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13-15 MARCH 2006

OOSTENDE, BELGIUM

International Council for the Exploration of the Sea

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0 Executive Summary

The 2006 meeting of the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) was hosted by the Institute of Marine Research, Oostende, Belgium with Francis Kerckhof as host and with Stephan Gollasch as chair. In total 26 participants from Australia, Belgium, Canada, Croatia, Germany, Greece, Italy, Lithuania, the Netherlands, Norway, Spain, Sweden, the United Kingdom, the United States of America and a representative from PICES attended the meeting

Progress with the Terms of Reference

ToR a) Prepare a documented response for the CONSSO Issue Group on Sustainable Shipping (IGSS) report and **ToR b)** Discuss and report on the feasibility of using the CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management.

The scoping study was considered in great detail and WGBOSV notes with appreciation that the comments made on the first draft scoping study at last years meeting were all addressed. For reasons of comparison the draft and unapproved risk assessment based ballast water management study prepared for HELCOM was also considered at the meeting. Further, WGBOSV noted the ballast water management guideline for the Mediterranean Sea as prepared for RAC/SPA and the draft "Practical guidelines for ballast water exchange in the Antarctic Treaty area" as provided by Maritime and Coastguard Agency, United Kingdom.

The scoping study was considered for its use as a basis for the preparation of an ICES Code of Best Practice for Ballast Water Management. The group believes that the findings of the scoping study team are very reasonable and the study maybe used as a starting point for future ballast water management approaches. However, several such studies were developed since the last WGBOSV meeting in ICES Member Countries. The preparation of an ICES Code of Best Practice for Ballast Water Management would be a repetition of the already prepared studies. To avoid a duplication of effort WGBOSV suggests that another ballast water management approach is not developed. The group believes that with today's knowledge no considerable improvement can be achieved on work already carried out. WGBOSV further suggests that, after the CONSSO scoping study is finalised, ICES may consider to link to the document also expressing that WGBOSV commented on the draft study.

Instead of developing an ICES Code of Best Practice for Ballast Water Management WGBOSV recommends working intersessionally to prepare a draft management approach for hull fouling of vessels with the aim to enable a comprehensive review and the finalization of such guidelines at next years meetings (see below).

WGBOSV encourages all ICES Member Countries to consider signing the IMO Ballast Water Management Convention.

ToR c) Review, evaluate, and report on existing or developing port sampling and monitoring strategies used by ICES member countries for non-indigenous species and recommend cost effective modifications as required.

In addition to the port sampling protocols prepared by ICES member countries, port sampling initiatives of non-ICES member countries were also reviewed for comparison. Experience has shown that many introduced species were first recorded in ports or port regions. Port sampling programmes may also be used as early detection measure of new introduced species with the aim to apply mitigation measures such as species eradication programmes. The CRIMP protocol may be taken as a starting point when preparing future port sampling protocols. WGBOSV suggests to develop an ICES Code of Best Practice for Port Sampling at next years meeting.

ToR d) Continue its global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, CIESM, BMB and PICES Member States and of invited experts.

The chair highlighted the participation of PICES and the potential for cooperative links between ICES, IMO, IOC, CIESM, BMB and PICES on matters of interest to WGBOSV. Here, of particular interest is that PICES launched its first working group addressing biological invasions. Darlene Smith (Canada) attended the meeting representing PICES. She reported that the interaction with WGBOSV was informative and that PICES continued to express their interest for cooperation.

The relative importance of shipping vectors for species invasions was assessed at the meeting. Prime invasion vectors for aquatic species are shipping and intentional species introductions for aquaculture purposes. The relative importance of invasion vectors is regionally very different. Addressing ballast water mediated species invasions will not stop the invasion process as in several regions hull fouling is the dominating species introduction vector.

ToR e) Critically review and report on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation.

Ballast Water Treatment. The results of the IMO review on best available technology for ballast water treatment as undertaken during IMO MEPC53 in July 2005 were considered. Two treatment systems both making use of active substances were identified as likely being able to meet the strict IMO ballast water discharge standard D-2. At MEPC54 the two systems were given "basic approval" according to the IMO active substance guideline provided some additional information is submitted. This request for additional information was already fulfilled by one system which will soon be tested onboard in full scale according to the IMO approval guideline for ballast water management systems.

New ballast water treatment systems develop. At this meeting new candidate technologies were introduced from the Netherlands (flocculation similar to the technologies used in sewage treatment), Sweden (advanced electrochemical disinfection system which produces powerful disinfectants such as hydroxyl radical directly into the media and also providing direct oxidation of microorganisms and other contaminants on the electrode surface), Belgium (new chemical treatment) and the USA (bench scale tests of ferrate as secondary treatment). Further details on ballast water treatment technologies currently being tested cannot be given due to patents pending.

It appears that any new ballast water treatment system is likely to involve a combination of technologies, for example, primary filtration or physical separation followed by a secondary biocidal treatment using e.g. UV or biodegradable "active substances".

Concerns were expressed regarding the release of concentrated biological material as e.g. filter backwash during ballast water uptake. Several ICES Member States may have regulations in place which may not permit the release of such material (e.g. countries of the European Union and USA).

Test facilities of ballast water treatment systems will be available later in 2006 in Norway and the USA. Plans to launch similar facilities exist in e.g. Australia, the Netherlands and Singapore. Efficacy tests of such systems according to IMO may take more than three months and the availability of more than one test facility will result in timely tests of treatment systems not to delay the entry into force of the IMO Ballast Water Management Convention.

Active substances. Treatment systems using the addition of active substances and active substances generated in the ballast water flow may result in discharge of residual chemicals into receiving systems. A GESAMP Group was set up to evaluate those substances for IMO. The group is also asked at its next meeting to recommend which treatment systems need to be evaluated regarding active substances. To the extent that these residuals may pose a risk to ambient organisms, it was the sense of the ICES group that IMO should encourage use of multiple approaches, e.g. primary physical separation methods to reduce the concentrations of the active substances required to achieve effectiveness, and the quantities of active substance residuals or by-products in the discharge stream.

It was recommended that the WGBOSV should continue to support the Ballast Water Working Group of the International Maritime Organizations Marine Environment Protection Committee (IMO MEPC BWWG). It was recommended that WGBOSV should comment and contribute to the development of the Guidelines currently being worked on in the Ballast Water Working Group at MEPC (e.g. on ballast water sampling, risk assessment and the designation of ballast water exchange zones).

ToR f) Review, evaluate, and report on existing and emerging hull fouling regulations and treatment options.

The first hull fouling guidelines were developed in Australia. However, it is unclear what measures may be taken once it is proven (due to e.g. sampling) that species of concern are attached to a ships hull. This is especially true for larger commercial vessels. WGBOSV noted that hull fouling guidelines are currently lacking from most ICES Member Countries. It is anticipated that a hull fouling guideline to minimize species introduction will become a widely recognized instrument and may also be applicable outside the ICES region. Therefore, WGBOSV suggests preparing an ICES Code of Best Practice for Hull Fouling Management.

All ICES Member States are urged to consider the ratification of the IMO Convention on Antifouling Systems.

ToR g) Prepare a technical ballast water sampling manual.

A ballast water sampling manual was discussed and a first draft was prepared. The ICES Ballast Water Sampling Manual should be in line with the IMO Ballast Water Sampling Guideline. This guideline is still in preparation and consequently the ICES Ballast Water Sampling Manual could not have been completed at the meeting. The IMO sampling guideline is scheduled to be ready for approval at MEPC55 (October 2006). WGBOSV therefore recommends finalizing the ballast water sampling manual at next years meeting.

Representativeness of data. During the discussions one major issues of concern was the representativeness of data. To take representative samples is of key importance as sample analysis may have legal implications in case of non-compliance with the standards in the IMO Ballast Water Management Convention. Also, inefficient sampling techniques may result in false positives. Most representative samples may be taken when the ballast water is sampled continuously during the entire discharge time.

Replicate sampling. According to the IMO ballast water sampling guideline three replicate sampling events need to be taken when assessing the efficacy of ballast water treatment systems. Filling a ballast water tank is a unique event as the species composition and density cannot be replicated over time. Further, organisms may concentrate in certain water depths inside the ballast tank and sampling for replicates is therefore not recommended over time, i.e. take samples after 10% of the ballast water in the tank is emptied, after 50% and after 80% of the tank is emptied. To avoid pseudo-replication each tank should be considered as one replicate. To allow for replicate sampling it is suggested to install various sampling points in the ballast water discharge line and to sample the treated ballast water simultaneously.

Use of stains to assess organism viability. WGBOSV suggests using vital stains to assess the viability of organisms. For phytoplankton organisms SYTOX Green proved to be efficient and for zooplankton samples Neutral Red may be used.

New sampling methods. WGBOSV noted that new sampling techniques are continually developing. These technologies are especially designed for the purpose of ballast water sampling and may be easier to use onboard vessels compared to standard plankton sampling technologies.

Sample analysis tools

- **Bacteriae.** So far microorganisms were rarely cultured in experiments with ballast water treatment systems. It seems that selective culture media may be useful to assess the number of colony forming units per "indicator" bacteria as mentioned in the IMO standard.

- **Phytoplankton.** For sample analysis the chlorophyll content gives only an indication as these results do not enable assessment on organism numbers per water volume. Some sample processing technologies are developing, i.e. a broad spectrum live/dead stain coupled with microscopic or flow cytometer. Ongoing activities need to identify the right stain and the right tracking instrument. However, it is not clear yet whether or not microscopic analysis can be carried onboard ships as the ship movements and engine vibration cause negative impact.

- **Zooplankton.** The new counting chambers proved to work efficiently during onboard tests of ballast water treatment systems.

Colony forming vs. single specimens. The IMO ballast water discharge standard refers to organism number per size class. A question arose in which size category a colony falls when the single cell is below 50 micron but the colony is above 50 micron. WGBOSV believes that in those cases the individual specimen size should be measured. This group finding is based upon the IMO standard as it refers to organisms and not to colonies. Further, viability tests should address the smallest unit enabled to reproduce which is the individual and not the colony. However, one problem remains in case the individual is below 10 micron (not addressed in the IMO standard), but the colony is above 10 micron. When considering here the individual size alone some species are excluded. However, WGBOSV believes that the above explanation why individuals should be measured should apply.

The 2006 meeting of WGBOSV was closed on Wednesday, March 15 at 5.00 pm. There was consensus that there is an ongoing demand for WGBOSV to meet on an annual basis, especially as guidelines relevant to the expertise of WGBOSV are currently in the final stage of development at IMO MEPC. The invitation of Croatia to host next years meeting of WGBOSV was much appreciated and the group suggested meeting in Dubrovnik for at least 3 days during the week beginning Monday, March 19th 2007.

1 Opening and structure of the meeting

The 2006 meeting of the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) was hosted by the Institute of Marine Research, Oostende, Belgium with Francis Kerckhof as host and with Stephan Gollasch as chair. In total 26 participants from Australia, Belgium, Canada, Croatia, Germany, Greece, Italy, Lithuania, the Netherlands, Norway, Spain, Sweden, the United Kingdom, the United States of America and a representative from PICES attended the meeting (Annex 1).

Apologies were received from Dandu Pughiuc, International Maritime Organization (IMO) and Jose Matheickal (GloBallast Programme). Preparations for meetings of the IMO Marine Environment Protection Committee (MEPC) and funding constraints made their participation impossible. Further apologies were received from Ulrika Borg, Swedish Maritime Safety Inspectorate; Ingrid Bysveen, Directorate for Nature Management, Norway; Egil Dragsund, Det Norske Veritas, Norway; Tracy Edwards, Joint Nature Conservation Committee, United

Kingdom; Brian Elliott, Maritime and Coastguard Agency, United Kingdom; Bella Galil, National Institute of Oceanography, Israel; Greg Ruiz, Smithsonian Environmental Research Center, USA and Matthias Voigt, Hamann AG, Germany. Also, Henrik Enevoldsen the IOC Project Coordinator of the IOC Science and Communication Centre on Harmful Algae was unable to attend.

The meeting was opened at 9 am on Monday March 13th 2006 with Stephan Gollasch and Francis Kerckhof welcoming participants, particularly new members who had not attended WGBOSV meetings previously. The chair highlighted the participation of PICES and the potential for cooperative links between ICES, IMO, IOC, CIESM, BMB and PICES on matters of interest to WGBOSV. Here, of particular interest is that PICES launched its first working group addressing biological invasions, which in part, was initiated by Stephan Gollasch as chair of WGBOSV at the 2003 meeting in Vancouver where for the first time a PICES representative joint a meeting of WGBOSV.

As in previous years, the meeting took the form of plenary sessions with round table discussions and drafting sessions following each session as well as evening drafting group sessions. WGBOSV considered the outcome of the round table discussions and other recommendations of the meeting at a final session on Wednesday afternoon.

2 Terms of reference, adoption of agenda, selection of rapporteur

2.1 Terms of Reference

The meeting took note of the Terms of Reference (ToR) (Annex 2) and the Agenda was structured so as to allow each ToR to be addressed. This required the preparation of papers and reports by members for presentation at the meeting. Several documents were circulated well in advance to allow familiarisation with the content of bulky documents prior to the meeting. The Chair thanked the members for preparing these reports and papers.

2.2 Adoption of Agenda

The Agenda was adopted (Annex 3) with amendments to reflect unforeseen changes. Abstracts of selected talks are presented in Annex 4.

2.3 Selection of Rapporteur

As in previous years, Tracy McCollin, United Kingdom, was appointed as rapporteur.

3 Terms of reference for the 2004 meeting of wgbosv

The terms of reference were received as ICES Resolution 2005/2/ACME06 (Annex 2).

3.1 Progress with terms of reference

ToR a) Prepare a documented response for the CONSSO Issue Group on Sustainable Shipping (IGSS) report and to:

- review, comment, and report on the final version of the Scoping Study prepared under IGSS.
- provide recommendations for ACME regarding any “post-scoping” study phase.

The scoping study was considered in great detail on Monday. Unfortunately the principle investigator of this study, Egil Dragsund from Det Norske Veritas, Norway, was unable to attend, but made available his presentation on the study. The presentation was given by Cato ten Hallers-Tjabbes with input from Stephan Gollasch, who were both co-authors of the study. WGBOSV completed this task at the meeting.

ToR b) Discuss and report on the feasibility of using the CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management.

The scoping study was further considered for its use as a basis for the preparation of an ICES Code of Best Practice for Ballast Water Management. WGBOSV noted the findings and recommendations of the study and supports the ballast water management approach suggested. WGBOSV recommends not to prepare an ICES Code of Best Practice for Ballast Water Management as this would be a duplication of effort. WGBOSV further suggests that, after the CONSSO scoping study is finalised, ICES may consider to link to the document also expressing the that WGBOSV commented on the draft study.

ToR c) Review, evaluate, and report on existing or developing port sampling and monitoring strategies used by ICES member countries for non-indigenous species and recommend cost effective modifications as required.

In addition to the port sampling protocols prepared by ICES member countries, port sampling initiatives of non-ICES member countries were also reviewed for comparison. WGBOSV completed this task at the meeting and suggests to prepare a Code of Best Practice on Port Sampling at next years meeting.

ToR d) Continue its global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, CIESM, BMB and PICES Member States and of invited experts.

The relative importance of shipping vectors for species invasions was assessed at the meeting. WGBOSV completed this task for 2005 at the meeting.

ToR e) Critically review and report on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation.

Grateful thanks are expressed to Anja Kornmüller (Germany) who prepared a summary of new developments relevant to ballast water treatment systems, to Tracy McCollin (United Kingdom) for her summary of the IMO review of ballast water treatment technologies, and also to Ulrika Borg who made available a document introducing a new Swedish ballast water treatment system. WGBOSV completed this task at the meeting.

ToR f) Review, evaluate, and report on existing and emerging hull fouling regulations and treatment options.

A summary of relevant guidelines was prepared. WGBOSV completed this task at the meeting and suggests preparing an ICES Code of Best Practice for Hull Fouling Management.

ToR g) Prepare a technical ballast water sampling manual.

A ballast water sampling manual was discussed and a first draft is included in the meeting report. WGBOSV suggests improving this manual intersessionally and finalizing it at the next years meeting.

4 Response for the CONSSO Issue Group on Sustainable Shipping (IGSS) Scoping Study and provision of recommendations for ACME regarding any "post-scoping" study phase (ToR a)

A ballast water management strategy for the North Sea has been developed for the Issue Group on Sustainable Shipping (IGSS) of the Committee of North Sea Senior Officials' (CONSSO). The first draft version of this strategy was discussed at last years WGBOSV meeting. This year the (pre-)final version of this Scoping Study was considered in great detail at the meeting (Annex 5). Unfortunately the principle investigator of this study, Egil Dragsund (Det Norske Veritas, Norway), was unable to attend the meeting, but made available his presentation. The presentation was given by Cato ten Hallers-Tjabbes with input from Stephan Gollasch, who were both co-authors of the study.

The scoping study has been instigated by the Maritime and Coastguard Agency (MCA) in the United Kingdom, on behalf of a consortium of countries who were co-funding the project, namely: Belgium, Germany, the Netherlands, Norway, Sweden and the United Kingdom. The responsible overall coordinator of the scoping study, Brian Elliott of the Maritime and Coastguard Agency in the United Kingdom, was unavailable to attend the meeting due to overlapping commitments. However, he took part in the discussions via telephone calls during meeting breaks. Mr. Dragsund was also contacted via telephone to address certain questions as expressed by the group participants.

The strategy recognizes that ballast water treatment on vessels will eventually be the preferred ballast water management method. As treatment technologies are not yet available ballast water exchange is recommended as an interim measure. The recommended strategy is based upon ballast water exchange for vessels sailing through oceanic waters. For vessels unable to exchange ballast water or not sailing through oceanic waters, the port state or port states may designate areas for ballasting exchange operations or identify areas where ships need to apply additional measures, as outlined in the Annex to the IMO Convention.

WGBOSV notes with appreciation that the comments made on the first draft scoping study at last years meeting were all addressed.

For reasons of comparison the draft and unapproved risk assessment based ballast water management study prepared for HELCOM was also considered at the meeting (see Annex 6). Further, WGBOSV noted the ballast water management guideline for the Mediterranean Sea as prepared for RAC/SPA (see Annex 7) and the draft "Practical guidelines for ballast water exchange in the Antarctic Treaty area" (Annex 6) as provided by Maritime and Coastguard Agency, United Kingdom.

4.1 Review and comments on the Scoping Study

The group considers this document a valuable contribution. It was agreed that the basic principles of the CONSSO scoping study were appropriate for the purpose of the ballast water management based on risk assessment.

The following comments on the Scoping Study for Ballast Water Management Strategy for the North Sea/North West Europe reflect the discussions at the meeting and the following conclusions were agreed:

Definitions

- WGBOSV noted that the definitions of "bioprovince" and "region" need clarification. There is confusion between biological and geographical terms. It was suggested that a decision is taken regarding the terms and that a glossary is provided in the beginning of the document. The term "province" may be used in relation to biology and the term "region" in relation to trade and economics and one map should clearly outline this.

- For definitions of freshwater and fully saline waters the Venice system should apply (Venice System (1959) Symposium on the classification of brackish waters, Venice, April 8-14, 1958. *Arch.Oceanog.Limnol*, 11 (supplement), 1-248.).

Ballast Water Origin Information

- The lack of accurate information regarding the origin of ballast water is of concern when preparing risk assessment approaches. WGBOSV suggests that IMO ballast water reporting forms as provided in the IMO Guidelines 868(20) are used until more advanced recording systems are generally available.

Risk Assessment

- **Environmental matching**
  Environmental matching should only be used for extreme differences between ports i.e. freshwater and marine or cold water and tropical ports as this would mean so that the risk of introductions is very low. Very accurate information regarding the areas where ballast water operations occur would be required to make this decision. This should also include anchorages and port approaches.

- **Species Specific approach**
  The bioprovince approach is built upon the assumption that a species present in one area of the province would survive in another so the species specific approach would be focussed on obtaining information with regard to which non-native species (or harmful native) are present in a port. If any are present then the ballast water would have to be managed to reduce the risk of transporting these species to an area where they are not present. Port surveys to obtain this information would be very expensive but existing monitoring programmes could be extended to include sampling in ports.

Ballast Water Exchange

- Accurate information would be required regarding the salinity of the ports but if both ports are always within the freshwater range then exchange in polyhaline or mixoeuhaline waters could be assumed to reduce the risk of introducing species. Exchanging in marine regional areas may not be as effective as other factors e.g. dispersion, would have to be taken into account. This may require other management methods. It is unlikely that ballast water exchange zones will be implemented in seas such as the North, Baltic and the Mediterranean Seas.
- The group agreed that a short deviation to meet the depth/distance criteria for ballast water exchange might be of benefit although noting that this may be undesirable to Parties of IMO. However, though deviations can be costly to ship, when compared to cost of dealing with non-native species (e.g. in the USA costs estimates as high as are $825,000 annually for zebra mussel control at one power station and $ 1 billion[1] annually for zebra mussel control generally) it may be an option to be considered.

Other Information

- It should be made clear that it is human mediated transport of species that is being addressed in this report.
- The need for co-operation between countries in order to develop strategies such as a ballast water information clearing house or a harmonised European ballast water

1 Pimentel, D., Zuniga, R. and Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52(3): 273-288).

management approach between the North, Baltic and Mediterranean Seas was expressed.

- WGBOSV recommends adopting a precautionary approach.
- All initiatives considered referred to the lack of data relevant to the management of ballast water. This included ballast discharge information, origin of ballast water and biological (port) data.
- A risk assessment is currently being developed for the Port of Venice.

4.2 Overall summary of discussions

Mandatory ballast water management should be the ultimate goal while voluntary instruments may be implemented as an awareness raising tool.

The goal is ballast water treatment but ballast water exchange is suggested as an interim solution although it is acknowledged that it is of limited effectiveness and should not be considered as an alternative to effective ballast water treatment options.

4.3 Recommendations for the "post-scoping study" phase

In addition to the post scoping study recommendation as expressed in last years WGBOSV report we recommend that:

- Efforts should be made to obtain data to enable accurate risk assessments to be carried out.
  - The data required includes information on ballast water origin and quantities, information on non-native species in donor and recipient ports/port areas and accurate environmental data.
  - The approach chosen should take into account the guidelines currently being prepared by IMO including:
    - risk assessment
    - ballast water exchange zones
    - ballast water exchange guidelines
- Duplication of effort to prepare ballast water management approaches should be avoided.
- Regional co-operation should be encouraged between countries bordering European seas for mutual benefit. WGBOSV strongly suggests co-operation on a regional level and also consultation with other developing ballast water management strategies (e.g. HELCOM, RAC/SPA).
- The designation of ballast water exchange zones (also for intra-European shipping) should be evaluated in greater depth.
- Clear guidance should be provided for when each type of risk assessment i.e. species specific and environmental matching, should be used.
- Environmental match of ballast water donor and recipient regions is a suitable approach to assess the risk of species introductions as a first step or in case species specific data are lacking.
- Future risk assessment initiatives should not only focus on the port itself, but may also consider the wider port region including anchorages and port approaches where ballast water operations occur.
- WGBOSV suggests selecting a limited number of ports to prepare an on-line demonstration risk assessment tool.
- It is recommended that the developing EU legislation on ballast water management is consulted to ensure that both approaches are in line.
- For information gathering and also as part of an awareness campaign, ships may be asked to forward ballast water information. WGBOSV urges use of the ballast water reporting form in IMO Guideline 868(20) to fill knowledge gaps.

5 Discuss and report on the feasibility of using the CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management (ToR b)

Ballast water management recommendations of e.g. USA, Russia, HELCOM, OSPAR via IGSS/CONSSO as well as the relevant IMO recommendations were summarized in the 2004 WGBOSV meeting report. A worldwide summary of ballast water regulations was also provided. This year the scoping study (see above, Annex 5) was considered in great depth with the aim to assess whether or not the principles outlined in the study are applicable for the ICES region. The recommendations from new studies on risk assessment based ballast water management approaches, prepared for HELCOM (see Annex 6), the draft "Practical guidelines for ballast water exchange in the Antarctic Treaty area" (Annex 8) as provided by Maritime and Coastguard Agency, United Kingdom, and the ballast water management recommendations as discussed at the RAC-SPA action plan workshop concerning species introductions and invasive species in the Mediterranean Sea (Annex 7) were also considered when working on this ToR.

5.1 Risk Assessment of Ballast Water Mediated Species Introductions – a Baltic Sea Approach

It should be noted that the extract of the following report was not approved yet by HELCOM (Annex 6). Further discussions at the HELCOM headquarters are scheduled for the end of April 2006.

The Baltic Sea countries have international obligations to address invasive alien species, principally according to the Convention on Biological Diversity (1992) and, concerning marine areas, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (IMO 2004).

5.1.1 Recommended actions

Aggressive invaders represent a threat to the biosecurity of most coastal countries of the world. Shipping (ballast water and hull fouling) has been and will continue to be the most important vector for unintentional species introductions into aquatic environments.

5.1.2 Suggested ballast water management approach for the Baltic

Each vessel arriving in the Baltic poses a risk of introducing a new aquatic invasive species (AIS). Even ships with no ballast on board (NOBOB) are at risk of introducing new AIS. This indicates the urgent need for efficient ballast water treatment systems. As those systems are not yet readily available, BWE is the only option to reduce the risk of AIS introductions with ballast water release. In addition all measures should be undertaken to avoid species uptake in the ballast water donor region.

5.1.3 High risk shipping routes

The risk assessment carried out for the selected ports revealed that high risk shipping routes are those connecting ballast water donor and recipient regions in the same bioregion or within identical climate zone(s). The major difficulty in Europe is that ballast water exchange cannot be carried out on those shipping routes as all high risk ports are in regional seas that do not meet the IMO depth and/or distance limits for ballast water exchange during the ships voyage. As ballast water exchange cannot be carried out here as a risk reducing measure, this indicates the need for ballast water treatment.

Ports with the lowest risk levels are all very distant (i.e. oceanic shipping) and many also have temperature regimes different from the Baltic. Here, provided safety permits, a ballast water exchange should be carried out as risk reducing measure.

Due to the varying salinity conditions throughout the Baltic and its adjacent waters, a route-specific approach to address ballast water management is recommended. All shipping routes may be grouped in three categories as outlined below. The measures recommended below assume that ballast water treatment systems are unavailable and also that ballast water reception facilities are lacking. As a result the "only" risk reducing measure is ballast water exchange.

The following scenarios were addressed (see Annex 6 for details).

