be used for commercial purposes.

To subscribe to the list, please send the following message to listserv@bdt.org.br:

SUBSCRIBE BIOCONTROL-L your name

To send messages to the list, just address them to BIOCONTROL-L@bdt.org.br

11.2.8 IRRO Discussion List (IRRO-L)

"IRRO is an information network, run on a non-profit basis, which aims to provide access to all types of information relevant to the release of animals, plants and micro-organisms into the environment. IRRO is an acronym for the Information Resource for the Release of Organisms to the Environment. The decision to establish the IRRO was taken in 1991, under initial impetus from the United Nations Environment Programme (UNEP), and the intervening period has been used to establish priorities and to search for funds.

Information of interest for IRRO might include details of, for example, releases of non-indigenous, novel or genetically modified organisms. It might cover ecological data relevant to receiving environments. It could include information on the regulatory oversight of releases of non-indigenous organisms or genetically modified organisms. It could include information on the impacts of biodiversity. There are many other possibilities.

IRRO is intended to be a network which will facilitate access to existing relevant databases and other information sources located throughout the world. It is envisaged that there will be many types of users of the IRRO with many different interests. They could include NGOs (non-governmental organizations), policy makers, scientists interested in academic issues or those interested in accessing information relevant to regulatory/oversight purposes.

The aim of this list is to discuss any topic of interest to the development of the IRRO.

In order to subscribe to this list, send a message to listserv@bdt.org.br with a single text line in the body of your message that says: SUBSCRIBE IRRO-L your-full-name"

11.2.9 Sites with additional information on electronic mailing lists

Information on listservs on all topics
http://www.tile.net/tile/listserv/index.html

Aquatic Animals Mailing Lists
http://www.actwin.com/fish/lists.html

BIOSCI mailing lists and newsgroup archives
http://www.w3.org/hypertext/DataSources/bySubject/Bio/Overview.html
BIOSCI/bionet Electronic Newsgroup Network for Biology
http://www.bio.net/

Guides to Listserv and bitnet mailing lists
http://galaxy.einet.net/GJ/lists.html

Listserv Lists
http://www.clark.net/pub/listserv/listserv.html
LISTSERV Home Page
http://www.tile.net/tile/listserv/viewlist.html
Liszt: Searchable Directory of e-Mail Discussion Groups
http://www.liszt.com/

12 Databases on non-indigenous species

As far as known, six major relevant databases are available or in preparation listing the aquatic non-indigenous species of their region. The Australian database is not available on the Internet but one can order a file containing the relevant information.

12.1 FAO - Food and Agriculture Organization, the FAO Database on Introductions of Aquatic Species (DIAS)

http://www.fao.org/waicent/faoinfo/fishery/agreem/agreem.htm

http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm

The FAO Database on Introductions of Aquatic Species (DIAS) can be searched through search forms. Users can provide new data to the database by filling in an input form. Web pages on "Highlights on Introductions", statistics on the database and a glossary are linked. The home page is located at the FAO Fisheries Home page by selecting "Databases and Statistics". The webside is expected to grow as users provide new records of introductions and as new information and relevant publications become available. This site represents an important source of information on both the benefits and risks of species introductions. The FAO database on introductions of aquatic species was initiated by R. Welcomme in the early 1980's. It considered primarily only freshwater species of fish and formed the basis for the 1988 FAO Fisheries Technical Paper no. 294. The database has been expanded to include additional taxa, such as molluscs and crustaceans, and marine species. In the mid 1990's a questionnaire was sent to national experts to gather additional information on introductions and transfers of aquatic species in their countries. The database, which contains now almost 2900 records, can be queried through the Search Form. Users aware of other introductions of aquatic species not already included in the database or that have additional information on the records in the database are requested to fill in the Input Form. Periodically this information will be validated and added to the database.

12.2 Baltic

A database on non-indigenous species of the Baltic ins under development. At two meetings of the working group on Non-Indigenous Estuarine and Marine Organisms of the Baltic Marine Biologists (held in Klaipeda 1995 and in Gdynia 1996) a standardized entry format for a joint database on the Baltic non-indigenous species was elaborated (see the relevant Internet homepage http://www.ku.lt/nemo/mainnemo.htm and
http://www.grida.no/prog/norbal/ballerin/environ/wg_alien.htm). The database should lead to the development of a complete (as far as possible) accounts of aquatic species to become established in the Baltic Sea region, including the Baltic Sea itself, its gulfs and coastal lagoons as well as adjacent water bodies which potentially can serve a recipient of new introductions (like, for example, Lake Ladoga). Special attention will be paid to numerous published and unpublished data written in different languages of the Baltic Sea countries in order to make it available for international readers. An entry to the database will contain following main topics: TAXONOMY (incl. local common names, if available), IDENTIFICATION, VECTORS OF INTRODUCTION (if known), DISTRIBUTION (incl. first record, present distribution, area of origin, etc.); ABIOTIC PREFERENCES & BIOLOGY; EFFECTS (incl. possible social and economical impacts); REFERENCES; SOURCE.

