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REPORT OF THE

ICES/IOC/IMO STUDY GROUP ON BALLAST WATER AND SEDIMENTS

Llandudno, UK
12–13 April 1999

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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1 TERMS OF REFERENCE

The third and final (under its current mandate) meeting of the ICES/IOC/IMO Study Group on Ballast Water and Sediments (SGBWS) was held in Llandudno, North Wales, UK, 12–13 April 1999 with 49 participants, including 37 attendees representing 11 ICES Member Countries (Canada, Estonia, Finland, France, Germany, Ireland, Netherlands, Norway, Sweden, UK, USA), 11 guests from Australia, Brazil, Chile, Georgia, Israel, Italy, and Turkey, and 1 representative each from both the International Maritime Organization (IMO) and the Intergovernmental Oceanographic Commission (IOC) (Annex 1). The meeting was chaired by Dr J.T. Carlton (USA). Dr M. Nauke represented the IMO and Dr T. Knap represented the IOC. Dr Nauke opened with remarks on the current activities of the IMO in ballast water management (see Section 2.1). Dr Knap commented on the interests and concerns that the IOC has relative to ballast water and species invasions, and noted in particular two related initiatives, the Global Investigation of Pollution in the Marine Environment (GIPME) and the Global Ocean Observing System (GOOS).

In March 1997, the SGBWS meeting in La Tremblade, France, had an attendance of 19 participants, while last year's second meeting in The Hague had 42 participants. The third meeting of SGBWS was thus the largest meeting ever convened of ballast water scientists and managers in the world, exceeding even last year's impressive attendance.

The SGBWS was established by ICES Council Resolution in 1996 (ICES C.Res.1996/3:10). The terms of reference for the 1999 meeting of SGBWS (ICES C.Res.1998/2:5:3) were to:

a) continue the global assessment and review of the status of ballast water biological and ecological research, through the participation of representatives from Member Countries and invited scientists from all major ballast water research groups in the world;

b) continue the evaluation of the development of ballast water control technologies;

c) continue the review of the relationship between ballast water movement and the invasion of exotic marine organisms, including updates on the latest ballast-mediated invasions globally, particularly relative to those species that are now invasive in other regions of the world and that are ballast-transportable—but have not yet arrived—in Member Countries.

2 CURRENT RESEARCH ACTIVITIES ON BALLAST WATER AND SEDIMENTS

The major portion of the two-day meeting was devoted to presentations and discussions on national and global research and management activities on ballast water and ballast sediments as a vector for the transportation, inoculation, and introduction of exotic marine, brackish water (estuarine), and freshwater organisms. Questions and discussions followed each presentation, and time was devoted in the breaks to individual conferences and dialogues. Summaries of each talk are presented below. Annex 1 provides detailed contact information for each presenter. Following the two days of presentations, questions, and discussion, SGBWS convened in plenary to summarize the meeting, arrive at conclusions, and offer recommendations.

2.1 Ballast Water Science

Ballast Water Study at Sture, Norway

H. Botnen

The main purpose of this investigation, funded by Norsk Hydro and the Directorate for Nature Management, was to assess the potential of unintentional introductions of non-indigenous aquatic species via ballast water to Sture. The oil terminal at Sture has been in operation since 1988 and now about 370 vessels arrive annually, discharging about 14 million tonnes of ballast water. From 22 April 1996 until 27 September 1997, zooplankton and phytoplankton samples were collected from 30 crude carriers (tankers) arriving from international ports to the oil terminal at Sture, in western Norway. Along with the biological sampling, temperature, salinity, oxygen, phosphate, and nitrogen were measured. Information such as ballast water origin, amount and age (duration between ballasting and deballasting) was obtained from the chief mate. Most samples were collected during spring and early summer, although sampling was undertaken during the autumn as well. However, no sampling was undertaken in November and December 1996 or in January 1997.

Live organisms were found in 29 vessels and 200 taxa were identified. Ballast water arriving from remote areas contained non-indigenous species, whereas ballast water from northern European and Scandinavian waters mostly contained species that are present in Norwegian waters. Multivariate correlation analyses between the species assembly in the samples and abiotic variables was undertaken. For phytoplankton, the best correlation was achieved for the combination of ballast water age, season, and salinity. For zooplankton, the best correlation was achieved for the combination of salinity and age of ballast water.

Ballast Research in England and Wales: Marine Organisms Transported in Ships' Ballast

T. McCollin, J. Hamer, and I. Lucas

The research is being carried out on behalf of the Ministry of Agriculture, Fisheries and Food (MAFF) and involves investigating the number and types of marine organisms carried in ships' ballast and associated sediments into ports around England and Wales. MAFF is responsible for the marine environment and fisheries interests and requires this information in order to develop its policy on the discharge of ballast water and sediments into coastal waters around England and Wales. This project is closely related to research that has been carried out in Scotland and the methods are based on those developed at the Marine Laboratory in Aberdeen.

Ballast water and the associated sediments were sampled from 112 vessels arriving at 21 English and Welsh ports. The most common origin of ballast was Northern Europe, but samples from the United States, Canada, Japan, and the Mediterranean were also collected. Samples were taken via a deck hatch whenever possible. Net samples were collected for zooplankton counts and identification, and an integrated sample was taken for phytoplankton counts and identification and salinity analysis. A sediment sample was obtained by pumping up from as close to the bottom of the tank as possible; this sample was examined for dinoflagellate cysts. It was not always possible to sample through a deck hatch and, in some cases, samples were taken via sounding pipes, air over flows or ballast pump bleed pipes.

All but one of the water samples contained phytoplankton, with some evidence of a seasonal pattern of temperate spring and autumn blooms. A number of toxic and/or nuisance species were found, e.g., *Pseudonitzschia* spp., *Dinophysis* spp., *Ceratium* spp., *Dictyocha* spp. and *Phaeocystis* spp. Dinoflagellate cysts were recorded in 84 % of the sediment samples. *Scrippsiella hangoei*, *Pentapharsodinium tyrrenicum* and *Gymnodinium catenatum*, dinoflagellate species not previously recorded in British waters, were identified, as were some potentially toxic species, of which *Alexandrium tamarense/catanella* was the most common.

The findings of the project demonstrate that viable organisms are being transported into English and Welsh ports. There is therefore a potential risk of non-native species becoming subsequently established within British waters. Much of the shipping discharging ballast in British waters, i.e., coastal and close continent traffic, will not be subject to the new IMO regulations and hence there is still a risk of secondary introduction of species from established populations at other European ports.