- **Ships on oceanic voyages**
    - Scenario 1 – Matching salinity or temperature in donor and recipient region for ships operated on oceanic voyages
    - Scenario 2 – Non-matching salinity or temperature in donor and recipient region for ships operated on oceanic voyages
- **Intra-European shipping**
    - Scenario 1 – Matching salinity or temperature in donor and recipient region for ships operated on NW-European shipping routes
    - Scenario 2 – Non-matching salinity or temperature in donor and recipient region for ships operated on inner-European shipping routes
- **Intra Baltic shipping**
  Designation of a ballast water exchange zone within the Baltic
    - Ballast water exchange zone for shipping from outside the Baltic
    - Ballast water exchange zone for inner-Baltic shipping

5.1.4 The HELCOM ballast water management approach in the wider European context

As indicated above, various ballast water management approaches are currently developing, e.g. for the OSPAR region, Mediterranean and Caspian Seas. The HELCOM approach recommends to exchange the ballast water of ships arriving from outside the Baltic and also in inner-Baltic shipping (in certain instances – see above). Problems occur when identifying appropriate ballast water exchange zones as neighbouring seas and jurisdictions may be affected, e.g. recommending to exchange ballast water of ships of inner-European origin prior to entry into the Baltic may result in a water exchange in the North Sea. From the Baltic perspective this is considered as a risk reducing measure. However, at the same time it exposes the North Sea to additional ballast water discharges, but the ultimate goal should be to reduce the amount of ballast water discharges to the essential minimum. This conflict of interest may only be solved by the development of a European-wide ballast water management approach. It is therefore recommended to launch a working group of experts involving various stakeholders across all European seas. The target of this initiative should include harmonizing the ballast water management approach across all European seas and further developing guidelines on how to identify ballast water exchange zones especially for inner-European shipping. It may be considered to launch a "*European Ballast Water Management Decision Support System*".

It should be noted that, assuming the IMO Ballast Water Management Convention enters into force as planned, ballast water exchange is only a risk reducing measure of limited duration, i.e. according to the Ballast Water Management Convention the first ships need to meet the higher discharge standards (organism concentration limit) by January 1st 2009. All risk reducing measures including ballast water exchange, are seen as an essential tool to protect European seas from new species introductions. As a result, although ballast water exchange may have a limited duration, provided the Ballast Water Management Convention enters into force as planned, all efforts in this regard will reduce the risks of new species introductions. Further, the entry into force of the Ballast Water Management Convention may be delayed due to lack of signatory countries with sufficient world fleet tonnage. It is also believed that the implementation of mandatory ballast water exchange requirements may prompt the ratification of the Ballast Water Management Convention.

5.2 RAC-SPA Action Plan concerning species introductions and invasive species in the Mediterranean Sea

Taking into account the regional geography, biodiversity, shipping patterns within the Mediterranean and those entering and exiting the sea, it is a given that cooperation within the Mediterranean Sea region is crucial for minimizing the risk of ballast-transported introductions of alien species. Therefore, it is recommended that the RAC-SPA Action Plan encourage the Contracting Parties to sign and ratify the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, to ensure rapid and harmonized implementation of the Convention and of guidelines developed thereto, and, insofar as it means permit, assist the Contracting Parties in implementing the actions required at the national level (Annex 7).

Priority at the regional level should be given to establishing the research capacity and financial resources needed for:

- collecting reliable data concerning maritime traffic and ballast water uptake and discharge.
- carrying out biotic baseline surveys for alien species and harmful aquatic organisms and pathogens in major ports using harmonized methodologies.
- gathering information for the identification of potential BWE areas, monitoring and reviewing of designated BWE areas, taking note of the relevant IMO guideline.
- carrying out harmonized risk assessment studies for major ports using appropriate methodologies, taking note of the relevant IMO guideline.
- assessing risk caused by vessel movement within the Mediterranean and from without the Sea.
- Conducting vector-based risk assessment, species-based risk assessment in combination with a pathway-based risk assessment.
- establishing a common regional information 'clearing house' linking data obtained from the traffic and ballast water studies, from the ports' risk assessment studies and the biotic surveys, and forming an early warning system flagging outbreaks of harmful aquatic organisms and pathogens.

5.3 Practical guidelines for ballast water exchange in the Antarctic Treaty area

At the recent Antarctic Treaty Committee for Environmental Protection (CEP IX) meeting in Stockholm in June this year, concerns were raised by the Council of Managers of National Antarctic Programs (COMNAP) about invasive marine species being transported into Antarctic waters and between biologically distinct regions within the Antarctic Treaty Area, through ship's ballast water. Particular concerns were also raised about transportation of sub-Antarctic species across the Polar Front and the movement of Arctic species to the Antarctic from vessels transiting between the two areas (Annex 8).

The meeting agreed, therefore, that some elements of the IMO Ballast Water Management Convention (BWM Convention) could be implemented within the Antarctic Treaty Area before it comes into force. Therefore, the development of an interim Regional Ballast Water Management Strategy for Antarctica, based on ballast water exchange, was suggested in line with the following BWM Convention principles:

- ballast water exchange is to be used as an interim measure until suitable treatment technologies have been developed;
- parties with common interests bordering enclosed and semi-enclosed seas shall endeavour to seek co-operation with neighbouring Parties through regional agreements to develop harmonised procedures (Article 13(3)); and,
- a party or parties can put in place additional measures to those in Section B of the Convention, such as regional management strategies based on ballast water exchange, which will require ships to meet a specified standard or requirement (Regulation C-1).

Such a strategy would then be replaced by the requirements of the full BWM Convention when it comes into force.

5.4 Conclusions

At this year's meeting the group discussed the following items relevant to ballast water management:

- **Phase out of ballast water exchange**

  Ballast water exchange is seen as an interim solution as scientific studies have proven its limited effectiveness and the water depth and distance from shore requirements as set forth in the IMO Ballast Water Management Convention cannot be met in intra-European shipping.

- **Applicability of IGSS scoping study findings within ICES Member Countries**

  The group believes that the findings of the scoping study team are very reasonable and the study maybe used as a starting point for future ballast water management approaches. However, several such studies were developed since the last WGBOSV meeting in ICES Member Countries (see above summaries of the OSPAR, HELCOM and RAC/SPA studies). The preparation of an ICES Code of Best Practice for Ballast Water Management would be a repetition of the already prepared studies.

- To avoid a duplication of effort WGBOSV suggests that another ballast water management approach is not developed. The group believes that with today's knowledge no considerable improvement can be achieved on work already carried out.

5.5 Recommendations

- The group was not clear as to why a new code is required as this would seem to be a duplication of effort. Rather than developing a new code, WGBOSV recommends that existing ballast water management approaches (e.g. management approaches developed in Europe, USA, Australia, New Zealand and others) are critically reviewed and commented upon at next years meeting with the aim to improve such guidelines.

- It was also not clear at whom the code was aimed as guidelines developed by IMO are already in the process of ratification. As the EU prepared a legal instrument in order to have some legislation in place before the entry into force of the IMO Convention on Antifouling Systems (see hull fouling section of this report) it is anticipated that the IMO Ballast Water Management Convention may be treated in a similar manner.
- Instead of developing an ICES Code of Best Practice for Ballast Water Management WGBOSV recommends working intersessionally to prepare a draft management approach for hull fouling of vessels with the aim to enable a comprehensive review and the finalization of such guidelines at next years meetings. Hull fouling guidelines are currently developing in Australia and WGBOSV noted that such measures are currently lacking from most ICES Member Countries. It is anticipated that a hull fouling guideline to minimize species introduction will become a widely recognized instrument and may also be applicable outside the ICES region.
- WGBOSV further suggests that, after the CONSSO scoping study is finalised, ICES may consider to link to the document also expressing that WGBOSV commented on the draft study.

6 Review, evaluate, and report on existing or developing port sampling and monitoring strategies used by ICES member countries for non-indigenous species and recommend cost effective modifications as required (ToR c)

Various port sampling studies have previously been completed and some are ongoing today. The following highlights the findings of those studies with an emphasis on European port sampling programmes.

6.1 CIESM's PORTAL [PORT surveys in the Mediterranean Sea for ship-transported ALien organisms]

It is estimated that about 220,000 vessels of more than 100 tonnes cross the Mediterranean annually, carrying 30% of the international sea borne trade volume, and 20% of the petroleum. With some 2000 merchant ships plying the Mediterranean at all times, the sea is exceptionally susceptible to ship-transported bioinvasions, whether by fouling or ballast.

Recognizing that the littoral and infralittoral biota of the Mediterranean sea is undergoing a rapid and profound change, a multidisciplinary CIESM workshop (November, 2002) examined the extant knowledge of the scale and impact of ship-transported aliens in the Mediterranean and Black sea region (CIESM workshop monographs, 20; http://www.ciesm.org/publications/istanbul.html) recommended implementing a Mediterranean-wide program of port and port-proximate surveys using standardized protocols to identify alien species and organisms that pose significant risk to human health that might be disseminated by shipping from the region – a harmonized, modular “port-watch” program for the Mediterranean. The survey methods follow the CRIMP protocols for baseline port surveys for alien species developed by Hewitt and Martin (1996), updated (Hewitt and Martin, 2001), and later adopted by GloBallast.

While recognizing that only a spatially and temporally comprehensive survey is likely to detect all alien species, scientific, logistic and cost constraints necessarily restrict the survey's scope. CIESM launched, late in 2003, the first basin-wide minimal targeted port-survey program – PORTAL. The survey targets macrophytes, bryozoans, serpulids, hydroids, ascidians, mollusks and barnacles inhabiting port and port-proximate manmade hard-substrates and organisms that pose significant risk to human health that might be disseminated by shipping from a dozen Mediterranean ports (*Vibrio cholerae*, dinoflagellate cysts). The "core" participants are mostly part of CIESM's region-wide network of scientists and marine institutions, including taxonomic experts that assist in analyzing the material collected, on an entirely voluntary basis! A dedicated round-table session was held during the 37th CIESM Congress, Barcelona, where preliminary results were presented to the Mediterranean community (http://www.ciesm.org/events/port survey.pdf).

Samples collected from 12 Mediterranean ports were analyzed.

Bearing in mind the results of the "pilot" project CIESM plans to extend the program to compare the number and identity of fouling alien taxa in ports and adjacent marinas, and to document the presence of pathogenic microorganisms in ports with nearby marine farming facilities, and to assess the risk of these pathogens for human health in terms of their abundance and pathogenicity. Ports will be selected for basin-wide coverage, patterns of maritime traffic (i.e. volume, destination diversity), vicinity of marinas and mariculture facilities, and nearby marine laboratories.

6.2 Aliens in Hellenic Seas: emphasis on introductions in ports

A literature review of the alien biota recorded in the broader area of the major Hellenic ports (Peiraias, Thessaloniki) that is in inner Saronikos and Thermaikos Gulfs has revealed the presence of 32 and 14 species respectively of which only 5 are common (Annex 4).

6.3 Protocols for Baseline Port Surveys for Introduced Marine Species in Australia

The baseline port survey program established by CRIMP in 1995 was intended to begin the process of determining the scope and scale of marine biological invasions in Australian coastal waters and at the same time provide a basis for assessing the efficacy of the recommended sampling protocols. In total 42 Australian ports were sampled. As part of the *National System for the Prevention and Management of Marine Pest Incursions* (National System) Australia is now developing an ongoing monitoring strategy that focuses on standardised monitoring processes to detect high risk species at priority locations around Australia. Simon Barry gave an outline of this strategy (Annex 4).

6.4 Port surveys in New Zealand

A national programme of port surveys for introduced marine species was initiated in 2001 and involves generalised pest surveys in the country's 13 major commercial shipping ports and in three boating marinas, which are the first ports-of-call for most of the pleasure vessels that enter the country. The port surveys are modelled on the CRIMP protocols (Hewitt and Martin 2001) and share the same general purpose: to identify the range of native and introduced species present in the ports so that an initial baseline can be established for future monitoring. The sampling effort is ongoing and will at least deliver data for eight additional ports.

6.5 GloBallast Port Baseline Survey

During the GloBallast Programme the ports of all demonstration sites were sampled by using the CRIMP port monitoring protocols, i.e. Dalian (China), Mumbai (India), Kharg Island (Iran), Saldanha (South Africa), Odessa (Ukraine) and Sepetiba (Brazil).

6.6 Port biological sampling in Estonia

Pelagic and benthic invertebrate communities were studied in Muuga harbour (Port of Tallinn, Gulf of Finland) – one of the largest terminals in the Baltic Sea. Samples were taken during the ice-free seasons, generally twice per month during 2002-2005. In each occasion three predefined sites were visited. Zooplankton sampling was performed as vertical tows with Juday net (mesh size 90 µm). Samples were analysed semiquantitatively; the whole sample was analysed to identify all species. Macrozoobenthos samples were colleced with an Ekman bottom grab. The sediment samples were washed through a 0.25 mm mesh. In the laboratory the animals were counted under a stereo dissecting microscope. The total dry weight of the animals in each sample was determined to the nearest 0.5 mg and calculated for an area of 1 m^2 (see Annex 4).

6.7 Comparisons of introduced hard bottom species in marinas and natural habitats on the Swedish west coast

A pilot study was performed, where eight marinas were chosen based on their position (four north and four south of the city of Göteborg), size, and availability by car. The eight chosen coastal areas were as far as possible in the proximity of the marinas. Monitoring sites were randomized from satellite images, on average 1 for each 50 m of the jetties in the marinas (including buoys when present), and 1 for each 25 m of natural coastline. Due to limitation in time (one month – July 2005) and personal (1 student making the surveys by snorkling), the monitoring was restricted to document selected, already introduced or potential candidates to hard bottom organisms on natural and artificial substrates. Sediment or pelagic samples were not taken, and native species were only described in general terms for dominant species. At each monitoring site 10 macroalgae and 5 invertebrates were searched for and their occurrence documented as semiquantitative scores (made by the same person) according to: 1) solitary specimens; 2) common, but not dominating; 3) dominant or belt-forming. This gave us more information than just marking presence or absence of the species of interest. Future rapid surveys of this kind ought to take into account the differences in size of the localities to be monitored, to facilitate statistical comparisons. (see Annex 4).

6.8 Characterization and invasion status of Finnish coastal ports

The aim of the study includes characterizing biota in ports and compare the findings to nearby "non-impacted" communities. Sampling was focussed on littoral (port scratch and net samples, including artificial substrates vs. control areas), benthos (port samples vs. monitoring studies) and phytoplankton.

6.9 Introduced marine species - Pilot studies in ports of western Norway

Environmental monitoring surveys are regularly undertaken at some west Norwegian ports. Benthic soft sediment fauna, and flora and fauna in the littoral zone are among the many parameters which are surveyed. Introduced species rarely occur in the samples taken during these surveys, although it is well known that organisms arrive to these ports in international ballast water and sediments in ballast tanks. In total, annually, approximately 30 million tonnes of ballast water is discharged in these ports. In an attempt to find and identify possible introduced species a pilot survey for this particularly purpose was undertaken in the littoral zone in 2001. During the summer of 2002 fouling panels were exposed in one port where annual discharge of international ballast water is approximately 10 million tonnes. At the same time fouling panels were exposed in a control port where national ballast water is discharged, and at a control site without discharge of ballast water. The panels were exposed from June to October and the panels were suspended at 0 m, 2 m and 5 m depth (see Annex 4).

6.10 Port sampling in the USA

There are several approaches being used throughout the US to conduct port surveys, i.e. port baseline surveys and rapid assessment surveys.

6.10.1 Baseline Surveys

Baseline surveys were carried out in various ports. Comprehensive studies were prepared for three ports and 20 additional ports were sampled in a less comprehensive way. Of prime focus was the fouling community and the seasonal, spatial and temporal pattern was documented in the comprehensive studies over three years. The sample analysis is ongoing.

6.10.2 Rapid Assessment Surveys

Judy Pederson (USA) reports that Rapid Assessment Surveys have been conducted on the West Coast, East Coast, and planned for other areas. In addition to the Rapid Assessment Surveys, another approach is to deploy settlement plates throughout harbors.

Rapid Assessment Surveys are designed to provide a qualitative assessment of native and non-native species found on floating docks in ports and marinas. The locations are representative of the current and past use of the area relative to potential sources of introductions, e.g. historical shipping, aquaculture, commercial and recreational boating, and other human-mediated activities. Floating docks are used because they are underwater throughout the tidal cycle, accessible, and relatively consistent from location to location.

Ten to 12 taxonomists who are familiar with native and non-native species in macro-invertebrate and macroalgal groups visit each dock for approximately one hour. At the dock, field identifications are recorded along with environmental data on temperature, salinity and depth. Approximately three sites are visited each day, samples are refrigerated and returned to a laboratory for verification of the field identifications by each of the taxonomists. Some organisms are preserved and identified later, possibly being sent to other taxonomists. A community sample is archived along with any specimens that the taxonomists wish to keep.

The verified species data are recorded by each investigator, entered into an access data base, quality checked, and used to create a web-based geographic information system map for the web. The data provide both native and non-native species.

The findings include several new reports of species were made in the New England surveys. In addition, individualized data for states, or particular localities or agencies are prepared from the database. The data have been used to support efforts in the New England states, e.g. State Aquatic Nuisance Species Management Reports, legislation, citizen monitoring programs, and community action to prevent or better manage invasive species.

The advantages of a Rapid Assessment Survey are a relatively quick turn-around time, and information for ports, states, and local authorities to use in responding to introduced species issues. It is relatively cheap, but it does not survey all habitat types.

6.11 Port sampling in the United Kingdom

Six ports in England and Wales were sampled using a range of techniques based on the CRIMP protocol. The main objectives of the project were to:

- Review current survey procedures within the OSPAR region and develop a port sampling programme that will complement existing information and any on-going surveys being carried out within the convention area
- To provide a baseline record of the occurrence, distribution and abundance of non-native species in major UK ports and harbours
- To evaluate the present status of non-native species in UK ports and harbours
- To develop recommendations for the structure of future monitoring programmes with regard to OSPAR and IMO requirements and suggest areas for future monitoring.

Further information can be found at http://www2.defra.gov.uk/research/project_data/More.asp?I=WT06021&SCOPE=0&M=CFO&V=UCWBOS.

6.12 Summary

WGBOSV prepared a summary table of selected port studies (Table. 1).

Table. 1 Summary of previous and ongoing port sampling studies.

Item	CRIMP Protocol	Portal	Australia NZ	United Kingd.	Norway	Sweden (pilot study)	Estonia	Finland	SERC USA	Rapid Assessment USA	Research	Citizen
Biodiversity	x	x		x	x		x	x	x	x	mixed	mixed
Protocol	x	x	x	x	x	x			x	x		
Cost	$$$$	$PD	$$	$	$$$$	$$	$	$	$$$$	$$PD	$	($)
Target species			some	x		15 spp.					yes	yes
QA/QC Experts	x	x	x	x	x	x		x	x	x	x	mixed
Performance Standard			x		x change	x			?		mixed	
Qualitative /quantitative	x	x	x	x	x	Semiquantitative	x	x				
Habitat type	all	fouling: hard substrate, Sediment: dinoflagellate Water: *Vibrio*	all		all	Fouling + rock/stone (8+8 natural areas	pelagic & benthic in-vertebrates	benthos, littoral, sessile fauna	plates: artificial	docks: artificial	mixed	mixed
Frequency	~10 years	one off	annual		annual start: less frequent	once (summer)	3 years		mixed; one off; seasonal	3-5 years	mixed	regular
Duration: (long periods for species identification)	14 days	1 week				2 days / area			3-4 days/ location	1 week	mixed	~1day/ month; seasonal

6.13 Conclusions

The following general conclusions can be made in relation to this ToR:

- Experience has shown that many introduced species were first recorded in ports or port regions.
- The port sampling protocols developed showed varying level of detail.
- Port sampling programmes may also be used as early detection measure of new introduced species with the aim to apply mitigation measures such as species eradication programmes.
- The group believed that the sampling strategies should be selected according to the sampling study objectives. It should be noted that accuracy of data and costs are directly related.
- The CRIMP protocol may be taken as a starting point when preparing future port sampling protocols.
- A project proposal on port sampling in Europe is currently being developed and will likely be submitted with a request to gather funds within the European Commission Seventh Framework Programme for Research and Technological Development.

6.14 Recommendations

- Results from port sampling studies may be used to facilitate risk assessment approaches. Currently species specific risk assessments can only be addressed in a more general manner as such information is lacking for many ports. Knowing the species assemblages of ports would enable an assessment of the likeliness of such species to be pumped onboard vessels. Once this assessment can be made a risk assessment for the next port of call of the vessel is enabled. The more comprehensive the port studies are, the more detailed a risk assessment approach can be applied. The ultimate goal of the species specific approach may include a risk assessment on a route specific or vessel by vessel basis.
- It should be noted that baseline studies for natural occurring bacterial communities in ports is basically absent, and there is little hope for establishing such knowledge in the foreseeable future. When considering risk assessment for bacteria, environmental matching seems to be the only option.
- Wherever possible an identical sampling protocol should apply as this will allow for better comparison of biological data from donor and recipient ports.
- Ongoing monitoring programmes may consider contributing to planned port sampling initiatives by adding a few sampling stations in or near ports.
- WGBOSV suggests to develop an ICES Code of Best Practice for Port Sampling.

7 Global review of shipping vectors (ToR d)

WGITMO believes that the prime introduction vectors of biological invasions are shipping and species introductions for aquaculture purposes (see WGITMO report for details). However, the relative importance of invasion vectors very different across regions. All participants at the meeting were asked to assess the relative importance of invasion vectors for their home countries and the result is outlined in Table 2. It should be noted that the vector importance assessment is based upon estimations, as the invasion vector cannot be known for all organisms. One example is the introduction of oysters that may have arrived as larvae in ballast water, as adults via hull fouling or as target species in aquaculture enhancements or for stocking purposes.

WGBOSV recommends consulting the Vector Handbook prepared by WGITMO and published as an ICES Cooperational Research Report. Further, Norway reported that the number of accidental species introductions for aquaculture purposes appeared to have dropped after the release of the ICES Code of Practice on the Introductions and Transfers of Marine Organisms. Italy reported that 18 % of the known introduced species reached its coastal waters via the Strait of Gibraltar and the Suez Canal, a process also known as Lessepsian migration.

Table 2 Estimated relative importance of shipping vectors. * includes movements of species with fishing gear

Country/region	Relative vector importance [%]				
	non-shipping vectors*	aquaculture	shipping	ballast water	hull fouling
Australia, Port Phillip Bay					77
Baltic Sea		14	48		
Belgium		33		33	33
Canada Pacific			majority		
Canada, Atlantic			majority		
Canada, Great Lakes				majority	
Croatia				38	62
Germany				50	50
Greece	75		25		
Italy	18	19		20	50
Norway	33	33	33		
Spain		16			
Sweden				majority	
the Netherlands		21		10	28
UK		40	53	18	24
USA, New England States		4		28	45
USA, San Francisco Bay		22		24	26

7.1 Selected research initiatives on biological invasions

Research initiatives on biological invasions and their introduction vectors are increasing on a global scale. The group's attention was drawn to ongoing projects in Europe. An introduction to the following projects was given in last years meeting report:

- Nordic-Baltic Network on Invasive species (NOBANIS)
- Assessing Large Scale Environmental Risks with Tested Methods (ALARM)
- Delivering Alien Invasive Species Inventories for Europe (DAISIE)
  The DASIE European Alien Species Expertise Registry has recently been set up and contains already more than 580 experts from 64 countries http://daisie.ckff.si/.

- AquaAliens
- Algal Introductions to European Shores (ALIENS)
- Disease Interactions and the Pathogen Exchange Between Farmed and Wild Aquatic Animal Populations (Fish, Mollusc and Crustaceans) – a European Network (DIPNET)

Allegra Cangelosi draw the groups attention to the Great Ships Initiative which is an industry led co-operative effort that is regional and binational in scope and aims to resolve the problems of ship mediated invasive species in the GLSLSS as quickly, effectively and economically as possible. The project will have various scales of research and will investigate treatment tools for vessels, monitor harbours for new invasives and facilitate the approval and installation of treatment systems.

7.2 Risk Assessment Contribution to IMO's Marine Environment Protection Committee (MEPC)

As per March 2006, the IMO Ballast Water Management Convention was ratified by 6 countries with 0,62% of the world fleets tonnage (see www.imo.org). For entry into force a ratification by 35 countries with 30% of the world tonnage is required.

WGBOSV input on the risk assessment guideline currently under development at MEPC was provided to MEPC53 in form of a written submission (MEPC53/2/10). The document was introduced at the meeting by an oral statement of the Chair as a representative of ICES. The information made available was noted and appreciated by MEPC, especially by the Ballast Water Working Group. It is believed that the contribution of WGBOSV improved the risk assessment guideline.

With appreciation WGBOSV notes that Stephan Gollasch was asked to represent ICES at MEPC54 (March 2006) and at the subcommittee "Bulk Liquid and Gases" (BLG10) which is scheduled for April 2006 enabling independent statements to be made outlining the findings of WGBOSV.

Currently, IMO guidelines are being developed to further the uniform implementation of the IMO Ballast Water Management Convention. Of particular interest to WGBOSV are the following guidelines:

7.2.1 Risk Assessment Guideline

The purpose of the guidelines includes assisting the development of scientifically robust risk assessment with the aim to grant exemptions for ballast water management requirements on certain ships and/or shipping routes.

A system is needed that documents biological separation between coastal regions. These regions are defined as biological provinces. We recognize that several classification systems exist and no single system is sufficient for all species (see document MEPC53/2/10). Determination and agreement of an acceptable system for the purpose of ballast water risk based exemptions requires significant scientific discussion to seek agreement and should be fit for purpose.

The bioprovinces approach is still the subject of controversial discussions at IMO. It is not clear yet which of the various bioprovince concepts developed earlier should be used. At this years WGBOSV meeting, Cato C. ten Hallers-Tjabbes, summarized the findings of a recent meeting (Ocean Sciences Meeting, February 20-24, 2006) related to bioprovinces. The conclusions made at the Ocean Sciences Meeting have implications for the IMO Risk Assessment Guideline on ballast water risk exemptions:

Open Ocean Bioprovinces:

- Ecologicallly different biogeochemical provinces are operating within each ocean
- Province boundaries are dynamic and change geographical position throughout a year (tested each month) (Campbell et al.)
- Bioprovinces represent a permanent structure of nested spatial scales; the underlying structure is persistent (Mountfort et al.):
- Near-surface gyre circulations, determined by temperature, salinity and oxygen
- Patterns of diverse mosaic of thermocline waters at 250-300 m depth
    - 1000 m intrusive spread of intermediate/cold waters filling the deep ocean basin.
- 3-D scaling is critical when classifying oceans. Nested patterns exist down to level 3 (Lynne et al.)

The seven NW Atlantic Langhurst bioprovinces were revisited. Input data: Sea surface temperature (SST), Biomass (chlorophyll-a), bathymetry, Longhurst boudaries:

- Province boundaries vary over the seasons
- A province for continental slope waters between the Gulf and the N-W continental shelf needs to be added (Devred et al.).

Coastal Seas

- Dynamics of coastal biogeochemical provinces differ from those of the open ocean
- Many factors in coastal seas are different from or additional to what is in the open ocean and those factors all vary on a range of time scales. Their combined influences yield the dynamic benthic habitat that characterizes coastal ecosystems.
- As an example: Sea-floor surface structure influences the speed and level of intrusion of overlying water into pore waters, which influences the dynamics of remineralisation (Jahnke et al.).

