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

8 – 10 March 2010

Hamburg, Germany



ICES

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Executive summary

The 2010 meeting of the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors was hosted by the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie (BSH)) in Hamburg, Germany with Manfred Rolke as host and Tracy McCollin as chair. In total there were 35 participants over the course of this meeting and the joint meeting with the Working Group on Introductions and Transfers of Marine Organisms (WGITMO). There were also three participants by correspondence. The participants were from Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Japan, Spain, Sweden, the United Kingdom, the United States of America, and the Netherlands. There were also participants representing the Intergovernmental Oceanographic Commission (IOC) and the European Space Agency and contributions by correspondence from the European Maritime Safety Agency (EMSA), Lithuania and the United States of America.

The purpose of the meeting was to discuss issues relating to the transport of non-native species *via* shipping vectors and to assess the technologies and management options that could be used to reduce the risk of introducing non-native species. The statistical basis for sampling ballast water to ensure compliance with the ballast water performance standard in the Ballast Water Convention was also discussed in detail.

The approach taken at the meeting was to allow participants to present an overview of relevant research on the first day, the second day was set aside for a detailed discussion relating to the statistical aspects of determining compliance with the ballast water performance standard and statistical experts were invited to the meeting to aid this discussion. The morning of the third day was a joint meeting with the WGITMO and the presentations and discussions were related to subjects that were relevant to the Terms of Reference of both groups.

The structure of the report will outline the progress in relation to each of the Terms of Reference and give a brief summary of the main outcomes of the group's discussion for each Term of Reference. More detailed presentations and reports pertaining to these discussions will be added to the annexes.

The group made good progress for each of the Terms of Reference and the discussions resulted in a number of actions required by the group, some of which will require intersessional work. One action was to draft a request that the participation of the International Maritime Organization (IMO) in the group be made formal. The IMO's participation has been on an informal basis for a number of years and it was felt that a more formal arrangement would enable closer working links between the WGBOSV and the IMO, particularly with regard to input into the Terms of Reference. The discussion on the statistical basis for sampling ballast water to ensure compliance with the ballast water standard was felt to be a very useful contribution to discussions at IMO and a formal submission to the IMO will be prepared intersessionally.

Opening of the meeting

The meeting was opened at 09.00 on Monday 8th March, 2010 with Tracy McCollin and Manfred Rolke welcoming participants. This was followed by words of welcome from Dr. Bernd Brügge, Head of the Department Marine Science of the Federal Maritime and Hydrographic Agency. As there were some new members to the group each participant gave a short introduction giving their name, institution and brief outline of their research.

1 Adoption of the agenda

The Agenda (Annex 2) was structured on the basis of the Terms of Reference contained in ICES Resolution 2009/2/ACOM 28 as shown below and was adopted with minor changes.

Gemma Quilez Badia, Spain was appointed as rapporteur.

2 WGBOSV (ToR)

2009/2/ACOM28 The **ICES/IOC/IMO Working Group on Ballast and other Ship Vectors [WGBOSV]** (Chaired by: Tracy McCollin*, UK) will meet in Hamburg, Germany 8-10 March 2010 (back to back with WGITMO with a common session) to:

- a) Continue to critically review and report on the status of shipping vector research with an emphasis on new developments in ballast water treatment technology, risk assessment, ballast water sampling devices, and selection of ballast water exchange zones to contribute to guidelines currently in preparation by IMO, and to address areas of specific interest, e.g. chemical contaminant and microbiology in ballast water and sediment,
- 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) Discuss and evaluate the sampling strategies under consideration at IMO and provide comment with the aim to prepare a written submission to relevant IMO committees in response to requested information. Statistical experts will be invited to attend and contribute at the meeting,
- d) Continue and elaborate the cooperation with PICES WG 21,
- e) To provide data and information on how climate change may alter the distribution of NAS and shipping operations, and hence the risks for introductions of NAS via shipping to the benefit of ICES SGCC (Steering Group on Climate Change).

Material and data relevant for the meeting must be available to the group no later than 14 days prior to the starting date.

WGBOSV will report by 20 March 2010 for the attention of ACOM.

3 Progress in relation to Terms of Reference

Progress against each Term of Reference will be discussed and summarised on the basis of the group's discussions.

3.1 Term of Reference a)

Continue to critically review and report on the status of shipping vector research with an emphasis on new developments in ballast water treatment technology, risk assessment, ballast water sampling devices, and selection of ballast water exchange zones to contribute to guidelines currently in preparation by IMO, and to address areas of specific interest, e.g. chemical contaminant and microbiology in ballast water and sediment

The contributions to this Term of Reference were mostly provided by each of the participants giving an overview of the relevant research in each of their countries. A brief overview is provided for each country and, where available, more detailed information is contained with the National Reports in Annex 5. A summary of the information provided by members of the group and relevant references are given at the end of this section.

3.1.1 Belgium

Belgium did not have any new research to report. However, Belgium is starting the process of implementing the Ballast Water Convention.

3.1.2 Canada (also see National Report Annex 5)

Canada has been carrying out a number of research projects in recent years and an overview was given of these and also of research that will be carried out in the future. The presentation by Canada outlined the results of the research priorities for the past five years that examined the efficacy of ballast water exchange and flushing at reducing the risk of introducing non native species to freshwater ports. These methods have been shown to be effective at reducing the risk of introductions into freshwater ports. Further details were then given regarding the Canadian Aquatic Invasive Species Network (2006-2011) and the work that has been undertaken as part of this project. The main themes within the network are Vectors and Pathways, Factors Affecting Establishment Success and Risk Assessment Modelling. The current research priorities being undertaken are assessing domestic ballast water within the Great Lakes, evaluating the IMO Discharge standards *via* mesocosm and dye dispersion studies and assessment of the risks of introducing non native species to the Arctic. Further planned work includes sampling and analysis methods and the potential of a new research network to continue and progress the research already carried out. The new network will be linked to climate change and will examine the spread of non native species in Canada and will take into account shipping in the Arctic.

3.1.3 Denmark

Currently Denmark is not undertaking any academic research but preparations are underway for ratification of the Convention. Some Danish companies are developing treatment technologies and also test facilities. The ship owners association and the environment agency with Denmark are considering how the Ballast Water Convention will be implemented.

3.1.4 Estonia (also see National Report Annex 5)

Currently there is neither ongoing nor planned ballast-water related research in Estonia. According to the HELCOM Baltic Sea Action Plan, Baltic Sea countries should ratify the IMO BWC preferably in 2010 but no later than 2013. For this purpose, HELCOM Correspondence Working Group on the Implementation of the HELCOM Ballast Water Road Map was created where all HELCOM member countries participate. It is currently planned that Estonia will ratify the convention in 2013. For this purpose, one national coordination meeting has already been held and another was planned for 2010 with involvement of representatives from all key authorities, including the Ministry of Environment and Ministry of Economy and Communication. It is very likely that monitoring of alien species will be started in 2010, although probably in a very limited scope.

3.1.5 France (also see National Report Annex 5)

A research project known as EFFORTS and funded by the European Union's FP6 Program is now in its third year. The aim of the project is to provide educational resources for ports on a variety of subjects such as sampling and the use of active substances that may be used for treatment. The three year project has carried out sampling on vessels in the port of Le Havre and has tested some ballast water treatments based on two known technologies (Peracetic acid – Hydrogen peroxide and menadione) and one new technology based on alkyamine salts. The new technology has been tested both in the laboratory and on board vessels and seems to be effective against selected bacteria and phytoplankton and has been found to degrade relatively fast.

A future research project will involve sampling waters in La Rochelle harbour in close proximity to where the moored ships discharge ballast water. The targeted species will be potentially toxin producing phytoplankton.

3.1.6 Germany (also see National Report Annex 5)

Germany is involved in a European Union Interreg Project – Ballast Water Opportunity (BWO), which is funded by the European Regional Development Fund (ERDF) and aims towards unified ratification and implementation of the Ballast Water Management Convention in the North Sea Region. Germany is responsible for two of the six work packages within the project. The project is currently in the early stages but has initiated dialogue between the North Sea countries on a number of issues needing standardisation. Other outcomes of the project include the opening of additional test facilities at the Royal Netherlands Institute for Sea Research and research into ballast water sampling both for certification and compliance control.

The Federal Maritime and Hydrographic Agency (BSH) is responsible for the type approval of ballast water treatment systems in Germany and is currently dealing with eleven technologies at various stages of the type approval process.

Further work has been undertaken to address the issue of obtaining a representative ballast water sample and ballast water sampling using different sampling scenarios has been undertaken to evaluate how representative samples for compliance control may be collected. The results of this work were submitted to the International Maritime Organization and further details can be found in the National Report.

There have also been changes to the German Nature Protection Law, which now includes an obligation to monitor and eradicate or control as well as requirements for permission to release plants and animals into the wild.

There are also two risk assessment projects in relation to ballast water being undertaken. One is funded by the European Space Agency and is testing remote sensing as a technique for the risk assessment for ballast water exchange. The research uses several different data sources to gather information that can be used to calculate the risk index. This project could be used to identify ballast water exchange zones.

The second project is being carried out by scientists from the University of Oldenburg who are developing a mathematical model to quantify the probability of introducing nonnative species through ballast water exchange by cargo ships. The backbone of the model is an AIS data base of global ship movements of roughly 16,000 ships larger than 10,000 gt for the year 2007. These data are combined with invasion relevant quantities such as environmental similarity of ports, travel time of ships and biogeographical similarity of ports. The model enables a calculation of invasion probability each time a ship called at a port. Invasion probabilities can be summarised for each ship, port, country, ecoregion, etc. In addition, it is possible to estimate the main source region from which bio-invasion is most likely to occur.

3.1.7 Greece (also see National Report Annex 5)

Greece is carrying out several projects in relation to non native species and these are outlined in detail in the National Report in Annex 5. Much of the research focuses on studies of the impact of non native species or undertaking surveys to assess the abundance of non native species. Potential future studies include one aiming to develop a simplified instrument that can monitor and alert about climate change occurring in sea areas in order to be prepared against relevant consequences and to protect biodiversity and another examining the survival and adaptation of non native species that could be discharged in ballast water in harbours.

A network of experts was established in 2007 to encourage the collaboration in the research and management of aquatic alien species at both national and international levels. The outcome was ELNAIS, the Hellenic Network for Aquatic Alien Species, which consists of 50 experts carrying out relevant research who are based in 11 research centres across the country. The network maintains an open information system regarding non native species in Greece. The ELNAIS network is also allowing examination of the data to assess trends in the introduction of non native species in Greek waters.

Greece has also carried out some studies on the impact of non native species on human health e.g. toxic phytoplankton *Ostreopsis ovata* and the toxic pufferfish *Lagocephalus sceleratus*, on the economy e.g. the rapid expansion of the blue cornetfish *Fistularia commersonii* and on the ecology e.g. the expansion of *Percon gibbesi* and *Caulerpa racemosa*.

3.1.8 Japan

There is currently no national ballast water project in Japan but there are two committees that deal with ballast water and biofouling. It is known that in Japan most invasive non native species are transported by fisheries, out of the 67 known introductions 44 have been introduced *via* this vector and non native species such as *Hydroides elegans* have caused US \$20 million of damage to oyster farms.

Japan is currently undergoing the type approval process for two methods and is developing methods of analysing viability of organisms. Further research is being carried out on In Water Cleaning (IWC) methods that are being developed to clean vessel's hulls whilst they are in the water. The machine is operated by a diver and uses a net to catch the debris as it is cleaned. There is ongoing work to improve the efficiency of the system.

3.1.9 Lithuania (also see National Report Annex 5)

Lithuania participated in the meeting by correspondence and submitted an overview of work that is being carried out to improve an online Biopollution assessment tool. This was presented to group by the chair, Tracy McCollin, and the group were advised to read through the contribution and try out the new on line tool and pass any comments for changes or improvements onto Sergej Olenin at sergej@corpi.ku.lt.

3.1.10 Spain (also see National Report Annex 5)

In Spain there are some publications becoming available regarding new introductions into Spanish waters and there are two new species recorded this year *Mnemiopsis leidyi* and *Blackfordia virginica*.

3.1.11 United Kingdom (also see National Report Annex 5)

Newcastle University is undertaking several ballast water related projects, including one (the BaWaPla project) that has led to a treatment system that is now undergoing the IMO Type Approval process. The university is also undertaking a project with Orkney Island Council to examine the council's ballast water policy and the effects on trade. The university is also the lead partner in a proposal (MOVEMENTS) that has been submitted under the European Union Framework 7 programme. The proposal is currently submitted and is under review and it is anticipated that the partners will hear whether they were successful or not around the middle of 2010.

Two projects, one funded by the Scottish Government and the other funded by the Esmée Fairbairn Foundation (Marine Aliens II) will both examine hull fouling as a vector for introducing non native species. The combination of these projects means that both recreational and commercial vessels will be targeted and will give a good overview of the risks associated with each type of vector.

An eradication of the invasive sea squirt *Didemnum vexillum* is underway at Holyhead Marina in North Wales. The work to wrap the chains and pontoons in plastic (with or without chemicals to speed the process up) will be finished by about March 2010 and then ongoing monitoring will assess whether more work needs to be carried out. It is likely that eradication may be carried out in one location in Scotland and a feasibility study will assess the options for the other populations of *Didemnum* sp. in the south of England.

3.1.12 United States of America (also see National Report Annex 5)

A wide variety of work is being carried out in the US in relation to both ballast water and biofouling. This is briefly summarised here but readers are recommended to consult the National Report in Annex 5 for more details.

A report has been issued that specifically reviews the treatments that may have the capabilities to meet California ballast water discharge standards

http://www.psmfc.org/ballast/wordpress/wp-content/uploads/2009/10/TechUpdate_final.pdf).

The aquatic nuisance species (ANS) program at the Naval Research Laboratory in Key West, Florida is continuing. The work carried out includes developing and testing protocols for verification of ballast water treatment technologies. Other work carried out covers a range of technical testing issues and these are listed in the National Report along with the relevant references.

The Great Ships Initiative (GSI) is a collaborative effort in the Great Lakes region led by the Northeast-Midwest Institute and is operating an IMO-consistent land-based ballast treatment test facility in the freshwater environment of Lake Superior. GSI, which collaborates closely with the U.S. Maritime Administration and other U. S. federal agencies, Great Lakes states, the U.S. and Canadian Great Lakes St. Lawrence Seaway Port Authorities and maritime industry, and the University of Wisconsin and Minnesota, conducts bench, land-based and shipboard tests in support of ballast treatment validation. It has also conducted detailed tests in relation to sampling methods the results of which will be discussed in more detail under Term of Reference c).

The Maritime Environmental Resource Center (MERC) is a State of Maryland initiative that provides test facilities, information, and decision tools to address key environmental issues facing the international maritime industry. The primary focus is to evaluate the mechanical and biological efficacy, costs, and logistical aspects of ballast water treatment systems and to assess the economic impacts of ballast water regulations and management approaches. MERC have worked with several partners such as the University of Maryland, Smithsonian Environmental Research Center and the US Maritime Administration to evaluate the performance of several ballast water treatment systems in the laboratory, in land-based tests, and onboard active vessels. Amongst other projects MERC has also refined sampling, statistical and analytical methods for treatment testing (see under Term of Reference c)) and has also begun studies on ship biofouling.