The Role of Sediments in Ballast Water Management

G. Rigby, G. Hallegraeff, and A. Taylor

The role of ballast tank sediments in the dispersal of marine organisms around the world in ships' ballast water is not well understood. Sediments have been considered as possible hosts for the retention and ultimate dispersion over long periods of time, of toxic dinoflagellate cysts and other undesirable organisms. Sediments in ballast tanks may generally be considered to consist of 'organic' and mineral-based sediments. The former represent the proportion of sediment attributable to organisms present and the latter to inert mineral matter that has been entrained in the water during ballasting.

In order to gain a better understanding of the role of these sediments, a preliminary study was carried out on the BHP bulk carrier, Iron Whyalla. In this study, a series of samples was taken from a range of different locations in the ballast tanks. Chemical, physical, and biological analyses were undertaken.

Observations during sampling showed that there were only minimal amounts of sediment throughout the tanks. In general, the double bottom tanks were essentially free of sediment. Small amounts of fine material were evident behind some longitudinals and on stiffeners. One of the samples collected from behind the longitudinal girders in the forepeak tank contained a larger proportion of coarser material, primarily large flakes of rust.

Very little organic material (0.01 %–5.2 %) was present in any of the samples, indicating the presence of only small amounts of biological material. The majority of material consisted of mineral matter, with the SiO_2 and Al_2O_3 compositions and ratios consistent with those generally found in fine clays. Apart from one of the samples (which contained a lot of large pieces of rust from the ship) the rest of the samples contained a large amount of very fine material (mainly mineral matter). Approximately 80 %–90 % of this fine material was smaller than 25 µm in size, and 50 % was smaller than 10 µm. Microscopic examination of the samples showed very little evidence of biological material or remains (sparse diatom frustules). There were only relatively minor variations in chemical, physical, and biological analyses for the various samples. Examination of a core sample taken from one of the double bottom tank locations showed no evidence of gradual build up of material over time.

These observations suggest that essentially all of the biological material taken on during ballasting of this ship is discharged during the deballasting operations. The very fine nature of the material present shows that there is little chance of dinoflagellate cysts or zooplankton material being retained. Further work is being planned to examine sediments from other types of ships, especially those that ballast in shallow ports where larger amounts of sediments could be retained.

EU Concerted Action on 'Testing monitoring systems for risk assessment of harmful introductions by ships to European waters'

S. Gollasch

During recent decades, ballast water discharges have increased throughout the world in most major ports. The intensity of shipping and the structure of vessels have undergone major changes over the past decade. In conjunction with these developments, dredging of harbours and river estuaries has also changed the hydrodynamics of these systems, and there are further altered environmental conditions in coastal habitats, all possibly leading to an increased opportunity for the survival of exotic species.

The objectives of the Concerted Action include the following: State-of-the-art European ballast water studies, documentation and intercalibration of ship sampling techniques, an assessment of potential treatment options to reduce the risks arising from ballast water releases and a public awareness campaign. Furthermore, European waters will be considered as donor areas so documentation of information from previous European studies on introduced species (case histories) will be undertaken. Additionally, through the case histories, the Concerted Action will consider the major pathways of introductions in an attempt to understand the requirements for the development of adequate treatment techniques. At the same time, the Concerted Action will aim to create an awareness about the dimension and nature of the problem within the science community, the regulatory and intergovernmental bodies, as well as in the shipping industry and with the public.

During a series of land-based, ocean-going and intercalibration workshops, the Concerted Action partners and invited experts meet and work on the objectives listed. The most recent has been a three-day workshop held at the CEFAS Conwy Laboratory from 9–11 April 1999. Since this meeting was held immediately before the ICES WGITMO and the joint ICES/IMO/IOC Study Group meetings, a number of invited experts were able to attend. So far, eight case histories of introduced species, regional ocean-going workshops and the intercalibration of ballast water sampling techniques have been finalised. The public awareness programme is an ongoing objective during the entire period of the Concerted Action. Handouts, flyers and posters have been prepared. The Concerted Action Internet homepage is under construction and will be available soon.

Brief results of the ocean-going workshops of the EU Concerted Action are as follows: Two vessels were accompanied on their European voyages. The Russian hydrographic ship 'Sibiryakov' was joined on its voyage from St. Petersburg to Lisbon and the oil carrier 'Nordic Torinita' on its trip from Cork, Ireland, to Sture, Norway. During both trips various sampling methods were applied to several ballast water tanks. The initial results and recommendations are as follows:

- the temperature variation in short-term voyages, when mostly undertaken in one climate zone, is not a critical factor controlling the survival of the specimens in the ballast water;
- the main factors causing the mortality of species in ballast water during the first days of transport are damage during the pumping process, lack of light (orientation problems), and wind-induced currents in the ballast tank;
- for future ocean-going workshops, the number of sampling techniques should be limited to the most effective methods—during the trips, one sampling trial took about two hours to complete (a limited number of sampling techniques would enable the sampling of one ballast tank more than once a day);

- the cone-shaped net and bucket samples revealed the highest numbers of organisms in both wing tanks that were investigated;

- the recommended methods for zooplankton sampling are 55 µm cone net, 55 µm net, bucket, and hand pump;

- a new method of using traps inside ballast tanks to catch species in ballast water was not successful, it is possible that a new trap design and a longer period of exposure during better weather conditions will reveal better results (traps should be tested during longer-term ocean-going voyages; it was also noted that chemical light sticks in traps may attract organisms to the traps).

Bacteria and Viruses in Ballast Water

A. Jelmert, O.K. Nilsen, O. Enger, and L. Gram

The objectives of the project were to examine some properties (primarily the numbers and genomic diversity) of bacteria and viruses entering the Mongstad Harbour via ballast water and sediments. A particular challenge was to examine whether specific gene sequences found in ballast water also could be found in the recipient. A third goal was to examine the prevalence of resistance to various antibiotics in bacteria present in ballast water compared to a reference sample station. Main tools were epifluorescence counts, agar plate counts (with and without antibiotics), and PCR amplification of DNA fragments from the 16S rDNA region. The fragments were separated by degrading gradient gel electrophoresis (DGGE), and selected bands were compared with existing databases for similarity. Preliminary results show very high numbers of bacteria and viruses in one ship with a short travel time (4 days) and brackish water (BW). The corresponding culturable numbers of bacteria were approximately 2–3 orders of magnitude lower. Typically, most DNA bands were found both in BW and the recipient, but some bands unique to brackish water have been found. Further analysis of these bands is in progress. Bacteria resistant against oxytetracycline have been found in higher numbers in BW than in organisms from the reference site. Bacteria with possible resistance to other antibiotics have been found, but these observations will need confirmation by other tests.