7.2.2 Guideline to Identify Ballast Water Exchange Zones

The purpose of this IMO guideline is to provide guidance for the identification, assessment and designation of sea areas where ships may conduct ballast water exchange.

At the recent Ocean Sciences Meeting (see above), the following recommendations were made which may be considered when planning to identify ballast water exchange zones:

- Include dynamics of ecoregional boundaries, vertical hierarchy and relationship to benthic structure of bioregions, while leaving the meaning intact and the precautionary approach standing.
- Take into account flexibility of ecoregional boundaries and influencing factors.
- Include salinity profiles.

7.2.3 Ballast Water Sampling Guideline

The objectives of the guideline are to provide practical and technical guidance on ballast water sampling for the purpose of determining whether the ship is in compliance with the Ballast Water Management Convention.

Some aspects relevant to this guideline were commented on and statements were made at MEPC53 accordingly. At this years WGBOSV meeting sampling recommendations and protocols to assess the viability of organisms were made (see ToR g below) and it is planned that the WGBOSV findings will be communicated to IMO as oral statement of the Chair at the IMO subcommittee meeting BLG10 in April 2006.

7.3 Global Ballast Water Management Programme (GloBallast)

The GloBallast Programme came to an end in December 2004. As a result, the GloBallast Programme Coordination Unit at IMO was unable to be represented at this meeting of the WGBOSV due to funding constraints. Currently the preparation of GloBallast II (GloBallast Partnerships) is ongoing. The funding authorities appreciated the proposed programme which may be launched later in 2006. To obtain an update on the programme and/or specific information on GloBallast Partnerships visit http://globallast.imo.org in the first instance and contact Jose Matheickal at jmatheic@imo.org for further details.

7.4 ICES WGITMO

As invasion vectors may overlap there is a need for close cooperation between working groups that target intentional introductions with others focussed on unintentional introductions. WGBOSV noted with interest that WGITMO continues to prepare “Species Alert Reports” and the Summary of National Reports submitted to WGITMO meetings. Both documents are considered as helpful tools to increase awareness, one key issue in biological invasions.

7.5 PICES

Darlene Smith (Canada) attended the WGBOSV meeting representing PICES. She reported that the interaction with WGBOSV was informative and that PICES continued to express their interest for cooperation. The attendance of ICES representatives at previous PICES Annual Meetings was much appreciated. In 2005 the PICES Annual Meeting was held in Vladivostok, Russian Federation with Session W2 entitled "Introduced species on the North Pacific" cosponsored by ICES and jointly convened by Yasuwo Fukuyo (Japan/PICES), Stephan Gollasch (Germany/ICES) and Glen Jamieson (Canada/PICES). Stephan Gollasch attended the PICES Annual Meeting in Vladivostok, Russian Federation and outlined an introduction to the history, practices and work products resulting from the ICES efforts on the introductions of marine organisms. He concluded with a number of suggestions including the establishment of a PICES Working Group on Species Invasions (not limited to HABs), and the reciprocal attendance of PICES and ICES members at their annual meetings and working sessions. He urged PICES member countries to follow the ‘ICES Code of Practice for the Introduction and Transfer of Organisms’ when planning species introductions, and emphasised the need for both regional and global networks to most efficiently deal with biological invasions, given that an invasive species could originate from a non-PICES nation. Darlene Smith summarized the findings of this PICES Annual Meeting (see Annex 9).

At this years annual meeting PICES agreed to launch a working group on biological invasions, i.e. WG 21 on Aquatic Non-indigenous Species. The Terms of Reference include:

- Complete an inventory of all aquatic non-indigenous species in all PICES member countries together with compilation and definitions of terms and recommendations on use of terms. Summarize the situation on bioinvasions in the Pacific and compare and contrast to other regions (*e.g.*, Atlantic, Australia, etc.);
- Complete inventory of scientific experts, in all PICES member countries, on aquatic non-indigenous species subject areas and of the relevant national research programs/projects underway;
- Review and evaluate initiatives on mitigation measures (*e.g.*, ICES Code of Practice for the Introduction and Transfer of Marine Organisms; IMO Ballast Water Management Convention and others such as the Canadian Introductions and Transfers Code);
- Summarize research related to best practices for ballast water management;
- Coordinate activities of the PICES WG on aquatic non-indigenous species with related WGs in ICES through a joint back to back meeting of the PICES and ICES Working Groups on invasive species in 2007/8;
- Develop and recommend an approach for formal linkages between PICES and ICES on aquatic non-indigenous species;
- Publish final report summarizing results and recommendations.

A close cooperation between ICES and PICES is of particular interest as many introduced species in ICES Member Countries originate from coasts of the Pacific Ocean. The groups attention was also drawn to the PICES Annual Meeting in Seoul, Korea in September/October 2006 and the joint ICES/PICES meeting on "Marine Bioinvasions" in 2007, likely to be held in Boston, USA, and ICES input was strongly encouraged. ICES is asked to consider funding the participation of Stephan Gollasch at the PICES Annual Meeting in Korea to continue the fruitful cooperation between the two groups.

7.6 Baltic Marine Biologists (BMB)

Stephan Gollasch (Germany) represented the BMB working group "Non-indigenous Estuarine and Marine Organisms" (NEMO). NEMO was established in 1994 and is currently convened by Stephan Gollasch. NEMO will actively continue its work with the aim to further raise awareness relevant to biological invasions and to facilitate international cooperation in research initiatives along the Baltic shores.

7.7 ERNAIS ejournal Aquatic Invasions

The European Research Network on Aquatic Invasive Species (ERNAIS), which currently includes more than 100 experts (scientists, managers and administrators) from 27 countries (http://www.zin.ru/rbic/projects/ernais/) continues to grow. A main objective of ERNAIS is facilitation of international cooperation in research, scientific information exchange and management of aquatic invasive species in Europe and worldwide.

Another objective of ERNAIS was of particular interest to WGBOSV, i.e. the new electronical journal Aquatic Invasions – the European journal of applied research on biological invasions in aquatic ecosystems. Aquatic Invasions is a rapid on-line journal focusing on biological invasions in European (geographic Europe) inland and coastal waters and is available for free at http://www.aquaticinvasions.ru/. The journal provides the opportunity of timely publication of first records of biological invaders for consideration in risk assessment and early warning systems. Also, the journal provides the opportunity to publish relevant technical reports and other accounts not publishable in regular scientific journals. Aquatic Invasions is part of the developing European early warning system on aquatic invasive species, with an important service of protection of authors rights on primary geo-referenced information on species records. Aquatic Invasions is published on behalf of the International Association of Theoretical and Applied Limnology (SIL) with start-up funding from the European Commission Sixth Framework Programme for Research and Technological Development Integrated Project ALARM (http://www.alarmproject.net).

7.8 Conclusions

The following general conclusions can be made in relation to this ToR:

- Prime invasion vectors for aquatic species are shipping and intentional species introductions for aquaculture purposes.
- The relative importance of invasion vectors is regionally very different.
- Addressing ballast water mediated species invasions will not stop the invasion process as in several regions hull fouling is the dominating species introduction vector.

7.9 Recommendations

- WGBOSV recommends considering the inclusion of dynamics of regional ecoregional boundaries when preparing an environmental matching risk assessments.
- WGBOSV encourages all ICES Member Countries to consider signing the IMO Ballast Water Management Convention.

8 Review on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation (ToR e)

A brief review on research initiatives relevant to ballast water mediated species introductions was given in the previous section and in last years WGBOSV meeting report. Selected ballast water management approaches were also referred to above. In this section the focus was laid on completed and developing studies of ballast water treatment systems. Presentations were given by Anja Kornmueller on the challenges of testing ballast water treatment systems and by Matt Gregg on the efficacy of three commercially available ballast water biocides against vegetative microalgae, dinoflagellate cysts and bacteria (Annex 4).

8.1 Ballast Water Treatment

Review of ballast water treatment technologies at IMO

A review was carried out in order to assess whether technologies to treat ballast water would be available to allow the implementation of the D-2 standard to take place by the dates set out in the Ballast Water Management Convention. The review was carried out using an evaluation tool in the form of a series of questions that were phrased in such a way as to require either a negative or positive answer in most cases. This allowed a direct comparison between the technologies for the majority of the criteria included in the review, which included the following:

- Availability
- Safety
- Environmental acceptability
- Practicability
- Cost effectiveness
- Biological effectiveness

Information was received on 16 systems but some of these were duplications so 13 systems were considered in all although information from a 14th system was submitted during the meeting. The 13 systems considered, with the relevant reference paper, were:

- Heat method (MEPC 53/2/15, submitted by Australia)
- Filtration and Chlorine Dioxide Treatment Method (MEPC 53/2/15, submitted by Australia)
- Mechanical Separation and Disinfection (MEPC 53/2/11, submitted by Germany)
- Filtration and UV (MEPC 53/2/11, , submitted by Germany)
- Physical Separation and Disinfection (MEPC 53/2/11, , submitted by Germany)
- Filtration and Disinfection (MEPC 53/2/11, submitted by Germany)
- Filtration and UV radiation (MEPC 53/2/16, , submitted by Norway)
- Filtration, Dual Pulsed Shock Wave/Supersaturation and Oxygen Deprivation (MEPC 53/2/16, submitted by Norway)
- Electrochemical Disinfection (MEPC 53/2/31, submitted by Korea)
- Filtration and Advanced Oxidation (MEPC 53/2/6, submitted by Sweden)
- Chlorine Dioxide (MEPC 53/2/14, submitted by USA)
- Separation and Ultraviolet Radiation (MEPC 53/2/14, submitted by USA)
- Filter and Advanced Oxidation Technology (MEPC 53/2/14, submitted by USA)

The data contained within these submissions was used to complete the evaluation tool and the results were used to assess whether the technologies achieved each of the criteria outlined above. An outline of the main findings is given below.

Safety

There were no safety concerns that were not within the normal range of hazards to be found on board ships although storage of Active Substances would have to be given careful consideration.

Environmental Acceptability

The main concerns raised were regarding the discharge of water that had been treated by an Active Substance although it was noted that these concerns would be addressed by guidelines (G9) developed by IMO. It was also noted that some technologies may have other waste streams that would need to be addressed and that ballast water that had been heated may need to be cooled to less than 10°C above the ambient temperature. The use of filters raised some concerns regarding the back flushing waste and it was agreed that the design should ensure that any residual waste could only be discharged at the point of origin. Although some systems would result in air emissions from the use of electrical power the review group felt this should be evaluated in relation to the air emissions from ballast water exchange and that of the total emissions from the ship.

Practicability

The review group agreed that some of the systems are very large and could be impracticable although the modular construction suggested by some manufacturers could be a way forward. As many of the systems operate on uptake and/or discharge there is generally no limitation on voyage length although there are some in-tank treatments that would require retention of the ballast for one or two days. Some systems are also likely to be affected by water quality e.g. effects of turbidity on UV systems and the need for better filtration may cause flow rate limitations.

The systems can be installed without the need for dry docking and some can be installed during service. The systems would have the potential to be installed on ships of the size range required i.e. < 5000 m^3 ballast water capacity. There would generally be no special requirements with regard to ship design to accommodate most of the systems and the systems are generally automatic and do not require specialist attention. As the systems are currently under development there was very little information regarding issues such as calibration, consistency of manufacture, reliability and durability. It was estimated that the life-cycle of the systems would be about 10 years or more.

Cost Effectiveness

There was not enough information provided in the submissions to be able to assess the cost effectiveness of the systems and it was also noted that costs are likely to stabilise at lower levels once the systems are fully developed.

Biological Effectiveness

The information submitted with regard to biological effectiveness had not used consistent test conditions as the guidelines that outlined these (G8) were only agreed at the same session that the review took place. The results are therefore not directly comparable between the different systems. However, most of the technologies had achieved at least some elements of the D-2 standard although only two met all elements during land based testing [i.e. (a) physical separation with hydrocyclone and filtration followed by a chemical disinfection process and (b) chlorination] and both used Active Substances. As more time would be required to approve systems that use Active Substances this may mean that all systems which make use of Active Substances may not be available in time for the implementation of the D-2 standard as outlined in the Ballast Water Management Convention.

Conclusions drawn at the IMO review

The results of the evaluation tool were used to assess whether there were technologies available that met the required criteria of D-2. Overall, the review group noted that although some systems had already been purchased others required further development and all systems required type-approval testing according to IMO Guideline G8 on type-approval testing. However, no system could have achieved the type-approval testing given that the guidelines on type approval and approval of Active Substances were only agreed at the same session that the review took place.

The review group also noted that there would be a delay in the availability of land based facilities, which would further delay testing. However, land based testing and ship based could be run in parallel, which would mean that type approval would be achieved more quickly. If Active Substances were to be used there would be a further time commitment required for approval of the active substance. Overall, the review group felt that there are technologies that meet the criteria of safety, environmental acceptability and practicability but only two that are biologically effective to the D-2 standard. However, the type approval guidelines (G8) agreed at this session will mean that testing will become standardised and comparisons of results from different tests should be more straightforward and should indicate more clearly whether the D-2 standard is achieved.

The review group recommended that the dates contained within the Convention for the implementation of the standards did not need to be amended but given the tight deadlines for achieving this it was recommended that a further review be undertaken at MEPC 55 which is scheduled for October 2006.

8.2 A novel heavy metal free marine antifoulant and a promising compound for ballast water treatment

ECONEA® has been developed for use in marine antifouling coatings for ship and boat hulls. It is highly effective against the major marine invertebrate fouling organisms and is, as such, one of the very few organic compounds that can act as an alternative to copper in marine antifouling coatings.

Next to the application in marine antifouling coatings, ECONEA® is a promising compound to treat ballast water in an environmentally friendly way. For a first evaluation of the biological effectiveness, a trial was conducted at the University of Newcastle upon Tyne, UK, applying a standard test protocol that was developed during the European MARTOB project, including a standard mixture of representative organisms. The results of these experiments showed 95-100% mortality for all examined zooplankton species at a dosage rate of 1 µg/ml ECONEA®, after 24 hours exposure.

By virtue of its extremely short hydrolytic half-life in seawater (half-lifes of 3 and 15 hours at 25 and 10ºC, respectively), ECONEA® does not accumulate in the marine environment, whereas the breakdown products provide acceptable margins of safety to non-target marine organisms.

8.3 Conclusions

The following general conclusions were made in relation to this ToR:

- **Ballast Water Treatment**
  The results of the IMO review on best available technology for ballast water treatment as undertaken during IMO MEPC53 in July 2005 were considered. Two treatment systems both making use of active substances were identified as likely being able to meet the strict IMO ballast water discharge standard D-2. At MEPC54 the two systems were given "basic approval" according to the IMO active substance guideline provided some additional information is submitted. This request for additional information was already fulfilled by one system which will soon be tested onboard in full scale according to the IMO approval guideline for ballast water management systems.
  WGBOSV looks forward to the outcome of the second review of best available technology for ballast water treatment scheduled for October 2006 at MEPC55.
  New ballast water treatment systems develop. At this meeting new candidate technologies were introduced from the Netherlands (flocculation similar to the

technologies used in sewage treatment), Sweden (advanced electrochemical disinfection system which produces powerful disinfectants such as hydroxyl radical directly into the media and also providing direct oxidation of microorganisms and other contaminants on the electrode surface), Belgium (new chemical treatment) and the USA (bench scale tests of ferrate as secondary treatment). Further details on ballast water treatment technologies currently being tested cannot be given due to patents pending.

It appears that any new ballast water treatment system is likely to involve a combination of technologies, for example, primary filtration or physical separation followed by a secondary biocidal treatment using e.g. UV or biodegradable "active substances".

Concerns were expressed regarding the release of concentrated biological material as e.g. filter backwash during ballast water uptake. Several ICES Member States may have regulations in place which may not permit the release of such material (e.g. countries of the European Union and USA).

Test facilities of ballast water treatment systems will be available later in 2006 in Norway and the USA. Plans to launch similar facilities exist in e.g. Australia, the Netherlands and Singapore. Efficacy tests of such systems according to IMO may take more than three months and the availability of more than one test facility will result in timely tests of treatment systems not to delay the entry into force of the IMO Ballast Water Management Convention.

- **Active substances**

  Treatment systems using the addition of active substances and active substances generated in the ballast water flow may result in discharge of residual chemicals into receiving systems. A GESAMP Group was set up to evaluate those substances for IMO. The group is also asked at its next meeting to recommend which treatment systems need to be evaluated regarding active substances. To the extent that these residuals may pose a risk to ambient organisms, it was the sense of the ICES group that IMO should encourage use of multiple approaches, e.g. primary physical separation methods to reduce the concentrations of the active substances required to achieve effectiveness, and the quantities of active substance residuals or by-products in the discharge stream.

- **Public awareness**

  There has to be a continuous effort in order to maintain awareness. The group noted the growing ERNAIS network of experts in biological invasions, coordinated by Vadim Panov (Russia) and Stephan Gollasch (Germany). WGBOSV noted the development of ERNAIS and supports the electronical journal as an early warning instrument for first records of aquatic invaders which is currently lacking.

8.4 Recommendations

- It was recommended that the WGBOSV should continue to support the Ballast Water Working Group of the International Maritime Organizations Marine Environment Protection Committee (IMO MEPC BWWG). It was recommended that WGBOSV should comment and contribute to the development of the Guidelines currently being worked on in the Ballast Water Working Group at MEPC (e.g. on ballast water sampling, risk assessment and the designation of ballast water exchange zones).

- As concerns have been expressed at meetings of the IMO MEPC regarding the use of active substances for ballast water treatment WGBOSV suggests applying risk assessment tools to identify "high risk" ballast water. The use of active substances may then be limited to treating high risk ballast water and by doing so will keep the use of such substances to the essential minimum.

- It is recommended that this TOR should remain on the agenda of WGBOSV to
    - continue its global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, CIESM, BMB and PICES Member States and of invited experts.
    - critically review and report on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation.
- As stated already in last years meeting report, WGBOSV encourages all ICES Member Countries to consider signing the IMO Ballast Water Management Convention.

9 Review, evaluate, and report on existing and emerging hull fouling regulations and treatment options (ToR f)

As with ballast water, species transports with hull fouling is an important vector for species invasions – regionally possibly the dominating introduction vector. When addressing hull fouling, it should be noted that this vector does not refer to sessile organisms only, but also that many mobile species have been transported on ship hulls. Further, fouling organisms are also transported on surfaces inside vessels, e.g. in-tank fouling and fouling in the ships cooling circuit.

Several initiatives to address hull fouling and biological invasions are currently developing – many of these focus on unwanted impacts caused by the biocide component of the antifouling paint – rather than aim to reduce the introduction of non-indigenous species, which certainly is a much appreciated "side-effect" when applying antifouling systems.

Concern was also expressed that non-organotin vessel paints may not be as effective in preventing organism fouling and may therefore increase the number of species being moved unintentionally with ships. As a result the species invasion rate may increase. It should be noted that newly designed antifouling systems are believed to be as effective as organotin-based paints. Long-term application tests are currently underway. Biocide-free paints, such as silicone-based paints, have also been tested.

A first review of existing and emerging hull fouling regulations and treatment options was prepared. Hull fouling guidelines are in preparation in Australia, New Zealand, USA and in the Mediterranean Sea countries (through RAC/SPA). The following text was partly extracted from the RAC/SPA hull fouling guideline (see Annex 7).

9.1 IMO Convention on the Control of Harmful Antifouling Systems on Ships

The international Convention on the Control of Harmful Antifouling Systems on Ships (AFS Convention) was adopted in 2001. The convention will enter into force 12 months after 25

States representing 25% of the world's merchant shipping tonnage have ratified it. As per March 2006 16 IMO member states with a gross tonnage of 17,27% of the worlds fleet ratified the Convention (see www.imo.org). By 2008, ships either:

(a) shall not bear such compounds on their hulls or external parts or surfaces; or

(b) shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.

This Convention applies to ships of all types and sizes (including fixed and floating platforms, floating storage units (FSUs), and Floating Production Storage and Offtake units (FPSOs).

9.2 European Commission

As an interim measure before the IMO Convention on antifouling systems enters into force, an EC Regulation (782/2003) on the prohibition of organotin compounds on ships was introduced in 2003. There were concerns with the dates prescribed in the IMO Convention and the Commission has issued an interpretation of the regulation. The regulation:

- bans the application of TBT antifouling paints on all ships flying flags of EU states from 1/1/2003
- bans the presence of TBT antifouling paints on all ships in EU ports by 1/1/2008 (sealer coats accepted)
- requires surveys and certification for EU flagged vessels coated after 1/1/2003 and for foreign flag vessels when the AFS Convention enters into force

9.3 Australia

Management measures are being developed and implemented in Australia to address biofouling risks from a wide range of sectors through the "National System for the Prevention and Management of Marine Pest Incursions" including small international and apprehended vessels, fishing vessels, domestic recreational vessels, ports, marinas, slipways, aquaculture, commercial shipping, non trading vessels and petroleum and gas activities.

Regular hull fouling inspection of certain vessels is ongoing and is carried out by e.g. underwater camera documentation or SCUBA diving.

The measures will provide options for managing and treating biofouling of hulls, vessel niche areas (such as seas chests, internal seawater systems, sea intake grates, bow tunnels, transducers, docking support block areas, propellers, shafts and rudders) as well as on gear and equipment. The measures will also include best practice guidelines to minimise the marine pest translocation risks that may be associated with aquaculture stock, equipment and infrastructure.

The management measures are being developed collaboratively by the Australian Government, state and territory governments, marine industry associations, recreational groups, conservation organisations, researchers and other stakeholders.

The biofouling guidelines for commercial fishing vessels, domestic recreational vessels and international small and apprehended vessels have been finalised.

Best management practice guidelines are being developed for the other sectors and will be initially implemented as voluntary measures with the potential to become mandatory after reviews of their effectiveness and uptake. Risk assessment projects are being undertaken to analyse the risk of biofouling associated with niche areas of commercial ships and for various aquaculture operations. The process for developing guidelines for commercial shipping is outlined in attachment 4. These projects will present management options that will feed into the development of biofouling guidelines for the respective sectors.

It is anticipated that the guidelines for all sectors will begin to be rolled out in October 2006.

9.3.1 National Best Practice Guidelines for Commercial Fishing Vessels in relation to Managing Marine Pests

Biofouling on commercial fishing vessels will be managed through voluntary best practice guidelines. The aim of the guidelines is to manage the risks of entrainment and translocation of marine pests as biofouling associated with commercial fishing vessels and gear.

The biofouling guidelines are intended to assist commercial fishing vessel owners, skippers, engineers and crews to apply best management practice to reduce the risk of entrainment and translocation of marine pests through vessel maintenance, cleanliness and effective antifouling. Examples of measures included in the guidelines include:

- Cleaning and scraping of hulls at designated facilities with containment of all biological matter;
- Internal Water System (IWS) maintenance by physical cleaning at access points and by periodic flooding with freshwater;
- Application (and re-application) of antifouling systems appropriate to the vessel type, operating conditions and voyage profile;
- Keeping maintenance records;
- Clearing decks and any refuge areas on deck that may harbour a pest, such as spaces under winches and around deck fittings;
- Clear warps and anchors of biological matter and mud/sand as they are hauled.
- Rinsing vessels with fresh water whenever possible; and
- Never releasing a known marine pest back into the water.

Implementation

A consultation process with the Fishing Industry is underway to refine and finalise the guidelines in terms of how they will be delivered. A communications sub-strategy will then be implemented to ensure that the industry is aware of the guidelines, focused initially on those fisheries that have a higher risk of entrainment and translocation based on their characteristics.

9.3.2 National Best Practice Guidelines for Recreational Vessels in Relation to Managing Marine Pests

The management of biofouling on recreational vessels will be through voluntary best practice guidelines. The aim of the guidelines is to manage the risks of entrainment and translocation of marine pests as biofouling associated with recreational vessels and gear.

The biofouling guidelines are intended to assist recreational boat users to apply best management practice to reduce the risk of entrainment and translocation of marine pests through vessel maintenance, cleanliness and effective antifouling. Examples of measures included in the guidelines include:

- Cleaning and scraping of hulls at designated facilities with containment of all biological matter;
- Internal Water System (IWS) maintenance by physical cleaning at access points and by periodic flooding with freshwater;
- Application (and re-application) of antifouling systems appropriate to the vessel type, operating conditions and voyage profile;
- Keeping maintenance records;
- Rinsing vessels with fresh water whenever possible; and
- Never releasing a known marine pest back into the water.

Implementation

A consultation process with recreational boat users has commenced to identify the best way to reach this highly diverse sector.

9.3.3 National Border Biofouling Protocol for Apprehended and International Vessels Less Than 25m in Length

The management of biofouling on apprehended and international vessels less than 25m in length will be through regulation under the *Quarantine Act 1908*. The aim of the regulation is to manage the biofouling risks on vessels less than 25 metres and apprehended and rescued vessels (regardless of size) entering Australia from international waters. The regulations will contribute to fulfilling item 14.1 (d) of the Intergovernmental Agreement on a National System for the Prevention and Management of Marine Pest Incursions.

Description of the requirements

Under this protocol, vessels less than 25m will be required to demonstrate that their vessels have current, effective antifouling paint and the hulls and any equipment are free from biofouling. The vessel will be subject to an inspection by the Australian Quarantine and Inspection Service (AQIS), which will form an adjunct to the routine pratique inspection conducted on every international vessel at the first port of call in Australia.

The AQIS inspection will include verification of antifouling documentation and/or inspection of a vessels' hull and equipment to determine the presence of biofouling (this may involve the use of underwater cameras and SCUBA divers or removing the vessel from the water). If a vessel's Master can produce documentation to indicate current, effective antifouling (current as per manufacturers specifications) or if the vessel has been slipped and cleaned within the last month, then the risk of marine pests being attached to the vessel could be considered 'low'. This would be verified with a cursory visual inspection.

For visual inspections, a vessel and associated equipment would be considered 'clean' if no more than a slime layer (a layer of unicellular algae defined as *primary fouling*) is detected. If organisms such as mussels, barnacles and weeds (defined as *secondary fouling*) are detected, then treatment of the vessel's hull and equipment may be required.

A visibly fouled hull or unacceptable documentation in relation to hull cleaning or antifouling application could result in a vessel being subjected to a more rigorous inspection of the hull for presence of biofouling organisms (e.g. removal of the vessel from the water) and hull cleaning may be required in a suitable facility.

Apprehended vessels will be visually inspected as soon as possible after they are seized, and appropriate treatment or disposal of the vessel carried out. The current quarantine risk mitigation practise is for the destruction of the majority of apprehended vessels.

A Regulation Impact Statement for the regulation of small international vessels and apprehended vessels is being finalised in consultation with the Office of Regulation Review. Amendments have been drafted for the Quarantine Regulations and Proclamation to provide Quarantine Officers with the legislative powers to deal with the arrival of fouled vessels.