A study carried out by a researcher at Portland State examined biofouling on in-service containerships and found that the accumulation of fouling on containerships may be lower than on other ship types but more data are required to verify this finding. The abstract and reference and contained within the National Report in Annex 5.

The United States National Report also contains a useful summary of the U.S. Coast Guard regulations and state regulations (both those that have been passed and those that have been submitted). The U.S. Coast Guard had a proposed rulemaking available for public comment, which has now closed and the responses are being analysed. The proposal contained two Phases: Phase I are comparable to the IMO Convention and Phase II is up to 1000X more stringent. Also, there is California Hull Fouling Legislation that is currently in Assembly. Again, the details are in Annex 5.

3.1.13 The Netherlands (also see National Report Annex 5)

The Netherlands have a testing facility based at the Royal Netherlands Institute for Sea Research and have undertaken several land based tests of ballast water treatment systems. Other research in the Netherlands also includes large mesocosms to study the strategies of and conditions for invasive species.

The Royal Netherlands Institute for Sea Research are also the co-ordinators of a large Interreg project known as the Ballast Water Opportunity project (see

www.northseaballast.eu for further details) which is a project for regional cohesion, innovation and future strategies in ballast water policies and ballast water management, focusing on:

Coherence and harmonisation for implementation, monitoring and enforcement

Innovation based on scientific knowledge for implementation, enforcement and development

Development of future strategies to reduce ship-borne bio invasions

3.1.14 European Maritime Safety Agency (also see Annex 5)

An overview of the European Maritime Safety Agency's (EMSA) Ballast Water Action Plan was provided to the group and presented by the chair, Tracy McCollin (this can be found in Annex 5). One of the actions points was to host a workshop to identify how a joint EU ballast water sampling strategy can be developed and this workshop was held from 23rd-24th February, 2010 at EMSA in Lisbon. As the workshop had been held so close to the WGBOSV the final report was not ready but the host of the workshop (Brian Elliott, EMSA) provided an overview for the chair of WGBOSV to read to the group to outline the main outcomes of the workshop and also the specific areas where it was felt that the WGBOSV could provide input. There was a specific request for the group to suggest methods that would be suitable for use as an initial step for undertaking an indicative analysis of the ballast water to assess whether full scale compliance testing was required. The request was for methods that would be rapid, simple to use and would give an indication as to whether the ballast water may not be in compliance with the ballast water discharge standard. The methods would be something that could possibly be used by Port State Control as first step in the process of assessing compliance. The outcome of the discussion the group had on this issue will be covered in Term of Reference c).

3.2 Summary and references

The presentations provided by the group members provided information on a variety of issues related to this Term of Reference. Several countries reported that they had ballast water treatment systems at various stages of the Type Approval process and updates were also given regarding the availability of new testing facilities e.g. in Denmark. This is very positive progress and it would seem that there are now a number of ballast water treatment processes that are available to the shipping industry. Lloyds Register maintains a register of the systems that are available and this is a key document in providing a lot of information regarding the specifications of the treatment technologies available. The document is available from www.lr.org/bwm and is updated regularly. Other scientific reviews treatment technologies have also been carried out (Gregg *et. al.* 2009, Tsolaki and Diamadopoulos, 2009) and these provide a useful summary of the work that has been carried out to achieve the treatment technologies that are available to date.

Risk assessment was also dealt with both in the National Reports and through presentations on mathematical modelling and remote sensing that suggested ways in which high risk shipping routes or ballast water exchange zones could be identified. Further information was provided with regard to a rapid assessment study by Manfred Rolke on behalf of Christian Buschbaum and the abstract of this talk is provided below in section 2.2.1.

Discussion on ballast water sampling devices was limited within this term of reference as the members of the group discussed this in much greater detail under term of reference c) as this related to the discussion on representative sampling.

The issue of microbiology in ballast water and sediment was raised briefly and information was provided in the form of papers outlining the results of surveys of the microbial community in ballast water (Seiden *et. al.* 2010, Sun *et. al.* 2010)

3.2.1 Rapid assessment of non-native species in German coastal waters

Christian Buschbaum, Karsten Reise, Dagmar Lackschewitz

Intensive international trade along the global water ways has caused a dramatic increase in the introduction of alien species in native coastal ecosystem with substantial effects on local species communities and ecosystems. Despite strong consequences of alien species on ecosystem goods and services, no comprehensive concept exists for German coastal waters with the objective of both detection and assessment of exotic organisms. Thus, the aim of our pilot project was to get an overview of benthic alien species along the German North Sea and Baltic Sea coast. Due to the high probability that alien species first establish at ports and marinas in a new environment, we selected eight ports at the North Sea coast and four sites at the Baltic Sea as our study sites. At each location, we studied the species communities of artificial structures such as pontoons and boulders that provide a suitable habitat for exotic organisms. Additionally, we took sediment samples and identified all organisms to species level. At the North Sea coast, we found a total number of 103 species, 26 of them alien species. At the Baltic Sea coast we identified a total number of 81 species. With a number of 7, the occurrence of exotic species was comparatively low here. Besides the high number of non-native organisms we also detected three new species at the North Sea coast which were not found detected before (*Tricellaria inopinata*, Bryozoa; *Sinelobus stanfordi*, Tanaidacea; *Telmatogeton japonicas*, Diptera). The project enabled a first comprehensive overview on the occurrence and spatial distribution of non-native species in German coastal waters and, therefore, provides valuable information on the invasion status of single species and the arrival of new exotics. Additionally, it has the potential to serve as a first step for a long-term monitoring program on neobiota. This program would be an important tool to get significant information on the development and status of non-native species in German coastal waters.

3.2.2 References

- Gregg, M., Rigby, G. and Hallegraeff, G.M. 2010. Review of two decades of progress in the development of management options for reducing or eradicating phytoplankton, zooplankton and bacteria in ship's ballast water. *Aquatic Invasions*. 4 (3): 521-565.
- Seiden, J.M., Way, C. and Rivkin, R.B. 2010. Microbial hitchhikers: dynamics of bacterial populations in ballast water during a trans-Pacific voyage of a bulk carrier. *Aquatic Invasions*. 5(1): 13-22.
- Sun, B., Moulard, R., Way, C. and Rivkin, R.B. 2010. Redistribution of heterotrophic prokaryotes through ballast water: A case study from the west coast of Canada. *Aquatic Invasions* 5(1):5-11.
- Tsolaki, E. and Diamadopoulos, E. 2009. Technologies for ballast water treatment: a review. *Journal of Chemical Technology and Biotechnology*. 85: 19-32.

3.3 Term of Reference 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

The meeting was attended by representatives of ICES, IOC, CIESM and BMB. PICES was not represented at this meeting but the chair of WGBOSV (Tracy McCollin) and WGITMO (Judy Pedersen) had both attended a joint ICES/PICES meeting after the Marine Bio-invasions Conference in Portland, Oregon on 27th August, 2009 where issues of joint interest and potential areas for collaboration were discussed. The main areas for collaboration were to provide a list of taxonomic experts in ICES member states that could be called upon to identify any new species that had arrived in PICES member states and might be from the ICES area. Other issues that were discussed were the development and linking of databases of non native species. However, it was concluded that the databases are not yet at the stage where they can be amalgamated. The WGBOSV group was encouraged to put forward names of taxonomic experts.

A call for contributions to the ICES Annual Science Conference in Nantes, France 20-24th September, 2010 was also circulated amongst the group and it was highlighted that there will be a Theme Session on Global Change and Aquatic Bio-invasions. Members of the WGBOSV were encouraged to submit contributions to this session.

The IMO was also not represented at the meeting, partly owing to other commitments but also because there has been an ongoing problem with the fact that the IMO have no official record of an agreement to take part in the work of the WGBOSV. There has been an informal collaboration for several years but the IMO cannot put time aside to contribute to the meeting unless there is a formal agreement. On the advice of Dandu Pughuic of the IMO it was agreed that the group should draft a document requesting that the participation of the IMO be made formal. This document would then be sent to ICES and would be submitted to either the IMO Marine Environment Protection Committee (MEPC) in September, 2010 or the Committee on Bulk Liquids and Gases in February, 2011 depending on when the document is ready and can be submitted in accordance with the deadlines set by the IMO for submitting documents. The group made a start at drafting the document and further work was carried out after the meeting and the draft sent to ICES is in Annex 6.

Two requests were sent to the WGBOSV *via* the IOC. One related to a request for collaboration from the IOC Intergovernmental Panel on Harmful Algal Blooms (IOC IPHAB) on the issue of invasive phytoplankton in ballast water and the other was related to a request from GESAMP for members of the group to volunteer to review the "GloBallast Review Study on Establishing Equivalency in the Performance Testing and Compliance Monitoring of Emerging Alternative Ballast Water Management Systems". These requests are both contained within Annex 7. Prior to the meeting the chair (Tracy McCollin) of WGBOSV contacted the chair (Joe Silke) of the ICES Working Group on Harmful Algal Bloom Dynamics and discussed the possibility of collaboration towards responding to the request from IPHAB. The chairs of both groups agreed that they could respond to this request and agreed to raise it at their respective Working Group meetings. At the WGBOSV meeting it was agreed that the group could provide information regarding which phytoplankton had been found in ballast water and sediments in previous studies as a starting point for the WGHABD preparing a list of species that are likely to be transported in ballast water and may cause problems if introduced into new areas. The information provided by the group members was sent to the chair of WGHABD after the meeting and will be discussed at

their meeting in April, 2010. The chairs of both groups will then discuss the best way forward to respond to the request from the IOC IPHAB.

The request from GESAMP was forwarded to the group prior to the meeting and four members of the group volunteered to review the document. GESAMP will take a decision regarding who will carry out the review and will contact the volunteers to inform them of this decision.

3.4 Term of Reference c)

Discuss and evaluate the sampling strategies under consideration at IMO and provide comment with the aim to prepare a written submission to relevant IMO committees in response to requested information. Statistical experts will be invited to attend and contribute at the meeting.

In order to achieve a positive outcome for this term of reference the meeting was arranged so that one day was set aside for discussing this issue. The issue of sampling ballast water in order to ensure compliance with the discharge standard within the Ballast Water Convention is a topic that has proved very difficult to obtain consensus on. The main issues are how to sample ballast water in order to obtain a sample that is representative of the whole discharge, how much volume should be sampled and the effect taking a sample throughout the discharge or at different time intervals during the discharge has on the statistical analysis of the results of the sampling. Several experts were invited to give presentations outlining the results of various shore and ship based sampling experiments as well as presentations that covered the statistical theory of sampling ballast water. Other statistical experts also attended the meeting to provide advice and to aid the discussion.

The abstracts of the presentations, where available, are given below and the outcome of the group's discussion is provided after these.

Allegra Cangelosi, Northeast-Midwest Institute

A study by the Northeast-Midwest Institute which took place at the Great Ships Initiative land-based testing facility explored the relative representativeness of a range of ship discharge sampling options. A first set of tests compared the relative capacity of three in-line sampling methods with each other for capacity to collect live plankton and total protists. The output of this comparison over several trials was that an elbow shaped pitot such as that described by the United States Naval Research Laboratory (and also recommended in the IMO G2 Guidelines on Ballast Water Sampling) yielded the highest and least variable plankton density estimates in water drawn at 340 cubic meters per hour from an ambient water source in the Great Lakes. A second set of tests contrasted in tank sampling methods using the matched 200 cubic meter retention tanks at the GSI facility. In these tests, it was determined that an 80 micron net was best at collecting all forms of live zooplankton in the water masses analyzed, even those with minimum dimensions less than 50 microns. A third set of tests contrasted estimates developed based on replicate 80 um net samples with pump and hose at three depths (averaged) using a set of independent 200 cubic meter ambient water masses. These tests found the pooled pump and hose samples collected more representative samples than the 80 micron net samples, even under the ideal circumstances for plankton net sampling using the 200 cubic meter tanks at the GSI facility. Finally, the best in-line and best in-tank sampling methods were directly contrasted using independent 200 cubic meter water masses. In these analyses, continuous in-line sampling was found to be at least as representative if not more so than

the pump and hose sampling in tank. These findings corroborate the potential representativeness of continuous in-line sampling for compliance monitoring

Stephan Gollasch, GoConsult

Germany noted that the uncertainties to assess compliance with the IMO Ballast Water performance Standard D-2 Standard refer to the lack of knowledge how to take representative ballast water samples. There is no clarity regarding the number of samples to take, sample volumes, sampling during the entire discharge time of a ballast water tank or in the beginning, middle and end of a discharge event. The need for a representative sample, and the difficulties involved in obtaining such a representative sample, cannot be overstressed.

Consequently, Germany funded an onboard scientific ballast water sampling study comparing different sampling scenarios with the aim to evaluate how representative samples for compliance control with the D-2 Standards of the Ballast Water Management Convention may be taken. This study was undertaken in September 2009 on the Pure Car and Truck Carrier *Toronto* with the support of Wilhelmsen Ships Equipment (Lysaker, Norway) and Resource Ballast Technologies Ltd (Cape Town, South Africa). This voyage would not have been possible without the essential support of Whil. Wilhelmsen ASA as ship owner and Wilhelmsen Lines Car Carriers Ltd in Southampton (WLCC) as ship managers and the outstanding help of the crew.

The sampling team comprised of Dr. Stephan Gollasch (GoConsult, Hamburg, Germany), Prof. Dr. Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia) and Mariusz Slotwinski (Wilhelmsen Ships Equipment, Poland). The tests were independent from any possible onboard performance tests of the Resource ballast water treatment system. However, as ships currently are lacking in-line sampling points, this vessel was selected as such sampling points were installed on this vessel to test the performance of the treatment system in the future.

The key findings include

The exercise has demonstrated the great variability in the ability of the different sampling methods used. For this reason caution must be exercised when making any quantitative comparisons with ballast sampling methods used.

Although it may be inappropriate to base findings regarding sample representativeness on a single sampling voyage, the following tentative conclusions were drawn:

The sequential trials showed different organism numbers of the samples taken in beginning, middle and end, but no consistent trend could be identified,

Almost all unsplit samples contained less living organisms compared to the individual splits which may have resulted from the higher water volume sampled in unsplit samples (see below),

The sequential sampling events 2, 10 and 13 resulted in comparatively larger water volumes (> 4000 L) in the sample taken over the entire discharge time, but the viable zooplankton organism numbers in the sequential samples with smaller water volumes (ca. 300 – 750 L) are much higher (see below).

For zooplankton samples the sample volumes may have impacted negative on organism survival (the more volume was sampled the higher the number

of organism in the concentrated sample), and highly concentrated samples result in much higher organisms concentrations per water volume compared to nature which may have impacted organism viability,

Sampling has shown that organisms were not homogeneously distributed inside tanks, but no consistent trend was found.