The Netherlands Ballast Water Sampling Programme, 1999

L.P.M.J. Wetsteyn and S. van Gool

After a literature review in 1998 by a consultant (AquaSense), it was found that Rotterdam and Amsterdam export much more ballast water than they import. The amount of discharged (imported) ballast water is much smaller, but is still a considerable part of the total discharged amounts in Europe. Because of this, and also because of ecological uncertainties, it was decided to continue with ballast water research and to see what is actually entering The Netherlands in ballast water tanks.

The reported data on amounts of ballast water, discharged by different types of ships, and the possible origin of this water, were used to design a sampling scheme (see Table 1) with types of ships and origins planned to be sampled in 1999.

Table 1. Number and types of ships planned to be sampled in 1999.

	Europe	North America	Asia	Total
Container	6	2	2	10
Multi-purpose	4	2	2	8
Tanker	4	2	1	7
Bulk carrier	2	1	1	4
Other	2	1	1	4
Total	18	8	7	33

Emphasis will be on the sampling of phytoplankton and zooplankton in ballast water and, if possible, will be done at most in four ballast water tanks on each visited ship. The preferred method is to sample with plankton nets (20 µm and 55 µm) via manholes, if allowed and if possible. Only in this way will the whole water column be sampled, and not only phytoplankton but also larger, fast-swimming zooplankton will be caught. Because sampling via manholes is not always possible, sampling of plankton through sounding pipes is a viable second option. One disadvantage of this

method is that only samples from the tank floor can be obtained. However, as a consequence of safety regulations, electricity cannot be used on tankers and a hand pump or air should be used. If the above-mentioned methods fail, sampling via the ballast water pump is another possibility. Plankton samples will be taken to the laboratory alive and as fixed samples. Fixed samples will be used to analyse plankton species composition and concentrations and results will be compared with data from the Dutch phytoplankton monitoring programme (from 1990 to the present). In order to estimate the (autotrophic) viability upon arrival, the percentage of fluorescent particles in live samples will be measured routinely by flow cytometry.

Sediment samples will be obtained by pumping up a sediment/water mixture from just above the tank floor or, as a slurry, from opened and ventilated ballast water tanks; sampling in ventilated ballast water tanks on board docked ships is also a real possibility. Only fresh sediment samples will be taken and used for cyst identification and germination experiments in North Sea water and a standard artificial medium.

Port authorities, ships' owners and agencies have been approached in order to obtain entrance to ships of different types and from different origins. Until now, only three ships have been sampled: one chemical tanker and two multi-purpose vessels. More ships' owners have agreed and more samples will be obtained and analysed this year.

The Prince William Sound, Alaska, Ballast Water Research Project

J. Kopp

The first year of a two-year project researching (a) the risk of tanker traffic introducing aquatic non-indigenous species into Prince William Sound, Alaska, and (b) the present role of non-indigenous species in the Sound has been completed. This ambitious project, funded by the Prince William Sound Regional Citizens' Advisory Council, the U.S. Fish and Wildlife Service, and Alaska Sea Grant, encompasses five major components:

1) sampling and analysis of tanker ballast water, of ballast sediments, and of hull and sea chest fouling communities;

2) measuring the temperature and salinity tolerances of ballast water plankton;

3) measuring the effectiveness of empty-refill and flow-through ballast exchanges;

4) field sampling for intertidal and fouling non-indigenous species in the Sound; and,

5) analysis of curated biological samples previously collected from the Sound.

This project, which is being conducted by the Smithsonian Environmental Research Center (SERC), will continue through 1999, with a final report expected before the years's end.

2.2 Ballast Management and Treatment Programmes

The International Maritime Organization (IMO) Current Work Related to the Preparation of a Legal Instrument on Ballast Water Management, Accompanied by a Programme for Developing Countries

M. Nauke

At the United Nations International Maritime Organization, legally binding provisions are being developed on ballast water management aimed at reducing the risk of transferring harmful aquatic organisms and pathogens with ships' ballast water. IMO's Marine Environment Protection Committee (MEPC) in late 1998 had requested the Secretariat to evaluate various options for a legal framework containing such provisions, and to prepare an outline for sets of regulations for consideration at the forthcoming session of the MEPC in June–July 1999. The model for a new Convention was noted, in particular the substantive draft regulations set out in an annex to the proposed Convention, and further an International Code of Practice on Ballast Water Management which could form an appendix to the annex. Other appendices would contain standard or models of relevant certificates, supporting forms as well as guidelines providing assistance in the effective implementation of the Convention. Instead of a Convention, other options, such as a new Annex under the existing MARPOL 73/78 Convention, were possible. To facilitate the early entry into force of the new legal instrument, an awareness programme, training schedules and curriculae in particular for developing countries, as well as technical assistance including provision of technical equipment are being planned as part of a new UNDP/IMO/GEF project entitled, 'Removal of Barriers to the Effective Implementation of Ballast Water Control and

Management Initiatives in Developing Countries'. A project proposal has been forwarded in April 1999 for consideration by the GEF Council, together with a programme of planned activities, including the establishment of an information network (clearing house), national and regional task teams, workshops and seminars for staff of port authorities, maritime administrations, surveyors and shipping agents. IMO, as the executing agency of the ballast water project, in order to effectively carry out its tasks in this regard, has to draw upon the experience of and knowledge gained within the ICES/IOC/IMO Study Group on Ballast Water and Sediments.

Review and Update of Ballast Water Research Activities at the Smithsonian Institution

G. Ruiz

Over the past seven years, a collaborative research programme has been developed at the Smithsonian Environmental Research Center (SERC) to address a broad range of issues in marine and estuarine invasion biology. The overall goal of this programme is to:

1) measure patterns of non-indigenous species transfer, invasion, and impact;

2) test specific and general mechanisms that underlie these patterns;

3) assess the efficacy of management strategies to limit the spread and impact of non-indigenous species.

Although this research focuses on non-indigenous species (NIS) invasions, there is also interest in the unique opportunities that invasions offer in understanding the fundamental processes of 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). SERC is located on Chesapeake Bay, near the middle of the U.S. Atlantic coast, and has focused much attention to date on Chesapeake Bay as a model system to examine patterns and mechanisms of invasion. A core group of approximately 15 researchers is based in the region, and has many collaborators outside of the region who participate in the Chesapeake-based research. This programme also includes 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., there are research projects in Alaska, California, Florida, and Massachusetts primarily, and this work often involves collaboration with scientists based outside of the Chesapeake region. SERC has also developed collaborative overseas research in Australia, Israel, Italy, Netherlands, and New Zealand.