Implementation

The voluntary implementation of the protocol commenced on 1 October 2005. It is proposed that the protocol become mandatory in October 2006. The protocol would be implemented through amendments to existing legislation. AQIS is responsible for implementing the protocol. The protocol will be formally reviewed to facilitate adaptive management in order to most effectively and efficiently minimise the marine pest risk from biofouling.

9.3.4 Marine Biofouling associated with Commercial Shipping

Biofouling presents a significant risk for introducing marine pests to Australian waters. A scientific study undertaken in 1999 estimated that 77% of exotic marine species in Port Phillip Bay, one of the most heavily infested marine ecosystems in the Southern Hemisphere, were introduced by biofouling (Thresher *et al.*, 1999; Hewitt *et al.*, 2004). Despite the effectiveness of modern antifouling paints used in commercial shipping, anecdotal evidence suggests that niche areas of ships can become fouled and present a risk of introducing marine pests to a new environment. These niche areas include areas along the hull such as seachests bow thrusters, bilge keels and docking block strips.

The Australian Government and the shipping industry are undertaking a project investigating biofouling risk and prevention on commercial ships. The main objectives of the commercial vessel biofouling project are:

- Confirm that all niche areas associated with commercial vessels have been identified;
- Identify risks associated with these areas; and
- Identify management options to prevent biofouling in each identified area.

Hull maintenance practices, ship design principles and application of new and established technology are likely to be important in managing biofouling risks.

Potential management options range in complexity. Simple suggestions include reducing refuge areas and creating flush surfaces where possible, replacing square bares on intake and outlet grates with round bars and using different antifouling coatings in different areas on the hull depending on the hydrodynamic characteristics of the specific area. Where vessel operation is impacted, some of these practices are being employed already. Moving the position of docking blocks at each dry dock is another practice that may be effective in reducing biofouling.

The policy response is in a developmental stage. In-water cleaning and hull cleaning measures before re-entry in Australian waters are discussed. Further, it is considered to request vessels to submit a documentation on the interdocking interval which may be assessed by comparing the suggested interdocking period as suggested by the paint manufacturer.

Currently selection criteria for ships to be sampled are in development. Criteria may include the origin of the vessel and the interdocking period.

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9.4 New Zealand

Strong linkages exist between New Zealand and Australia on this matter and similar regulations are under development in New Zealand.

9.5 USA

Since 2001 a comprehensive Ballast Water and Hull Fouling Management Program for the State of Hawaii is under development. Management options/requirements considered to prevent new organisms from being introduced include periodic cleaning of the underwater surfaces, and effective and environmentally friendly coatings. There are three main components to allow for a useful hull fouling management programme (Scott Godwin, pers. comm.):

- Pro-active measures, i.e. monitoring programmes, risk assessment, awareness raising, education
- Re-active measures, i.e. rapid response programme
- Post-event measures, i.e. management plan

9.6 Mediterranean countries

At the recent RAC/SPA meeting (see also ballast water management section) hull fouling guideline principles were drafted (see also Annex 7). The results from this meeting will be communicated to country focal points. It is assumed that an awareness campaign may be initiated first. The next step may be the development of detailed guidelines.

The guideline has a general objective to minimise the number of unintentional species introductions associated with hull fouling, to achieve this, the following seven specific objectives are targeted.

1. To encourage necessary research and the development and sharing of an adequate knowledge base to address the problems of hull fouling mediated introductions of alien species in the Mediterranean.

2. To increase awareness of hull fouling as a major introduction vector.
3. To technically assist and advise the Mediterranean coastal States, if requested, to ratify the IMO AFS Convention.
4. To encourage the development and implementation of control efforts, such as hull cleaning measures.
5. To encourage the development of a framework for national legislation and regional cooperation to regulate the introduction of hull fouling mediated species introductions, their eradication and control.
6. To design a lead agency, which would have a central responsibility within the government for coordinating the national response to the above issues.
7. To form a national taskforce to develop and implement the proposed guidelines. This national taskforce may be cross-sectoral and multidisciplinary.

The guideline addresses three substantive concerns of the alien species problem (see Annex 7):

- enhancing knowledge and research efforts;
- improving understanding and awareness; and
- providing appropriate prevention measures.

9.7 Conclusions

The following general conclusions can be made in relation to this ToR:

- Given the ban of Tri-butyl-tinn-containing antifouling paints by 2008 and the potential implications for hull fouling, including that on smaller vessels, WGBOSV assumes that this could become an issue of increasing importance in ICES member countries.
- The first hull fouling guidelines were developed in Australia. However, it is unclear what measures may be taken once it is proven (due to e.g. sampling) that species of concern are attached to a ships hull. This is especially true for larger commercial vessels.
- In the USA an awareness raising effort on species introductions in the hull fouling of ships is ongoing. It is planned to distribute outreach material, sample ship hulls of recreational ships and commercial vessels.

9.8 Recommendations

All ICES Member States are urged to consider the ratification of the IMO Convention on Antifouling Systems.

- WGBOSV recommends preparing a draft ICES Code of Best Practice for the Management of Ships Hull Fouling (see Recommendations in section 5 above).

10 Prepare a technical ballast water sampling manual (ToR g)

Experience has shown that sampling ships´ ballast water is far from simple. For biological analysis carried out to assess the variety of organisms arriving in ballast (qualitative analysis) and in addition to determine their viability, several sampling methods have been developed.

Unfortunately, these techniques are neither considered adequate when planning to sample ships for efficacy tests of ballast water treatment systems nor for compliance control sampling for the ballast water discharge standard as set forth in the IMO Ballast Water Management Convention (both being quantitative approaches). Consequently, IMO is currently preparing a guideline on ballast water sampling. It is hoped that the findings of WGBOSV will support the development of this guideline which will be discussed at IMO in April 2006.

Ballast water management systems are required to meet the standards as outlined in Regulation D-2 of the International Maritime Organization (IMO) Convention for the Control and Management of Ship`s Ballast Water and Sediments (the Convention). To allow for comparison and adjustments, the issue should be revised once the IMO Guideline on Ballast Water Sampling is completed. This is scheduled for MEPC55 (October 2006).

Regulation D-2 of the Convention stipulates that ships meeting the requirements of the Convention must discharge:

- less than 10 viable organisms per cubic meter greater than or equal to 50 micrometers in minimum dimension, and
- less than 10 viable organisms per millilitre less than 50 micrometers in minimum dimension and greater than or equal to 10 micrometers in minimum dimension, and
- less than the following concentrations of indicator microbes, as a human health standard:
    - Toxigenic *Vibrio cholerae* (serotypes O1 and O139) with less than 1 Colony Forming Unit (cfu) per 100 millilitres or less than 1 cfu per 1 gramme (wet weight) of zooplankton samples,
    - *Escherichia coli* less than 250 cfu per 100 millilitres, and
    - Intestinal *Enterococci* less than 100 cfu per 100 millilitres.

Documenting the number of organisms above 50 microns is especially challenging as less than 10 organisms per cubic meter of water are acceptable. As a result more than 1,000 liters of water need to be sampled – and this needs to be carried out multiple times as more than one sampling point, several replicates and various sampling occasions are required. A new sampling device was developed to solve this challenging sampling requirement. This device is described further below.

WGBOSV discussed ballast water sampling in detail and the following sections reflect the discussions at the meeting.

10.1 Sampling point design (in-line sampling)

All sampling points should be fitted to the ship's ballast water piping system in a straight section (a) prior to the treatment system and (b) after the treatment systems between the system and the ballast water discharge point as close as possible to the discharge point. The opening of the sampling point should be directed against the water flow (Figure 1).

Sampling points for the control and treatment system tests must be identical to allow for comparison of results.

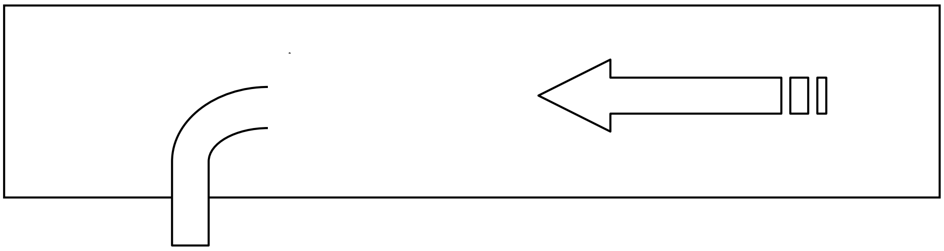

Figure. 1 Suggested sampling point design in ships´ ballast water pipe.

10.2 In-tank sampling

If in-tank sampling is needed (e.g. holding time experiments) a plankton net should be used as multiple scientific studies have shown that other sampling access points (e.g. sounding pipes) or sampling methods do not likely reveal accurate results. However, samples may also be taken by using pre-installed hoses at different water levels.

According to the draft IMO Ballast Water Sampling Guideline and also the Prototype Guideline several sampling options need to be considered. Samples may be collected by using pumps, buckets, sampling bottles or other water containers, as appropriate for the tank being sampled and the analytical method used. Whenever possible samples should be taken from multiple depths inside the ballast tank.

During 1999 a European Union Concerted Action study on species introductions was carried out. This included an intercalibration workshop on in-tank ship ballast water sampling techniques and took various phytoplankton and zooplankton sampling methods into account. For the first time, a variety of the techniques in use world-wide were compared using a plankton tower spiked with the brine shrimp larvae as a model ballast tank while phytoplankton samples were taken simultaneously in the field (Helgoland Harbour, Germany). The sampling devices included three cone shaped and eleven non-cone shaped plankton nets of different sizes and designs. Net lengths varied from 50 - 300 cm, diameters 9.7 - 50 cm and mesh sizes 10 - 100 µm (Table 3 & 4). Three pumps, a Ruttner sampler and a bucket previously used in ballast water sampling studies were also compared.

Table 3 Intercalibration of phytoplankton sampling methods for ballast water, indicating net and pump characteristics, including mesh size, net opening, net mesh filtering area, seam area per net (not filtering) and estimated average water volume sampled. Vertical tows were standardized for all nets from 4 m depth to the surface, pump hoses were lowered to 2 m depth. Method coding: CN = Cone net, N = net, P = pump, R = Ruttner bottle followed by net diameter and net length or pump weight.

Method coding	Type	Mesh size (µm)	Diameter (cm)	Length (cm)	Volume sampled (l)	Filtering net area (cm^2)	Seam area (cm^2)
N80/100	net	80	30.0	100	273.3	4,255	400
N55/50	net	55	25.0	50	196.3	1,626	43
N20/100	net	20	14.2	100	63.3	2,304	98
N20/45	net	20	14.3	45	64.2	1,270	95
CN10/80	net, cone-	10	9.7	80	29.5	1,841	45

	shaped						
P30	pump + hose	integrated	42.0 (hose)	-	8.0	-	-
P15	pump + 20 µm net	20	14.3 (hose)	45	30.0	-	-
P1.5	pump + 20 µm net	20	14.3 (hose)	45	50.0	-	-
R	Ruttner bottle	-	10,0	46	1.5	-	-

Table 4 Intercalibration exercise for zooplankton sampling in a plankton tower serving as model for a ballast tank indicating net and pump characteristics, including mesh size, net opening, net mesh filtering area, seam area per net (not filtering) and estimated average water volume sampled. Vertical tows were standardized for all nets from 3 m depth to the surface, pump hoses were lowered to 2 m depth. Method coding see Table 3.

Method coding	Type	Mesh size (µm)	Diameter (cm)	Length (cm)	Volume sampled [L]	Filtering net area (cm²)	Seam (cm²)
N20/80	net	20-30	20	80	94.2	2,556	164
CN55/80	net, cone-shaped	55	9,7 (cone)	80	19.5	1,841	45
N55/80	net	55	25	80	147.3	1,841	45
N100/150	net	100	40	150	340.2	9,467	504
N55/50	net	55	25	50	147.3	1,626	43
CN70/250	net, cone-shaped	70	50	250	212.1	11,946	140
N53/75	net	53	30	75	205.0	1,480	*
N45/150	net	45	30	150	198.2	5,973	*
N80/150	net	80	30	150	191.4	6,345	*
N80/100	net	80	30	100	212.1	4,255	400
N62/300	net	62	50	300	477.1	16,420	1,030
P1.5	pump (1,5 kg) +net	55	25	80	50.0	-	-
P30	pump (30 kg) +net 55µm	55	25	80	30.0	-	-
P15/3	pump (15 kg) +net 55µm	55	25	80	30.0	-	-
P15/8	pump (15 kg) +net 55µm	55	25	80	30.0	-	-
R	Ruttner bottle (2 kg)	-	10	46	1.5	-	-
B	Bucket	-	40	40	12.0		

This first assessment indicated that for sampling ballast water a wide range of techniques may be needed. Each method showed different results in efficiency and it is unlikely that any of the methods will sample all taxa (Figure 2 & 3). However, several methods proved to be valid elements of a hypothetical “tool box” of effective ship sampling techniques. The Ruttner water sampler and the pump P30 provide suitable means for the quantitative phytoplankton sampling, whereas other pumps prevailed during the qualitative trial. Pump P15 and cone shaped nets were the best methods used for quantitative zooplankton sampling.

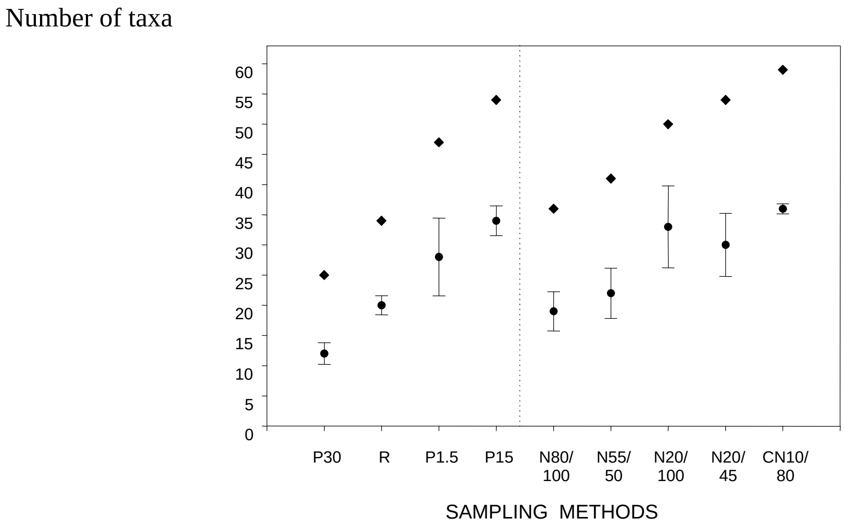

Figure 2 Qualitative evaluation of various sampling techniques used simultaneously at the pontoon of Helgoland harbour. Circles: average total number of taxa, diamonds: combined taxa sampled in all five replicates. Standard deviation (vertical bars). Left hand side point source sampling techniques (pumps and Ruttner sampler), right hand size integrated net samples. Coding of sampling methods see Table 1.

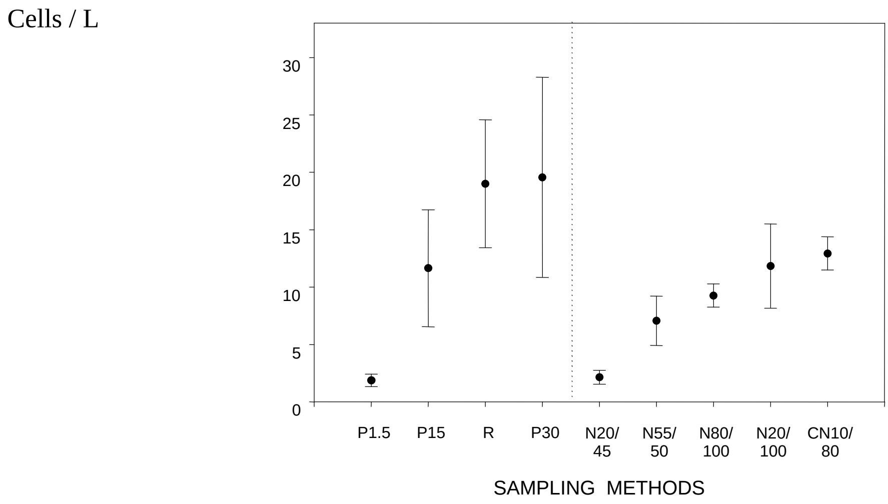

Figure 3 Quantitative evaluation of various sampling techniques used simultaneously at the pontoon of Helgoland harbour. Average number of Coscinodiscus wailesii per litre (5 replicates) and standard deviation (vertical bars). Left hand side point source sampling techniques (pumps and Ruttner sampler), right hand size integrated net samples. Coding of sampling methods see Table 1.

When employing plankton nets:

- the sample should be taken in a vertical net haul from the deepest sampling point accessible in the tank; and
- all plankton nets should be lowered to the maximum accessible depth inside the ballast tank and retrieved at a speed of approximately 0.5 m/s.

Multiple vertical net hauls may be needed to meet the required sample volume. The water volume sampled may be measured by flow meters in the opening of the net or by noting the sampling depth and net opening diameter.

When employing pumps:

- Pump intake pipes should be lowered to multiple depths (if possible) for different samples to obtain a vertical sample.
- The water volume sampled may be measured by flow meters in the hose or by using larger buckets to measure the pumped water volume.

For efficiency tests of in-tank treatment systems (recirculation systems) samples should be taken immediately before and after the treatment system as outlined above. It is also recommended to take additional samples from the ballast water tank by lowering a plankton net.

10.3 Concentration of samples for counting of organisms

Samples should be concentrated by means of filtration with a maximum meshsize of 50 micron (diagonal dimension) for organisms above 50 micron and with a maximum meshsize of 10 micron (diagonal dimension) for organisms smaller than 50 micron and above 10 micron.

Where there are high organism numbers and / or in the presence of high numbers of inorganic particles the sample may be divided by using a plankton splitter. Samples should contain at least 300 animals after splitting.

10.4 Viability tests and enumeration, taking into consideration automated means of enumeration, e.g. flow-cytometry

The viability of organisms should be analysed as soon as possible after sampling. The IMO requires sample analysis within 6 hours after sampling. The 6 hours time limit refers to relatively short generation times of certain taxa, possible mortality in storage prior to analysis which may have an impact even after a few hours and predator prey interactions.

Viability of an organism can be determined through live/dead judgement by appropriate methods including, but not limited to: morphological change**,** mobility, staining using vital dyes or molecular techniques.

It may also be considered to use a video systems to identify the movement of organisms over time.

Representatives of all species, native and surrogate taxa, shall be analysed after treatment to assess their viability. Whenever possible regrowth / recovery experiments should be carried out to prove species inactivation. Both experiments should be repeated with organisms in a control test.

The number of all living organisms present in the sample should be documented according to their minimum size apart from microorganisms where the organism size is irrelevant for the IMO discharge standard.

10.4.1 Larger plankton (>= 50 micrometer)

Microscopic evaluation for organisms greater than or equal to 50 micrometers in minimum dimension should be carried out with a stereo microscope at magnifications of at least 16x. In case of high organism numbers and / or in the presence of high numbers of inorganic particles the sample may be divided by using a plankton splitter. Samples should contain at least 300 organisms after splitting.

In order to avoid heating of the sample, a low energy LED-light or glass fibre lights should be used during the analysis.

Any microscopic analysis onboard of ships is also a challenge, especially when the ship is in motion. When using Petri dishes and a stereo-microscope, counting of organisms may not be accurate as the ship movement induces water movements in the Petri dish. As a result organisms may be counted twice and some may be missed out from counting. To avoid this, a Bogorov counting chamber may be used. During minimal ship movements, this chamber proved to be efficient during onboard trials. However, with increasing ship movements, specially designed chambers for analysis are needed. Examples for chambers that allow for greater accuracy in counting larger organisms onboard are given in Figure 4.

Figure 4 Newly designed zooplankton counting chambers.

Viability tests

When assessing the viability of larger organisms visual inspection seems essential. Analysis of living organisms may be assessed by documenting movements of organisms. Onboard sample analysis has shown that organisms sampled from the outlet water stream of a ballast water treatment system, i.e. after treatment, are impaired in their physical abilities. For example, copepods showed no movement when analysed under a stereomicroscope. However, bright illumination during sample analysis resulted in organism movement and also poking of non-moving organisms was used to assess viability. Consequently, each (intact) organism found was poked during the sample analysis which is a time consuming task (Gollasch, unpubl.).

Analysis of viable organisms may be evaluated by use of a vital stain. Preserved zooplankton samples should be transferred to 70 percent ethanol solutions to prevent inhalation of formalin fumes during sample counting.

10.4.2 Smaller plankton (< 50 micrometer and >= 10 micrometer)

Samples for organisms less than 50 micrometers and greater than or equal to 10 micrometers in minimum dimension should be reduced when needed to 30 ml by filtering via a 10µm mesh and rinsing with organism free water at ambient salinity and temperature. Live samples could be used for direct inspection of organism numbers and sizes or samples could be preserved with Lugol's solution, and placed in a settlement chamber overnight. Intact phytoplankton and other protist cells (i.e. undamaged cells are supposed to be living) should be counted by using an inverted microscope and magnifications of at least 200x. The counting of the organsims should be carried out in accordance to the UNESCO approved method of Sournia (1978)[1]. Analysis of viable organisms may be evaluated also by use of a vital stain.

For phytoplankton and other protists the following techniques may also be considered to assess viability:

- The enrichment technique which includes a dilution series sufficient to ensure that changes in the numerical abundances of at least 10^5 can be detected during the phytoplankton and other protists viability test.
- Isolation and viability testing of single resting cells of phytoplankton and other protists should be attempted.
- Phytoplankton and other protists should be conducted under light and dark conditions. This enables evaluation of the response of autotrophic (light) and heterotrophic (dark)

1 SOURNIA, A. (Ed.). 1978. Phytoplankton manual. UNESCO. Paris.

organisms. Incubations in light and dark exposure should include media appropriate to the specific organism type and should also include different levels of nutrients.

- The measurement approach includes a dilution series by media and incubation at a constant temperature for 7 to 14 days.
- To replace microscopy, other particle counting methods (e.g. flow-cytometry - see below) may be used.

10.4.3 Microorganisms

Microbial samples should be cultured from different dilutions of the original sample, because high numbers of colonies on the media could prevent exact enumeration of the samples. It is proposed to start with standard dilutions of 1:1, 1:10, 1:100 and 1:1000. Several bacterial growth media to identify the target indicator microorganisms as identified in Regulation D-2, may need to be used to assess the treatment systems efficacy. It should however be noted that less than 5% of the known marine bacteria can be cultured using today’s technologies. In addition to plating, numerical abundance of the microorganisms may be determined using (epifluorescence) microscopy and flow-cytometry.

Multiple bacterial growth media should be used for viability tests. The minimum number of media used will include media for heterotrophic bacteria, a marine agar, and a nutrient agar. If only the bacteria specifically identified in Regulation D-2 have to be analysed, selective media should be used. It has to be emphasized that any microbial analysis of ballast water meaningful results can only be obtained if specific attention is given to avoiding infection with microorganisms from other environmental sources. Therefore, a clean working environment and good laboratory practices need to be applied.

10.5 Currently available techniques with their limitations, and future perspectives on the development of these technologies

10.5.1 New sampling device for organisms above 50 micron

The newly designed sampling device, developed by Hydrobios, one of the leading manufacturers of scientific sampling gear in Germany, allows sampling of larger organisms for (a) compliance control and (b) for efficacy tests of ballast water treatment systems.

This device consists of a flexible sampling bag with a filtering cod-end both designed especially for this purpose. The device is completely independent from the ships operation (other than ballast water operations), i.e. does not require power supply etc. The filtering cod-end can be unscrewed and after cleaning of the bag the unit is ready for use immediately, i.e. several samples may be taken in a short period of time by simply sealing one cod-end and screwing on another cod-end. Sealed cod-ends may be placed in a water tight container to avoid damage or impairment of survival of sampled organisms. Alternatively, the filtering sieve of the cod-end may be replaced with a new sieve after each sampling occasion onboard. This also eases the cleaning of the sieve to avoid organism contamination with future samples, and they can be carried to the analysing laboratory. The filter sieve replacement is a matter of minutes and allows the use of only one cod-end for multiple samplings.

The integrated flow-meter enables a precise measurement of the water volume filtered. This is difficult when using buckets, especially when the vessel to be sampled is moving, due to heavy seas or in cargo operations buckets may overflow. Compared to using buckets a bigger water volume can be filtered as the device collects and filters the water at the same time. , i.e.

up to 2.5 tonnes of ballast water were sampled in less than 30 minutes. Discharge of filtered water after sampling may be carried out by dumping it in the bilge water system. Where sampling is undertaken in areas where water spillage cannot be tolerated, the spillage can be minimised by directing the filtered water with a hose to a sink – or by placing a water collecting tank underneath the device that may be emptied as requested. In case the treatment system uses backwash-lines to discharge filter backwash material, this backwash line may also be used to discharge the filtered water.

Where the sampling procedure takes longer, organism survival may be impaired by the long sampling time. To allow optimal organism survival, the tap of the cod-end may than be opened every 10 minutes to extract sampled organisms (subsample). This means that organism exposure to air is minimised. Organisms in all subsamples should be counted.

All these advantages will result in an efficient, timely and accurate sampling of ballast water. Also the time efficient application means that the number of samples or replicates taken by the sampling crew may be increased without any extra working hours. The limiting factor is the concentration of organism and particular matter in the water. When the organism and particle concentration in the water is low, sampling can be "endless" when the time for filling the device equals to the time needed for water filtration through the filtering cod-end.

10.5.2 Technical Details Filter Bag and Cod-end

The filter bag (Figure 5) and cod-end (Figure 6) are especially designed for the purpose of ballast water sampling. The cod-end may be unscrewed from the sampling bag after sampling (Figure 7).

Diameter: 40 cm
Length: 100 cm
Cod-end: PVC, 60 mm diameter, two side windows covered with Monyl 50 micron mesh size (diagonal dimension) = filtering panels and with tap.

Figure 5 Filter bag with flow-meter.

Figure 6 Cod-end with tap.

Figure 7 Cod-end may be unscrewed from filtering bag.

The flow meter outlet in the net is bent which results in spiral water flow in the sampling bag. By doing so the organism damage during sampling is minimised and the filtration rate of the cod-end is increased.

10.5.3 Sampling options for organisms below 50 micron and above 10 micron

For a rapid and accurate analysis of the abundance of phytoplankton and bacteria, microscopic inspection maybe complemented by flow cytometry. Based on the red autofluorescence of the photosynthetic pigments this automated technique enables a rapid and precise analysis of the plankton community and also separates phytoplankton from other particles. DNA staining may be used to analyse for bacteria or viruses. Flow cytometry offers more than a simple replacement of the labour intensive microscopic counting method since it can be combined with cell-specific staining techniques. Often the different ballast water treatment systems kill the planktonic organisms, although not through a process of total disintegration. Subsequently, non-viable but still intact cells will also be counted by classical counting techniques resulting in a false assessment result. For more accurate analysis the viability of phytoplankton and bacteria cells may be determined by using dye stains. The dye cannot penetrate through intact cell membranes. Where the cell membrane is damaged the dye binds to the DNA. This results in a bright fluorescent signal of the DNA-dye complex. As a result intact and unstained cells are living (Figure 8).