Full recovery of organisms contained in ballast tanks may remain impossible, indicating that results of ballast water samplings may well underestimate the actual number of organisms (and species) being present in the ballast tank.

Recommendations

Although the results cannot be used to show a consistent trend, we recommend the following when planning to take representative samples:

When using nets in in-line samplings, ensure that the cod-end and as much as possible of the net filtering net surface is covered with water during the entire sampling process as otherwise organisms survival may be negatively impacted. This may be done by using larger buckets and placing the lower part of the net into the bucket,

During longer sampling times, i.e. more than 30 minutes, extract the organisms from the cod-end and transfer them to a 1 L bottle to avoid a negative impact on organism survival during the sampling process,

Especially zooplankton survival in concentrated samples is critical. We therefore recommend that these samples should be processed onboard immediately after sampling. Directly thereafter the phytoplankton samples should be processed,

For the phytoplankton sample processing it is recommended not to concentrate the samples onboard because the filtration causes damage to the cells resulting in unrepresentative viability counts,

For compliance control assessments phytoplankton viability tests should be done as soon after the samples were taken, but no longer than 2 days after the sampling event. In case this cannot be done onboard, the samples should be kept cool and it is further recommended to take two sets of samples, one living and a second preserved with Lugol solution,

In the sequential samples it was shown that the organism concentrations are different when sampling in the beginning, middle and end and no trend could be observed, i.e. phytoplankton and zooplankton samples show contrary results. This indicates that all samples, i.e. beginning, middle and end, are needed and one cannot only use one sampling sequence instead of all three to assess the organism numbers,

In case sequential samplings are undertaken, we recommend to use a 10 minute time window for each sample (i.e. beginning middle and end) as this seems to be a good compromise considering logistics during sampling, including the water volume and gear handling, and organism numbers,

As samples below 500 L showed very high differences in zooplankton organism numbers and the D-2 Standard refers to less than 10 organisms greater than 50 micron in minimum dimension per tonne, we recommend that water volumes for compliance control samplings should at best consist of at least 1000 L, but no more than 2000 L. The upper limit is recommended because higher volumes will likely result in very high zooplankton organism

densities in the concentrated samples which has a negative viability impact.

Ehsan Mesbahi, University of Newcastle

IMO's G2 guideline (Guidelines for ballast water sampling) clearly states that ballast water samples are required to be representative of the whole ballast water discharged. Enforcement and implementation of the ballast water convention largely depend on defensible case based on evidence that a ship entering territorial waters has not complied with regulations. Statistical representativeness of ballast water samples have been discussed in this study (Pazouki et. al. 2009) with additional emphasis on practicality of the sampling procedure. Universally accepted mathematical methodologies for determination of a representative number of "samples" from an unknown "population" have been used to identify minimum number of samples which could be considered statistically representative of the ship's ballast water. Results clearly indicate that a large amount of ballast water must be sampled to achieve certain level of confidence which could be translated as true representation of the ship's ballast water discharged and potentially used in any further legal actions by states or ship operators.

Pazouki, K., Cabezas-Basurko, O. and Mesbahi, E. 2009. Ballast Water Sampling: Methods, Analysis, Representativeness and Legal Issues. Report on behalf of the Maritime and Coastguard Agency. Newcastle University Project No. RP577.

Lisa Drake, Naval Research Laboratory Key West

Summary of presentation

It was shown by testing experimentally (in the laboratory) that zooplankton and protists in a homogenous sample meeting the IMO discharge standard followed a Poisson distribution. Applying the statistical theory behind these assumptions, it was calculated that to ensure a zooplankton sample was less than the IMO discharge standard, a 60m³ volume of sample would have to be collected, concentrated to 1 liter, and 20-ml of the concentrate analyzed. If a larger subsample or the entire concentrated sample was analyzed, the volume of sample collected would decrease. A count of more than 6 organisms in the sample would mean the water had exceeded the discharge standard. The work carried out has also looked at filtering mechanisms to assess whether there was damage to the organisms during sampling or an effect of crowding of the zooplankton within the sample (sources of sampling error).

Mario Tamburri, Marine Environmental Resource Center

Whitman Miller, George Smith, Mario Tamburri*, Greg Ruiz

Smithsonian Environmental Research Center, *University of Maryland Center for Environmental Science, Maritime Environmental Resource Center

Sampling Effort and Statistical Power at Threshold Densities: Investigating IMO > 50 µm Ballast Water Discharge Standards

Problem:

Assessing sampling effort to reliably resolve densities of >10/m³ from those of ≤10/m³, for live organisms >50 µm

Treatment system testing and compliance monitoring

Approach:

Model sampling statistics at IMO standard ($\leq 10/m^3$)

- Compare sampling effort and density

Poisson probability distributions used to estimate uncertainty for single treatment/dischARGE trials

- Mean
- 95% Confidence Intervals
- β and Statistical Power (quantify false negative rates)

Binomial experiments (multiple trials)

- Determine likelihood of detecting density $>$ threshold
- Reliability of process for quantifying extreme values (rare events)

Assumptions:

BW is sampled integratively from discharge pipe to control for any underlying spatial structure of organisms

Total discharge volume is processed

All live organisms $> 50 \mu m$ are captured/detected

Hypothesis:

Ho: treatment system reduces live organism density to $\leq 10/m^3$

Conclusion:

If the assumptions are kept, then these statistical models show that sample volumes of 5 to 10 m^3 can provide the statistical confidence (95%) and power required to determine if treated water is in compliance with IMO D2 standards for live organisms $> 50 \mu m$ in size in ballast water treatment testing and in compliance monitoring.

3.4.1 Outcome of discussion

Following all the presentations, the group discussed the findings of the various studies that had been presented and how these could be presented in a form that could be submitted to the IMO in order to provide input into the discussions at the Ballast Water and Biofouling Working Group. The group agreed that a paper should be submitted to the IMO outlining the main findings of the presentations. The paper would cover what volumes are necessary to ensure representativeness when samples are taken either as a continuous integrated sample or as discrete sequential samples (e.g. at the beginning, middle and end of the discharge). The statistical theory and the assumptions made would be described and the paper would provide details regarding the confidence intervals associated with each method of taking a sample. The paper should consider the required volumes that would be required to be sampled using each of these two methods i.e. continuous integrated or discrete samples. If possible, it would also be useful to include analysis from multiple vessel's discharge that looks for temporal variation in organism and particle concentrations during the complete discharge of tanks or vessels. This would give some indication as to whether samples should be collected during a particular period of discharge.

Overall, the group agreed that the organisms in the ballast tank generally agreed with the assumptions of a Poisson distribution but that stratification would also have to be taken into account and that taking an integrated sample over the whole of the

ballast water discharge was likely to require a much smaller volume of water to be sampled than if the samples were taken at discrete intervals during the discharge.

3.4.2 Request from European Maritime Safety Agency Workshop

As outlined above (Section 2.1.14) the European Maritime Safety Agency (EMSA) held a workshop in February, two weeks before the WGBOSV meeting and one of the outcomes was to request information from the WGBOSV regarding potential methods for carrying out an indicative analysis as outlined in section 6.3 of the G2 Guidelines for Ballast Water Sampling developed by the IMO. EMSA requested that the group discuss this issue and provide a list of methods that have the potential to be used as a rapid, simple and reliable method of assessing whether the ballast water is likely to be out of compliance with the D2 standard and there is a need to undertake more detailed sampling.

The group discussed this issue and came up with the following list of methods that could be tested to assess whether they had the potential to be used in this way.

One suggestion was that a ship strategic inspection based on risk assessment would be a way of choosing vessels that might be out of compliance and use this as a way of choosing which vessels should be targeted for full scale compliance testing.

Other methods that could be used on board the vessel (once threshold values have been identified) could be:

1. Chlorophyll a and in situ fluorescence
2. Swimming zooplankton
3. Adenosine triphosphate (ATP) for protists and bacteria. ATP transports chemical energy within cells for metabolism and could be used to assess whether there are viable cells present
4. Polymerase chain reaction (PCR) for bacteria and protists. PCR is a method of amplifying DNA and could be used to assess whether target organisms are present.
5. Proxy (chlorine levels or active substances)
6. Visual inspection of equipment or equipment log
7. Fv/Fm Pulse Amplitude Modulation (PAM). This can be used to detect chlorophyll content and photosynthetic activity in the water.
8. Continuous in-tank sampling

3.5 Term of Reference d)

Continue and elaborate the cooperation with PICES WG 21

A summary of the discussion of a joint ICES WGITMO and WGBOSV with PICES Working Group 21 held after the International Marine Bioinvasions Conference (IM-BIC) held in Portland, Oregon in August 2009 was presented to the group by Judy Pedersen (chair of ICES WGITMO). The main topics of discussion were:

PICES Taxonomy Project

This project was initiated with Japanese funding to develop a database of non-native species for PICES countries. The project included a rapid assessment survey of floating docks, buoys and sampling plates that had been deployed three months earlier. To date the sampling has taken place in Dalian, China (2008) and the Island of Jeju, Korea (2009). This approach has brought together local taxonomic experts and government officials and has enabled lists of non-native species to be generated for each country. Further work in ports using similar techniques has been undertaken by Japanese scientists.

A linked project has also been undertaken to better understand the current status and impacts of marine non-native species through effective prevention and monitoring measures. The project included a workshop that reviewed the regional status of marine non-native species, provided the scientific basis for management plans and also established the research priority and direction in the Western Pacific. This included establishing a quality assurance standard and protocol for scientific data on non-native species.

PICES Marine Invertebrate Database

The purpose of this database is to provide a common dataset for all the PICES countries that all the countries can input data into and also access all the data that is stored in the database. Currently the database is quite complicated and requires a lot of information such as references and extensive information on habitat, life history, distribution, impact etc. The database is not yet at a stage where it has been demonstrated to function fully and therefore the ICES groups have not taken on this approach for managing their data. However, the ICES groups are in contact with the two developers of the database and it was hoped they would be able to attend the ICES meetings but unfortunately this was not possible.

Discussion on Collaborative Projects

Although there were several activities proposed for joint efforts such as 1) joint scientific studies amongst scientists, 2) setting up fellowships for young scientists and 3) developing a database of taxonomic experts to share many of these would be limited by the availability of funding. It was agreed that the list of taxonomic experts would be the only feasible option at this time and the groups were encouraged to provide lists of experts that would be willing to be added to the list and consulted from time to time. This was discussed within the ICES Working Group meetings and it was agreed that group members should consult with possible candidates for the list and forward names onto Judy Pedersen (chair of ICES WGITMO).

3.6 Term of Reference e)

To provide data and information on how climate change may alter the distribution of NAS and shipping operations, and hence the risks for introductions of NAS via shipping to the benefit of ICES SGCC (Steering Group on Climate Change).

This term of reference was discussed on several occasions throughout the meeting and the group also had a specific discussion on this topic. It was agreed that climate change is likely to alter the distribution of non native species and that changes in shipping operations e.g. vessels using the Northwest Passage, will provide another route for the transport of non native species. The group agreed that this was an issue

of importance and should be kept on the agenda for future meetings. The group had a general discussion regarding the effects of climate change and although there was general agreement that climate change will have an influence there is very little scientific evidence for how species might respond. There is some suggestion that some species will increase their ranges in response to warmer temperatures e.g. *Crassostrea gigas* and *Marenzelleria* spp. but in order to be sure that it is climate change that is having an effect it would be important to set out criteria for assessing this. It was agreed that there is currently a lot of uncertainty regarding how non native species might respond to changes in climate.

Members of the group provided a series of references that have examined the issue of climate change and the effect on non native species. Some papers have specifically examined the influence of reduced ice cover and the movement of species between oceans (Reid et. al. 2007) and others have described the potential impact of climate change on the range of non native and native species (Reid et. al. 2009, Vermeij and Roopnarine, 2008). Climate change is also mentioned as a potential factor that will have to be taken in to consideration when dealing with non native species that are already present and how changes will influence the spread within the ecosystem (Rooney and Paterson, 2006). Other papers discuss the potential for the spread of disease (Lipp et. al. 2002) such as Cholera.

3.6.1 References in relation to climate change

- Lipp, E.K., Huq, A. and Colwell, R.R. 2002. Effects of Global Climate Change on Infectious Disease: the Cholera model. *Clinical Microbiology Reviews* 15(4): 757-770.
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- Reid, P.C., Johns, D.G., Edwards, M., Starr, M., Paulin, M. and Snoeijs, P. 2007. A biological consequence of reducing Arctic ice cover: arrival of the Pacific diatom *Neodenticula seminae* in the North Atlantic for the first time in 800 000 years. *Global Change Biology* 13: 1910-1921.
- Rooney, R.C., and Paterson, M.J. 2006. Ecosystem effects of rainbow smelt (*Osmerus mordax*) invasions in inland lakes: a literature review. *Can. Tech. Rep. Fish. Aquat. Sci.* 2845: iv + 33 p.
- Vermeij, G.J. and Roopnarine, P.D. 2008. The Coming Arctic Invasion. *Science* 321: 780-781.

4 Closing of the meeting

The meeting closed at lunchtime on 10th March, 2010 after the joint meeting with WGITMO. The chair thanked the hosts at BSH for their work in organising the meeting and providing the meeting room and refreshments. The chair also thanked the participants for their input to the meeting and the preparations they had made in order to present their work. The chair also thanked the rapporteur, Gemma Quilez Badia, for her help during the meeting.

Annex 1: List of participants

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

08 – 10 March 2010

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Annex 2: Agenda

ICES/IOC/IMO WORKING GROUP ON BALLAST AND OTHER SHIP VECTORS

Hamburg, Germany, 8-10th March 2009

Federal Maritime and Hydrographic Agency

Bernhard-Nocht-Str. 78

20359 Hamburg

MONDAY 8TH MARCH

08.30 – 09.00 **Setting up computers (someone from BSH on hand to help)**

09.00 **Opening of the Meeting**

Welcoming remarks (Dr. Bernd Brügge, Head of the Department Marine Science of the Federal Maritime and Hydrographic Agency and Tracy McCollin)

Logistics

Introduction of Participants and Guests

09.45 **Review of Terms of Reference and Agenda**

10.00 **ToR a and b**

Highlights from the National Reports. I have allowed 15 minutes each but if people only want to give a very brief overview for a few minutes that is fine as others will require more time.

10.00 – 10.15 Belgium Francis Kerckhof

10.15 – 10.30 Canada Sarah Bailey

10.30 – 10.45 Denmark Per Andersen

10.45 – 11.00 Estonia Henn Ojaveer

11.00- 11.30 **Coffee break**

11.30 – 11.45 France Daniel Masson

11.45 – 12.00 Germany Stephan Gollasch/Manfred Rolke

12.00 – 12.15 Germany Hanno Seebens

12.15 – 12.30 Germany Kerstin Stelzer

12.30 – 12.45 Greece Argyro Zenetos

12.45 – 13.00 Discussion

13.00 –14.00 **Lunch**

14.00 – 14.15 Japan Yukio Nagahama

14.15 – 14.30 Lithuania Sergej Olenin (presented by T. McCollin)

14.30 – 14.45	Spain	Gemma Quilez Badia
14.45 – 15.00	Discussion	
15.00 – 15.30	Coffee	
15.30 – 15.45	UK	Tracy McCollin
15.45 – 16.00	US	Judy Pedersen
16.00 – 16.15	Netherlands	Cato ten Hallers-Tjabbers
16.15 – 16.30	EC	Brian Elliott (by correspondence)
16.30 – 17.15	Discussion of points raised during the overview of the National Reports and any other points in relation to ToR a) and b).	