The National Invasive Species Act of 1996 (NISA) directed the United States Coast Guard (USCG) in conjunction with the Smithsonian Environmental Research Center (SERC) to develop a clearing house for the synthesis, analysis, and interpretation of national data concerning ballast water management and ballast-mediated invasions. As a result, the National Ballast Water Information Clearinghouse (hereafter Clearinghouse) was established in 1997 at SERC. NISA calls for a variety of measures to reduce the risk of exotic species invasions associated with release of ballast water by ships. Among these, NISA requests that all ships arriving to U.S. ports from outside the Exclusive Economic Zone (EEZ) follow voluntary guidelines for open-ocean exchange of ballast tanks that are to be discharged in U.S. waters. This management practice is intended to minimize the transfer of non-indigenous species. A key element of this legislation is tracking the effectiveness of voluntary guidelines for ballast water management. This assessment includes measuring: (a) the level of compliance with voluntary guidelines, (b) changes in the rate and patterns of ballast water delivery, and (c) reduction in the rate of ballast-mediated invasions. The Clearinghouse was created to provide synthesis and analysis of these measures on a national scale. More generally, the Clearinghouse will function as a central source of information on ballast water and ballast-mediated invasions to include: spatial and temporal patterns of ballast water delivery and management; patterns and rates of marine and estuarine invasions; directory of ongoing and past research on ballast water and ballast-mediated invasions; general information on a broad range of topics relevant to this issue. Together, these elements will provide a valuable resource, which is now lacking for ballast water management and ballast-mediated invasions. The Clearinghouse will produce reports on national patterns of ballast water management and invasion, as well as databases that are available via the Internet. This approach is intended to provide access to a rich source of information for education, management, policy, and research.

National Ballast Survey

The U.S. Coast Guard and the Clearinghouse are implementing a nationwide programme, the National Ballast Survey (NABS), to measure ballast water management and delivery patterns for commercial vessels that arrive to U.S. ports from outside of the EEZ. The National Ballast Survey is designed explicitly to create a national database on ballast water that will allow us to: measure patterns of ballast water delivery and management (including especially exchange);

measure among-year changes in ballast water management by vessel type, geographic region, and season; assess the accuracy of data through use of multiple, independent data sources and direct water testing.

The data from NABS will be used to measure the rate of voluntary compliance with guidelines for open-ocean ballast exchange. It is expected that estimates will be made of rates of ballast water exchange, both in terms of the frequency of vessels that undergo exchange and the percentage of ballast water exchanged, for different vessel types (e.g., bulk carriers, oil tankers, container ships, etc.). Furthermore, it is planned to test for differences in space and time for (1) the rate of exchange and (2) the amount of foreign ballast release.

The design phase for NABS is now nearing completion, and various aspects of the programme have already been implemented. It is expected that this programme will be fully implemented during 1999. The Clearinghouse is responsible for management and analysis of the extensive data collected under this programme, and is assisting the U.S. Coast Guard in the development and implementation of data collection techniques.

The National Ballast Survey will result in a comprehensive analysis and biennial report to the U.S. Congress on the status of ballast water delivery throughout the country. The first report and its underlying data will provide a nation-wide baseline on the current status of ballast delivery and management patterns, and subsequent biennial reports will measure trends or changes in ballast water management. Although the Clearinghouse will provide analyses and interpretation of patterns for ballast water management, policy recommendations will be made by other groups outside the Clearinghouse.

Effectiveness of Ballast Water Exchange

Although the National Ballast Survey will provide a detailed assessment of compliance with NISA's voluntary guidelines for ballast exchange, it is important to recognize this as only one measure of effectiveness. NABS is designed to measure the rate of implementation for this management strategy but does not measure the actual effect on reducing the rate of invasion. It is perhaps intuitive that reducing the supply of organisms that arrive to our ports in ballast water (via ballast water exchange) will result in fewer invasions overall, and there is a good deal of support for this logic. However, ballast water exchange is not 100 % efficient, as not all organisms are removed by exchange. Thus, the effectiveness of this management strategy depends upon both (a) the degree of implementation and (b) the relationship between supply and invasion rates.

Measuring the pattern and rate of invasions is integral for evaluating the effectiveness of ballast water exchange, or any other management strategy, to reduce invasions. For example, as the rate of ballast water exchange increases over time (i.e., the supply of ballast-transferred organisms declines), its effectiveness is best characterized by changes in the rate of invasion. Thus, it is of paramount importance to link measures of patterns of ballast water delivery to associated patterns of invasion.

The Clearinghouse strives to integrate patterns of ballast delivery and invasion. NABS has developed a programme for assessment of ballast water delivery patterns in space and time. As a collaborative effort, the Clearinghouse is actively developing a parallel programme to measure rates of invasion nationwide.

The above information is also found on two SERC websites: http://www.serc.si.edu/invasions/index.htm and http://www.serc.si.edu/invasions/ballast.htm.

Ballast Water Management and Research Activities in Canada

M. Gilbert

Two initiatives have recently been undertaken in Canada with regard to the management of foreign ballast water discharges and the associated potential introduction of non-indigenous aquatic species in Canadian waters.

The first initiative is the recent creation of a National Ballast Water Working Group (NBWWG) under the aegis of the Canadian Marine Advisory Council to bring together scientific and technical expertise on ballast waters for a better management of this issue in Canada. The NBWWG shall act as the prime government/industry coordinating body on ballast water issues in Canada and shall monitor and oversee related research and management activities on ballast water. The NBWWG will provide recommendations to the Standing Committee on the Environment (SCE) on policy, regulations, and operations. Safety issues will be dealt with through reports to the Standing Committee on Construction and Machinery (SCCM).

Membership of the NBWWG will include representatives from the federal government (Transport Canada and DFO, including the Canadian Coast Guard), the shipping industry and port authorities, and it will be co-chaired by government and industry representatives who will be selected every two years. In addition, the NBWWG will include chairs of regional working groups representing distinct ecosystems in Canada (Pacific, Great Lakes, Atlantic, and Arctic); the regional groups will provide guidance to the NBWWG regarding ballast water issues that are specific to their respective areas. The NBWWG is scheduled to meet twice a year, in advance of SCE meetings, which are usually held in May and November.

The second initiative that was recently undertaken is the development and implementation of a three-year National Ballast Water Research Programme within the Department of Fisheries and Oceans (DFO) to provide the NBWWG with the appropriate scientific background and support to minimize risks for the ballast water-mediated introduction of non-indigenous aquatic species in Canadian waters.