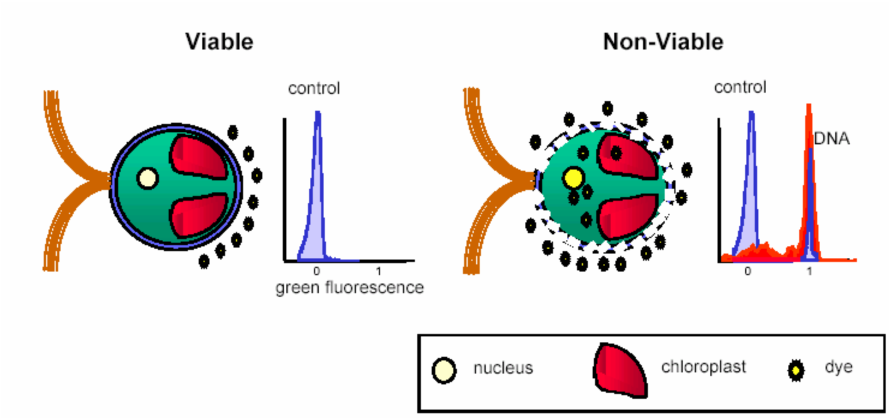

Figure 8 Viability analysis through DNA fluorescent dying using a flow cytometer (source: M. Veldhuis, NIOZ, 2004).

10.5.4 Rapid counting of stained mesozooplankton samples by using a colour scanner

For analysis the samples were poured into a beaker to allow a thorough mixing until the organisms are distributed randomly. Where organism densities were high sub-samples were taken using a Stempel pipette. Afterwards the samples were stored for 24 hours in a small bottle and 0.5 ml Eosin (5 g/l) was added as a stain. The samples were concentrated through meshes with a mesh size smaller than the mesh size of the sampling gear and filtered sea water was added. For counting the sample was emptied into a transparent, square plastic tray. For analysis the tray was put on a colour scanner and colour images were taken with 600 dpi resolution. Imaging software was used to process the scan resulting in the number of organisms and their body size. The system has proven to work efficiently during various tests of with zooplankton.

10.6 Conclusions

The following general conclusions can be made in relation to this ToR:

- **Representativeness of data**
  During the discussions one major issues of concern was the representativeness of data. To take representative samples is of key importance as sample analysis may have legal implications in case of non-compliance with the standards in the IMO ballast water management convention. Also, inefficient sampling techniques may result in false positives. Most representative samples may be taken when the ballast water is sampled continuously during the entire discharge time.

- **Replicate sampling**
  According to the IMO ballast water sampling guideline three replicate sampling events need to be taken when assessing the efficacy of ballast water treatment systems. Filling a ballast water tank is a unique event as the species composition and density cannot be replicated over time. Further, organisms may concentrate in certain water depths inside the ballast tank and sampling for replicates is therefore not recommended over time, i.e. take samples after 10% of the ballast water in the tank is emptied, after 50% and after 80% of the tank is emptied. To avoid pseudo-replication each tank should be considered as one replicate. To allow for replicate sampling it is

suggested to install various sampling points in the ballast water discharge line and to sample the treated ballast water simultaneously.

- **Use of stains to assess organism viability**

  WGBOSV suggests using vital stains to assess the viability of organisms. For phytoplankton organisms SYTOX Green proved to be efficient and for zooplankton samples Neutral Red may be used.

- **New sampling methods**

  WGBOSV noted that new sampling techniques are continually developing. These technologies are especially designed for the purpose of ballast water sampling and may be easier to use onboard vessels compared to standard plankton sampling technologies.

- **Sample analysis tools**

  Bacteriae

  So far microorganisms were rarely cultured in experiments with ballast water treatment systems. It seems that selective culture media may be useful to assess the number of colony forming units per "indicator" bacteria as mentioned in the IMO standard.

  Phytoplankton

  For sample analysis the chlorophyll content gives only an indication as these results do not enable assessment on organism numbers per water volume. Some sample processing technologies are developing, i.e. a broad spectrum live/dead stain coupled with microscopic or flow cytometer. Ongoing activities need to identify the right stain and the right tracking instrument. However, it is not clear yet whether or not microscopic analysis can be carried onboard ships as the ship movements and engine vibration cause negative impact.

  Zooplankton

  The above mentioned counting chambers proved to work efficiently during onboard tests of ballast water treatment systems.

- **Colony forming vs. single specimens**

  The IMO ballast water discharge standard refers to organism number per size class. A question arose in which size category a colony falls when the single cell is below 50 micron but the colony is above 50 micron. WGBOSV believes that in those cases the individual specimen size should be measured. This group finding is based upon the IMO standard as it refers to organisms and not to colonies. Further, viability tests should address the smallest unit enabled to reproduce which is the individual and not the colony. However, one problem remains in case the individual is below 10 micron (not addressed in the IMO standard), but the colony is above 10 micron. When considering here the individual size alone some species are excluded. However, WGBOSV believes that the above explanation why individuals should be measured should apply.

10.7 Recommendations

- The ICES Ballast Water Sampling Manual should be in line with the IMO Ballast Water Sampling Guideline. This guideline is still in preparation and consequently the ICES Ballast Water Sampling Manual could not have been completed at the meeting. The IMO sampling guideline is scheduled to be ready for approval at MEPC55 (October 2006). WGBOSV therefore recommends finalizing the ballast water sampling manual at next years meeting.

11 Update on US legislation relevant to introduced species

The U.S. Congress has not passed new legislation on aquatic invasions since the reauthorization of the Nonindigenous Species Act (NISA) of 1996 which expired in 2002. [1][1] However, several new bills are before Congress, a few of which are receiving attention. One relates directly to ballast water (Senate Bill 363), which was approved by the Senate Commerce Committee and placed on the legislative calendar in November 2005, but is not yet enacted due to objections by individual Senators. Two complementary proposed bills that address ballast water management and more broadly aquatic (and marine) nonindigenous species issues have been introduced by the Senate (S. 770) and the House of Representatives (H.R. 1592). These bills (S. 770 and H.R. 1592) were referred to respective legislative committees and remain pending.

The Ballast Water Management Act of 2005 (S.B. 363) focuses on managing ballast water and proposes standards for ballast water discharge that are more strict than those proposed by the International Maritime Organization (IMO). The legislation would amend the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 to establish a new, national approach to addressing invasive species in ballast water. The Ballast Water Management Act includes environmentally sound standards for ballast water treatment technologies (more stringent than the IMO) applicable immediately, and phases mandatory adoption of technologies over a 10-year period identical to the IMO time-frame. A similar bill is still under discussion by the House committee.

The S. 770 and H.R. 1592 also include sections on managing ballast water as well as other provisions such as research into other pathways, rapid response, education and outreach programs, and prevention and control strategies. S. 770 ballast provisions detail ways that ships could meet ballast water management requirements through ballast treatment in lieu of ballast water exchange in the near term. They also provide for a "final standard" (like that contained in the IMO Convention and S. 363) which ships must meet using best performing treatments after 2011. The Senate Environment and Public Works Committee is actively refining the language in S. 770 as introduced to generate a new bill which represents a compromise between the Senate Commerce Committee's S. 363 and S. 770. Whether as part of a comprehensive package addressing aquatic invasives like S. 770, or as a stand-alone ballast related measure like S. 363, if a compromise is struck by the two committees on ballast management, ballast-related legislation is likely to move forward this session in the Senate. Senate action could also break the logjam in the House and result in passage of U.S. ballast-related law.

In addition, several states have regulations and programs to manage ballast water that are in various stages of implementation. A recent court ruling requires the U.S. Environmental Protection Agency to include ballast water discharge under the National Pollution Elimination Discharge System Permits. It is not clear if this ruling applies to all areas of the U.S.

12 Approval of recommendations

The recommendations from this years meeting were discussed in detail and approved (Annex 10).

13 Planning of next years meeting

Recognising that non ship mediated introductions into many areas have had implications that need to be addressed, WGBOSV has benefited from WGITMO input and recommends continued meetings in conjunction with this group for mutual benefit.

The invitation of Croatia to host next years meeting of WGBOSV was much appreciated by the group. The group suggested meeting in Dubrovnik for at least 3 days during the week beginning Monday, March 19th 2007. It is interesting to note that shortly after the meeting is the deadline for submission of documents to IMO Marine Environment Protection Committee (MEPC) at its 56th session which is scheduled for summer 2007. In the past IMO submission were prepared shortly after the meeting and approved by ICES. IMO very much appreciated the input of WGBOSV (via ICES).

14 Closing of the meeting

The 2006 meeting of WGBOSV was closed on Wednesday, March 15 at 5.00 pm. There was consensus that there is an ongoing demand for WGBOSV to meet on an annual basis, especially as guidelines relevant to the expertise of WGBOSV are currently in the final stage of development at IMO MEPC. In the past WGBOSV was frequently called upon at IMO meetings to contribute relevant expert opinion. It is assumed that the risk assessment and ballast water sampling guidelines in particular may require certain expert input.

The chair thanked the host Francis Kerckhof and the hosting organizations the Fisheries Institute and the Management Unit of the North Sea Mathematical Models, Oostende, Belgium. He also thanked all presenters and facilitators of round table discussions and last but not least the rapporteur Tracy McCollin, United Kingdom, for keeping the chair and the meeting organized.

He further thanked all participants and especially those who contributed material to this and previous WGBOSV meetings during his chairmanship since 2001. All Terms of Reference given to the group over the years were addressed. However, due to time constraints some Terms of Reference were slightly delayed. In summary, the group worked very effectively with long working hours at meetings and also intersessionally, which would not have been possible without the tremendous enthusiasm of the group participants. Further, he wishes the new chair a successful time and looks forward to continue to work on aspects relevant to WGBOSV.

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Annex 2: TERMS OF REFERENCE

a) Prepare a documented response for the CONSSO Issue Group on Sustainable Shipping (IGSS) report and to:

• review, comment, and report on the final version of the Scoping Study prepared under IGSS.

• provide recommendations for ACME regarding any “post-scoping” study phase.

b) Discuss and report on the feasibility of using the CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management.

c) Review, evaluate, and report on existing or developing port sampling and monitoring strategies used by ICES member countries for non-indigenous species and recommend cost effective modifications as required.

d) Continue its global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, CIESM, BMB and PICES Member States and of invited experts.

e) Critically review and report on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation.

f) Review, evaluate, and report on existing and emerging hull fouling regulations and treatment options.

g) Prepare a technical manual with emphasis on protocols for:

- Sampling of ballast water (methods, amount of samples)
- Concentration of samples for counting of organisms
- Enumeration, taking into consideration automated means of enumeration, e.g. flow-cytometry
- Differentiation of viability with special attention on the use of stains
- Provide information of currently available techniques with their limitations, and future perspectives on the development of these technologies.

Annex 3: AGENDA

ICES/IOC/IMO Working Group on Ballast and other Ship Vectors
(WGBOSV)

Oostende Meeting 2006

Monday, March 13, 2006

9:00 AM Opening of the Meeting

- Welcoming Remarks
- Introduction of participants
- Logistics (telephone, FAX, Internet, photocopying, etc.)
  Francis Kerckhof, Belgium
- Review of Terms of Reference
- Review (changes, corrections, additions) and Adoption of the Agenda
- Reference to WGBOSV parent committees
  - ICES, IOC and IMO
  - Brief report of ICES Annual Science Conference, Aberdeen 2005
    Tracy McCollin, Scotland
- Cooperation PICES / ICES
  Darlene Smith, Canada

9:45 AM Session I

Ballast Water Management Report prepared for CONSSO Issue Group on Sustainable Shipping (IGSS) (ToR a)

- Detailed presentation of the CONSSO Report

10:30 – 11:00 AM Coffee Break

11.00 AM Session I continued

- WGBOSV review and comments on CONSSO Report
- Discussion and drafting of recommendations for ACME regarding any post-scoping study phase

12:50 – 13:00 PM Lunch

13.00 AM Session I continued

14:00 PM Session II

Discussion and report on the feasibility of using the CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management (ToR b)

15:30 – 16:00 PM Coffee Break

16:00 PM Session II continues

- Discussion
- Working Group Findings
- Drafting

17:00 PM end of day 1

Drafting Session

Tuesday, March 14, 2006

9:00 AM Session III
Review of the status of ballast water research with an emphasis on new developments in ballast water treatment technology and its evaluation (ToR e)

- Results of IMO Review of "Best available technology" as undertaken at MEPC 53
- Update on selected ballast water treatment systems

- Oral presentations:
  Ballast Water Treatment – Testing and challenges in the future
  Anja Kornmüller, Germany

  The effectiveness of commercially available ballast water biocides against vegetative microalgae, dinoflagellate cysts and bacteria.
  Matt Gregg, Australia

10:30 – 11:00 AM Coffee Break

11:00 PM Session III continues

- Discussion and drafting

12:30 – 13:30 PM Lunch

13:30 Session IV
Global review of shipping vectors (ToR d)

- Indication on relative importance of species introductions vectors.
- WGBOSV National Reports

15:30 – 16:00 PM Coffee Break

16:00 Session V
Review, evaluate, and report on existing or developing port sampling and monitoring strategies used by ICES member countries for non-indigenous species (ToR c)

- Port sampling
  - the US approach
  - the Australian approach
  - the GloBallast approach
  - the Mediterranean approach

- Oral presentations:
  New planned port sampling programme in Europe
  Sergej Olenin, Lithuania

  The port sampling programme in the Mediterranean Sea
  Bella S. Galil, Israel & Anna Occhipinti, Italy

The CRIMP Port Sampling Protocol
Simon Barry, Australia

The Swedish Port Sampling Initiative
Inger Wallentinus, Sweden

- Group discussion

17:45 PM end of day 2

Drafting Session

18.00 PM Reception at meeting venue

Wednesday, March 15, 2006

9:00 AM Session VI
Review and evaluation of existing and emerging hull fouling regulations and treatment options (ToR f)

- Review of existing hull fouling guidelines
  - Australia
  - New Zealand
  - Mediterranean Sea

10:30 – 11:00 AM Coffee Break

11:00 AM Session VI continued

- Discussion

12:30 – 13:30 PM Lunch

13:30 Session VII
Prepare a technical manual with emphasis on protocols for ballast water sampling and related matters (ToR g)

- Oral presentation:
  New ballast water sampling tool for organisms above 50 micron
  Stephan Gollasch, Germany

  New planned port sampling programme in Europe
  Roger Mann, USA & Marcel Veldhuis, the Netherlands

  The use of vital stains for viability assessment
  Jesus Cabal, Spain

- Review and discussion on draft ballast water sampling protocol

15:30 – 16:00 PM Coffee Break

16:00 PM Summary of Working Group Findings

- Session I
  Ballast Water Management Report prepared for CONSSO
- Session II
  CONSSO report as a basis for preparing a draft ICES Code of Best Practice for Ballast Water Management
- Session III
  New developments in ballast water treatment technology and its evaluation
- Session IV
  Global review of shipping vectors
- Session V
  Existing or developing port sampling and monitoring strategies
- Session VI
  Hull fouling regulations and treatment options
- Session VII
  Prepare a technical manual with emphasis on protocols for ballast water sampling and related matters

- Any other business
  - New electronic journal "Aquatic Invasions"
    www.zin.ru/rbic/AquaticInvasions/ or http://www.aquaticinvasions.ru/
  - Reference to ongoing Great Ships Initiative
    Allegra Cangelosi, USA
  - Canadian Research network on Aquatic Invasive Species
    Darlene Smith, Canada

- WGBOSV Recommendations
- Concluding Remarks
- New Chairperson of WGBOSV
- Planning of next meeting

17:00 PM Adjournment of the 2006 Meeting of WGBOSV

Annex 4: Abstracts from talks delivered at the meeting

Australia's Ongoing Marine Pest Monitoring Strategy

Simon Barry

Australia has a coastline of approximately 60,000 km and a marine jurisdiction of some 16 million km^2. These environments are susceptible to invasion by new marine pests and to translocations of pests already in Australian waters. Marine pests have the potential to seriously impact the marine environment, marine industries and coastal communities. Australia now knows much more about the marine pest status of their waters following the national port baseline survey program. These baseline surveys identified native and introduced species in 35 ports around Australia. The national port baseline survey program ceased in 2003, with the exception that a baseline survey at the Port of Dampier be undertaken.

As part of the *National System for the Prevention and Management of Marine Pest Incursions* (National System) Australia is now developing an ongoing monitoring strategy that focuses on standardised monitoring processes to detect high risk species at priority locations around Australia.

Primary Monitoring Objectives

- To detect new incursions of established target species at a given location i.e. species already established elsewhere in Australia but not recorded at that location; and
- To detect target species not previously recorded in Australia that are known to be pests elsewhere

Secondary Monitoring Objectives

- To detect species that appear to have clear impacts or invasive characteristics; and
- To identify high-risk times and/or optimum times for sampling target species (e.g. time of year when a species is present in the water column).

Results from the monitoring program will support the preventions and emergency preparedness and response elements of the National System. In particular, monitoring data will help guide marine pest management actions to:

- Inform the risk assessment used in the Ballast Water Decision Support System (DSS). The DSS assesses the risk of the ballast water on board a ship based on the presence of marine pests in the uptake and discharge ports and also whether the species can survive in the port of discharge and determines that ballast water exchange requirements for each ship.
- Trigger emergency response arrangements;
- Inform decision making for the ongoing management and control of established marine pest populations, including informing risk assessments;
- Review and improve measures that form part of the National System; and
- To inform broader policy decisions on marine pest management.

Monitoring target locations

The national approach targets an agreed number of locations, known as the National Monitoring Network. Analysis to identify the network locations was completed in two steps.

First it considered the high risk locations around Australia for introductions and translocations of new pests. Second, it optimised the results of the first step by considering the high risk locations for translocations of existing pests. The National Monitoring Network will be reviewed after three years to ensure that the monitoring strategy is effectively targeting the areas of highest introduction and translocation risk.

The National Monitoring Network provides the minimum monitoring locations required for the national monitoring strategy. The information provided from the network may be supplemented by data from other locations that may undertake monitoring programs that respond to local issues, assets of importance and priorities.

Monitoring target species

The national approach targets high risk species. A monitoring target species list has been compiled from the recommendations and analysis from the *National Priority pests: part II Ranking of Australian Marine Pests* (Priority Pest Report) Final Report for the Department of the Environment and Heritage (Hayes *et. al.* 2005), and existing target species.

The Priority Pest Report

The Priority Pest Report considers potential domestic and international target species. Species were prioritised according to their impact potential and invasion potential.

The Ballast Water DSS Target Species List

Species on this list are included in the risk assessment in the DSS as mentioned above.

The Emergency Management Interim Trigger List

This list is used in emergency management (preparedness and response) by the Consultative Committee for Introduced Pest Emergencies. Note that this list is currently under revision.

In addition to monitoring for target species it is necessary to recognise that we can not predict all species that have the potential to become invasive in Australian waters. A secondary benefit of monitoring may be the detection of species that are new and display invasive characteristics (e.g. rapid colonisation of substrate, high reproduction or growth rate).

Tools for Monitoring

New Zealand is also currently developing an ongoing surveillance program with objectives similar to Australia’s ongoing monitoring program.

In collaboration with New Zealand, Australia is developing a Monitoring Manual that describes how to design and implement a monitoring program to meet agreed minimum principles. The aim of agreeing minimum principles for marine pest monitoring and the collection of monitoring data is to ensure that data is collected using rigorous, consistent methods and meets agreed quality assurance/quality control (QAQC) principles, therefore providing confidence in management decisions made using the data.

The Australian Marine Pest Monitoring Guidelines have also been developed to provide the rationale for the approach to the routine collection of monitoring data and how it will be used to inform decision making in the Australian context. In addition: it explains the decision process for selecting the target species and locations for monitoring in Australia; outlines the governance arrangements for the implementation of monitoring programs and their progressive improvement with time; and provides the decision pathways and management actions stemming from monitoring results.

Implementation

- The Australian Ongoing Marine Pest Monitoring Strategy is expected to be ready for the launch of the National System in October 2006.
- Currently the Monitoring Manual is being trialled by South Australia. The trial and a review of the trial and manual are anticipated to be completed by mid 2006. An additional trial in New Zealand is being investigated. The finalised Monitoring Manual will be e-published.

References

Hayes, K., Sliwa, C., McEnnulty, F., Dunstan, P. (February, 2005) *National Priority Pests: Part 11 Ranking of Australian Marine Pests.* CSIRO Division of Marine Research final report for the Australian Government Department of Environment and Heritage. Available at http://www.marine.csiro.au/crimp/reports/PriorityPests Finalreport.pdf.

Aliens in Hellenic Seas: emphasis on introductions in ports

M.A. Pancucci-Papadopoulou, A. Zenetos and M. Corsini Foka

According to an update of marine aliens in Hellenic waters, 125 species have been recorded up to December 2005, the majority of them in the South Aegean Sea. Of those, 34 species are assumed to have been transferred via shipping. Considering a likely two mode introduction for about 10 species, shipping is the next most important vector (25%) after Lessepsianism (60%).

Ship born invaders are represented by phytoplankton (6 species), zooplankton (2 species), phytobenthos (7) and zoobenthos 19 [corals (1), Cirripedia (2), Mollusca (8), Polychaeta (4), Amphipoda (1), Decapoda (2), Bryozoa (1)].

A review of the alien biota recorded in the broader area of the major Hellenic ports (Peiraias, Thessaloniki) that is in inner Saronikos and Thermaikos Gulfs has revealed the presence of 32 and 14 species respectively of which only 5 are common. Those are: the dinoflagellate *Gymnodinium mikimotoi*, the nanoflagellate *Phaeocystis pouchettii*, the copepod *Paracartia grani*, the polychaete *Metasychis gotoi* and the mollusc *Crepidula fornicata.*

The presence of *Strombus persicus* which was earlier attributed to shipping in the eastern Meditteranean (Iskenderun) and consequently in Hellas is now argued. Its wide expansion in Rodos and many Hellenic areas, Saronikos Gulf included (the Peiraias port broader area) is rather due to its invasive character. Therefore Lessepsian migration appears to be its transport means. Similarly molecular studies of *Pinctqada radiate* populations in Saronikos have rather excluded shipping as mode of transportation.

Intensive research and data mining the last years has increased the number of aliens in Greek waters from 90 (end 2003) to 125 (present work) and in particular from 15 records of ship transported species recorded in 2002 (WGBOSV 2002), to 34. Systematic work in Hellenic ports, currently in progress, has brought into light more species carried in hull fouling (unpublished data).

Port biological sampling as a tool for monitoring invasive species in high-risk areas of bioinvasions

Arno Põllumäe, Ilmar Kotta and Jonne Kotta

Pelagic and benthic invertebrate communities were studied in Muuga harbour (Port of Tallinn, Gulf of Finland) – one of the largest terminals in the Baltic Sea. Samples were taken during the ice-free seasons, generally twice per month during 2002-2005. In each occasion three predefined sites were visited. Zooplankton sampling was performed as vertical tows with Juday net (mesh size 90 µm). Samples were analysed semiquantitatively; the whole sample was analysed to identify all species. Macrozoobenthos samples were colleced with an Ekman bottom grab. The sediment samples were washed through a 0.25 mm mesh. In the laboratory the animals were counted under a stereo dissecting microscope. The total dry weight of the animals in each sample was determined to the nearest 0.5 mg and calculated for an area of 1 m^2.

The most common and abundant zooplankton species in Muuga harbour and in the adjacent sea areas were the same: the copepods *Acartia bifilosa* and *Eurytemora affinis* and the rotifer *Synchaeta baltica*. The species composition differed between the harbour and adjacent areas with additional freshwater species – *Chydorus sphaericus, Diaphanosoma brachyurum*, *Asplanchna* sp. and *Argulus foliaceus* being present in the harbour. Of alien species, only two species were found: the cladoceran *Cercopagis pengoi* and larvae of the cirriped *Balanus improvisus*.

Benthic invertebrate communities were very different in Muuga harbour and the adjacent sea areas. Within the port area the bottom deposits were unstable due to dredging activities and ship induced bottom turbulence. Sediments are covered with finer deposits rich in organic matter. Consequently, the species diversity and densities are highly variable. When the level of physical disturbance was high the communities contained no or only a few macrobenthic species such as the native amphipod *Corophium volutator* and the invasive cirriped *Balanus improvisus*. *Macoma balthica* may appear at the later stages of succession following the reduction of physical disturbance. When the level of physical disturbance was low benthic communities had relatively high diversity as the organic rich bottom deposits offered good dietary conditions for most deposit feeders. Besides the above-mentioned species Oligochaeta, *Hediste diversicolor*, *Hydrobia ulvae*, *Mytilus edulis*, *Cerastoderma glaucum*, the alien *Mya arenaria* and Chironomidae larvae occurred in these areas. The third benthic alien species identified within the study was *Potamopyrgus antipodarum*.

Comparisons of introduced hard bottom species in marinas and natural habitats on the Swedish west coast

Christian Alsterberg and Inger Wallentinus

Regional boat traffic could have a great influence on the secondary dispersal of introduced species, occurring as fouling organisms on the hulls, as entangled in ropes or among fishing equipment or in the bilge water in the boats, to later be discarded from nets and cages or pumped out. Thus also surveys of marinas, where leisure or fishing vessels call, are of great interest to elucidate if they host more introduced species than natural areas.

A pilot study was performed, where eight marinas were chosen based on their position (four north and four south of the city of Göteborg), size, and availability by car. The eight chosen coastal areas were as far as possible in the proximity of the marinas. Monitoring sites were randomized from satellite images, on average 1 for each 50 m of the jetties in the marinas (including buoys when present), and 1 for each 25 m of natural coastline. Due to limitation in time (one month – July 2005) and personal (1 student making the surveys by snorkling), the monitoring was restricted to document selected, already introduced or potential candidates to hard bottom organisms on natural and artificial substrates. Sediment or pelagic samples were not taken, and native species were only described in general terms for dominant species. At each monitoring site 10 macroalgae and 5 invertebrates were searched for and their occurrence documented as semiquantitative scores (made by the same person) according to: 1) Solitary specimens; 2) Common, but not dominating; 3) Dominant or belt-forming. This gave us more information than just marking presence or absence of the species of interest.