17.15 Closing remarks

Review of tomorrow's agenda

Overnight drafting tasks.

17.30 Adjournment of Day 1**TUESDAY 9TH MARCH****09.00 Announcements****09.30 ToR c)**

The morning will consist of presentations directly related to sampling strategies and related statistical issues. Melanie Frazier from the US has provided a statistical background by correspondence.

09.30 – 10.00 Allegra Cangelosi (sampling background)

10.00 – 10.30 Stephan Gollasch (sampling background)

10.30 – 11.00 Ehsan Mesbahi (statistical background)

11.00 – 11.30 Coffee

11.30 – 12.00 Lisa Drake (statistics and sampling)

12.00 – 12.30 Mario Tamburri (land based testing/statistical background/compliance)

12.30 – 13.00 EMSA workshop outcome/ISO standard (Tracy McCollin)

Further presentations and discussion with the aim to start drafting a document for submission to IMO.

13.00 – 14.00 Lunch

The afternoon session will consist of further drafting of the IMO document.

15.00 – 15.30 Coffee

ToR e) Discussion regarding the issue of climate change

Cooperation with IMO and IOC

Requests from GESAMP/IOC/IMO

ToR for 2011 WGBOSV meeting

17.00 Closing remarks

Review of tomorrow's agenda

Overnight drafting tasks.

17.30 Adjournment of Day 2

WEDNESDAY 10TH MARCH

Joint meeting with WGITMO

09.00 Opening of the meeting

Welcoming remarks (Dr. Monika Breuch-Moritz, President of the Federal Maritime and Hydrographic Agency BSH, Judy Pedersen and Tracy McCollin)

Logistics

Introduction of Participants and Guests

09.45 Review of Terms of Reference and Agenda Items relevant to both groups

09.45 – 10.15 Rohan Holt (UK) *Didemnum vexillum* eradication in Wales

(Presented by Tracy McCollin)

10.15 – 10.45 Christian Buschbaum (Germany) Rapid Assessment

Presented by Manfred Rolke

10.45 – 11.00 Discussion

11.00 – 11.30 Coffee

11.30 – 13.00 ToR d)

Cooperation with PICES WG 21

Any other issues common to both groups

Climate change

Databases

Reporting issues and streamlining between the groups

Meeting venue for 2011

Review of WGBOSV ToR 2011

Intersessional work to be carried out

Closing WGBOSV and concluding remarks

13.00 – 14.00 Lunch

Annex 3: WGBOSV terms of reference for the next meeting

The ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors [WGBOSV] (Chair: T. McCollin, United Kingdom) will meet in La Rochelle, France from 14-16 March, 2011 with a back to back meeting with the Working Group on Introductions and Transfers of Marine Organisms on the morning of the 16th to:

- a) Continue to critically review and report on the status of shipping vector research with an emphasis on new developments in ballast water treatment technology, risk assessment and ballast water sampling and analysis in order to support the ongoing work at IMO.
- b) Continue its global review of shipping vectors through the participation of representatives from ICES, EEA, IMO, IOC, UNEP, CIESM, BMB and PICES Member States and experts as invited,
- c) Further discuss and evaluate the sampling strategies under consideration at IMO and provide comment to relevant IMO committees. Experts (e.g. statistical, engineering and ship operations) will be invited to attend and contribute at the meeting,
- d) Continue and elaborate the cooperation with PICES WG 21,
- e) To provide data and information on how climate change may alter the distribution of NAS and shipping operations, and hence the risks for introductions of NAS via shipping e.g impacts of Northwest Passage.
- f) Collaborate with other ICES/IOC Expert Groups as appropriate (e.g. Working Group on Harmful Algal Bloom Dynamics WGHABD)

WGBOSV will report by 1st April, 2011 to the attention of the ACOM Committee.

Supporting Information

Priority:	The Working Group review and report on the scientific and technical development in relation to ballast water and shipping vectors. As a joint working group it also follows and supports the work within IMO and the IOC on the same topics.
Scientific justification and relation to action plan:	
Resource requirements:	None.
Participants:	The Group is normally attended by some 25–35 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	ACOM.
Linkages to other committees or groups:	There is a very close working relationship with the Working Group on Introductions and Transfers of Marine Organisms (WGITMO), the Working Group on Harmful Algal Bloom Dynamics (WGHABD) and PICES Working Group 21.
Linkages to other organizations:	The work of this group is closely linked to work carried out by European Environment Agency (EEA), European Maritime Safety Agency (EMSA), the International Maritime Organization (IMO), Intergovernmental Oceanographic Commission (IOC), United Nations Environment Programme (UNEP), the Mediterranean Science Commission (CIESM), Baltic Marine Biologists (BMB) and PICES.

Annex 4: Recommendations

We suggest that each Expert Group collate and list their recommendations (if any) in a separate annex to the report. It has not always been clear to whom recommendations are addressed. Most often, we have seen that recommendations are addressed to:

- Another Expert Group under the Advisory or the Science Programme;
- The ICES Data Centre;
- Generally addressed to ICES;
- One or more members of the Expert Group itself.

RECOMMENDATION	FOR FOLLOW UP BY:
1. Submit a request for the formal involvement of IMO in the WGBOSV	Tracy Mc Collin and ICES
2. Produce a submission for IMO on the sampling strategies as discussed in the 2010 meeting of WGBOSV	WGBOSV and ICES
3. Respond to a request for IOC IPHAB	WGBOSV, WBHABD and ICES
4. Respond to a request from GESAMP	GESAMP
5.	
6.	

After submission of the report, the ICES Secretariat will follow up on the recommendations, which will also include communication of proposed terms of reference to other ICES Expert Group Chairs. The "Action" column is optional, but in some cases, it would be helpful for ICES if you would specify to whom the recommendation is addressed.

Annex 5 National Reports

5.1 Canada

Author(s) and contact details:

Sarah Bailey, Fisheries and Oceans Canada;

sarah.bailey@dfo-mpo.gc.ca

A Transport Vectors

1 Ballast

1.1 Biology of Ballast Water

TITLE: Hydrodynamics of ballast water discharge

DESCRIPTION: In an effort to assess how effective the proposed IMO D2 standards will be, an understanding of the dilution of ballast water into the recipient harbour water is needed. The short-range (< 1 km) and long-range (up to 8 km) dilution and dispersal of discharged ballast water was measured at two locations in the Great Lakes: Goderich, ON (a semi-enclosed port) and Sarnia, ON (a berth along a fast-flowing river). Results are currently being analyzed in the context of implications on population density of discharge taxa.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

1.2 Ballast Water Treatment

TITLE: Shipboard testing of NaCl brine as an emergency ballast water treatment.

DESCRIPTION: Six shipboard trials were conducted in 2008-2009 to evaluate the biological efficacy of brine treatment under operational conditions. Three tests were conducted from tanks containing large volumes of water with a treatment application of low salinity (45ppt) for multiple days of exposure. Conversely, three tanks containing only residual amounts of ballast water were treated with high salinity (115 ppt) for a short duration (hours). Results are being analyzed and will be submitted for publication in 2010.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

1.3 Ballast Water Sampling

TITLE: Ballast Water Sampling Methods

DESCRIPTION: The Canadian government has purchased a high resolution laser optical plankton counter, a FlowCAM, and an epi-fluorescent microscope with the goal to further develop sampling and analysis protocols for ballast water. The project will initially focus on organisms in the greater than 50 micron size class.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

TITLE: Ballast Water Sampling at Canadian Arctic Ports

DESCRIPTION: The introduction of ANS by ship vectors has been identified as an activity that may negatively impact the Canadian Arctic ecosystem, but there has been no scientific evaluation of the current risk level. In addition, climate change may increase the risk of ANS introductions to the Arctic because melting of the polar ice cap will allow increased vessel access to Arctic waters. An Arctic sampling study has been initiated at the most active ports (Churchill and Deception Bay) in order to quantify propagule pressure by ballast water to the ports. Sampling will continue in 2010.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

TITLE: Ballast Water Sampling of Domestic Ships on the Great Lakes

DESCRIPTION: Ballast operations of domestic ships operating on the Great Lakes have been highlighted as a potential vector of introduction (moving AIS from Eastern Canadian ports) and spread (between lakes). A ballast water sampling study was conducted in 2007-2008 to examine the species composition and to quantify the level of risk. The results are currently being analyzed and a publication is expected in 2010. (See also Rup *et al.* 2010)

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

1.4 Ballast Water Legislation/Regulations

TITLE: Alternate Exchange Zones

DESCRIPTION: Fisheries and Oceans Canada has been working to provide additional advice to Transport Canada regarding selection of alternate exchange zones. In 2009, three regions were considered: the Beaufort Sea, the Hudson Strait and Newfoundland. The report for Hudson Strait is available as a research document (Stewart & Howland 2009), while the remaining reports should be available in 2010.

PROJECT LEADER: Hudson Strait and Beaufort Sea: Kimberly Howland – Fisheries and Oceans Canada. Kimberly.Howland@dfo-mpo.gc.ca

Newfoundland: Cynthia McKenzie – Fisheries and Oceans Canada. Cynthia.mckenzie@dfo-mpo.gc.ca

- 2 Hull Fouling
- 2.1 Biology of Hull Fouling
- 2.2 Hull Fouling Treatment
- 2.3 Hull Fouling Sampling

TITLE: Hull Fouling Sampling at Canadian Arctic Ports

DESCRIPTION: The introduction of ANS by ship vectors has been identified as an activity that may negatively impact the Canadian Arctic ecosystem, but there has been no scientific evaluation of the current risk level. In addition, climate change may increase the risk of ANS introductions to the Arctic because melting of the polar ice cap will allow increased vessel access to Arctic waters. An Arctic sampling study has been initiated at the most active ports (Churchill, Iqaluit and De-

ception Bay) in order to quantify propagule pressure by hull fouling to the ports. Sampling will continue in 2010.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

TITLE: Hull Fouling Sampling at Canadian Ports

DESCRIPTION: A comprehensive hull fouling sampling project was conducted in 2007-2009 at ports across Canada's west coast, east coast and Great Lakes. 20 ships were sampled by underwater divers in each of the three regions, so that a comparative assessment of risk could be made. Results for the Great Lakes are published and indicate that risk of hull fouling to freshwater ports is minimal (Sylvester & MacIsaac 2010). Results from the east and west coast regions should be published in 2010.

PROJECT LEADER: Francisco Sylvester – Canadian Aquatic Invasive Species Network; University of Windsor. fsf@uwindsor.ca

- 2.4 Hull Fouling Legislation/Regulations
- 3 Sediments
 - 3.1 Biology of Sediments
 - 3.2 Sediment Treatment
 - 3.3 Sediment Sampling

TITLE: Evaluation of the discharge of ballast sediments with deballasting

DESCRIPTION: In order to better understand the risk of introduction associated with ship sediments, this project will examine the proportion of ballast sediments that is released during deballasting procedures. We will also examine which portion (i.e., strata) of the sediments is released. That is, are only surficial sediments released or are sediments and their associated fauna mixed at each ballasting and/or deballasting event. The work will also evaluate the sediment strata-dependent viability of phytoplankton cysts and diapausing stages.

PROJECT LEADER: Nathalie Simard – Fisheries and Oceans Canada. Nathalie.simard@dfo-mpo.gc.ca

- 3.4 Sediment Legislation/Regulations
- 4 Sea Chests
 - 4.1 Biology of Sea Chests
 - 4.2 Sea Chest Treatment
 - 4.3 Sea Chest Sampling

TITLE: Sea-chests as a Potential Vector for Aquatic Invasive Species along Canadian Coasts

DESCRIPTION: The primary goal of this project is to identify and quantify the communities, including potential AIS, being transported in sea-chests of both trans-oceanic and intra-continental ships entering Pacific and Atlantic ports and to estimate the potential propagule pressure from ships' sea-chests exerted on ports on both coasts of Canada. Potential vessels "of interest" are being sampled

opportunistically based on schedules provided by dry dock facilities. All sampling is being conducted in accordance with a national standard developed for sampling sea-chests for AIS. This ongoing project will be completed in 2010. A publication is expected in 2010.

PROJECT LEADER: Nathalie Simard – Fisheries and Oceans Canada. Nathalie.simard@dfo-mpo.gc.ca

4.4 Sea Chest Legislation/Regulations

5 Others

(see Handbook of Invasion Vectors, prepared by WGITMO and published as ICES Cooperative Research Report)

5.1 Biology

5.2 Treatment

5.3 Sampling

5.4 Legislation/Regulations

B Invasive Species Management

1 Eradication Programmes

2 Management and Control of Invasive Species

C Risk Assessment Approaches

TITLE: National risk assessment of ship-mediated vectors of AIS Introductions.

DESCRIPTION: This ongoing project is conducting a risk assessment of the shipping vector to assess the risk of AIS introductions to regions across Canada. This risk assessment will be based on analyses of vector activity (shipping traffic patterns) and environmental matching between donor and recipient ports. It will include a measure of impact potential based on connectivity to global high-volume ports. Canada plans to begin to establish guidelines for vector-based risk assessments this year through the national Centre of Expertise for Aquatic Risk Assessment.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca

D Occurrence of New Ship-mediated Introduced Species

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Economic (quantify if possible)

Ecological

F Other Relevant Information**G References**

Stewart, D.B., and K.L. Howland. 2009. An ecological and oceanographic assessment of alternate ballast water exchange zone in the Hudson Strait Region. DFO Canadian Science Advisory Secretariat Research Document 2009/008. vi + 96 p.

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Sylvester, F., and H.J. MacIsaac. 2010. Is vessel hull fouling an invasion threat to the Great Lakes? *Diversity and Distributions* 16:132-143.

5.2 Estonia

Author: Henn Ojaveer

There is neither ongoing nor planned ballast-water related research in Estonia. According to the HELCOM Baltic Sea Action Plan, Baltic Sea countries should ratify the IMO BWC preferably in 2010 but no later than 2013. For this purpose, HELCOM Correspondence Working Group on the Implementation of the HELCOM Ballast Water Road Map was created where all HELCOM member countries participate. Activities of this group has already resulted in several reports. It is currently planned that Estonia will ratify the convention in 2013. For this purpose, one national coordination meeting has already held and another was planned for 2010 with involvement of representatives from all key authorities, by incl. also Ministry of Environment and Ministry of Economy and Communication. It is very likely that monitoring of alien species will be started in 2010, although probably in a very limited scope.