To achieve this goal, the adequacy of existing guidelines for the control of ballast water discharges in Canadian waters will be assessed and ballast water treatment methods will be developed as an alternative to offshore ballast water exchanges to minimize risks of ballast water mediated introductions. The adequacy of current guidelines will be examined in two ways. First, risks for ballast water mediated introductions will be assessed for areas of intense international shipping traffic that are not covered by any guidelines for offshore ballast water exchanges to determine whether such guidelines should be developed or extended to include these areas (Bay of Fundy, Gulf of St. Lawrence, and the Pacific coast excluding the Vancouver port area). This risk assessment will involve ballast water sampling surveys for phytoplankton and zooplankton, including toxic phytoplankton, survival and viability studies onboard ships entering ports on the east and west coasts of Canada, habitat requirements studies, and an inventory of introduced species in some areas.

Second, the suitability of coastal backup areas for ballast water exchanges, as defined in existing guidelines for the Port of Vancouver (Race Rocks) and the Great Lakes/St. Lawrence areas (Gulf of St. Lawrence), will be assessed through oceanographic and dispersion modelling, and modifications will be proposed if deemed necessary. Finally, chemical ballast water treatment options will be examined for the Great Lakes, given the high risks for ballast water mediated introductions in this area and the apparent inadequacy of existing guidelines to minimize them to an acceptable level. This work will allow existing guidelines to be extended and/or refined, new guidelines to be implemented in some areas, and will give some insight into ballast water treatment methods in order to better protect the biodiversity and ecosystem stability of Canadian coastal and inland waters that are used for navigation.

Control of Ballast Tank Biofilm: Transfer of Exotic Organisms by Surface Chemical Release of Structure- and Sediment-Bound Biota

R.E. Baier

Biofouling and corrosion of underwater surfaces is a universal problem. This means that preventative maintenance is required to preserve operating efficiency. After fouling attachment, surfaces must be restored using methods that are environmentally acceptable. In ballast tanks, it is a concomitant need to shed all surface-bound or sediment-entrapped biomass into the volume phase for the purposes of effective exchange and control of non-indigenous species. Prior methods employed aldehydes, strong alkali solutions, and chlorine. These solutions when used in ballast compartments can cause significant structural deterioration.

The use of a cleaning and emulsifying solution is proposed, based on surface chemical principles, that will separate and displace the organic fouling layers from metal and sediment surfaces such that the fouling deposits can easily be entrained during ballast exchange operations. The basic technology was proven long ago for other ship-related cleaning problems at the U.S. Naval Research Laboratory by W.A. Zisman, H.R. Baker and their co-workers. These studies solved difficult technical problems of oil contamination and seawater corrosion of complex electronic devices, with much of the information translatable to safely cleaning surfaces which have accumulated biological slimes or gross fouling deposits.

After even a few days of contact with natural waters, all known materials are coated by organic films and slime-forming organisms, including bacteria, diatoms, and other microbiota. Effective displacement of organic layers coating a solid surface can be accomplished by specific surface-chemical action, the essential conditions being the same as are found for displacing water.

General requirements for the biofilm-displacing agent are as follows:

1) It should remove biopolymer and oil residues rapidly and gently and not require excessive hydraulic forces or brushing of the surface.

2) It should not cause damage, during or after the cleaning treatment, to the common structural materials employed in ship construction or ballasting.

3) It should be non-corrosive to any metals likely to be present and should retard the corrosion of any metal surface to which it is applied.

4) It should be non-toxic and non-irritating to skin and tissues.

5) It should be commercially available and inexpensive.

A marginally stable emulsion-type cleaner has been developed that is especially effective in meeting these requirements: the dispersed hydrophilic component of the emulsion readily penetrates the organic residues while the water portion serves to flush out the contaminants. The continuous water phase minimizes flammability and health hazards, as the emulsion fluid and detached biomass are then flushed away with exchange water for collection, reuse, or disposal.

The most complete removal of the fouling films occurs when the emulsion breaks as it contacts the surface so that the displacing agent is released to spread over, dissolve into, and replace the water-organic layers. A spray ejected at a high pressure cleans best and uses least emulsion. Field tests of such cleaning emulsions have shown that coatings and even the most delicate insulation in use on electrical motors are not damaged by such a fine spray applied at 80 psi. There is little danger of damaging the interior surfaces of ballast water systems. Rather, a corrosion-inhibiting and re-contamination inhibiting layer is left behind.

Biological Effects of Zinc on Ballast Water Biota

A. Jelmert

Literature data on the sensitivity of various aquatic biota to zinc suggest that the application of zinc sacrificial anodes in ballast water tanks will affect the survival of organisms transported in the ballast water. By applying a simplified model for release, it was calculated that the concentration of zinc may reach 2.5–18 mg Zn^{2+} per liter at pH 7.5, depending on ballasting/deballasting frequencies, and 1.16 mg Zn^{2+} per liter at pH 8.2, where the Zn^{2+} concentrations would be limited by the solubility of $Zn(OH)_2$. The concentrations anticipated in ballast water were from 50 to 200 times the concentrations shown to adversely affect gamete production and/or the early life stages of various biota such as a Japanese paeneid shrimp (*Penaeus orientalis*), a freshwater gastropod mollusc (*Anculus fluviatilis*), and fathead minnow (*Pimephales promelas*). It is the same concentration that was shown to have sublethal effects on larvae of herring (*Clupeus harengus*). Many sessile organisms have their early life stages as the main means of dispersion, and these early life stages appear especially vulnerable to dissolved zinc. Further studies on the topic are recommended.

Update on Hydrocyclone and UV Tests

A. Jelmert

The scope of the treatment was to remove suspended solids and to kill remaining biota by UV irradiation. The system consisted of an approximately 5 m long GRP tube with an accelerating inlet device that creates the cyclonic forces. Separated solids were collected in a purge in the opposite end, diverting approximately 10 % of the flow. The remaining filtrate passed through a UV irradiating unit producing doses from 90–110 mWs cm^{-2} at 254 nm, depending on water flow and transmissivity. The efficacy of the system was tested by injecting dense cultures of *Artemia* sp. nauplii, *Artemia* cysts, the dinoflagellate *Prorocentrum minimum*, the green algae *Tetraselmis* sp., and two isolates of marine bacteria. The removal of particulates and the mortality of various biota at four stages through the system were recorded. The test organisms were subjected to darkness for two days (*Artemia* and algae) and one day (bacteria) before survival was assessed. Preliminary results showed that approximately 15 % of the *Artemia* nauplii was removed in the hydrocyclone. The remaining *Artemia* nauplii after the UV unit had a mortality of 99.5 % and the various zooplankton also present in the water had a mortality of 99 %. Further data will be presented and discussed elsewhere.