We did not record any new introduced species – all eight species seen (7 macroalgae and 1 barnacle) are already known from the Swedish west coast. For 3 marinas and 1 coastal locality, all monitoring sites had at least one of the selected introduced hardbottom species. The barnacle *Balanus improvisus* was the most common introduced species in both marinas and at coastal localities, followed by the brown alga *Sargassum muticum*. Totally, both these species were more frequent in marinas than at the coastal localities. Other species were found more sporadically; 4 species were only recorded in marinas, 1 only at a coastal locality, and 1 in both types of habitats. Comparisons so far have been expressed as scores / m length, record ratio, and total scores / species. However, analyses so far have not shown any statistically significant differences between marinas and coastal localities. For both the marinas and the coastal localities, there was a large dispersion between geographical areas. Although there was a trend, it did not follow any obvious geographical gradient.

Future rapid surveys of this kind ought to take into account the differences in size of the localities to be monitored, to facilitate statistical comparisons.

Introduced marine species - Pilot studies in ports of western Norway

Helge Botnen

Environmental monitoring surveys are regularly undertaken at some west Norwegian ports. Benthic soft sediment fauna, and flora and fauna in the littoral zone are among the many parameters which are surveyed. Introduced species rarely occur in the samples taken during these surveys, although it is well known that organisms arrive to these ports in international ballast water and sediments in ballast tanks. In total, annually, approximately 30 million tonnes of ballast water is discharged in these ports.

In an attempt to find and identify possible introduced species a pilot survey for this particularly purpose was undertaken in the littoral zone in 2001. More than 80 taxa were identified in each of the three ports, of which in total 4 introduced species were found: *Bonnemaisonia hamifera*, ”*Heterosiphonia japonica*”, *Sargassum muticum* and *Codium fragile.*

During the summer of 2002 fouling panels were exposed in one port where annual discharge of international ballast water is approximately 10 million tonnes. At the same time fouling panels were exposed in a control port where national ballast water is discharged, and at a control site without discharge of ballast water. The panels were exposed from June to October and the panels were suspended at 0 m, 2 m and 5 m depth. After exposure wet weight of the fouling fauna was obtained and the species growing on the panels were identified. In total 123 taxa were identified, 53 taxa in the test port, 54 in the control port and 89 in the control site. Forty-five taxa occurred at all three sites. Three introduced species were identified: "*Heterosiphonia japonica*", *Bonnemaisonia hamifera* and *Caprella mutica*. "*Heterosiphonia*" and *Caprella* occurred at all three sites, whereas *Bonnemaisonia* occurred only at the control site. "*Heterosiphonia japonica*" and *Caprella mutica* were first found in Norwegian waters in 1996 and 1999, respectively, whereas *Bonnemaisonia hamifera* was first recorded in 1902.

CIESM's PORTAL [PORT surveys in the Mediterranean Sea for ship-transported ALien organisms]

Bella Galil and Anna Occhipinti- Ambrogi

It is estimated that about 220,000 vessels of more than 100 tonnes cross the Mediterranean annually, carrying 30% of the international sea borne trade volume, and 20% of the petroleum. With some 2000 merchant ships plying the Mediterranean at all times, the sea is exceptionally susceptible to ship-transported bioinvasions, whether by fouling or ballast.

Preventing alien species introductions is a task which needs scientific, administrative and political coordination at the regional level. It is in this context that RAC SPA has identified the problem of alien species as one of its major initiatives at the regional level. A recent workshop (December, 2005) ratified guidelines that address four substantive concerns of the alien species issues: enhancing knowledge and research efforts; improving understanding and awareness; strengthening the management response; providing appropriate legal and institutional mechanisms. The recommendations included Mediterranean-wide port surveys.

Recognizing that the littoral and infralittoral biota of the Mediterranean sea is undergoing a rapid and profound change, a multidisciplinary CIESM workshop (November, 2002) examined the extant knowledge of the scale and impact of ship-transported aliens in the Mediterranean and Black sea region (CIESM workshop monographs, 20; http://www.ciesm.org/publications/istanbul.html) recommended implementing a Mediterranean-wide program of port and port-proximate surveys using standardized protocols to identify alien species and organisms that pose significant risk to human health that might be disseminated by shipping from the region – a harmonized, modular "port-watch" program for the Mediterranean. The survey methods follow the CRIMP protocols for baseline port surveys for alien species developed by Hewitt and Martin (1996), updated (Hewitt and Martin, 2001), and later adopted by Globallast.

While recognizing that only a spatially and temporally comprehensive survey is likely to detect all alien species, scientific, logistic and cost constraints necessarily restrict the survey's scope. CIESM launched, late in 2003, the first basin-wide minimal targeted port-survey program – PORTAL. The survey targets macrophytes, bryozoans, serpulids, hydroids, ascidians, mollusks and barnacles inhabiting port and port-proximate manmade hard-substrates and organisms that pose significant risk to human health that might be disseminated by shipping from a dozen Mediterranean ports (*Vibrio cholerae*, dinoflagellate cysts). The "core" participants are mostly part of CIESM's region-wide network of scientists and marine institutions, including taxonomic experts that assist in analyzing the material collected, on an entirely voluntary basis! A dedicated round-table session was held during the 37th CIESM Congress, Barcelona, where preliminary results were presented to the Mediterranean community (http://www.ciesm.org/events/port survey.pdf).

Samples collected from 12 Mediterranean ports were analyzed *also* for the presence of two toxigenic serogroups of *Vibrio cholerae*, O1 and O139. Samples examined with fluorescent antibodies to determine the presence of toxigenic serogroups of *V. cholerae* were positive in 4 of the 12 ports sampled A subset of the live samples was tested for the presence of *V. cholerae* (no information on their toxicity or serogroup) using the biochemical protocol of Choopun et al. 2002. Half the samples tested (5 of 10) were positive.

The alien serpulids consisted of species from those that can be expected to occur in that harbour environment including old time established [alien] ones or, in the Levant, now common species from the Indo-Pacific. *Diphasia margareta*, an “Atlantic” hydroid living on barnacles and lacking medusae, and occasionally recorded from the Mediterranean, is possibly a shipping-transported species. *Microcosmus squamifer* was identified from Livorno, *Ascidia* cf. *savigni* and *Phallusia nigra* – both Erythrean species – were found in the Israeli samples as well as *Balanus reticulatus*. The widely invasive amphipod *Caprella scaura* was identified from Livorno port. Seven species of dinoflagellates new the Mediterranean , in addition to 12 new regional records were identified in the samples.

Bearing in mind the results of the “pilot” project CIESM plans to extend the program to compare the number and identity of fouling alien taxa in ports and adjacent marinas, and to document the presence of pathogenic microorganisms in ports with nearby marine farming facilities, and to assess the risk of these pathogens for human health in terms of their abundance and pathogenicity. Ports will be selected for basin-wide coverage, patterns of maritime traffic (i.e. volume, destination diversity), vicinity of marinas and mariculture facilities, and nearby marine laboratories.

Ballast Water Treatment – Testing and challenges in the future

Anja Kornmüller

Thirteen technologies (Table 1) have been evaluated as promising by the Ballast Water Review Group during MEPC 53. Due to the different test procedures and conditions used, no direct comparison of different technologies was possible, because the Guidelines for Approval of Ballast Water Management Systems (G8) were just adopted at the same session. Therefore, the first competitive evaluation concerning the biological efficiency can be carried out in the second review during MEPC 55, in case manufacturer will supply data of testing according to Resolution MEPC.125(53).

Type approval procedure

Due to the long-lasting and costly type approval the manufacturer might concentrate on the capacity range of 200 - 1000 m^3/h due to requirement to test at the maximal Treatment Rated Capacity (TRC).

The availability of landbased test facilities is not given yet. They might also not be suitable for every ballast water treatment system due to different capacities, which might need major adjustments of the piping etc. for each system tested. A small number of landbased test facilities might restrict the efficient and fast testing of different systems, because of the time for in-/de-installing and testing itself. This might delay the availability of type approved systems.

Suggestions:

→ The possibility of accepting the prototype testing carried out according Resolution MEPC.126(53) as shipboard type approval should be considered.

Active substances (AS)

In resolution MEPC.126(53) it is not clearly specified to whom in the Organisation the submission of the application should be addressed. In case this is only the MEPC than this will delay the whole process given by the meeting dates of MEPC. Therefore is would be favourable to submit the application directly to the Technical Group (TG), while the submission to MEPC has to be latest for its decision on basic approval.

Only very few companies, which were evaluated during the review at MEPC 53, have submitted for the approval of active substance up to now. Because some states require a national pre-evaluation like in the US (USCG) prior to submission to IMO, treatment systems may not be available in time concerning the effective date Jan 1, 2009.

Submissions to MEPC 54

In documents MEPC 54/2/1 and 2 by EC it is suggested to let the IMO decide instead of administration, whether a disinfection has to be rated as an AS. The EC also feels that the definition of "residual" is unclear in G9 and has to be defined further. From EC view, all disinfections shall be rated as AS beside oxygen deprivation.

Document MEPC54/2/3 is submitted by Korea concerning the approval of an electrolytic disinfection based on chlorine Cl_2, HOCl, OCl^-, O_3/OH*. During treatment a high initial chlorine concentration of 30 mg/L will be used and a residual concentration around 2.5 mg/L shall remain, which are both much higher than concentrations applied in drinking water treatment. The danger of explosion due to the formation of hydrogen gas is not addressed during electrolysis.

In document MEPC 54/2/9 Japan submits a very short description of three disinfections for the approval as AS.

- The use of hydrogen peroxide (H_2O_2, which seems to be stabilized. The kind of catalyst used to activate the hydrogen peroxide is not mentioned.

- The application of the Special pipe in combination with ozone. It is stated that ozone reacts with Br^- results in oxidant to bromate BrO_3^-, which shall be degraded within 1 - 3 days due to the applicant.

→ Comment: Bromate is known as being carcinogenic.

- The combination of filtration and magnetic separation, in which the AS inorganic coagulant, polymer and magnetite are used.

→ Comment: Magnetite Fe_3O_4 is already rust and might increase the corrosion in the BW piping and tanks.

- Inf-document 6 by Sweden is describing an electrolytic disinfection, which seems to be different from conventional chlorine electrolysis forming more OH-radicals and less chlorine. It is stated that only whole effluent toxicity tests are applicable for disinfection processes with short-living radicals.

Suggestions:

→ A continuous updating on disinfection methods would be needed to decide, if they have to be rated as an AS, and who is responsible for it.

→ All OH-radical producing disinfections must be rated as AS, even if they are physical treatment such as cavitation and ultrasound.

→ Meeting the WHO Drinking Water Standard can be used as criteria for uncritical AS.

→ Because of national pre-evaluations and the few submissions yet, a speed-up might be possible by giving data directly to TG and by allowing submission for AS to MEPC latest at decision on basic approval.

Environmental Acceptability

Sludge from filters and hydrocylons must be discharged directly at the location of origin, therefore only a treatment during ballasting is possible with theses processes. This is in compliance with the International Protocol 1996 concerning dumping at sea, but national (local) administration can decide in national waters incl. harbors independently, which might become a problem because of more stringent national water regulations.

Practicability

The practicability will not only depend on the treatment system but also on the type and operation of the ship, where it is planed to be use in. The best way to access the practicability is during prototype testing. Therefore there is a need for adopting the Guidelines for Prototype Testing at MEPC54.

Due to the low test water quality with > 1 or > 50 mg/L TSS during landbased type approval, there is a danger of later malfunction of equipment tested under these conditions onboard. This is caused by much higher TSS loads at some locations of BW uptake, like estuaries or harbors, for which these treatment systems might not be designed.

The durability can only be judged by experience obtained by long-term operation, because some effects like abrasion (high TSS!) and corrosion need some time to become a problem.

Safety

Besides the storage, the mixing and refilling of chemicals onboard have to be considered carefully. For example, in case the active substance is produced by mixing of different chemicals directly onboard, there might be reactions creating heat or gas.

The corrosion issue has not been considered enough in disinfection. In general, an increase of the oxidation potential occurs by all oxidizing disinfection processes (exception: UV, deaeration), which increases the risk of corrosion. The risk of corrosion is specific for each process:

- Deaeration e.g. by nitrogen gas increases the risk of microbiologically-influenced corrosion by sulfate reducing bacteria under anaerobic as well as under alternating conditions of de-oxygenation and oxygenation.

- In the report 440 by the Ship Structure Committee it was stated from theoretical and practical experiences:
  - > Hypochlorite effects no difference in the corrosion rates in fresh and salt water.
  - > For SeaKleen™ and PERACLEAN® OCEAN tests with bare steel and coating (ASTM D1654) indicated a potential for increased corrosion, especially of bare steel in splash zones.
- The increase of corrosion by hydrogen peroxide H_2O_2 is well-known by the application of the Fenton's process resulting in the formation of rusty iron hydroxides.
- DNV presented at the R&D Symposium in London (2003) that ozone increases the disbonding of coatings and therefore increases the corrosion risk.
- Cavitation is known for its damages to materials, e.g. pumps and piping and is consequently a start for corrosion.

→ In general, lab tests to assess the corrosion are not significant due to the missing influence by the flow.

Efficiency of three commercially available ballast water biocides against vegetative microalgae, dinoflagellate cysts and bacteria

Matthew D. Gregg and Gustaaf M. Hallegraeff

Summary

Ships' ballast water has been shown to be a major vector for the transfer of non-indigenous organisms across the world's oceans. One proposed solution to the problem of ballast-mediated aquatic invasions involves chemically treating ballast water to kill key target organisms. Here, we examine the efficacy of three commercially available ballast water biocides as stand-alone treatment options using vegetative microalgae, dinoflagellate resting cysts and bacteria as test organisms. Chemicals tested were the ballast water biocides SeaKleen® and Peraclean® Ocean, and the chlorine dioxide biocide Vibrex®. The main objective of this work was to test the ability of the biocides to inactivate resistant resting cysts of the dinoflagellates *Gymnodinium catenatum*, *Protoceratium reticulatum* and *Alexandrium catenella*. Dinoflagellate resting cysts provide a good model organism for assessing ballast water treatment options. Cysts are robust and a treatment system capable of killing cysts will likely kill a wide range of other organisms that occur in ballast water and sediment. Additional objectives included: 1) to compare effectiveness of the biocides against bacteria and vegetative microalgae; and 2) assess the degradability of each product, since for any biocide to be environmentally acceptable, it must degrade to a concentration low enough to avoid ecological impacts following discharge into receiving waters.

Vegetative microalgae

Vegetative microalgal cells were readily killed by low concentrations of the chemical biocides (Figure 1). Concentrations of 100 ppm Peraclean® Ocean and 2 ppm SeaKleen® were required for the complete mortality of vegetative cells of the dinoflagellates *Gymnodinium catenatum, Alexandrium catenella, Protoceratium reticulatum, Scrippsiella trochoidea*, the raphidophyte *Chattonella marina* and the green flagellate *Tetraselmis suecica* after 48 h exposure. The green flagellate, *Tetraselmis suecica,* was found to be considerably more resistant to the Peraclean® Ocean and SeaKleen® treatments than the vegetative dinoflagellates. For Vibrex®, a concentration of 25 ppm was required to destroy vegetative dinoflagellate cells after 2 h exposure (Figure 1). The biocide concentrations required for complete mortality of all the vegetative microalgae species did not decrease with an increase in exposure time. For example, a Peraclean® Ocean concentration of 25 ppm could not eliminate *A. catenella, G. catenatum* or *T. suecica* after 7 and 21 days exposure (data not shown). Likewise, with Seakleen®, increasing the exposure time to 24 h and 7 days resulted in the complete mortality of *C. marina, G. catenatum, P. reticulatum* and *S. trochoidea* at a concentration of 0.5 ppm, yet 1-2% of *A. catenella* survived (data not shown). It should be noted that phytoplankton density would be considerably lower in typical ballast water samples, compared to the high cell density (10^6-10^9 cells/L) achieved in clonal cultures grown under laboratory conditions. Therefore, it is possible that lower biocide concentrations would be required to control ballast water phytoplankton in an onboard situation, except under algal bloom conditions in ballasting ports (10^5-10^6 cells/L).

Dinoflagellate cysts

Dinoflagellate resting cysts were considerably more resistant to the chemical treatments compared to the more fragile motile vegetative cells. A Peraclean® Ocean concentration of 200ppm was required to effectively inactivate resting cysts of the dinoflagellates *Gymnodinium catenatum, Alexandrium catenella* and *Protoceratium reticulatum* when exposed to the biocide for a period of 12 weeks (Table 1). For SeaKleen®, the concentration required for inactivation varied considerably between test species (Table 2). G*ymnodinium catenatum* was identified as the least resistant to SeaKleen® with 100% mortality achieved at a concentration of 6 ppm following 8 weeks exposure. *P. reticulatum* cysts were effectively controlled at 8 ppm, whilst complete inactivation of *A. catenella* cysts was not achieved at 10 ppm. Ten ppm was the maximum concentration tested in the experiment.

Higher biocide concentrations were required to inactivate dinoflagellate cysts when exposure time was reduced from 8-12 weeks to a period of 2 weeks. For example, an increased Peraclean® Ocean concentration of 400 ppm was required to inactivate *G. catenatum* cysts when exposure time was reduced from 12 weeks to a period of 2 weeks (Table 4). For SeaKleen®, *P. reticulatum* cysts required an increased biocide concentration from 8 to 10 ppm for complete inactivation when exposure was reduced from 8 to 2 weeks (Table 5). No viable cysts were found in any Vibrex® treatment when exposed to the biocide for a period of 12 weeks (25-400ppm tested) (Table 3); however, following 2 weeks exposure, complete inactivation of all three species occurred at a concentration of 50 ppm (Table 6). A comparison of the results obtained from experiments conducted at 6 and 17°C indicate that the biocidal activity of the chemicals may be reduced at lower temperatures (Tables 4, 5, 6). For example, 79% of *P. reticulatum* were found viable at a Peraclean® Ocean concentration of 150 ppm at 6°C, whereas no viability was identified at the same concentration at 17°C.

Bacteria

The Gram-negative *Escherichia coli* was found to be more resistant to the Peraclean® Ocean and SeaKleen® biocides than the Gram-positive S*taphylococcus aureus*. A SeaKleen® concentration of 100-200 ppm was required to inhibit bacterial regrowth in seawater. *E. coli* was most resistant requiring a dosage of 200 ppm, whereas *S. aureus* was controlled at 100 ppm. With Peraclean® Ocean, regrowth of *S. aureus* was inhibited at 125 ppm, whereas *E. coli* required an increased concentration of 250 ppm. No significant difference in resistance was found between test species when treated with Vibrex®. At a Vibrex®concentration of 15 ppm, no regrowth of *E. coli* and *S. aureus* occurred.

Biocide degradation

The results of the degradation experiments using sensitive motile marine microalgae as bioassays indicate that the two chemical biocides tested (Peraclean® Ocean and SeaKleen®)

degraded slower than the claims by the biocide manufacturers. Peraclean® Ocean degraded faster than SeaKleen®. The manufacturer suggested that the half-life of Peraclean® Ocean in unfiltered seawater is 4 hours. In the present work, low concentrations (200 ppm) did degrade to a level non-toxic to marine microalgae in 3-6 weeks when prepared in filtered seawater (Figure 2). Higher concentrations (1000 ppm) did not degrade at all after 15 weeks when prepared in filtered seawater. The addition of sediments and the preparation of the biocide in natural seawater samples introduced a variable influence on the degradation of Peraclean® Ocean. In some instances the biocide was found to degrade faster with the addition of sediments and biological matter; but this was not always the case. For example, a Peraclean® Ocean concentration of 1000 ppm prepared in estuarine water from the Derwent River degraded to a non-toxic level in 14 weeks under 12h light/12h dark, while the same concentration prepared in estuarine water from the humic substances-laden Huon River did not degrade at all after 15 weeks (Figure 3). The degradation of Peraclean® Ocean occurred faster when exposed to light compared to samples stored in the dark, suggesting that Peraclean® Ocean would undergo minimal degradation when inside ballast tanks.

Inconsistencies exist in the literature concerning the degradation rate of SeaKleen®. The Environment Soundness Work Group (2004) claimed that SeaKleen® degrades to 21% of the initial concentration in darkness in seawater without any organisms after 28 days. In contrast, Herwig and Cordell (2004) reported a half-life of 18-24 h. In the present experiment, the degradation of 4 ppm SeaKleen® was found to be minimal after 15 weeks and it was not influenced by the presence of sediment, biological matter or light conditions. After 15 weeks, the 4 ppm SeaKleen® samples prepared in filtered seawater with 0, 0.1, 0.5 and 1g of ballast sediment resulted in the mortality of 80-82.5% of the indicator species (Figure 4). The 4 ppm SeaKleen® samples prepared in natural estuarine water did not degrade at all under both 12h light/12h dark and complete darkness. Higher SeaKleen® concentrations, such as those required to inactivate dinoflagellate cysts, also failed to degrade after 15 weeks indicating that the release of SeaKleen®-treated ballast water could potentially cause adverse effects on the marine microalgae at the point of discharge.

Conclusion

Results demonstrate that the applicability of each of the three chemical biocides as a routine ballast water treatment is limited by factors such as cost, biological effectiveness and possible residual toxicity of the discharged ballast water (assessed on the basis of impact on mortality of vegetative marine microalgae). Of the three biocides tested, Peraclean® Ocean holds the most promise. Peraclean® Ocean could effectively inactivate resting cysts of the marine dinoflagellates *Gymnodinium catenatum*, *Alexandrium catenella* and *Protoceratium reticulatum* at 400 ppm, could control bacterial growth at 125-250 ppm, and could eliminate vegetative microalgal cells at a concentration of 100ppm. SeaKleen® did not inactivate resting cysts of *A. catenella* at five times the recommended dose (10 ppm) and was found to degrade at a rate that could result in the discharge of residual toxic water into the marine environment. Together with the poor bactericidal properties of SeaKleen® (100-200 ppm required), this may limit the use of this biocide as a routine treatment option. Vibrex® is not a suitable ballast water treatment option due to the need for hydrochloric acid as an activator, however it was found to be the most effective against bacteria (complete inhibition at 15 ppm) indicating that onboard chlorine dioxide generators may provide an effective bacterial treatment option. Several issues regarding the shipboard use of the chemical biocides require in-depth follow-up studies. These include: 1) the demonstrated influence of low temperature on the biocidal activity of the chemicals; 2) the ability of the biocides to inactivate organisms in the presence of high sediment loads; 3) the corrosive effects on ships hulls and associated structures; and 4) the cost effectiveness of the chemical treatment.

Ultimately, to completely remove the threat of non-indigenous organism dispersal via ships ballast water, a treatment option that is 100% effective is required. At current costs, the chemical treatment of ballast water is widely viewed to be prohibitively expensive for routine use on all ships and should only for use in emergency situations or as an adjunct to other treatment technologies such as hydrocyclones and filtration. Although costs are likely to decrease considerably once production/application is increased, the possible environmental impacts resulting from the discharge of treated ballast water, as demonstrated here using sensitive bioassays with vegetative microalgal cultures, remains a serious impediment to the acceptability of chemical biocides for the routine treatment of ships' ballast water.

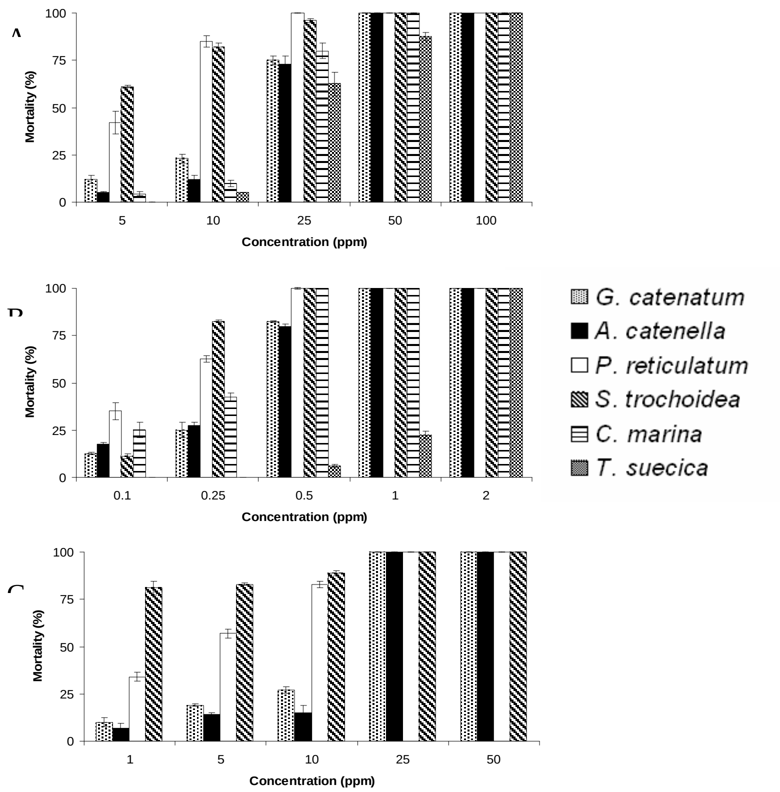

Figure1. Effect of varying concentrations of the chemical biocides on the mortality of vegetative microalgal cells. (A) Peraclean® Ocean treatment (48 h exposure), (B) Seakleen® treatment (48h exposure), (C) Vibrex® treatment (2 h exposure). Bars indicate standard error.

Table 1. Effect of different concentrations (ppm) of Peraclean® Ocean on germination of G. catenatum, P. reticulatum and A. catenella cysts at 17°C (as % of total number of cysts used) (12 weeks exposure).

Concentration	Total cyst germination (%)		
	G. catenatum	*P. reticulatum*	*A. catenella*
0 (control)	83.3 ± 2	90.4 ± 1.5	84.6 ± 8
50	67.4 ± 3.3	29.8 ± 3.5	43.2 ± 6
100	59.7 ± 6.2	16.3 ± 4.5	32.1 ± 11
200	0	0	0
400	0	0	0

Table 2. Effect of different concentrations (ppm) of Seakleen® on germination of G. catenatum, P .reticulatum and A. catenella cysts at 17°C (as % of total number of cysts used) (8 weeks exposure).

Concentration	Total cyst germination (%)		
	G. catenatum	*P. reticulatum*	*A. catenella*
0 (control)	89.6 ± 2.1	47.6 ± 6.9	55.4 ± 8.5
2	3.4 ± 2.2	50.8 ± 5.2	56.5 ± 7
4	5.4 ± 1.3	31.3 ± 9.6	17.1 ± 3.5
6	0	8.8 ± 2.6	19 ± 1
8	0	0	22.2 ± 11
10	0	0	32.8 ± 5.5

Table 3. Effect of different concentrations (ppm) of Vibrex® on germination of G. catenatum, P. reticulatum and A. catenella cysts at 17°C (as % of total number of cysts used) (12 weeks exposure).

Concentration	Total cyst germination (%)		
	G. catenatum	*P. reticulatum*	*A. catenella*
0 (control)	89.9 ± 2	81.7 ± 2.5	59.6 ± 5.5
25	0	0	0
50	0	0	0
100	0	0	0
200	0	0	0
400	0	0	0

Table 4. Effect of different concentrations (ppm) of Peraclean® Ocean on viability of G. catenatum, P .reticulatum and A. catenella cysts at 6 and 17°C (as % of total number of cysts used). (2 weeks exposure).