5.3 Germany

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A Transport Vectors

1 Ballast water

EU Interreg Project Ballast Water Opportunity (BWO)

This project is funded by the European Regional Development Fund (ERDF) and aims at the unified ratification and implementation of the BWMC in the North Sea Region. Within the different work packages the project deals with regional cohesion (coherence, harmonization and transparency), ballast water treatment systems (knowledge transfer, innovation, test bed, demonstration and certification of ballast water treatment systems), detection for monitoring and compliance control, strategies and dissemination.

For this project approval was granted by the Steering Committee of the Interreg IVb North Sea Region Programme in December and it started January 1st 2009.

This Interreg IVb North Sea project involves all relevant stakeholders in the North Sea region. The project is composed of 6 Workpackages:

- o WP1 - Organisation, Coordination and Management
- o WP2 - Coherence, Harmonisation & Transparency
- o WP3 - Knowledge transfer, Innovation, Test bed, Demonstration and Certification for Ballast Water Treatment Systems (BMTS)
- o WP4 - Knowledge transfer, Innovation, Test bed and Certification for Detection, Monitoring, and Compliance Enforcement Technology.
- o WP5 - Strategies
- o WP6 - Dissemination

Germany is responsible for WP2 (BSH) and WP4 (GoConsult).

Although in its early stages, the project yielded some important results in its first year. WP2 was able to initiate dialogue between the North Sea region countries on a number of issues needing standardisation. These range from questions of type approval for ballast water management systems to discussion of areas for exchange of ballast water and a framework for exemptions from the convention's regime. Progress in other WPs include the opening of additions test facilities at NIOZ, as well as the research into ballast water sampling both for certification and compliance control. Information on the project can be found at: <www.NorthSeaBallast.eu>.

1.1 Biology of Ballast Water

1.2 Ballast Water Treatment

Approval of Ballast Water Treatment Systems

The Federal Maritime and Hydrographic Agency (BSH) is responsible for the type approval of ballast water treatment systems in Germany and is currently involved in eleven approval procedures that are progressed at different rates ranging from one that received already a Type Approval Certificate to one with Final Approval, four with Basic Approval, and the remaining being busy with preparatory activities. For further details see http://www.bsh.de/en/Marine_data/Environmental_protection/Ballastwater/index.jsp

The consultancy company GoConsult, run by S. Gollasch, continues to be involved in onboard performance tests of ballast water treatment systems. More than 40 test voyages were undertaken since 2004 to test more than 10 different ballast water treatment systems.

1.3 Ballast Water Sampling

Germany noted that the uncertainties to assess compliance with the IMO Ballast Water performance Standard D-2 Standard refer to the lack of knowledge how to take representative ballast water samples. Uncertainty exists regarding the number of samples to take, sample volumes, sampling during the entire discharge time of a ballast water tank or in the beginning, middle and end of a discharge event. The need for a representative sample, and the difficulties involved in obtaining such a representative sample, cannot be overstressed.

Consequently, Germany funded an onboard scientific ballast water sampling study comparing different sampling scenarios with the aim to evaluate how representative samples for compliance control with the D-2 Standards of the Ballast Water Management Convention may be taken. This study was undertaken in September 2009 on the Pure Car and Truck Carrier Toronto with the support of Wilhelmsen Ships Equipment (Lysaker, Norway) and Resource Ballast Technologies Ltd (Cape Town, South Africa). This voyage would not have been possible without the essential support of Whil. Wilhelmsen ASA as ship owner and Wilhelmsen Lines Car Carriers Ltd in Southampton (WLCC) as ship managers and the outstanding help of the crew.

The sampling team comprised of Dr. Stephan Gollasch (GoConsult, Hamburg, Germany), Prof. Dr. Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia) and Mariusz Slotwinski (Wilhelmsen Ships Equipment, Poland). The tests were independent from any possible onboard performance tests of the Resource ballast water treatment system. However, as ships currently are lacking in-line sampling points, this vessel was selected as such sampling points were installed on this vessel to test the performance of the treatment system in the future.

The key findings include

The exercise has demonstrated the great variability in the ability of the different sampling methods used. For this reason caution must be exercised when making any quantitative comparisons with ballast sampling methods used.

Although it may be inappropriate to base findings regarding sample representativeness on a single sampling voyage, the following tentative conclusions were drawn:

The sequential trials showed different organism numbers of the samples taken in beginning, middle and end, but no consistent trend could be identified,

Almost all unsplit samples contained less living organisms compared to the individual splits which may have resulted from the higher water volume sampled in unsplit samples (see below),

The sequential sampling events 2, 10 and 13 resulted in comparatively larger water volumes (> 4000 L) in the sample taken over the entire discharge time, but the viable zooplankton organism numbers in the sequential samples with smaller water volumes (ca. 300 – 750 L) are much higher (see below).

For zooplankton samples the sample volumes may have impacted negative on organism survival (the more volume was sampled the higher the number of organism in the concentrated sample), and highly concentrated samples result in much higher organisms concentrations per water volume compared to nature which may have impacted organism viability,

Sampling has shown that organisms were not homogeneously distributed inside tanks, but no consistent trend was found.

Full recovery of organisms contained in ballast tanks may remain impossible, indicating that results of ballast water samplings may well underestimate the actual number of organisms (and species) being present in the ballast tank.

Recommendations

Although the results cannot be used to show a consistent trend, we recommend the following when planning to take representative samples:

When using nets in in-line samplings, ensure that the cod-end and as much as possible of the net filtering net surface is covered with water during the entire sampling process as otherwise organisms survival may be negatively impacted. This may be done by using larger buckets and placing the lower part of the net into the bucket,

During longer sampling times, i.e. more than 30 minutes, extract the organisms from the cod-end and transfer them to a 1 L bottle to avoid a negative impact on organism survival during the sampling process,

Especially zooplankton survival in concentrated samples is critical. We therefore recommend that these samples should be processed onboard immediately after sampling. Directly thereafter the phytoplankton samples should be processed,

For the phytoplankton sample processing it is recommended not to concentrate the samples onboard because the filtration causes damage to the cells resulting in unrepresentative viability counts,

For compliance control assessments phytoplankton viability tests should be done as soon after the samples were taken, but no longer than 2 days after the sampling event. In case this cannot be done onboard, the samples should be kept cool and it is further recommended to take two sets of samples, one living and a second preserved with Lugol solution,

In the sequential samples it was shown that the organism concentrations are different when sampling in the beginning, middle and end and no trend could be observed, i.e. phytoplankton and zooplankton samples show contrary results. This indicates that all samples, i.e. beginning, middle and

end, are needed and one cannot only use one sampling sequence instead of all three to assess the organism numbers,

In case sequential samplings are undertaken, we recommend to use a 10 minute time window for each sample (i.e. beginning middle and end) as this seems to be a good compromise considering logistics during sampling, including the water volume and gear handling, and organism numbers,

As samples below 500 L showed very high differences in zooplankton organism numbers and the D-2 Standard refers to less than 10 organisms greater than 50 micron in minimum dimension per tonne we recommend that water volumes for compliance control samplings should at best consist of at least 1000 L, but no more than 2000 L. The upper limit is recommended because higher volumes will likely result in very high zooplankton organism densities in the concentrated samples which has a negative viability impact.

1.4 Ballast Water Legislation/Regulations

Amendment of Federal German Nature Protection Law (BNatSchG)

The Amendment of the BNatSchG from 29. July 2009 entered into force 1. March 2010. The amendments referred to here concern "non-native, foreign and invasive species". The new version of BNatSchG paragraph 40 addresses non-native species.

In addition to preventive measures, the obligation to monitor and eradicate or control as well as requirements to get permission to release plants or animals into the wild, the liability measures against the unauthorized release of plants and animals taken by several German Federal States is now applicable to the entire country as long as invasive species are concerned.

The new version of the BNatSchG is available as PDF file at:

http://www.bmu.de/naturschutz_biologische_vielfalt/downloads/doc/44597.php

2 Hull Fouling

There are no recent research activities regarding hull fouling of vessels.

3 Sediments

There are no recent research activities regarding vessel sediment.

4 Sea Chests

There are no recent research activities regarding sea chests of vessels.

B Invasive Species Management

There are no recent activities regarding eradication programmes nor management and control efforts of invasive species in the aquatic environment.

C Risk Assessment Approaches

A project supported by the European Space Agency in which the applicability of satellite earth observation data for the application of ballast water exchange is investigated. The project Ballast Water is an Innovator II project, conducted under the Data User Element (DUE, www.esa.int/duel) of the European Space Agency (ESA). The DUE aims to bridge the gap between research projects, and the sustainable provision of Earth Observation products at an information level that fully responds to the operational needs of User Communities. The Innovator projects have the objective to

demonstrate applicability of remote sensing applications in new fields. They are test beds for novel and innovative ideas.

The Ballast Water Project has been started in January 2009 under the lead of Brockmann Consult with BSH (Federal Maritime and Hydrographic Agency Germany) as end user. The goal is to develop a risk assessment for ballast water exchange in the North Sea and Baltic Sea which might become a tool for supporting the implementation of the IMO Ballast Water Management Convention.

A study on quantifying the probability of invasion through ballast water exchange through global shipping was conducted at the University of Oldenburg. The scientists used AIS data for ships larger than 10,000 gt for the year 2007 and developed a network of global ship movements including almost 1,000 ports, 16,000 ships and 500,000 ship movements. For each ship movement a probability of invasion is calculated depending on 1) environmental similarity of ports calculated from temperature and salinity measurements/estimates, 2) biogeographical similarity of ports and 3) travel time of the ship. Using these quantities, an invasion probability can be calculated each time a ship called a port. The model enables a probability calculation for each link between two ports incorporating all ships traveling on this link, for each port, country, ecoregion, etc. It is further possible to compare the vulnerability to get invaded among regions and ports, to detect hot spots of invasion, dominant pathways of invasion and main source regions from which bioinvasion is most likely to occur. Ship types and seasonal dynamics can also be distinguished. A first paper describing the network of global shipping is recently released (Kaluza *et al.* 2010) and others will follow.

D Occurrence of New Ship-mediated Introduced Species

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
<i>Lennoxia faveolata</i>	2009: 01.12.2009 08.12.2009 16.12.2009	Southern Baltic: 54° 08,55' N 11° 50,00' E	unknown	Only few specimen	Leibniz Inst. for Baltic Sea Research Warnemünde, Germany

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

There are no recent research activities regarding the impact of introduced species. However, mesocosm experiments of *Mnemiopsis leidyi* vs. the native *Aurelia aurita* are planned for later this year to be carried out at the Institute for Marine Research in Kiel.

Economic (quantify if possible)

Ecological

F Other Relevant Information

G References

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- Nehring, S. & Meer, U. van der (in press): First record of a fertilized female blue crab, *Callinectes sapidus* Rathbun, 1896 (Crustacea: Decapoda: Brachyura), from the German Wadden Sea and subsequent secondary prevention measures. – Aquatic Invasions 5.

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5.4 Greece

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A Transport Vectors

Results of ongoing research project(s)

Project name: "Preliminary study of alien biota in the SE Aegean Sea" performed along the coasts of Rhodes Island (2008-2009).

Financed by: Prefecture of Rhodes island, Greece

Contact details: M. Corsini-Foka e-mail : mcorsini-foka@hsr-ncmr.gr

Results:

During 20 experimental boat seining, conducted up to 30 m of depth along the coasts of Rhodes on sandy-muddy bottom covered by vegetation and sandy bottom, 10 fish species comprising (13,5%) of the fish diversity were of Indo-Pacific origin. These include the earlier invaders *Siganus rivulatus*, *Stephanolepis diaspros*, *Upeneus moluccensis* and *Siganus luridus* as well as the most recent *Pteragogus pelycus*, *Sphyræna chryso-tænia*, *Fistularia commersonii*, *Upeneus pori*, *Lagocephalus suezensis* and *Lagocephalus sceleratus*. The monitoring of the area has confirmed the establishment of recent alien species in the SE Aegean. Thus, *Percnon gibbesi* and *Seriola fasciata* aliens of Atlantic origin were found to expand around the island. In addition, rare species such as the Indo-Pacific *Myra subgranulata*, *Synaptula reciprocans*, *Aplysia dactylomela*, *Callionymus filamentosus*, *Sphyræna flavicauda*, *Etrumeus teres*, *Petroscirtes ancyllodon*, *Torquigener flavimaculosus*, and *Scomberomorus commerson* were often encountered in the study area. 2 new species for the Greek waters were collected.

Related publications: HCMR 2009; Corsini *et al.*, submitted, Kondilatos *et al.*, submitted

Project name: Record of the benthic fauna in the National Marine Park of Zakynthos (2009)

Financing: Management Board of NMPZ

Coordinator: Dr Maria Thessalou-Legaki

project duration: 1 year: Jan-Dec 2009

Short description: The aim of the project was the recording of the benthic fauna in all dominant habitat types in the National Marine Park of Zakynthos. Specifically, the endobenthic macrofauna of soft bottoms and the epibenthic megafauna of hard bottoms and *Posidonia oceanica* meadows were studied.

Results: For selected species, including five alien species (*Percnon gibbesi*, *Siganus luridus*, *Caulerpa racemosa*, *Ganonema farinosum*, *Lophocladia lallemandii*, *Styopodium schimperi*), either population density or occupancy was estimated.

Related publications: Katsanevakis *et al.*, 2010; Katsanevakis *et al.*, submitted

Project name: Assessment of impact of four Invasive Alien Species (IAS) and fish diversity over *Posidonia oceanica* beds as related to IAS on a recently invaded area of the eastern Mediterranean

Parties:

- Department of Marine Ecology, Faculty of Science, Goteborg University, Sweden.
- Hydrobiological Station of Rhodes, Hellenic Centre for Marine Research

contact details: Stefanos Kalogirou, PhD student e-mail: skalogirou@hcmr.gr

Aim Quantitative assessment of the fish assemblage associated with *Posidonia oceanica* meadows and sandy bottoms in the eastern Mediterranean. Temporal and spatial dynamics in fish assemblage structure were investigated, including the development of a system for classifying the fish fauna into functional guilds.

Results: Seasonal boat seining hauls were performed at five locations between 5 and 35 m water depth. Approximately 109350 littoral fish were collected, belonging to 34 families and 88 species. Density of fish peaked during the summer due to the high density of juveniles. Among the species encountered, eleven were found to be non indigenous of Indo-Pacific origin, three of them using seagrasses mainly as juveniles, and four as residents. The non indigenous pest pufferfish, *Lagocephalus sceleratus*, ranked among the 10 most dominant species in terms of biomass (2 %) and was classified as a seagrass resident.