The Baltic Alien Species database will be used as a basis for environmental decision making (including issues related to ballast water treatment, etc.), it will also serve a factual source for university study courses on marine biology and ecology as well as for popular posters and information sheets for school classes, public aquariums and museums of natural history. Also it is believed that the research network on the Baltic non-indigenous species linking academic scientists and environmental monitoring specialists will continue its work also in the future after the present project is formally over. Presently the database on the Baltic NEMOs is under preparation.

For more information contact: Dr. Sergej Olenin, Klaipeda University, Lithuania (S.Olenin@samc.ku.lt) and see home page listed above.

12.3 North Sea

All data of the SOAEFD Ballast Water Project were archived in a dedicated relational database, resulting in a valuable resource on the biological and chemical composition of ships' ballast water (Macdonald & Davidson 1997).

12.4 Mediterranean Sea

http://com.univ-mrs.fr/gisposi/gisposi.htm

The GIS Posidonie bibliographic database on the spread of the tropical algae Caulerpa taxifolia in the Mediterranean Sea is now available at the following web address:

http://www.com.univ-mrs.fr/basecaul [in French]

For the latest news on the distribution of *Caulerpa taxifolia* in the Mediterranean Sea choose ”Pour avoir les dernieres nouvelles sur la Caulerpa” on the home page.

A searchable literature database on *Caulerpa taxifolia* is available at ”Si vous etes visiteur, vous pouvez consulter la base” on the homepage. A variety of search terms can be combined. The result of a research is a list of relevant references (without abstracts).

12.5 USA

12.5.1 SERC

The Smithsonian Environmental Research Centre hopes to develop a database on non-indigenous species in coastal environments of the USA. This database could be used to look for trends in invasion ecology. There is also a data base being developed by the US Geological Survey in Gainesville Florida, focusing primarily on terrestrial invading species (Ruiz pers. comm., Cangelosi pers. comm.).

12.5.2 NAS Non-Indigenous Aquatic Species (U.S. Geological Survey)

The National Non-Indigenous Aquatic Species Geographic Information System was established in 1993 at the U.S. Geological Survey, Biological Resources Division, Gainsville, Florida. Assessable to the public are information about introduced aquatic species since 1850 by general and scientific reports. The on-line database contains more than 36,000 geographically references of aquatic flora and fauna. The service is used to monitor the distribution of introduced species and to provide information of control and management.

http://www.nfrcg.gov/nas/nas.htm

12.5.3 Non-native Invasive Species Strategy (US)

http://jaguar.arw.r9.fws.gov/

"Various U.S. government Departments and Agencies are currently drafting a document regarding the subject topic. A draft is posted on the WWW at the listed address.

12.5.4. Hawaii

http://www.hear.org/

"The goal of the Hawaiian Ecosystems at Risk (HEAR) project is to provide resources (technique, methods, and information) to resource managers state-wide to aid in the fight against invasive non-indigenous species state-wide. The HEAR project is based at the CPSU office in the Botany Department of the University of Hawaii and funded by the U.S. Geological Survey's Biological Resources Division (formerly the National Biological Service)."

HEAR Websites include;

"The Harmful Non-Indigenous Species (HNIS) database is an in-progress product of the Hawaiian Ecosystems at Risk project. It will eventually comprise an online source of up-to-date information (names, locations, pictures, control methods) about harmful non-indigenous species in Hawaii. Additionally, it will provide a medium to allow feedback from scientists, professional resource managers, and the general public. As new information is received, it will be added to the database to ensure that the most current information is available.

Also available is the HNIS questionnaire. This questionnaire is used to collect detailed information about each species in the HNIS database. If you have information to report, or would like to assist in the progress of this project, you are encouraged to complete and submit one of these forms for a species which is on our "hit list" or for another species about which you are concerned."

12.6 Australia

A database of non-indigenous species established in Australian waters was compiled by CRIMP. The folder contains more than 75 records including taxonomical remarks of the species (picture), area of origin, the current distribution, associated effects / impacts to the environment and economy. The database was developed as a guide to Australia's introduced marine species and some potential invaders. It is intended as a descriptive and informative work for researchers and others interested in. The handbook has been designed to be supplemented with updates on the occurring non-native species and further species introductions. The unbound file shape allows an open ending handling (Furlani 1996).

Distribution information available at:

http://www.ml.CSIRO.au/~spinks/CRIMP/index.html

Editorial board (looking forward to e.g. corrections additional findings):

crimp@ml.CSIRO.au

12.7 New Zealand

The Invasive Species Specialist Group (ISSG) of IUCN´s Species Survival Commission is planning to organize links between already established databases on non-indigenous species. Further development uncertain. The ISSG also publishes the newsletter *Aliens*, and the *aliens-L listserver* (see below for information on how to subscribe).

The ISSG has also developed draft "Guidelines for the Prevention of Biodiversity Loss due to Biological Invasion". The draft guidelines can be accessed at the IUCN website at: http://www.iucn.org/themes/ssc/memonly/invguid.htm

12.8 Database of Integrated Coastal Zone Management Efforts

This world-wide database was created and supported by the U.S. Agency for International Development. The database includes national specific notes on contact persons, habitat, water quality management and protection activities.

http://brooktrout.gso.uri.edu/First_Page.html or:

http://brooktrout.gso.uri.edu/world.html

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