Concentration	Total cyst viability at 6°C (%)		Total cyst viability at 17°C (%)	
	G. catenatum	*P. reticulatum*	*G. catenatum*	*P. reticulatum*
0 (control)	94.1 ± 2	91.7 ± 4	97.9 ± 2.5	89.3 ± 3.5
50	83 ± 0	80.3 ± 1.5	96.4 ± 4	18.6 ± 8
100	84.2 ± 12.5	85.7 ± 0.5	89.5 ± 6.5	5.8 ± 4.5
150	89.3 ± 8.5	79 ± 2.5	85.2 ± 10.5	0
200	90.6 ± 4	0	34.6 ± 9	0
400	0	0	0	0

Table 5. Effect of different concentrations (ppm) of Seakleen® on viability of G. catenatum, P. reticulatum and A. catenella cysts at 6 and 17°C (as % of total number of cysts used). (2 weeks exposure).

Concentration	Total cyst viability at 6°C (%)		Total cyst viability at 17°C (%)	
	G. catenatum	*P. reticulatum*	*G. catenatum*	*P. reticulatum*
0 (control)	94.1 ± 2	91.7 ± 4	97.9 ± 2.5	89.3 ± 3.5
2	89.3 ± 2.5	92.5 ± 2.5	95 ± 5.5	83.1 ± 2.5
4	43.6 ± 12.5	76.7 ± 1	63.6 ± 5	80.6 ± 3.5
6	0	80.4 ± 0.5	0	46.2 ± 1.5
8	0	53.3 ± 6.5	0	27.4 ± 5
10	0	0	0	0

Table 6. Effect of different concentrations (ppm) of Vibrex® on viability of G. catenatum, P. reticulatum and A. catenella cysts at 6 and 17°C (as % of total number of cysts used). (2 weeks exposure).

Concentration	Total cyst viability at 6°C (%)		Total cyst viability at 17°C (%)	
	G. catenatum	*P. reticulatum*	*G. catenatum*	*P. reticulatum*
0 (control)	94.1 ± 2	91.7 ± 4	97.9 ± 2.5	89.3 ± 3.5
10	94.1 ± 10	96.2 ± 5.5	80 ± 3.5	87.4 ± 3.5
25	96.7 ± 2.5	86.9 ± 1	66.7 ± 1.5	79.8 ± 1.5
50	0	0	0	0
100	0	0	0	0

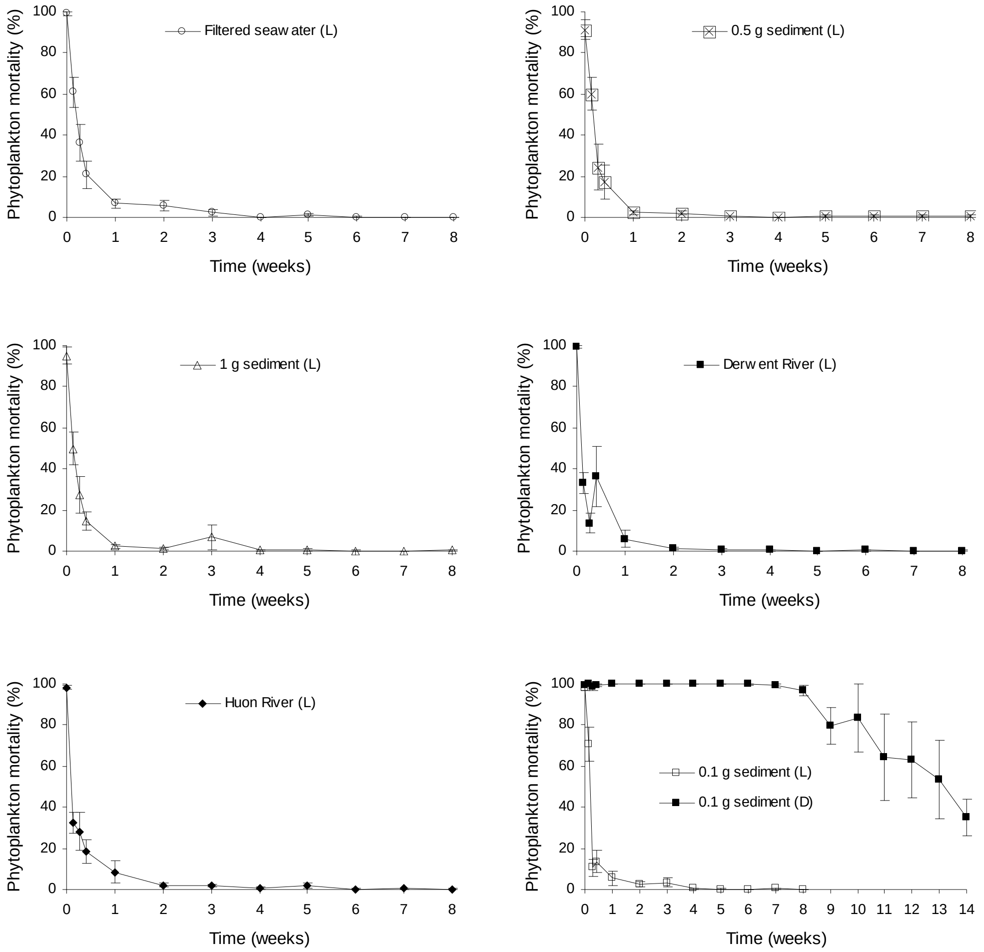

Figure 2. Degradation of 200 ppm Peraclean® Ocean. Degradation assessed weekly by applying the various ageing concentrations to five vegetative microalgal cultures. (A) 200 ppm Peraclean® Ocean in filtered seawater under 12 h light/ 12 h dark. (B) 200 ppm Peraclean® Ocean in filtered seawater containing 0.1 g of ballast sediment under 12 h light/ 12 h dark. (C) 200 ppm Peraclean® Ocean in filtered seawater containing 1 g of ballast sediment under 12 h light/ 12 h dark. (D) 200 ppm Peraclean® Ocean in seawater collected from the Derwent River under 12 h light/ 12 h dark. (E) 200 ppm Peraclean® Ocean in seawater collected from the Huon River under 12 h light/ 12 h dark. (F) 200 ppm Peraclean® Ocean in filtered seawater with 0.1g of ballast sediment under 12 h light/ 12 h dark (L) and complete darkness (D).

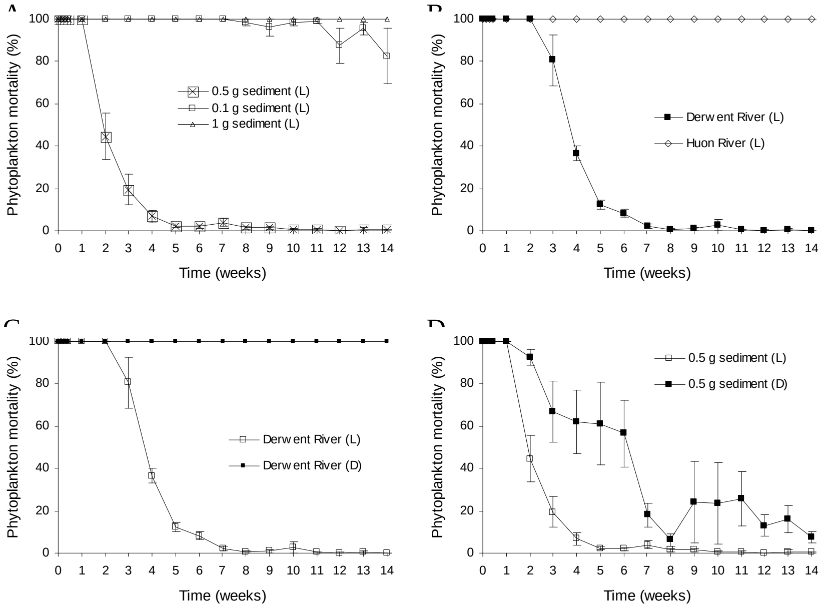

Figure 3. Degradation of 1000 ppm Peraclean® Ocean. Degradation assessed weekly by applying the various ageing concentrations to five vegetative microalgal cultures. (A) 1000 ppm Peraclean® Ocean in filtered seawater containing 0.1, 0.5 and 1 g of ballast sediment under 12 h light/ 12 h dark. (B) 1000 ppm Peraclean® Ocean in seawater collected from the Derwent and Huon Rivers under 12 h light/ 12 h dark. (C) 1000 ppm Peraclean® Ocean in seawater collected from the Derwent River under 12 h light/ 12 h dark (L) and complete darkness (D). (D) 1000 ppm Peraclean® Ocean in filtered seawater containing 0.5g of ballast sediment under 12 h light/ 12 h dark (L) and complete darkness (D).

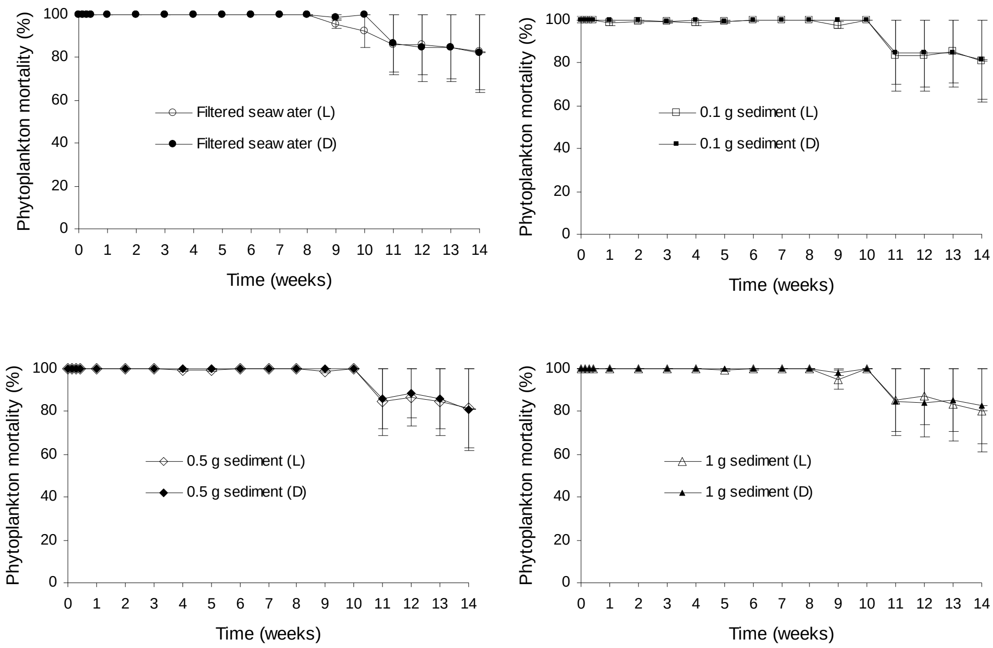

Figure 4. Degradation of 4 ppm SeaKleen®. Degradation assessed weekly by applying the various ageing concentrations to five vegetative microalgal cultures. (A) 4 ppm SeaKleen® in filtered seawater under 12 h light/ 12 h dark (L) and complete darkness (D). (B) 4 ppm SeaKleen® in filtered seawater containing 0.1 g of ballast sediment under 12 h light/ 12 h dark (L) and complete darkness (D). (C) 4 ppm SeaKleen® in filtered seawater containing 0.5 g of ballast sediment under 12 h light/ 12 h dark (L) and complete darkness (D). (D) 4 ppm SeaKleen® in filtered seawater containing 1 g of ballast sediment under 12 h light/ 12 h dark (L) and complete darkness (D).

Annex 5: CONSSO/IGSS Scoping Study on Ballast Water Management in the North Sea

Summary and recommendations

- The entire OSPAR Region should be included in the Ballast Water Management Strategy for the North West Europe and be subdivided into bio-provinces.
- The selective approach which allows for exemptions to management, either on a regional, trade or voyage specific level, based on appropriate risk assessment, is the most suitable management model for the OSPAR Region.
- Bio-provinces should initially mirror the areas in the OSPAR Quality Status Report, but should be revised in the light of further work being undertaken by OSPAR and the European Union.
- Borders between bioprovinces are never accurate and transition zones should be defined and included in the system.
- Dispersion of native species from one bioprovince to another is not acceptable;
- Non indigenous species dispersion within a region is not acceptable;
- Discharge of unmanaged ballast water in environmental emergency situations (such as harmful algal blooms) is not acceptable.
- A risk assessment procedure based on non-indigenous species and those native species known to cause harm needs to be developed to reduce the major risks of non indigenous species invasion in the waters of OSPAR.
- The most appropriate risk assessed management method should be applied en route where high and medium risks are identified for ballast water exchange between ports.
- More formal links need to be made between the Ballast Water Management Strategy for North West Europe and the work HELCOM are undertaking on Ballast Water Management. This could be achieved through the existing OSPAR/HELCOM liaison process. This include e.g.:
    - Common dedicated areas for ballast water exchange for vessels on voyage between two freshwater ports.
    - Definitions of freshwater and marine water.
    - Risk assessment system and method to be used.
- The feasibility of a voluntary scheme versus a mandatory scheme need to be investigated further.
- An Audit and ‘Gap’ analysis of existing monitoring schemes under OSPAR and European programmes in needed to evaluate whether the biological and physical information needed for risk assessment is already being gathered
- A list of non-indigenous species and species of concern needs to be identified and collated on an OSPAR, country by country, bio-province and coastal area by coastal area basis
- A notification procedure for biological emergency situations would have to be developed.
- Further analysis of the risks of spreading non-indigenous species through the various management options is required.
- Guidelines may need to be developed within OSPAR (and preferably IMO) on what is undue deviation and the rights of a port state to expect and/or force deviation.
- Any proposal for “no ballast”or “designated areas for ballast water exchange” need to be linked with the management and designation of areas under the EC Habitats and Birds Directives.

- For vessels going from a fresh water port to a fresh water port : Vessels should undertake Ballast water exchange in the marine environment in an appropriate/designated area. Definition of fresh water and seawater are needed.
- For vessels arriving from North America, South America and from around Southern Africa: Vessels should undertake ballast water exchange en route in waters greater 200nm from the shoreline than 200m depth. If this is not possible for safety reasons then vessels would be expected to make minor route deviations to areas within the 200nm limit that could be identified as discharge areas, so long as they are greater than 50nm from the coast.
- For vessels arriving from West Africa and the Mediterranean (or via the Suez Canal): If Vessels have not undertaken ballast water exchange en route in waters greater 200nm from the shoreline than 200m depth then they would be expected to undertake appropriate ballast water management measures, or make minor route deviations to areas within the 200nm limit that could be identified as discharge areas, so long as they are greater than 50nm from the coast.
- For vessels operating within a bio-province: These voyages should fall under the risk assessment. Ballast water can be discharged between ports where the risk is identified as low, however appropriate management measures will be needed for ballast water transfers are regarded as medium or high.
- For vessels operating between bio-provinces: Appropriate management measures will be needed such voyages. However, these measures will need to be risk assessed to ensure that they pose a low risk in transition areas.

Annex 6: Risk Assessment of Ballast Water Mediated Species Introductions – a Baltic Sea Approach

It should be noted the extract of the following report was not approved by HELCOM. Further discussions at the HELCOM headquarters are scheduled for the end of April 2006.

Recommendations to HELCOM

The Baltic Sea countries have international obligations to address invasive alien species, principally according to the Convention on Biological Diversity (1992) and, concerning marine areas, the International Convention for the Control and Management of Ships' Ballast Water and Sediments (IMO 2004).

At the meeting of the HELCOM Heads of Delegation, 14-15 June, 2005, Helsinki, Finland, (Paragraph 2.5, LD 6) it was decided to establish a project entitled "Risk Assessment of Ballast Water Mediated Introductions."

This Report, authored by Erkki Leppäkoski (contracted Project Manager; Åbo Akademi University, Turku, Finland) and Stephan Gollasch (GoConsult, Hamburg, Germany), makes ten key Recommendations to improve measures to reduce the introduction of ship-mediated alien species into the Baltic Sea and provide further a suggested ballast water management approach for the Baltic Sea.

1. Recommended actions

Aggressive invaders represent a threat to the biosecurity of most coastal countries of the world. Shipping (ballast water and hull fouling) has been and will continue to be the most important vector for unintentional species introductions into aquatic environments.

Introductions of aquatic invasive species (AIS) are considered as a key influence on various environmental and socio-economic sectors – thereby affecting many stakeholders. Biological invasions are a global phenomenon and thus a feature of ongoing global change – indicating the scale of the problem. The most obvious ecological impacts are directed to coastal biodiversity. AIS may change the native food web and some are known as ecosystem engineers, which result in substantial habitat modifications. It is not only the environment being at risk, also economical and human health issues were reported, e.g. during harmful algal blooms and human consumption of contaminated seafood. Tourism, one of the world's leading industries, is also potentially at risk when hit by harmful algal blooms.

The MARITIME group drafted in a meeting in Copenhagen October 2004 the HELCOM recommendations: "*Measures to address the threat of invasive species transported via the ballast water of ships*". Considering that ballast water exchange (hereafter BWE) is a limited option for ballast water management in the Baltic Sea, the group emphasized the need for regional cooperation when addressing the threat. The Governments of the Contracting Parties to the Helsinki Convention recommended:

- to designate/identify a clear responsibility for coordinating the national response to the issue,
- to request arriving ships to submit ballast water reporting forms using the IMO Guidelines (IMO Resolution A.868(20), adopted on 27 November 1997),

- to require ships flying the country's flag or calling at the country's ports to carry and implement a shipboard ballast water management plan (taking into account the IMO Guidelines),
- to provide adequate reception facilities for sediments in ports and terminals where cleaning and repair of ballast tanks occurs,
- to carry out by 1 January 2007 risk assessments for major ports. The risk assessments should be carried out using the compatible methodology developed under IMO,
- to cooperate in order to establish by 2006 the national and regional information systems for the data obtained from the ballast water reporting as well as during risk assessments, biological surveys and monitoring (including an early warning system),
- to conduct by 1 January 2007 biological surveys and establish a monitoring system for invasive aquatic species in major ports using harmonized methodology developed and updated by the appropriate HELCOM subsidiary bodies and to be based on guidelines prepared under the IMO,
- to link the port surveys and monitoring to an early-warning system, whereby ships can be alerted to outbreaks of harmful species, and
- to cooperate with the North Sea countries when implementing the provision of this Convention.

To address the recommendations from the MARITIME group, the following actions may be considered to significantly reduce the probability of ship-mediated introductions into the Baltic Sea:

1. *Identify pathways* leading to unintentional introductions, e.g. the importance of ballast water vs. other vectors.

2. *Assess*, in particular, *shipping routes that cross biogeographical zones*, which might connect previously separated flora and fauna.

3. *Identify most important source areas* of alien species introductions into the Baltic Sea. Despite academic interest, such information is essential for regional cooperation with the aim to jointly assess control measures and risk assessments. These source areas of species might be specific in different parts of the Baltic Sea and may also change in time due to changes in shipping pattern.

4. *Increase the exchange of information* between scientists and management agencies.

5. *Have in place a basin-wide early warning system* for taking rapid and effective action, including public consultation, should unintentional introductions occur. An early warning system rapidly reporting on new findings of AIS is an important tool when planning to undertake eradication measures of newly introduced AIS. With an early warning instrument, neighbouring countries may be made aware and by doing so concerted actions may be achieved[1].

6. *Support R&D focused on initiatives to reduce the problems of alien invasives arising from*

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1 Positive eradication examples are known, e.g. the successful removal of *Caulerpa taxifolia* off the Californian coast. It should however be noted that eradication efforts are only successful in case the new species is not established, colonizes a small area only and also benthic organisms may be easier to remove rather than planktonic species. Routine monitoring programmes should consider taking samples in regions of ballast water operations to timely proof the occurrence of new AIS.

ballast water discharges, understanding that preventing the introduction of alien invasive species should be the first goal and keeping in mind that mechanical or chemical eradication of *established* AIS is not an option, neither biological control of them (prevention is better than cure). The actions should be focussed on

- development of national and regional ballast water management programmes,
- research on sampling and monitoring regimes,
- information to port authorities and ships' crews on ballast water hazards,
- disseminating international guidelines and recommendations, such as the IMO Ballast Water Management Convention, IMO guidelines on BWE (completed) and BWE zones (in preparation), and
- development of an online decision support system to assist port authorities and ships' crews on appropriate ballast water uptake and discharge zones. This tool may eventually result in an online "*Baltic Sea Ballast Water Management Decision Support System*" providing information on zones in the Baltic Sea where ballast uptake/discharge is permitted/not permitted (depending on origin of the ballast water, taking into account various scenarios of ship routes, etc.). This online system may also include information on ballast water treatment options, risk calculations and occurrence of algal blooms.[2] Consequently, an early warning tool should be included to avoid ballast water uptake in (Baltic) areas where potential harmful species bloom.

7. It is strongly recommended that HELCOM should consider to introduce a *ballast water reporting system* (as also required by the IMO BWC) as soon as possible, i.e. already *before* the BWC has entered into force, to allow data gathering for risk assessment (see lack of data availability as outlined in the report).

8. *Identify high-risk ships or shipping routes through risk assessment* and special measures that can be applied for the management of their ballast water (for example treatment, BWE in designated areas outside the Baltic or treatment at land-based ballast water and sediment reception facilities).

9. *Elaborate a common structured procedure for species-specific assessment* to be used in developing a "black list" of harmful or potentially harmful alien species (= target species) that are especially undesirable to be introduced to the Baltic Sea. The presence/absence of target species will influence the risk level quantification of the shipping routes considered.

10. *Organize regional introductory training courses* for port administrators, environmental and fisheries administrators as well as NGOs.

2. Suggested ballast water management approach for the Baltic

Each vessel arriving in the Baltic poses a risk to introduce a new AIS. Even ships with no ballast on board (NOBOB) are of risk to introduce new AIS[3]. This indicates the urgent need

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2 A very good example of such system, which may be used as a model, is NEST (on eutrophication in the Baltic) developed by the Stockholm University.

3 In inbound traffic to the Great Lakes, NOBOB ships contain an average of 60 tonnes of unpumpable residual water and sediment in ballast tanks. This unpumpable ballast contains up to tens of millions of viable resting stages of invertebrates per tonne sediment (Gray et al. 2005). Experimental studies performed by the same authors showed that exposure to high-saline water does not effectively eliminate

for efficient ballast water treatment systems. As those systems are not yet readily available, BWE is the only option to reduce the risk of AIS introductions with ballast water release. In addition all measures should be undertaken to avoid species uptake in the ballast water donor region. The recommendations of the IMO Guideline 868(20) should whenever possible be followed. These measures include:

- *Precautionary practices,*
- *Minimizing uptake of harmful aquatic organisms, pathogens and sediments,*
- *When loading ballast, every effort should be made to avoid the uptake of potentially harmful aquatic organisms, pathogens and sediment that may contain such organisms. The uptake of ballast water should be minimized or, where practicable, avoided in areas and situations such as:*
- *areas identified by the port State… ...port States should inform local agents and/or the ship of areas and situations where the uptake of ballast water should be minimized, such as:*
    - *areas with outbreaks, infestations or known populations of harmful organisms and pathogens;*
    - *areas with current phytoplankton blooms (algal blooms, such as red tides);*
    - *nearby sewage outfalls;*
    - *nearby dredging operations;*
    - *when a tidal stream is known to be the more turbid; and*
    - *areas where tidal flushing is known to be poor.*
- *in darkness when bottom-dwelling organisms may rise up in the water column;*
- *in very shallow water; or*
- *where propellers may stir up sediment.*
- *Removing ballast sediment on a timely basis,*
- *Where practicable, routine cleaning of the ballast tank to remove sediments should be carried out in mid-ocean or under controlled arrangements in port or dry dock, in accordance with the provisions of the ship's ballast water management plan.*
- *Avoiding unnecessary discharge of ballast water,*
- *If it is necessary to take on and discharge ballast water in the same port to facilitate safe cargo operations, care should be taken to avoid unnecessary discharge of ballast water that has been taken up in another port.*

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sediment-bound resting stages but only reduce the numbers or viability of them. This unpumpable ballast may not be discharged when a ship arrives in a Baltic port. However, once one tank with residual ballast water and sediment was filled in one Baltic port the sediment and organisms may be recirculated into the water column and may be released when this ship calls for the next (Baltic) port and has to discharge this tank here.

3. High risk shipping routes

The risk assessment[4] carried out for the selected ports[5] revealed that high risk shipping routes are those connecting ballast water donor and recipient regions in the same bioregion or within identical climate zone(s). The major difficulty in Europe is that BWE cannot be carried out on those shipping routes as all high risk ports are in regional seas not meeting the IMO depth and/or distance limits for BWE during the ships voyage. As BWE cannot be carried out here as risk reducing measure, this indicates the need for ballast water treatment.

Ports with the lowest risk levels are all very distant (i.e. oceanic shipping) and many also have temperature regimes different from the Baltic. Here, provided safety permits, a BWE should be carried out as risk reducing measure.

Due to the varying salinity conditions throughout the Baltic and its adjacent waters, a route-specific approach to address ballast water management is recommended. However, all shipping routes may be grouped in three categories as outlined below. The measures recommended below assume that ballast water treatment systems are unavailable and also that ballast water reception facilities are lacking. As a result the "only" risk reducing measure is BWE.

3.1 Ships on oceanic voyages

Ships operated on oceanic voyages are usually enabled to meet the IMO water depth and distance limits for BWE. However, safety aspects may not enable to carry out BWE while being at sea. Further, BWE shows limited efficiency to remove organisms from ballast tanks. However, as an interim solution and until ballast water treatment systems become available, BWE should be carried out wherever possible on those voyages before entering the Baltic Sea.

3.1.1 Scenario 1 – Matching salinity or temperature in donor and recipient region for ships operated on oceanic voyages

In case a salinity and temperature match occurs in donor and recipient region, e.g. shipping routes connecting a brackish water port in the Chesapeake Bay (east coast of North America) with the Baltic proper (both regions are located in similar climate zones), a mid-ocean BWE should be carried out provided that safety permits. It is also recommended to exchange the ballast water in mid-ocean when ships connect two freshwater ports, e.g. Duluth (North American Great Lakes) and St. Petersburg (both ports are located in similar climate zones).

3.1.2 Scenario 2 – Non-matching salinity or temperature in donor and recipient region for ships operated on oceanic voyages

On shipping routes without salinity match, e.g. Singapore (= fully marine conditions) to Helsinki (= low-brackish conditions) BWE may not be carried out as the risk that a marine organism survives when being released into freshwater conditions is minimal. In case ballast water was taken onboard in a freshwater tropical port and released in Helsinki in winter, the species introduction risk is also minimal. Another case is the release of water from Singapore in the Baltic in the vicinity of thermal discharges (e.g. from power plants) in summer,

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4 For comparison, various risk assessment approaches were reviewed. A summary is available as Annex 1.