Last related publications: Kalogirou *et al.*, submitted

Project name: "Alien macroalgae of the sub-littoral zone of the Greek coasts"

parties

Athens University, Faculty of Biology, Department of Ecology & Taxonomy, Panepistimiopolis 15784, Athens, Greece

Hellenic Centre for Marine Research (HCMR), Institute of Oceanography, Anavyssos 19013, Attica, Greece,

contact details: PhD student Kostas Tsiamis: e-mail: kostas.tsiamis@gmail.com

Up to the summer of 2009 the list of alien marine macrophytes on Greek coasts reached 36 species, an over-doubling of the number known in 2005. These are categorised as 16 established, 6 casual and 14 debatable species. Most of them are red algae, whereas there is only one alien seagrass. The vast majority of alien macroalgae originates from the Indo-Pacific Ocean, and has been introduced to Greece mainly through the Suez Canal and/or by shipping. The distribution and expansion on the Greek coasts seems to be greater than originally expected, with several species exhibiting invasive behavior (e.g. *Caulerpa racemosa* var. *cylindracea*, *Styopodium schimperi*, *Asparagopsis taxiformis*), particularly in cases of already disturbed ecosystems. The research is still in progress.

Last related publications: Katsanevakis & Tsiamis, 2009; Tsiamis *et al.*, 2009; 2010

Planning of new research project(s), web site if available

Project name: REMede: Observation Network of Invasive Species and Marine Ecosystems in the Mediterranean (2010-2012)

Study area in Greece: Karpathos marine park

submitted to: STC Programme MED: Europe in the Mediterranean

parties: Italy, Greece, Spain, France, Cyprus, Croatia, Slovenia

co-ordinator for Greece: A. Zenetos

Aim: Implementation of a simplified instrument that monitors and alerts about Climate Change occurring in sea areas, in order to be prepared against relevant consequences and to protect biodiversity. Application of the system within pilot sea sites for early warning against the presence of alien species dangerous for the marine ecosystems. Editing a practical manual so that the system can be transferred within the Mediterranean. Training of managers, technicians and experts of pilot sites in order to implement the observation and early-warning system.

Project name: Non indigenous organisms in ballast waters: their survival and adaptation in harbours.

co-ordinator: E. Christou, HCMR

submitted to the Ministry of Education, Lifelong Learning and Religious Affairs

Aim: Study of the survival, adaptation and possible establishment of organisms transferred in ballasts of ships visiting selected ports in Saronikos Gulf from overseas.

B Invasive Species Management

NONE

C Risk Assessment Approaches

Recognizing the need for collaboration in the research and management of aquatic alien species at both national and international levels, and data exchange in particular, a network of experts was established in 2007 at HCMR. To date, the Hellenic network for Aquatic alien species (ELNAIS: <http://elnais.ath.hcmr.gr/>) includes 50 experts carrying out relevant research, who are based in 11 research centres/Universities across the country. ELNAIS is an open information system providing on line the state of art in aquatic alien species in Greece. There are currently 200 marine alien species recorded in ELNAIS, accompanied by photographs and distribution maps within Greece. ELNAIS, though without any financial support, is continually updated thanks to the input of experts and the enthusiasm of a small group, and aims to improve and become a powerful tool to scientists and stakeholders.

In 2009, Greek coastal and marine waters hosted 401 species of the worst invasive alien species threatening biodiversity in Mediterranean (i.e. species which are highly invasive and with negative impacts on native ecosystems, human health and the economy) (Streftaris & Zenetos, 2010). Of these 19 are invertebrates, 11 primary producers, and 10 vertebrates. These compared to the 29 species recorded up to 2000 represent a 28% increase (Streftaris & Zenetos, 2010). The observed increase is a serious cause of concern, although it may be partially related to the lower level of detail in screening alien species in earlier years.

¹ Note: Two vertebrates (the fish *Liza hematocheila* and *Micropterus salmoides*) occur both in marine and freshwaters

D Occurrence of New Ship-mediated Introduced Species

A check list of marine alien biota reported in Greece by June 2009 includes 193 species 64 of which have been introduced via shipping. Subsequent introductions plus some that had escaped the authors' attention are provided in Table 1.

Maintaining the Ellenic Network of Aquatic Invasive Species (ELNAIS) database is allowing for the extraction of trends over the years and their assessment. Since the 1950's there has been an increasing trend of introduction of alien species in Greek seas. Interestingly the past decade has been the climax of new introduction with 70 new species having been recorded over the period 2001-2010 (i.e. 41% of marine alien species in Greece have been recorded over the past 10 years) (ELNAIS, 2010).

Table 1: List of species subsequent to Zenetos *et al* 2009 update.

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
<i>Amphistegina madagascariensis</i> D'Orbigny, 1826 Foraminifera	1955-64	Castellorizo isl, Crete Saronikos	Via Suez/shipping	Established/questionable	Blanc-Vernet, 1969
<i>Amphisorus hemprichi</i> (Ehrenberg) Foraminifera	1974	Crete	Via Suez/shipping	established	Hollaus & Hottinger 1997
<i>Barbatia plicata</i> (Dillwyn, 1817) Mollusca	2004	Kastellorizo isl.	spreading	unknown	Tzomos <i>et al</i> , 2010.
<i>Coscinospira hemprichii</i> Ehrenberg 1839 Foraminifera	2003	Kyklades	spreading	established	Koukousioura <i>et al</i> , 2010
<i>Cymbaloporella plana</i> (Cushman) Foraminifera	2006	Saronikos	Via Suez/shipping	established	Koukousioura <i>et al</i> , 2010
<i>Triloculina fichteliana</i> d'Orbigny Foraminifera	2006	Saronikos	Via Suez/shipping	established	Koukousioura <i>et al</i> , 2010
<i>Planogypsina aceroalis</i> (Brady) Foraminifera	2009	Saronikos	Via Suez/shipping	Casual	Koukousioura <i>et al</i> , 2010
<i>Atergatis roseus</i> (Rüppell, 1830) Crustacea	2009	Rhodes isl.	Via Suez spreading	casual	Corsini-Foka & Pancucci-Papadopoulou, in press
<i>Phallusia nigra</i> Savigny, 1816 Ascidia	2009	Rhodes isl.	Via Suez spreading	established	Kondilatos <i>et al</i> , 2010

* Duplication with WGIT MO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Impact on human health

It should be noted that after some decades of sporadic records, *Ostreopsis* blooms are increasingly recorded with adverse consequences to human health and activities (aquaculture, tourism) all over the Mediterranean Sea (Brescianini *et al.*, 2006; Kermarec *et al.*, 2008).

In Greece the first record of *Ostreopsis ovata* was documented in 2003 from Thermaikos Gulf (Aligizaki & Nikolaidis, 2006). Available data from 6 years of Greek regulatory monitoring for marine lipophilic biotoxins on shellfish indicate that benthic dinoflagellate toxins are responsible for at least 30% of positive shellfish samples each year (Aligizaki *et al.*, 2009). Additionally, the recent detection of dinoflagellates once considered as tropical, such as the ciguatera causing genus *Gambierdiscus* (Aligizaki & Nikolaidis, 2008) constitutes another impending hazard for both the fisheries industry and consumer health in the Mediterranean Sea. The fact that potentially toxic benthic dinoflagellates are seldomly detected in the water column samples obtained in the framework of regulatory monitoring for "potentially toxic phytoplankton" (Regulation EC 854/2004) constitutes the introduction of benthic dinoflagellates in the regulatory monitoring for "potentially toxic microalgae" and the expansion of the regulatory monitoring for marine biotoxins to additional marine edible organisms, such as fish, more than essential (Aligizaki *et al.*, 2009)

The rapid expansion of the toxic pufferfish *Lagocephalus sceleratus* in the south and central Aegean Sea in all seasons, combined with its occurrence along the north-eastern Aegean coasts as north as Larissa (ELNAIS website: NEWS) shows that this tropical species was able to adapt and occupy rapidly all the Aegean coastal waters. A survey carried out by purse seine in November 2007 along the SE coast of Rhodes (sandy bottom, 8-40 m of depth) described the extreme situation produced in some cases in local fishery by this new invader. Along with its congeneric *Lagocephalus suzensis*, *L. sceleratus* represented 43% in number and 38% in weight of the total fish catch (Corsini-Foka, 2010).

Economic Impact

The recent invading blue cornetfish *Fistularia commersonii* has been characterised as a «sprinter» (Karachle *et al.*, 2004). The phenomenon is alarming because *Fistularia commersonii* reproduces and grows very rapidly, reaching a large size and showing a unique ability of adaptation that allowed it to invade all the Mediterranean in just a few years, crossing from the east to the west. As it is subject to a very low fishing pressure, while predation on its large specimens appears limited to the invaded coastal area, it is left free to form large populations. *Fistularia commersonii* is an active piscivorous species with a clear aggressive behaviour when in schools which may seriously affect native species both economically and ecologically. The blue cornetfish feeds mainly on small fish, gobiids and several native fish, particularly *Spicara smaris*, *Mullus* spp. and *Boops boops* (Kalogirou *et al.*, 2007). Furthermore, the body features of *F. commersonii*, such as its dorsal-ventral flattened body and its tubular mouth, allow large sized specimens to reach very shallow waters and to suck young fishes and small decapods in large quantities.

Ecologic impact

The range expansion of *Percnon gibbesi* in the Aegean and Ionian Seas is recorded and evidence of its further establishment in Greek waters is provided by Katsanevakis *et al.* (2010). Established populations were observed in areas where *P. gibbesi* had not been previously reported: the Saronikos Gulf (central Aegean Sea), Chios Island (central Aegean Sea), Milos Island (central Aegean Sea), Zakynthos Island (central Ionian Sea), and Syvota (northeastern coast of the Ionian Sea). This species was also observed in new sites in the Messiniakos Gulf, Crete and Rhodes Islands, where it had been previously reported.

Tsiamis *et al.* (2010) noticed an interesting increase of established species, from 9 taxa in 2008 (Tsiamis *et al.*, 2008) to 14 taxa in 2009. Most of them are still advancing along the Greek coasts, and further expansion as well as new introductions can be expected in the near future. In Greece, small patches of *C. racemosa* were initially reported from two oligotrophic Ionian coasts in Greece (Zakynthos island and Pylos Bay) during 1993 (Panayotidis and Montesanto 1994). Since then, it has widely spread to the majority of the Greek coasts. The distribution map of the species (up to September 2009), based on a compilation of existing scientific as well as grey literature and on unpublished data/personal observations is presented in Tsiamis *et al.* (2010). *C. racemosa* was first observed during 1996 in the Saronikos Gulf, established in an unpolluted bay near the southeast entrance of the Gulf, and has rapidly spread from this location (Salomidi *et al.*, 2009).

The most visited areas by alien species in Greece appear to be the Dodecanese islands (Pancucci –Papadopoulou *et al.*, 2009) and the Saronikos Gulf (Zenetos *et al.*, in preparation.)

F Other Relevant Information

In the Mediterranean Sea, biodiversity changes occur at an unprecedented rate bringing the rate of introductions to 1 species every 1.5 week (Zenetos, 2010). Using long-term data of 149 warm alien species introduced in Greek waters since 1924, Raitsos *et al.*, (in press) showed that the introduction of warm and tropical alien species has been exacerbated by the observed warming of the eastern Mediterranean Sea. This phenomenon has accelerated after an abrupt shift in both regional and global temperatures that was detected around 1998, leading to a 150% increase in the annual mean rate of species entry after this date. The abrupt rising of temperature since the end of the 1990s has modified the potential thermal habitat available for warm-water species, facilitating their settlement at an unexpected rapid rate. The speed of alien species spreading and response to global warming is apparently much faster than temperature increase itself, presenting an important warning for the future of Mediterranean Sea biodiversity. In addition to the sea warming, other factors that enable and enhance biological invasions, such as salinity rise and oceanographic forcing, may also be responsible (Raitsos *et al.*, in press).

A trend analysis in alien species vs shipping traffic, sea surface temperature (SST) and pollution level in Saronikos Gulf (wider area hosting the port of Peiraias), has shown that climate change is clearly responsible for the increased rate of biological introductions (Zenetos *et al.*, in preparation).

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5.5 Lithuania

Author: Sergej Olenin, presented by Tracy McCollin

BINPAS: online Bioinvasion impact (biopollution) assessment system

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A standardised method to classify the impacts of invasive alien species on native species, communities, habitats and ecosystem functioning (the **biopollution index, BPL**) was developed in the framework of two EU FP6 projects, ALARM and DAISIE (Olenin *et al.*, 2007). According to this method, the BPL calculation is based on abundance and distribution range (ADR) of the non-indigenous species (NIS) under consideration and the magnitude of its bioinvasion impact (Box 1).

Box 1. Biopollution assessment methodology

The assessment should be performed in a defined aquatic area (e.g. a coastal lagoon; offshore sand bank, or an entire regional sea) and for a defined period of time.

Abundance of a NIS is ranked as “low” (a species makes up only a small part of the relevant community: e.g. a population of a NIS forms a minor portion (few %) of the total community); “moderate” (an alien species constitutes less than a half of abundance of the native community); and “high” (it exceeds half, i.e. quantitatively dominates in the invaded community).

The distribution scored as “one locality” when a NIS was found only at one locality (e.g. sampling station) within the assessment unit; “several localities” (the species spread beyond one locality but is present in less than half of sampling stations), “many localities” (extends to more than a half of the stations) and “all localities” (found at all localities). Combination of the abundance and distribution scores gives five classes of ADR (A-E), ranking an alien species from low abundance in a few localities (A) to occurrence in high numbers in all localities (E).

After ADR is estimated, it is related to the magnitude of bioinvasion impacts, ranging from no impact (0) through weak (1), moderate (2), strong (3) and massive (4). Three categories of impacts have been considered, namely: 1) impact on native species and communities (ranging from C0 to C4); 2) impact on habitats (H0 to H4); 3) impact on ecosystem functioning (E0 to E4). In accordance with the suggested approach, the overall BPL for the assessment unit is determined according to the greatest impact level for at least on IAS which was noticed during the evaluation period in the assessment unit.

The BPL estimation is supported by an online “Bio-invasion impact (Biopollution) Assessment System” BINPAS (<http://corpi.ku.lt/~biopollution/>) which translates existing data on invasive species impacts into uniform biopollution measurement units and accumulates data on bio-invasion impacts. The system is hosted by the server of Coastal Research and Planning Institute, Klaipeda University, Lithuania (Figure 1).