Biological Test Results from the Great Lakes Ballast Technology Demonstration Project

A.A. Cangelosi

Three levels of filtration were tested for effectiveness for screening fresh- and salt-water organisms from the ballast water of ships. The three screen sizes (25 µm, 50 µm, and 100 µm) were evaluated aboard two experimental platforms—an operating commercial vessel in the fall of 1997 and a stationary barge in the fall of 1998—at a flow rate (1200 gallons per minute) typical of St. Lawrence Seaway-sized ocean-going ships. The host ship, the M/V 'Algonorth', owned by Algoma Central Marine, plies the Great Lakes/St. Lawrence System allowing tests in both fresh and salt water. The shipboard experimental platform consisted of the filter units and a pump mounted on the deck with piping to matched control and test upper wing ballast tanks. The stationary barge platform was docked at the Seaway Port Authority of Duluth in Duluth/Superior Harbour, and consisted of the same filter units and pump with piping to three identical catchment tanks of 175 gallons each with bottom outlets. Biological effectiveness was measured through comparing zooplankton, phytoplankton, and microbial concentrations with and without filtration treatment. Plankton samples were collected using plankton nets. Whole water samples were collected to examine chlorophyll and microbial content. The biological effectiveness experimental design and methods will be summarized. Test results for both planktonic and microbial organisms will be reported.

Scotland: Assessing the Effectiveness of Regional Exchange on Ballast Water Plankton

E. McDonald

Following the initial ballast water research carried out at the FRS Marine Laboratory in Aberdeen, a new project will soon begin to study the effectiveness of ballast water exchange in regional seas around Scotland.

Much of the ballast water discharged in Scotland originates from northern Europe and preliminary assessments of ballast water exchange in the North Sea and Irish Sea show that it may be less effective than in oceanic waters. The problems of managing ballast water in coastal and regional seas are recognized as being rather different from operations involving transoceanic voyages. The new Scottish project, funded by the Scottish Office Agriculture, Environment and Fisheries Department and Scottish Natural Heritage, will aim to address some of the problems of ballast water exchange in regional seas. With cooperation from industry, a series of trials are planned where planktonic organisms will be sampled from ballast tanks and from the ambient sea water during voyages, before, during, and following ballast exchange. These trials will run through a complete seasonal cycle and will aim to cover the normal trading routes of the vessels and also in targeted areas, which may be suitable for ballast water exchange.

Ballast Water Issues in Georgia

A. Shotadze and T. Gogotishvili

New oil pipelines have been approved for transit to Georgia for loading from offshore terminals in the Black Sea between Batumi and Poti. Details of the pipeline and shipping companies' plans for ballast water management are under study and being compared to other international guidelines.

Australia: The Ballast Water Decision Support System

K. Colgan

The possible introduction of harmful aquatic organisms and pathogens into Australian waters by shipping has been recognised as one of the major environmental issues to face Australia. These organisms can reach Australia from international ports in a number of ways with ballast water considered to be a major vector for the introduction of invasive marine species. Within Australia the principal Commonwealth agency responsible for ballast water issues is the Australian Quarantine Inspection Service (AQIS). AQIS receives advice from the Australian Ballast Water Management Advisory Council (ABWMAC) which is made up of key stakeholders in ballast water issues, including shipping, fishing and aquaculture industries, port authorities, environment interests and State and Commonwealth Government agencies. In July 1996, the ABWMAC established the Research Advisory Group (RAG) comprising scientific and technical experts to provide advice on the development and implementation of the Strategic Ballast Water Research and Development Programme.

The outcomes of the Strategic Ballast Water Research and Development Programme are central to the development of effective ballast water management practices. A key focus of the Programme is the development of a risk assessment based Decision Support System (DSS) as an effective ballast water management tool for AQIS, the shipping industry, and other relevant government agencies and port authorities. It is envisaged that the DSS will provide a scientifically sound and objective risk assessment tool for application to each vessel voyage and will allow authorities and the industry to more effectively manage ballast water discharges from international and coastal vessels.

The DSS will be essential in the implementation of Australian Government Policy as Australia moves towards mandatory ballast water arrangements in the year 2000. It is expected that the move to mandatory arrangements will coincide with the ratification, by the International Maritime Organization, of the international regulatory framework for the management of ballast water expected to take place either in late 2000 or early 2001.

The objectives of the DSS are to:

- assess the level of risk a vessel poses on entry to Australian waters;
- determine the options for minimizing any risk; and
- establish a system that will develop incrementally through time.

The essential components of the DSS will be:

- a 'trigger mechanism' that provides notification in advance of a ship's arrival and the need to run the DSS;

  This will be the Ballast Water Reporting Form. As of 1 October 1998 it is mandatory for all vessels intending to visit an Australian port to complete this form and submit it to AQIS.

- a quantitative risk assessment methodology based on 'target species' which produces a risk assessment associated with the biological risk a vessel poses;
- a qualitative risk assessment methodology which produces a risk assessment associated with the management aspects of the vessel and its ballast water;
- information databases which hold static and dynamic information required by the DSS;
- a decision mechanism that associates the risk with an associated action and maintains audit trail of the decision process; and
- communication links between the required information sources, the risk assessment, the decision-makers, and the vessel.

The DSS will be triggered by the vessel submitting the information on the Ballast Water Reporting Form, ideally before leaving the last port of call and before reaching Australian waters. It is proposed that this information could be submitted by telex. When the information is received from the ship, the quantitative and qualitative risk assessments are performed and the levels of risk combined using a set of rules to produce a risk level associated with the vessel entering the Australian port. The combined level of risk would then be used to allow or prevent entry of the vessel into an Australian port. The decision regarding level of risk and options for the vessel, should they be determined a high risk vessel, would be communicated back to the vessel. If, for example, a vessel were determined to be a low risk, then it is possible that no action would be required of the vessel. If a vessel is determined to be a high risk, then it is envisaged that a range of options may need to be presented to the ship's master and he would need to decide which option was most suitable for the situation. If a vessel was unable to comply with any of the options, AQIS would need to be informed and a further discussion could take place. It is intended that a basic version of the DSS will be developed and operational by November 2000.