5 Copenhagen (Denmark), Gothenburg (Sweden), Kiel (Germany), Klaipeda (Lithuania), Sköldvik and the port region Tornio, Kemi, Raahe (Finland).

especially if such species show a broad salinity tolerance. In this case we recommend to carry out BWE as the abiotic conditions of donor and recipient region overlap.

3.2 Inner-European shipping

In northwest (NW)-European shipping the IMO water depth and distance limits for BWE cannot be met. However, the risk to introduce species remains high when donor and recipient regions show similar salinity and temperature conditions. The following scenarios may be considered.

3.2.1 Scenario 1 – Matching salinity or temperature in donor and recipient region for ships operated on NW-European shipping routes

When the shipping route connects ports with a match in salinity or temperature, e.g. Rotterdam (= brackish water) with the western Baltic (both ports are located in the identical climate zones), a BWE should be carried out in fully marine water conditions although the IMO depth and distance limits cannot be met. It is believed that organisms in the high saline water taken onboard during BWE will not likely survive when being discharged in lower saline brackish waters.

Fresh water ballast originating from outside the Baltic should also be exchanged prior release in freshwater habitats of the Baltic, e.g. on ship voyages from Antwerp to the eastern Baltic, both being freshwater port regions in the identical climate zone.

By doing so the risk to introduce a species is reduced, although the risk reduction is not as efficient as in ships operated on oceanic voyages due to the lower water depth in the BWE zone.

In addition ships operated in the Ponto-Caspian – Baltic inland waterway (matching salinity) should carry out a BWE en-route at best in the beginning of the canals.

3.2.2 Scenario 2 – Non-matching salinity or temperature in donor and recipient region for ships operated on inner-European shipping routes

Ships engaged in voyages without salinity or temperature match, e.g. La Coruna (Spain, marine conditions) to St. Petersburg (= freshwater conditions) may not carry out a BWE as the risk that a marine organism survives when being released into freshwater conditions is minimal.

3.3 Intra Baltic shipping

Inner-Baltic shipping poses the risk for secondary spread of previously introduced species.

As in NW-European shipping, ships operated within the Baltic are not able to meet the IMO water depth and distance limits for BWE. However, on certain shipping routes a BWE may be required in case a salinity match occurs between ports separated by more saline waters between them. As an example, ships carrying ballast water from St. Petersburg (= freshwater) and intend to discharge this ballast water in freshwater ports at river mouths in the southern Baltic Sea should exchange the water within the Baltic at the highest salinity. One reasoning for this scenario is that introduced freshwater organisms occurring in the inner Gulf of Finland would not be able to reach freshwater habitats adjacent to the southern or western Baltic as the increasing salinity between these areas prevents their natural spread.

3.4 Designation of a ballast water exchange zone within the Baltic

The IMO currently works out a guideline to identify BWE zones. A draft document will likely be discussed at the next meeting of IMO´s Marine Environment Protection Committee in Spring 2006. Once completed, this guideline should be reviewed for its applicability to address the risk of species movements in inner-Baltic shipping (see above).

3.4.1 Ballast water exchange zone for shipping from outside the Baltic

It is assumed that a BWE zone in the Baltic for ballast water originating from outside the Baltic cannot be identified as a biologically meaningful reasoning cannot be given as the Baltic is too shallow and all potential BWE zones are located in (very) close proximity to the coast. Instead, ships intending to discharge ballast water from outside the Baltic shall endeavor to exchange the ballast water prior entry into the Baltic Sea. However, this approach needs careful consideration with affected states as on a voyage from e.g. Antwerp to Helsinki this scenario would result in BWE in the North Sea and in other cases, where ships are on voyages from the Black Sea to NW Europe the Mediterranean Sea may be affected.

3.4.2 Ballast water exchange zone for intra-Baltic shipping

In rare instances a BWE in ships on inner-Baltic voyages may be required, e.g. transport of freshwater ballast across more saline waters which will be discharged in freshwater recipient regions (see above).

4. The HELCOM ballast water management approach in the wider European context

As indicated above, various ballast water management approaches are currently developing, e.g. for the OSPAR region, Mediterranean and Caspian Seas. The HELCOM approach recommends to exchange the ballast water of ships arriving from outside the Baltic and also in inner-Baltic shipping (in certain instances – see above). Problems occur to identify appropriate BWE zones as neighbouring seas and jurisdictions may be affected, e.g. when recommending to exchange ballast water of ships in inner-European traffic prior entry into the Baltic which may result in a water exchange in the North Sea. From the Baltic perspective this is considered as a risk reducing measure. However, at the same time it exposes the North Sea to additional ballast water discharges, but the ultimate goal should be to reduce the amount of ballast water discharges to the essential minimum. This conflict of interest may only be solved by the development of a European-wide ballast water management approach. It is therefore recommended to launch a working group of experts involving various stakeholders across all European seas. The target of this initiative should include to harmonize the ballast water management approach across all European seas and further to develop guidelines how to identify BWE zones especially for inner-European shipping. It may be considered to launch a "*European Ballast Water Management Decision Support System*".

It should be noted that, assuming the BWC enters into force as planned, BWE is only a risk reducing measure of limited duration, i.e. according to the BWC the first ships need to meet the higher discharge standards (organism concentration limit) by January 1st 2009. All risk reducing measures including BWE, are seen as an essential tool to protect European seas from new AIS introductions. As a result, although BWE may have a limited duration, provided the BWC enters into force as planned, all efforts in this regard will reduce the risks of new AIS introductions. Further, the entry into force of the BWC may be delayed due to lack of signatory countries with sufficient world fleet tonnage. It is also believed that the implementation of mandatory BWE requirements may prompt the ratification of the BWC.

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Annex 7: RAC-SPA Action Plan concerning species introductions and invasive species in the Mediterranean Sea

The main objective of the RAC-SPA Action Plan concerning species introductions and invasive species in the Mediterranean Sea is "*to promote the development of coordinated measures and efforts throughout the Mediterranean region in order to prevent, control and monitor the effects of species introduction*". It was determined that among the Actions required to attain the objectives of the Action Plan at the regional level "*A workshop made up of experienced Mediterranean scientists should convene ... that examines the different vectors of non-indigenous species introduction and propose possible control measures for their prevention.*" (UNEP(DEC)/MED WG.213/4 Appendix IV Art. 20). One of the aims of this workshop is to advise RAC-SPA concerning Regional control measurements including "*Guidelines for controlling the vectors of introduction into the Mediterranean of non-indigenous species and invasive marine species*".

It is thus incumbent on us to review the existing scientific research with respect to ballast-transported alien organisms in the Mediterranean, and provide RAC-SPA with recommendations on the following relevant priority issues for the Mediterranean region:

1 Ballast Water

Open ocean exchange of ballast water is at present the single widely-practiced procedure relied upon by management to reduce the risk of ballast-mediated bioinvasions. Indeed, it is widely recognized that the BWE standard is appropriate in the **interim** as a management measure. The premise for advocating BWE is that it replaces the entrained coastal species with oceanic plankton species that are ill adapted for survival in near-shore environments. Moreover, where harbours are riverine or estuarine, the osmotic stress of salinity change following BWE is perceived to act as a biocide.

The International Convention decrees (Regulation D-1) that "*ships performing Ballast Water Exchange in accordance with this regulation shall do so with an efficiency of at least 95 percent volumetric exchange of Ballast Water.*" "*For ships exchanging Ballast Water by the pumping-through method, pumping through three times the volume of each Ballast Water tank shall be considered to meet the standard described in paragraph 1. Pumping through less than three times the volume may be accepted provided the ship can demonstrate that at least 95 percent volumetric exchange is met*".

It is stated (Regulation B-4) that " *A ship conducting Ballast Water exchange .. shall": whenever possible, conduct such Ballast Water exchange at least 200 nautical miles from the nearest land and in water at least 200 metres in depth*". In cases where the ship is unable to do so, exchange shall be conducted "*as far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth*".

In areas where the distance from the nearest land or the depth does not meet the parameters, "*the port state may designate areas, in consultation with adjacent or other States, as appropriate, where a ship may conduct Ballast Water exchange*" (Reg. B-4.2). The designation of BWE Areas represents an issue underlining the need for regional cooperation and must take into account the guidelines on designation of areas for ballast water exchange (G14) pending MEPC 55 (October 2006).

Nearly the entire Mediterranean lies within 200 nm distance to the nearest shore and much of the internal traffic and most shipping lanes pass within the 50 nm limit.

PROBLEM: Finding areas within the Mediterranean where a ship may conduct BWE given the time and route constraints, yet ensure sufficient dilution while avoiding secondary introduction risk.

RESPONSE: Risk assessment studies – and data on shipping and ballasting patterns, biological surveys and monitoring.

Intra-Mediterranean Voyages

Regulation A-4 concerning Exemptions from the Regulations states: "*A party or Parties, in water under their jurisdiction, may grant exemptions to any requirements….* ", but an exemption will be granted only if based on "*Guidelines on risk assessment*", and only if it does "*.. not impair or damage the environment, human health, property or resources of adjacent or other states*". IMO currently works towards completion of the risk assessment guideline (G7).

PROBLEM: Are intra-Mediterranean voyages inherently "harmless" (because alien species once settled in one part of the sea, are able to spread through natural means, as well as through other anthropogenic vectors) and therefore should be exempt?

RESPONSE: Risk assessment studies – and data on shipping and ballasting patterns, biological surveys and monitoring.

Regional Early Warning Systems

Regulation C-2 that deals with "*Warnings Concerning Ballast Water Uptake in Certain Areas and related Flag State Measures*" encourages Port States to warn mariners of areas where ships should not uptake ballast water due to outbreaks of harmful aquatic organisms and pathogens. This assumes regional monitoring and communication.

PROBLEM: No regional early warning system exists.

RESPONSE: Port and port-proximate biological surveys and monitoring, combined with a common information system.

Recommendations

Taking into account the regional geography, biodiversity, shipping patterns within the Mediterranean and those entering and exiting the sea, it is a given that cooperation within the Mediterranean Sea region is crucial for minimizing the risk of ballast-transported introductions of alien species. Therefore, it is recommended that the RAC-SPA Action Plan encourage the Contracting Parties to sign and ratify the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, to ensure rapid and harmonized implementation of the Convention and of guidelines developed thereto, and, insofar as it means permit, assist the Contracting Parties in implementing the actions required at the national level.

Priority at the regional level should be given to establishing the research capacity and financial resources needed for:

- collecting reliable data concerning maritime traffic and ballast water uptake and discharge.
- carrying out biotic baseline surveys for alien species and harmful aquatic organisms and pathogens in major ports using harmonized methodologies.
- gathering information for the identification of potential BWE areas, monitoring and reviewing of designated BWE areas, taking note of the relevant IMO guideline.
- carrying out harmonized risk assessment studies for major ports using appropriate methodologies, taking note of the relevant IMO guideline.
- assessing risk caused by vessel movement within the Mediterranean and from without the Sea.
- Conducting vector-based risk assessment, species-based risk assessment in combination with a pathway-based risk assessment.
- establishing a common regional information 'clearing house' linking data obtained from the traffic and ballast water studies, from the ports' risk assessment studies and the biotic surveys, and forming an early warning system flagging outbreaks of harmful aquatic organisms and pathogens.

2 Hull fouling

The guideline has a general objective to minimise the number of unintentional species introductions associated with hull fouling, to achieve this, seven (see below) specific objectives are targeted.

1. To encourage necessary research and the development and sharing of an adequate knowledge base to address the problems of hull fouling mediated introductions of alien species in the Mediterranean.

2. To increase awareness of hull fouling as a major introduction vector.

3. To technically assist and advise the Mediterranean coastal States, if requested, to ratify the IMO AFS Convention.

4. To encourage the development and implementation of control efforts, such as hull cleaning measures.

5. To encourage the development of a framework for national legislation and regional cooperation to regulate the introduction of hull fouling mediated species introductions, their eradication and control.

6. To design a lead agency, which would have a central responsibility within the government for coordinating the national response to the above issues.

7. To form a national taskforce to develop and implement the proposed guidelines. This national taskforce may be cross-sectoral and multidisciplinary.

This guideline addresses three substantive concerns of the alien species problem:

- enhancing knowledge and research efforts;
- improving understanding and awareness; and
- providing appropriate prevention measures.

Each of the following sections include possible actions for consideration of RAC SPA and others. It should be noted that these actions may be combined with recommendations resulting from other management approaches aiming to reduce alien species introductions, such as ballast water mediated species introductions and/or species imports for mariculture purposes.

KNOWLEDGE AND RESEARCH

An essential element in the campaigns against alien invasive species is the effective and timely collection of information and sharing of data. Sometimes information which may alert management agencies to the potential dangers of new introductions is unknown. Frequently, however, useful information is not widely shared or available in an appropriate format for many countries to take prompt action, assuming they have the resources, necessary infrastructure, commitment and trained staff to do so.

Recommended Actions

1. Develop an adequate knowledge base (including, but not limited to the dimension of the hull fouling situation, evaluation of potential control options) as a primary requirement to address the problems of hull fouling mediated introductions, and to make this easily available through an Internet-based database.

2. Develop, review and update a list of known alien invasive species which are likely to become dispersed in the hull fouling of ships and whose introduction into the Mediterranean Sea should be avoided.

3. Encourage research initiatives on prevention measures, such as biocide-free antifouling paints or hull cleaning measures.

AWARENESS

Improved public awareness based on scientific information is fundamental to prevent or reduce the risk of species introductions with hull fouling, this is also importance in smaller vessels such as motor yachts and sailing boats. However, an education programme alone is unlikely to achieve the desired objective of minimising the risks posed by hull fouling.

It should also be addressed in the awareness programme that fouling organisms are transported on surfaces inside vessels, e.g. in-tank fouling and fouling in the ships cooling circuit.

Recommended Actions

1. Identify the specific interests and roles of relevant stakeholders, sectors and communities with respect to hull fouling mediated species invasions. The general public, especially (recreational) boat owners, are an important target group.
2. Port and marina operators are key target groups for information/education efforts leading to an increased awareness and understanding of the issues, their role in prevention and possible solutions.

3. Dockyard and ship scrapyard operators also belong to the key target group. Organisms removed form ship hulls while in dock should not be dumped in the sea, but should be discharged on land.

4. Include communication strategies in the planning phase of all prevention and control programmes. By ensuring that effective consultation takes place with all affected stakeholders, many issues may be resolved or accommodated in advance.

PREVENTION AND CONTROL

Preventing the introduction of alien species is the cheapest, most effective option, i.e. prevention is better than cure. Since the impacts of alien species are unpredictable, the precautionary principle should apply. Further, once introduced and established eradication efforts to eliminate a species from the marine environment are very costly and for many species this may prove impossible.

Recommended Actions

1. Encourage industry and stakeholders to develop guidelines and codes of conduct to reduce hull fouling of vessels and so to minimise species invasions.

2. Develop dissemination programmes for such guidelines to all stakeholders.

3. Evaluate the applicability of existing international hull cleaning and management measures (monitoring and control).

Role for RAC SPA

Effective response measurements depend on national and regional legislation which provide for preventive as well as remedial action, establishing clear accountabilities and operational mandates.

Cooperation between countries is essential to prevent or minimize risks from introductions of potential or proven alien invasive species. Such cooperation is to be based on the responsibility that countries have to ensure that activities within their jurisdiction or control do not damage the marine environment of other countries or the Mediterranean Sea.

It may further be considered to follow the currently emerging hull fouling guidelines (e.g. in Australia, U.S.A.) and, once completed, to evaluate these guidelines for application in the Mediterranean Sea.

Regional level

1. Evaluate the need for bilateral or multilateral approaches including the consideration to adapt existing multi-country efforts, with respect to the prevention or control of hull fouling mediated alien species introductions.

2. Recommend cooperative action to prevent potential alien invasive species from spreading across borders; recommend coordination with REMPEC when relevant.

3. Provide assistance and technology transfer as well as capacity building related to hull fouling and its management techniques and control options.

4. Exchange findings with neighbouring and other countries and bodies as appropriate.

National level

1. Recommend the ratification of the IMO AFS Convention.

2. Encourage the development of national strategies and plans for responding to actual or potential threats from alien invasive species introduced in the hull fouling of vessels, within the context of national strategies and plans for the conservation of biodiversity and the sustainable use of its components. These strategies may include

- Routine vessel monitoring to document the risk of species invasions in hull fouling.
- Identification of vessels which likely carry high risk species in their hull fouling (risk assessment).
- Identify ports which receive a large number of "critical" vessels.
- Evaluate hull treatment methods for "critical" vessels.
- Make all dockyards and scrapyards operators aware that organisms removed from ship hulls should be collected and discharged safely on land.
- Strongly encourage marina operators to apply the proposed guidelines

3. Ensure that appropriate national legislation is in place, and provides for the necessary control, as well as the necessary administrative powers to respond rapidly to emergency situations.

4. Encourage the development of adequate National knowledge base (including, but not limited to the dimension of the hull fouling situation, evaluation of potential control options).

5. Encourage the exchange of findings with neighbouring and other countries and bodies as appropriate.

Annex 8: Draft practical guidelines for ballast water exchange in the Antarctic Treaty area

The following draft guidelines for ballast water exchange in the Antarctic Treaty area were provided prior the meeting by Brian Elliot, United Kingdom.

Introduction

At the CEP IX meeting in Stockholm (June 2005) COMNAP raised the issue of the introduction of non-native marine species to Antarctic waters in ship ballast water. Vessels may transport marine organisms in ballast water from one biological region to another. On release of the ballast water at a different location the potential exists for transported species to colonise and multiply within the new site. Invasive marine species contained within ballast water could be transported into Antarctic waters, or moved between biologically distinct regions within the Antarctic Treaty Area, with negative effects for existing Antarctic marine ecosystems. Particular concerns relate to the transportation of sub-Antarctic species across the Polar Front, or even the movement of Arctic species to the Antarctic from vessels transiting between the two areas.

Norway noted that the issue was of global concern and referred to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004. Norway suggested that consideration should be given to a voluntary application of the Convention within the Antarctic Treaty Area, as the entry into force of the Convention may yet take some time. Following general agreement among Antarctic Treaty Parties with the Norwegian proposal, the United Kingdom offered to develop practical guidelines for ballast water exchange relating to the Antarctic Treaty Area. This document is a first draft of such guidelines and the United Kingdom would welcome feedback on them from all interested parties.

Ballast water guidelines

- The application of these Guidelines shall apply [by 200[X]] to those vessels covered by Article 3 of the IMO's International Convention for the Control and Management of Ships' Ballast Water and Sediments (the Ballast Water Convention), taking into account the exceptions in Regulation A-3 of the Convention. These Guidelines do not replace the requirements of the Ballast Water Convention, but provide a Ballast Water Regional Management Plan for Antarctica under Regulation C-1 of this Convention.
- A Ballast Water Management Plan shall be prepared for each vessel with ballast tanks entering Antarctic waters.
- Each vessel entering Antarctic waters shall keep a record of ballast water exchange.
- For vessels intending to exchange ballast water within the Antarctic Treaty Area, ballast water must first be exchanged before arrival in Antarctic waters (preferably just north of either the Antarctic Polar Frontal Zone or 60 ^{o}S, whichever is the furthest north).
- If only partial ballast water exchange in Antarctic waters is intended, then only those tanks that will be emptied need to undergo water exchange at the Antarctic Polar Frontal Zone.
- [If the vessel has taken on ballast water in Antarctic waters, it is recommended that the ballast water be exchanged on the journey north at the Antarctic Polar Frontal

Zone, particularly if the vessel is proceeding to Arctic waters to prevent bipolar exchange of species.]

- [If ballast water is to be exchanged between biologically distinct regions within Antarctic waters, resulting in potential risk of intra-regional transfer of marine species, a risk assessment should be performed by a competent authority.]
- Release of sediments from ballast tanks should not take place in Antarctic waters.
- For vessels that have spent significant time in the Arctic, sediment should be discharged and tanks cleaned before entering Antarctic waters (south of 60^{o}S).
- If the safety of the ship is in any way jeopardized by a ballast exchange, it shall not take place. Additionally these guidelines shall not apply to the uptake or discharge of ballast water and sediments for ensuring the safety of the ship in emergency situations or saving life at sea in Antarctic waters.
- Treaty parties are invited to exchange information (via COMNAP) on invasive marine species or anything that will change the perceived risk associate with ballast waters.

Annex 9: Summary of the PICES XIII Annual Meeting, Session S5

PICES Establishes Working Group 21: Aquatic Non-indigenous Species

Darlene Smith

The North Pacific Marine Science Organization (PICES), is an intergovernmental scientific organization, established in 1992 to promote and coordinate marine research in the northern North Pacific and adjacent seas. Its present members are Canada, Japan, People's Republic of China, Republic of Korea, the Russian Federation, and the United States of America.

PICES is composed of several comities including the Marine Environmental Quality (MEQ) Committee. The MEQ Committee's area of responsibility is to promote and coordinate marine environmental quality and interdisciplinary research in the northern North Pacific. This includes understanding the sources and fates of contaminants found in the marine environment, the ecology of harmful algal blooms, marine environmental quality aspects of mariculture, and the transport and introduction of non-indigenous species and stocks. The MEQ Committee recommended that a working group on aquatic non-indigenous species be created.

The PICES governing council approved the creation of Working Group 21: Aquatic Non-indigenous Species at PICES XIV held in Valadivostok, Russia, October 2005.

WG-21 has a three year mandate ending 2008 with the following Terms of Reference

1. Complete an inventory of all aquatic non-indigenous species in all PICES member countries together with compilation and definitions of terms and recommendations on use of terms. Summarize the situation on bioinvasions in the Pacific and compare and contrast to other regions (*e.g.*, Atlantic, Australia, *etc.*);
2. Complete an inventory of scientific experts, in all PICES member countries, on aquatic non-indigenous species subject areas and of the relevant national research programs/projects underway;
3. Review and evaluate initiatives on mitigation measures (*e.g.*, ICES Code of Practice for the Introduction and Transfer of Marine Organisms; IMO Ballast Water Management Convention and others such as the Canadian Introductions and Transfers Code);
4. Summarize research related to best practices for ballast water management;
5. Coordinate activities of the PICES WG on aquatic non-indigenous species with related WGs in ICES through a joint back to back meeting of the PICES and ICES Working Groups on invasive species in 2007/8;
6. Develop and recommend an approach for formal linkages between PICES and ICES on aquatic non-indigenous species;
7. Publish final report summarizing results and recommendations.

Additional information on PICES and WG-21 can be found at www.PICES.int

The PICES WG-21 membership list includes:

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Dr. Tom Therriault, Canada ,TherriaultT@pac.dfo-mpo.gc.ca

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Annex 10: Recommendations

WGBOSV unanimously recommends that Mr Anders Jelmert (Norway) be appointed as Chair of the WGBOSV.

There was consensus that there is an ongoing demand for the WGBOSV and that the group should continue to meet, preferably in conjunction with WGITMO, in accordance with the terms of reference below.

It was recommended that the WGBOSV convene again in Dubrovnik, Croatia for at least three days during the week beginning 19th March, 2007 to:

(a) provide advice to e.g. the International Maritime Organization with an emphasis on the guidelines on sampling, risk assessment and ballast water exchange zones. These guidelines are currently in preparation by IMO.

(b) continue its global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, CIESM, BMB and PICES Member States and of invited experts.

(c) critically review and report on the status of ballast water research with an emphasis on new developments in ballast water treatment technology and ballast water sampling devices.

(d) finalize the ICES Ballast Water Sampling Manual.

(e) prepare a draft ICES Code of Best Practice for the Management of Ships Hull Fouling.

(f) continue reviewing port sampling protocols with the aim to prepare a draft ICES Code of Best Practice for Port Sampling.

(g) Recognising that non ship mediated introductions into many areas have had implications that need to be addressed, WGBOSV has benefited from WGITMO input and recommends continued meetings in conjunction with this group for increased benefit to ICES member countries.

The various intersessional activities [see especially (d), (e) and (f)] make a meeting obligatory in 2007 to reach final agreement.

Priority:	The current activities of this Group will direct ICES towards issues related to unintentional species invasions. As species invasions are considered one of the top four negative anthropogenic impacts on the oceans the activities of the Group are considered to have a very high priority. There was very strong and unanimous consensus by the group to further facilitate and support initiatives on ballast water research and ship-mediated introductions especially as research initiatives are increasing on a global scale. The Working Group believes that its findings are of high value for groups such as the International Maritime Organizations´ Ballast Water Working Group and relevant working groups within IOC and PICES.
Scientific Justification:	Global update on research initiatives currently underway is essential for exchange of information, mutual benefit and possibly joint cooperation and to identify knowledge gaps to be addressed in future research. This is necessary to maintain an overview of ongoing ship-mediated species introductions and to assess the relative importance of certain vectors. Information regarding new ballast water treatment options frequently appear expressing the need for appropriate evaluation of new techniques. Other outstanding related topics include the IMO Guidelines on ballast water sampling guidelines, risk assessment and the designation of ballast water exchange zones and WGBOSV believes to have the expertise to comment (and improve) these draft IMO guidelines. Consideration of hull fouling and other non-ballast shipping vectors is of equal importance for species invasion compared to ballast water in some areas. Hull fouling and other non-ballast shipping vectors also need to be considered as in some regions the number of introduced species being transported as fouling on ship hulls in the past is greater than in the ballast water of ships. It is therefore necessary to maintain an overview of ongoing ship-mediated species introductions and to assess the importance of ship hull fouling as invasion vector. WGBOSV recommends to (a) finalize the ICES Ballast Water Sampling Manual, (b) prepare a draft ICES Code of Best Practice for the Management of Ships Hull Fouling and (c) to prepare a draft ICES Code of Best Practice for Port Sampling. These guidelines will be prepared intersessionally and these various intersessional activities make a meeting obligatory in 2007 to reach final agreement. Ongoing interest of WGITMO in ship-mediated invasions was stated. Invasion vectors may overlap indicating the need to closely cooperate between working groups that target intentional introductions with others focussed on unintentional introductions. Some species may be spread by several different vectors (e.g. mussel larvae may be transported in ballast tanks, adult mussels as hull fouling of ships or as intentional introductions for aquaculture purposes). WGBOSV recommends that both groups continue to meet "back to back" for mutual benefit.
Relation to Strategic Plan:	Related to objectives

Resource Requirements:	None required other than those provided by host country and national members.
Participants:	Participation of representatives from ICES Member Countries, IMO, IOC, PICES, CIESM, shipping agencies, and scientists from relevant research groups world-wide.
Secretariat Facilities:	None required
Financial:	None required
Linkages to Advisory Committees:	ACME
Linkages to other Committees or Groups:	WGITMO as well as to other related ICES Working Groups, such as Working Group on Harmful Algal Bloom Dynamics (WGHABD), PICES WG15 on Harmful Algal Blooms and the newly established PICES WG21 on biological invasions.
Linkages to other Organisations:	IOC, IMO, PICES, CIESM, BMB
Cost Share	ICES 100%