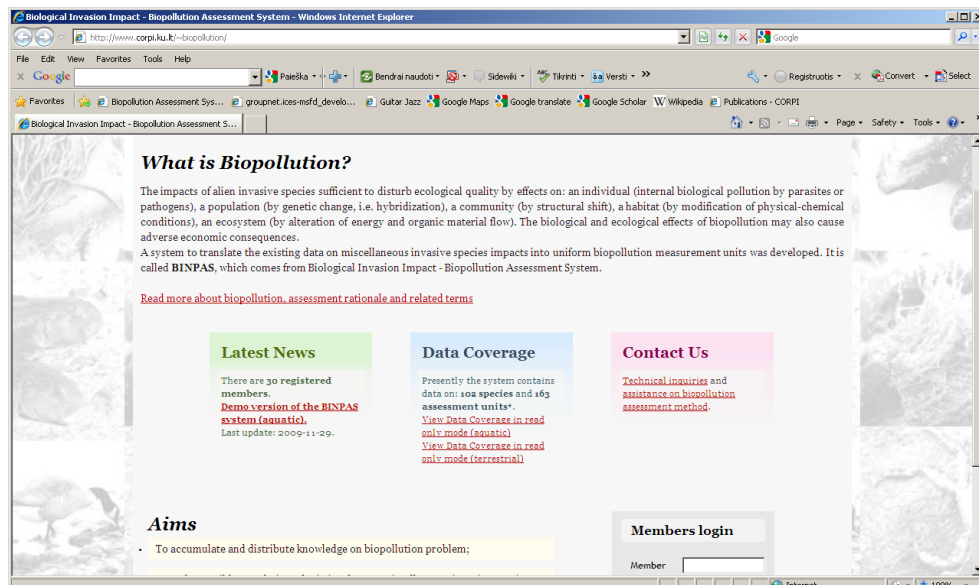


Figure 1. Front page of the Bioinvasion impact (Biopollution) Assessment System. Users may get access in three different modes: “Guest” – to try the functionality of the system; “Demo” – to view data collected so far; and “Registered user” – to enter and edit new data.

BINPAS implies three confidence levels while assessing ADR and the impacts: high (data documented by field studies for the given assessment unit), medium (data documented for a part of the assessment unit and extrapolated to the entire system by expert judgment) and low (expert knowledge of the species impact based on data from studies made elsewhere applied).

Presently (February 2010), BINPAS contains data on 102 species (mostly aquatic, but also some terrestrial ones) from more than 160 assessment units.

The BPL assessment approach needs to be developed further in order to specify the magnitude of impacts in different categories and for different groups (phytoplankton, macrofauna, macroalgae, fishes, etc). It may be used for monitoring of biopollution effects, evaluation of effectiveness of bio-invasion management, and prioritizing impacting species (incl. quarantine measures in aquaculture).

Acknowledgement

Development of BINPAS is supported by FP7 EU FP7 project MEECE (Marine Ecosystem Evolution in a Changing Environment) and the Lithuanian State Science and Studies Foundation project BINLIT (Biological invasions in Lithuanian ecosystems under the climate change: causes impacts and projections).

5.6 Spain

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A Transport Vectors

- Results of ongoing research project(s) i.e. project title, host institute, contact details, co-ordinator, project duration, key objective(s), website if available
 - Planning of new research project(s), web site if available
- 1 Ballast
 - 1.1 Biology of Ballast Water
 - 1.2 Ballast Water Treatment
 - 1.3 Ballast Water Sampling
 - 1.4 Ballast Water Legislation/Regulations

 - 2 Hull Fouling
 - 2.1 Biology of Hull Fouling
 - 2.2 Hull Fouling Treatment
 - 2.3 Hull Fouling Sampling
 - 2.4 Hull Fouling Legislation/Regulations

 - 3 Sediments
 - 3.1 Biology of Sediments
 - 3.2 Sediment Treatment
 - 3.3 Sediment Sampling
 - 3.4 Sediment Legislation/Regulations

 - 4 Sea Chests
 - 4.1 Biology of Sea Chests
 - 4.2 Sea Chest Treatment
 - 4.3 Sea Chest Sampling
 - 4.4 Sea Chest Legislation/Regulations

 - 5 Others

(see Handbook of Invasion Vectors, prepared by WGITMO and published as ICES Cooperative Research Report)

 - 5.1 Biology
 - 5.2 Treatment
 - 5.3 Sampling
 - 5.4 Legislation/Regulations

B Invasive Species Management

3 Eradication Programmes

4 Management and Control of Invasive Species

C Risk Assessment Approaches**D Occurrence of New Ship-mediated Introduced Species**

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
<i>Mnemiopsis leidyi</i>	2009	Cap de Creus, Mediterranean coast of Spain (42°19'05.78" N, 3°19'31.40" E)	It is unclear whether <i>M. leidyi</i> was transported by currents or ships from other areas of the Mediterranean Sea.	The authors suggest that it might be established.	Fuentes <i>et al.</i> , 2009
<i>Blackfordia virginica</i>	2008	Guadiana estuary, Spain (37°15'30" N, 7°25'58" W).	Probably introduced by nautical activities.	Authors suggest local reproduction	Chícharo <i>et al.</i> , 2009

* Duplication with WGIT MO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Economic (quantify if possible)

Ecological

F Other Relevant Information**Published work on NIS introduced via Ballast Water:**

Butrón, A. 2008. Evaluación de los riesgos potenciales del fitoplancton tóxico introducido por aguas de lastre en el Puerto de Bilbao y sus implicaciones para la gestión. Informe técnico elaborado para el Puerto Autónomo de Bilbao. 148 pp. (Not publically available).

García García-Revilla, Miguel and Fernández-Delgado, Carlos. 2009. La introducción por mar de especies exóticas invasoras a través del agua de lastre de los barcos. El caso de Doñana. Universidad de Córdoba. 173pp.

G References

Chícharo, M. A., Leitão, T., Range, P., Gutierrez, C., Morales, J., Morais, P. and Chícharo, L. 2009. Alien species in the Guadiana Estuary (SE-Portugal/SW-Spain): *Blackfordia virginica* (Cnidaria, Hydrozoa) and *Palaemon macrodactylus* (Crustacea, Decapoda): potential impacts and mitigation measures. *Aquatic Invasions* 4 (3): 501-506.

Fuentes, V., Atienza, D., Gili, J.M. 2009. First records of *Mnemiopsis leidyi* A. Agassiz 1865 off the NW Mediterranean coast of Spain. *Aquatic Invasions* 4 (4): 671-674.

5.7 United Kingdom

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A Transport Vectors

- Results of ongoing research project(s) i.e. project title, host institute, contact details, co-ordinator, project duration, key objective(s), website if available
- Planning of new research project(s), web site if available

Ballast (biology, treatment, sampling, legislation/regulations)

An updated version of the Lloyds Register “Ballast Water Treatment Technology Current Status” report will be available in March 2010. It will be available as an electronic version at www.lr.org/bwm from 25 February and will be made available as a hard copy (with any amendments received) for MEPC 60 in March 2010.

Contact: www.lr.org/bwm

The BaWaPla project (<http://www.bawapla.com/project.htm>) has led to a treatment system that is now going through the Type Approval process. The treatment is based on a filter and UV. The project will be completed in May 2010.

Contact: Ehsan Mesbahi Ehsan.mesbahi@newcastle.ac.uk

Newcastle University are undertaking a project with Orkney Island Council called “SEA of Change in Ballast Water Management Policy”. The final report is not yet completed. Please contact Ehsan Mesbahi for further information.

Contact: Ehsan Mesbahi Ehsan.mesbahi@newcastle.ac.uk

A proposal has been submitted under the EU FP7 programme. The MOVEMENTS proposal has 21 partners and is co-ordinated by Newcastle University. The aim of this project is to join research forces to meet challenges in ocean management and improve understanding and the predictive capacity concerning marine ecosystems and how they respond to a combination of natural and anthropogenic factors. The project will investigate how rapid environmental changes will affect the full range of goods and services provided by the oceans and the development measures that could be developed to mitigate or adapt to these changes. The study will collect biological data from all regions identified by the project criteria and will recommend new management techniques for each port/country under investigation, and provide a unified, integrated European-based approach to Bio-Invasion. This will then lead to recommendations on policy reviews and enforceability analysis at Local, Regional and Continental levels as well as evaluating the market, economic and social impacts of various management techniques on various European regions.

Contact: Ehsan Mesbahi Ehsan.mesbahi@newcastle.ac.uk

Hull Fouling (biology, treatment, sampling, legislation/regulations)

A Scottish Government funded project is currently being carried out by Marine Scotland – Science. This is a three year project, which started in April 2009. The aim of the project is to assess the risk of transporting non native species into Scottish waters *via* biofouling. The project will collect samples from the hulls of vessels entering Scottish dry docks and will also use a dive team to sample larger vessels.

Contact: Tracy McCollin <t.a.mccollin@marlab.ac.uk>

Another project (Marine Aliens II) is also underway. This project is coordinated by the Scottish Association for Marine Science (SAMS) and has partners from all over the UK. During the summer of 2009 there was a set of coordinated field work carried out by the partners that involved deploying settling panels in marinas around the UK for a period of two or eight weeks. The aim was to examine any differences in the organisms settling on the panels and also to examine whether harbour design influenced what settled on the panels. The analysis is currently underway.

Contact: Tracy McCollin t.a.mccollin@marlab.ac.uk or Liz Cook Elizabeth.Cook@sams.ac.uk. Website currently being updated.

Sediments (biology, treatment, sampling, legislation/regulations)

Sea Chests (biology, treatment, sampling, legislation/regulations)

The Scottish Government funded project mentioned above will include sampling of niche areas such as the sea chests.

Others (biology, treatment, sampling, legislation/regulations)

(see Handbook of Invasion Vectors, prepared by WGITMO and published as ICES Cooperative Research Report)

B Invasive Species Management

Eradication Programmes

An eradication of *Didemnum vexillum* is being undertaken in Holyhead Marina in North Wales. This involves wrapping pontoons and mooring chains in plastic sheeting or large plastic bags to create an anoxic environment (Kleeman, 2009).

As the *Didemnum vexillum* has also been found on the south coast of England further surveys have been carried out on the north west and east coast of England and there have been no sightings. A survey on the west coast of Scotland has found *Didemnum vexillum* at one location and a further survey of the east coast of Scotland is planned in the near future to assess whether there is any *Didemnum vexillum* present. Discussions are ongoing regarding the management options for the one location it has been found in Scotland.

Defra and Natural England have commissioned a study to consider options for a management strategy utilising the techniques developed for Holyhead Marina. The study will use GIS techniques to inform decisions regarding the risk posed to e.g. shellfisheries, conservation areas or potential spread via recreational craft.

Contact: Gabe Wyn, Chair of the *Didemnum vexillum* Working Group
g.wyn@ccw.gov.uk

Management and Control of Invasive Species

C Risk Assessment Approaches

Risk assessments are being carried out for a number of non native species (terrestrial and aquatic) on behalf of the GB Programme Board on Non Native Species and these are listed on their web site <www.nonnativespecies.org>

D Occurrence of New Ship-mediated Introduced Species

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
<i>Didemnum vexillum</i>	2009	Gosport (several marinas) Cowes Lymington Dartmouth	Recreational vessels		g.wyn@ccw.gov.uk

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Economic (quantify if possible)

A report outlining the possible economic impacts of *Didemnum vexillum* in North Wales has been carried out (Kleeman, 2009)

CABI is undertaking a study entitled "Estimating the Costs of Invasive Non Native Species on the British Isles". Contact Angela.Robinson@scotland.gsi.gov.uk for further information.

Ecological

F Other Relevant Information

G References

- Holt, R.H.F, Ramsay, K., Mowat, S., Kent, F.E.A., Griffith, K. (2009). Survey of a non native ascidian (sea squirt) *Didemnum vexillum* in Holyhead Harbour. CCW Marine Monitoring Report No: 67.
- Kleeman, S.N. (2009). *Didemnum vexillum* – Feasibility of Eradication and/or Control. CCW Science Report. Report No. 875, 53pp, CCW, Bangor.
- Griffith, K, Mowat, S, Holt, R.H.F, Ramsay, K, Bishop, J.D.D, Lamber, G, Jenkins, S.R. (2009). First records in Great Britain of the invasive colonial ascidian *Didemnum vexillum* Kott, 2002.

5.8 United States of America

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A Transport Vectors

- Results of ongoing research project(s) i.e. project title, host institute, contact details, co-ordinator, project duration, key objective(s), website if available
- Planning of new research project(s), web site if available

1 Ballast

This section reflects the status of the national effort by the U.S. Coast Guard; cross-cutting efforts by two organizations, and comments of several states on issues related to ballast water. Rather than comment on the biology of ballast water and ballast water treatment, these issues are combined within the comments of different discussions. For the last several years, the WGITMO report covers non-native species legislation that includes ballast water regulations for each country.

1.1 Biology of Ballast Water

1.2 Ballast Water Treatment

California: October 2009 Update: Ballast Water Treatment Technologies For Use in California Waters (http://www.psmfc.org/ballast/wordpress/wp-content/uploads/2009/10/TechUpdate_final.pdf). *It should be noted that this report is specific to a review of treatments that may have the capabilities to meet California ballast water discharge standards.*

1.3 Ballast Water Sampling

At the national level the U.S. Coast Guard and the U.S. Environmental Protection Agency

- Naval Research Laboratory Key West (NRLKW), Lisa Drake
lisa.drake.ctr@nrl.navy.mil.

The aquatic nuisance species (ANS) program at Naval Research Laboratory is located in Key West, Florida, USA and has been in operation since 2004. Since that time, the program has conducted research to inform the US EPA's Environmental Technology Verification (ETV) Program's Generic Protocol for the Verification of Ballast Water Treatment Technologies (Lemieux *et al.*, in review). At NRLKW, four valid tests of the Severn Trent de Nora BalPure™ electrolytic chlorination treatment system were completed (October 2006 – February 2007) as a beta test of the ETV protocol.

The multi-disciplinary ANS team is comprised of engineers (5), a physical scientist, a computer scientist, facilities engineers (3), biologists (3; with a post-doctoral researcher to join the group in March), and a statistician. The biologists and two engineers dedicate all of their time to the project; the other team members also have additional non-ANS responsibilities.

The following technical testing issues have been addressed at NRLKW: design, construction and operation of discharge sample ports; valve effects on organism mortality; control and automation of ballast water management system testing; mode of injection for standard test organisms and ambient organisms; augmentation of ambient POC and DOC; concentration of ambient organisms; population dynamics within ballast tanks; post-collection sample degradation time; comparison and development of methods for protist viability; determination of zooplankton viability; development of a discharge sampling system; validation of discharge sampling system (inorganic microbeads); statistics of sampling. Please see Section G, the References section, for a list of reports of recent work that are currently in review.

1.4 Ballast Water Legislation/Regulations

This section covers both the U.S. Coast Guard regulations and state regulations.

Coast Guard's proposed rulemaking was available in August 2009 for a public comment period, which ended in December 2009. It will take several months for the Coast Guard to respond officially. The proposed Phase I standards are comparable to the IMO Convention, and Phase II is up to 1000X more stringent. Over 300 comments have been submitted from individual states, non-government organizations, and the maritime industry.

1.5 Ballast Water Legislation/Regulations

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Great Ships Initiative

The Great Ships Initiative, a collaborative effort in the Great Lakes region led by the Northeast-Midwest Institute, is operating an IMO-consistent land-based ballast treatment test facility in the fresh water environment of Lake Superior. It is also conducting bench and shipboard tests in support of ballast treatment validation. GSI testing is independent, publicly subsidized, subject to intense quality assurance and quality control, and transparent (all results are made public). The GSI facility is fully booked for 2010.

In 2010, in addition to this testing, the GSI team is collaborating with the U.S. Maritime Administration, the State of Minnesota, and the region's maritime industry to design and trail on 12 ships ballast discharge sampling ports and apparatus. It is hoped that this work will be directly relevant to efforts by ICES, ISO and IMO in their efforts to develop ballast discharge sampling guidelines.