2.3 Education and Outreach Programmes

The United States Pacific Coast Ballast Outreach Project

(February 1999–March 2001)

J. Cassell, A. Dehalt, and K. Hart

Coastal areas throughout the United States have been seriously impacted by introductions of aquatic nuisance species. For instance, the San Francisco Bay-Delta estuary is host to over 200 non-indigenous or exotic species. Research indicates that ballast water is the leading vector for introductions of aquatic nuisance species to coastal areas, and hundreds of species have been found in ballast tanks and sediments.

Recent legislation, the National Invasive Species Act of 1996 (NISA 96), requires the U.S. Coast Guard to develop voluntary ballast management guidelines to prevent new introductions of exotic species to U.S. waters. Compliance with the voluntary guidelines may be problematic for the Pacific Coast maritime industry due to the current reliance on open-ocean exchange as the primary ballast management technique (high seas on the Pacific Ocean make conditions frequently unsafe for open-ocean exchange). There has also been no focused effort to educate the Pacific Coast industry about aquatic nuisance species and ballast management issues. This project will provide an education programme to improve the industry's knowledge about these issues and to stimulate industrial interest and involvement in the development of new ballast management technologies that are appropriate for the Pacific Coast. This project will provide an outreach programme to educate the shipping industry, government agencies, and the general public about aquatic nuisance species and ballast management issues relevant to the West Coast.

The project will comprise five major components:

1) A general education publication on Pacific Coast aquatic nuisance species and ballast management issues. The publication will be provided to a variety of audiences including the Pacific Coast shipping industry, the general public, and natural resource professionals. An educational poster will be included as an insert.

2) A series of educational forums to increase industry awareness and knowledge of ballast management issues. Forums will be half-day events (in coordination with related maritime events) where individuals involved with the development of ballast management or ballast technology approaches will be invited to provide a presentation to representatives of the West Coast maritime industry.

3) A biannual newsletter and website focusing on ballast management issues. The newsletter will provide current information on nationwide ballast technology and management research and West Coast aquatic nuisance species issues. The project website will contain announcements, linkages to other websites, and a list-serv where participants can discuss issues and submit questions.

4) General outreach through providing articles and announcements to existing education and maritime publications and websites.

5) The formation of an industry working group which will provide a basis for initiation and funding of future West Coast ballast management demonstration projects.

3 CONCLUSIONS AND FINDINGS

The following is a summary of the major conclusions and findings, as agreed by SGBWS participants. These conclusions and findings are based on the reports that were presented at the meeting, and on substantive and extended discussions arising from those reports.

With rapidly increasing global trade and extensive coastal environmental changes, an enormous number of invasions of non-native estuarine and marine plants, invertebrates, and fish have characterized the last quarter of the 20th century. These range from the red tide causing dinoflagellates to zebra mussels and comb jellyfish, and hundreds of other species. In turn, it is clear that there is an ever-increasing potential for the continued spread of non-native species by shipping activities. The concern for this potential is further reflected in a growing menu of legislative actions aimed at ballast water management, including internationally applicable, legally-binding provisions that are now under consideration by the International Maritime Organization with a view toward their adoption in the year 2000.

The following were the key conclusions arising from the third meeting of the ICES/IOC/IMO Study Group on Ballast Water and Sediments:

- Ballast water and sediment management must be viewed as a complex multilayered system. An understanding of the wide variety of vessel types (including ship age and condition, and ballast systems), ballasting history (and thus sources and ages of water and sediments), voyage routes, sea conditions, and durations, the changing biological, chemical, and physical conditions that occur inside ballast systems during transport that may impact biotic survival, and the changing environmental nature of both donor and receiver ports, form an intricate foundation for ballast research and management.

- In turn, the choice of sampling devices and instruments (the sampling 'tool box') to assess the biotic diversity of ballast water is closely linked to the nature of the specific research questions being asked and the overall research design. Strong funding support for systematics and taxonomy is the 'sine qua non' (= without which nothing) for understanding and appreciating the biodiversity of ballast biota. Also critical to assessing ballast biological diversity is continued research on rapid and accurate identification techniques, such as those that may employ molecular probes.

- Management techniques, including risk assessment science, can and should take a wide variety of approaches and forms, including working closely with ship operators to facilitate an understanding of the problems of exotic species, coordinated with an extensive menu of ballast management guidelines. These guidelines should include port-of-origin management (such as avoiding ballasting during red tides or disease outbreaks), at-sea management (mid-ocean exchange as long as safety permits), and if necessary port-of-arrival management.

- Due to the ecological, economic, and environmental impacts of ballast-mediated invasions in coastal, estuarine, and inland waters of many countries, ballast water research programmes are growing in number and depth around the world. It is crucial that researchers (a) collaborate in their research efforts to aim for a cumulative, global, and unified database, (b) establish standardized sampling methods and techniques that ensure the generation of comparative data, and (c) remain in contact with each other through fluent and frequent communication. Facilitating this need will be international consortia such as this Study Group, continuously updated websites, a joint international ballast website providing links to all research and management groups, cooperative programmes, and training programmes for developing countries to establish and implement effective internationally applicable ballast management provisions.

- Public and thus political awareness and outreach are key components of moving forward with international ballast water management. In this regard, establishing the actual or potential relationships between human health concerns (such as the spread of human diseases, including cholera), human economic concerns (such as the spread of shellfish and finfish diseases, the spread of algae causing harmful algal blooms, the spread of species impacting industrial systems, and the spread of species impacting resource utilization and value), and the movement of ballast water and sediments, will remain central to ballast management and science. Included in this is the interpolation of how global changes in climate and the changing coastal and inland water environments globally will either enhance or depress the potential for species invasions.

- It is recognized that effective ballast management will involve a variety of techniques, approaches, treatments, and controls, played out against a wide variety of spatial and temporal scales. There is urgent need to continue and to expand cooperative research programmes that explore the application of management approaches and treatments relative to different vessel types, trade routes, ballast load configurations, weather conditions, and the many other factors that are involved in reducing the transfer and movement of species. Of particular importance will be the implementation of on-board treatment systems as they become available and accepted as effective, to supplement open ocean exchange. In all ballast management strategies, it is critical to emphasize the global nature of ballast movement, while acknowledging regional challenges as well.

- Equally important is the recognition that a ship is a floating 'biological island' and as such is capable of carrying a vast array of living organisms (including bacteria, fungi, protists, animals, and plants) by a variety of means and methods, including (a) as external surface fouling on the hull, (b) in compartments where water enters the vessel (such as seawater pipes and sea chests), (c) on anchors and anchor chains, and (d) in ballast tanks and ballastable cargo holds. In these 'ship habitats' organisms may be attached to hard substrates, occur in organic films, be suspended in water, or occur in accumulated sediments. An expanded view of the ship as a biological dispersal vector is to recognize both ballast and non-ballast components, especially with potential future bans on certain types of hull antifouling paint.

4 RECOMMENDATIONS

There was very strong and unanimous consensus by SGBWS that an international meeting of scientists and managers concerned with ocean-going and coastal ships as vectors for exotic species invasions should be continued. Rather than being a finite look at ballast water and sediments, it was unanimously agreed that this aspect of invasion science is just beginning, that numerous research groups are now starting important programmes, and that it is important to share the fruits of this research. The growth of SGBWS from 19 participants in 1997 to 49 participants in 1999 is a clear measure of the logarithmic rise importance in this field. It was further emphasized that it is important to recognize all ship systems that may be involved in the movement of non-indigenous organisms. It is also important, along global and international lines, to keep the group as a consortium of ICES, IOC, and IMO, rather than to convert the Study Group to an ICES Working Group. This will thus ensure the broadest possible subscription to the topic.

It was thus recommended by the ICES/IMO/IOC Study Group on Ballast Water and Sediments that an 'ICES/IOC/IMO Study Group on Ballast and Other Ship Vectors' [SGBOSV] be convened for a period of not less than five years. The first meeting of SGBOSV should be scheduled for 2001 at a time and place to be determined and under the leadership of a Chair or Co-Chairs to be duly appointed. Toward this end, a letter has been sent from Mr W.A. O'Neil, Secretary General of the International Maritime Organization (London), to Professor C.C.E. Hopkins, General Secretary, International Council for the Exploration of the Sea, on 6 May 1999, expressing IMO's interest in continuing cooperation with ICES in these matters.

SGBWS further recommends that the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) include on its agenda for its meeting in 2000, specific oversight of ballast water and other ship vector issues.

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ANNEX 2: AGENDA

Monday, 12 April 1999

9:00	Opening of the Meeting
	Welcoming Remarks
	Introduction of Participants and Guests
9:15	Review of Terms of Reference (above)
	Review of the Agenda (below): changes, corrections, additions
9:30	H. Rosenthal and S. Gollasch (on behalf of the Concerted Action group): Update on the European Union Concerted Action ballast water activities
9:50	M. Nauke: IMO's current work related to the preparation of a legal instrument on ballast water management, accompanied by a programme for developing countries
10:10	A. Knap: Remarks on the Global Investigation of Pollution in the Marine Environment (GIPME) and the Global Ocean Observing System (GOOS) Health of the Oceans Panel
10:30	Coffee break
11:00	G. Ruiz: Review and update of ballast water research activities at the Smithsonian Institute
11:20	J. A. Kopp: The Prince William Sound, Alaska, Ballast Water Project
11:40	B. Wetsteyn: Introduction to the Netherlands Ballast Water Sampling Programme
12:00	Lunch
2:00	A. Cangelosi: Ballast Water Filtration Studies in the Great Lakes
2:20	A. Jelmert: Ballast water and Hydrocyclone / UV Tests
2:40	R. E. Baier: Biofilm buildup, control, and resistance as a function of ballast tank structural/coating materials
3:00	Coffee Break
3:40	G. Rigby and G. Hallegraeff: Ballast tank sediments; analyses of ballast exchange efficiencies
4:00	A. Jelmert: Preliminary results from a study on bacteria and viruses in ballast water
4:20	T. McCollin, J. Hamer, and I. Lucas: Ballast sampling programme in England and Wales
4:40	S. Gollasch (on behalf of the Concerted Action group): Survival rates on species in ballast tanks during interregional voyages
5:00	Review of Tomorrow's Agenda; Questions
5:15	Adjournment of Day 1

Tuesday, 13 April 1999

9:00	Opening of Day 2
9:10	N. Huelsmann and B. Galil: Ships as Trojan horses: trophic interrelationships in ballast tanks
9:30	M. Gilbert: Canada Ballast Water Research Programme
9:50	M. Voigt and S. Gollasch: A Chemical Treatment for Ballast Water
10:10	A. Jelmert: Possible effects of zinc sacrificial anodes on ballast water biota
10:30	Coffee Break
11:00	K. Colgan: Australian AQIS Ballast Water Activities, and the Australian Decision Support System (DSS)
11:20	A. B. Andersen: Ballast Water Risk Management, Risk Matrix Methodology, Hazard Assessment and Decision Support
11:40	A. Dehalt and J. Cassell: USA Pacific Coast Ballast Outreach Project: Bringing New Technology and Management Practices to the Maritime Industry
12:00	Lunch
2:00	A. Shotadze and T. Gogotishvili: Ballast Water Issue in Georgia
2:20	E. McDonald: Scotland Ballast Programme
2:40	H. Botnen: Organisms in ballast water at Sture
3:00	Coffee Break
3:30	Summary of Findings
3:45	Concluding Remarks
4:00	Adjournment of the Third and Final Meeting of the Study Group

ANNEX 3: RECOMMENDATIONS

There was very strong and unanimous consensus by SGBWS that an international forum for scientists and managers concerned with ocean-going and coastal ships as vectors for exotic species invasions should be continued. Rather than being a finite look at ballast water and sediments, it was unanimously agreed that this aspect of invasion science is just beginning, that numerous research groups are now starting important programmes, and that it is vitally important to continue to share the fruits of this research. The growth of SGBWS from 19 participants in 1997 to 49 participants in 1999 clearly indicates the logarithmic rise in this important field. It was further emphasized that it is important to recognize all ship systems that may be involved in the movement of non-indigenous organisms. It was felt important, along global and international lines, to maintain the group as a consortium of ICES, IOC, and IMO experts rather than to convert the Study Group to an ICES Working Group. This continued cooperation will thus ensure the broadest possible subscription to a timely topic.

The ICES/IMO/IOC Study Group on Ballast Water and Sediments therefore recommends that an 'ICES/IOC/IMO Study Group on Ballast and Other Ship Vectors' [SGBOSV] be established for a period of not less than five years. SGBOSV should meet in 2001 at a time and place to be decided and under the leadership of a Chair or Co-Chairs to be duly appointed. Toward this end, a letter has been sent from Mr W.A. O'Neil, Secretary General of the International Maritime Organization (London), to Professor C.C.E. Hopkins, General Secretary, International Council for the Exploration of the Sea, on 6 May 1999, expressing IMO's interest in continuing its cooperation with ICES in these matters.

Until such time that the SGBOSV formally meets, the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) should include on its agenda, the specific oversight of ballast water and other ship vector issues.