A study by the Northeast-Midwest Institute which took place at the Great Ships Initiative land-based testing facility explored the relative representativeness of a range of ship discharge sampling options. A first set of tests compared the relative capacity of three in-line sampling methods with each other for capacity to collect live plankton and total protists. The output of this comparison over several trials was that an elbow shaped pitot such as that described by the United States Naval Research Laboratory yielded the highest and least variable plankton density estimates in water drawn at 340 cubic meters per hour from an ambient water source in the Great Lakes. A second set of tests contrasted in tank sampling methods using the matched 200 cubic

meter retention tanks at the GSI facility. In these tests, it was determined that an 80 micron net was best at collecting all forms of live zooplankton in the water masses analyzed, even those with minimum dimensions less than 50 microns. A third set of tests contrasted estimates developed based on replicate 80 um net samples with pump and hose at three depths (averaged) using a set of independent 200 cubic meter ambient water masses. These tests found the pooled pump and hose samples collected more representative samples than the 80 micron net samples, even under the ideal circumstances for plankton net sampling using the 200 cubic meter tanks at the GSI facility. Finally, the best in-line and best in-tank sampling methods were directly contrasted using independent 200 cubic meter water masses. In these analyses, continuous in-line sampling was found to be at least as representative if not more so than the pump and hose sampling in tank. These findings corroborate the potential representativeness of continuous in-line sampling for compliance monitoring.

The Northeast-Midwest Institute also analyzed ship discharge data from shipboard trials of a treatment system on an operating ship in the Great Lakes. This analysis showed that the rate of discharge of live zooplankton was significantly different at the beginning of the discharge process from the end (over time). These data further corroborate the importance of continuous in-line sampling to obtain a representative estimate of live zooplankton concentrations in a ballast discharge flow a given ballast tank.

Maritime Environmental Resource Center

The Maritime Environmental Resource Center (MERC, www.maritime-enviro.org) is a State of Maryland initiative that provides test facilities, information, and decision tools to address key environmental issues facing the international maritime industry. The primary focus is to evaluate the mechanical and biological efficacy, costs, and logistical aspects of ballast water treatment systems and to assess the economic impacts of ballast water regulations and management approaches. The three main Center objectives are to:

- (1) Provide technology developers/vendors with facilities and expertise for pilot-scale and shipboard evaluations of treatment systems and provide regulatory agencies with standardized third-party data on system performance,
- (2) Provide ship builders and shipping lines with information and decision tools to select the most appropriate ballast water treatment options for particular sizes and types of vessels used along particular shipping routes, and
- (3) Remove as much uncertainty as possible from emerging markets for treatment systems in order to encourage buyers and sellers to engage with one another and make the necessary investments to accelerate the adoption of treatment technologies.

Working with partners such as the University of Maryland, Smithsonian Environmental Research Center, and US Maritime Administration, MERC has evaluated the performance of several ballast water treatments systems in the laboratory, in land-based tests, and onboard active vessels. MERC has also (a) complete cost analyses of ballast water treatment alternatives, (b) completed an initial analysis of compliance monitoring and enforcement related to ballast water regulations, (c) examined discharge toxicity issues related to the use of active substances to treat ballast water, (d) refined sampling, statistical and analytical methods for treatment testing, and (e) initiated evaluations of filter systems designed for ballast water. Finally, MERC has also

begun studies on ship biofouling, including an investigation of the responses of fouling organisms to freshwater.

Status of State Regulations that have been passed.

In the U.S., the US Coast Guard wants all states to adhere to a national standard to have consistent standards and therefore consistency in enforcement. The U.S. Coast Guard does not enforce the state regulations and most states do not have the resources to enforce their own regulations. The exception is California, which has a fee built into their regulations, has funding to hire enforcement agents that work cooperatively with the U.S. Coast Guard.

New York state requires that ships perform a ballast water exchange or a salt-water flush at least 50 nautical miles from shore in water at least 200 meters deep. *New York state has both coasts that about the Great Lakes and the ocean.*

New York state also requires existing vessels to install ballast water treatment systems to comply with those standards before January 1, 2012. The third condition sets forth more rigid standards for those discharges, which vessels constructed on or after January 1, 2013 will be required to meet.

Note: The New York regulation has been challenged in court, and to date has not been overturned.

Wisconsin will start regulating oceangoing ships arriving in its Great Lakes waters at the start of the next shipping season, Feb. 1, 2010, to stop the flow of invasive species arriving in their ballast water.

States that have submitted legislation, these have not been passed as of 3/2010.

Maine LDS 1693 - "An Act to Protect the Environment and Natural Resources of the State by Regulating the Discharge of Certain Substances into the Environment"? – *the ballast water standards are similar to USCG*

Massachusetts: proposing an act: An Act Creating the Non-indigenous Species Management Plan – *no specific mention of ballast water.*

California Proposed Regulation: Amendments to Article 4.7, Performance Standards for the Discharge of Ballast Water For Vessels Operating In California Waters -The proposed amendments would require the submission of information, on forms developed by the Commission, regarding the installation and use of ballast water treatment systems on vessels operating in California waters.

Although some activities to manage hull fouling occur in several places, e.g. power washes, scraping, hand scraping, air drying, and other approaches. But these have not been systematically

2 Hull Fouling

2.1 Biology of Hull Fouling

Report by California State Lands Commission (CSLC) and papers by Ian Davidson at Portland State

Davidson *et al.*, 2009 – Twenty-two in-service containerships at the Port of Oakland (San Francisco Bay, California) were sampled to test the hypothesis that the extent and taxonomic richness of fouling would be low on this type of ship, resulting from relatively fast speeds and short port durations. The data showed that the extent of microorganisms (invertebrates and algae) was indeed low, especially across the large

surface areas of the hull. Less than 1% of the exposed hull was colonized for all apart from one vessel. These ships had submerged surface areas of >7000 m², and fouling coverage on this area was estimated to be <17 m² per vessel, with zero biota detected on the hulls of many vessels. The outlying smaller vessel (4465 m²) had an estimated coverage of 90% on the hull and also differed substantially from the other ships in terms of its recent voyage history, shorter voyage range and slower speeds. Despite the low extent of fouling, taxonomic richness was high among vessels. Consistent with recent studies, a wide range of organisms were concentrated at more protected and heterogeneous (non-hull) niche areas, including rudders, stern tubes and intake gratings. Green algae and barnacles were most frequently sampled among vessels, but hydroids, bryozoans, bivalves and ascidians were also recorded. One vessel had 20 different species in its fouling assemblage, including non-native species (already established in San Francisco Bay) and mobile species that were not detected in visual surveys. In contrast to other studies, dry dock block areas did not support many organisms, despite little antifouling deterrence in some cases. Comparisons with previous studies suggest that the accumulation of fouling on containerships may be lower than on other ship types (e.g., bulkers and general cargo vessels), but more data are needed to determine the hierarchy of factors contributing to differences in the extent of macrofouling and non-native species vector risks within the commercial fleet.

Davidson, I.C., C.W. Brown, M.D. Sytsma, and G. M. Ruiz. 2009 The role of containerships as transfer mechanisms of marine biofouling species. *Biofouling* 25: 645-655.

- 2.2 Hull Fouling Treatment
- 2.3 Hull Fouling Sampling
- 2.4 Hull Fouling Legislation/Regulations

Proposed US Legislation on Hull Fouling: In November 2009, the U.S. House of Representatives is considering a bill, H.R.3618 - Clean Hull Act of 2009. This bill, if passed, would provide for implementation of the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001, and for other purposes.

Upcoming California Hull Fouling Legislation: B 740 (in Assembly) This bill would define the term "vessel fouling", require removal and recordkeeping of vessel fouling organisms from hull, piping, propellers, sea chests, and other submerged portions of qualifying vessels at least every 60 months, and require in-water cleaning of the submerged portion of a vessel while in the waters of the state to be conducted using specified procedures. Additionally, the bill would require the CA State Lands Commission, by January 1, 2010, to develop and adopt regulations governing the management of vessel fouling on those vessels arriving at a California port or place, to protect the waters of the state.

- 3 Sediments
 - 3.1 Biology of Sediments
 - 3.2 Sediment Treatment
 - 3.3 Sediment Sampling
 - 3.4 Sediment Legislation/Regulations
- 4 Sea Chests **Nothing to report for this section; although see pending legislation for California on hull fouling.**
 - 4.1 Biology of Sea Chests

- 4.2 Sea Chest Treatment
- 4.3 Sea Chest Sampling
- 4.4 Sea Chest Legislation/Regulations

5 Others

(see Handbook of Invasion Vectors, prepared by WGITMO and published as ICES Cooperative Research Report)

WGITMO prepares and maintains a database on introduced species that includes their locations, first report, spread, and probable vector(s) among other data. We will be turning this over to WGITMO and would suggest that WGBOSV contribute through this mechanism.

- 5.1 Biology
- 5.2 Treatment
- 5.3 Sampling
- 5.4 Legislation/Regulations

B Invasive Species Management

1 Eradication Programmes

A synopsis of eradication programs and their success is being summarized in WGITMO.

2 Management and Control of Invasive Species

C Risk Assessment Approaches

D Occurrence of New Ship-mediated Introduced Species

The U.S. new introductions are submitted with the ICES WGITMO report.

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Economic (quantify if possible)

Ecological

The economic (such as it is) and ecological impacts are summarized in the WGITMO National Reports, 5 and 10 year summary reports, and Cooperative Research Reports have this information. It is also a reporting column in our annual database collections.

One publication from the previous year that addresses this issue is:

Lovell SJ and Drake LA. 2009. Tiny Stowaways: Analyzing the Economic Benefits of a U.S. Environmental Protection Agency Permit Regulating Ballast Water Discharges. Environmental Management 43: 546-555. <http://www.springerlink.com/content/w0480752184tr8v2/>

F Other Relevant Information

Summary of Tamburri presentation on sample size statistics

Whitman Miller, George Smith, Mario Tamburri*, Greg Ruiz

Smithsonian Environmental Research Center, *University of Maryland Center for Environmental Science, Maritime Environmental Resource Center

Sampling Effort and Statistical Power at Threshold Densities: Investigating IMO > 50 μm Ballast Water Discharge Standards

Problem:

Assessing sampling effort to reliably resolve densities of $>10/\text{m}^3$ from those of $\leq 10/\text{m}^3$, for live organisms $>50 \mu\text{m}$

Treatment system testing and compliance monitoring

Approach:

Model sampling statistics at IMO standard ($\leq 10/\text{m}^3$)

- Compare sampling effort and density

Poisson probability distributions used to estimate uncertainty for single treatment/discharge trials

- Mean

- 95% Confidence Intervals

- β and Statistical Power (quantify false negative rates)

Binomial experiments (multiple trials)

- Determine likelihood of detecting density $>$ threshold

- Reliability of process for quantifying extreme values (rare events)

Assumptions:

BW is sampled integratively from discharge pipe to control for any underlying spatial structure of organisms

Total discharge volume is processed

All live organisms $>50 \mu\text{m}$ are captured/detected

Hypothesis:

H_0 : treatment system reduces live organism density to $\leq 10/\text{m}^3$

Conclusion:

If the assumptions are kept, then these statistical models show that sample volumes of 5 to 10 m^3 can provide the statistical confidence (95%) and power required to determine if treated water is in compliance with IMO D2 standards for live organisms $> 50 \mu\text{m}$ in size in ballast water treatment testing and in compliance monitoring.

G References

Lemieux EJ, Grant J, Wier T, Drake L, Robbins S, and Burns K. In review. Generic Protocol for the Verification of Ballast Water Treatment Technologies, Version 3.3. Submitted to the EPA Environmental Technology Verification Program.

Steinberg, MK, Robbins SH, Riley SC, Lemieux, EJ, and Drake LA. In review. Development of a Method to Determine the Viability of Organisms $\geq 50 \mu\text{m}$ (Nominally Zooplankton) in Ships' Ballast Water: A Combination of Two Vital, Fluorescent Stains. Letter report submitted to the Naval Research Laboratory.

Drake, LA, Steinberg MK, Robbins SH, Riley SC, Nelson BN, and Lemieux, EJ. In review. Development of a method to determine the viability of organisms $\geq 10 \mu\text{m}$ and $< 50 \mu\text{m}$ (nominally protists) in ships' ballast water: a combination of two vital, fluorescent stains. Letter report submitted to the Naval Research Laboratory.

Steinberg, M.K., S.C. Riley, S.H. Robbins, B.N. Nelson, E.J. Lemieux, and L.A. Drake. In review. Geovalidation of a method to determine the viability of organisms $\geq 10 \mu\text{m}$ and $< 50 \mu\text{m}$ (nominally protists) in ships' ballast water using two vital, fluorescent stains. Letter report submitted to the Naval Research Laboratory.

Steinberg, MK, Hyland W, Riley SC, Robbins SH, Schrack EC, Wier TP, Lemieux EJ, Drake LA. In review. Meeting Requirements for Challenge Water Used to Verify Ballast Water Treatment Technologies: Concentrating Ambient Marine Organisms $\geq 50 \mu\text{m}$ in Minimum Dimension. Letter report submitted to the Naval Research Laboratory.

5.9 The Netherlands

Author(s) and contact details:

Cato ten Hallers (cato.ten.hallers@nioz.nl) and Marcel Veldhuis (marcel.veldhuis@nioz.nl)

A Transport Vectors

- Results of ongoing research project(s) i.e. project title, host institute, contact details, co-ordinator, project duration, project objective(s), website if available

Development of ballast water testing science: several papers submitted and presentations given (R&D Forum, Malmö, January 2010).

Ballast Water Opportunity project (Jan 2009-Dec 2013, coordinated by NIOZ; 13 Partners; 29 sub partners, from science, policy, shipping, ports, industry, Environment and Nature conservation) www.NorthSeaBallast.eu.

Environmental acceptability of BWM Systems criteria and developments

- Planning of new research project(s), web site if available

1 Ballast

1.1 Biology of Ballast Water

Land-locked large mesocosm study on strategies of and conditions for invasive species

1.2 Ballast Water Treatment

Further development of ballast water testing science

1.3 Ballast Water Sampling

Criteria, potential strategies and solutions for BW sampling

1.4 Ballast Water Legislation/Regulations

- 2 Hull Fouling
 - 2.1 Biology of Hull Fouling
 - 2.2 Hull Fouling Treatment
 - 2.3 Hull Fouling Sampling
 - 2.4 Hull Fouling Legislation/Regulations

- 3 Sediments
 - 3.1 Biology of Sediments
 - 3.2 Sediment Treatment
 - 3.3 Sediment Sampling
 - 3.4 Sediment Legislation/Regulations

- 4 Sea Chests
 - 4.1 Biology of Sea Chests
 - 4.2 Sea Chest Treatment
 - 4.3 Sea Chest Sampling
 - 4.4 Sea Chest Legislation/Regulations
- 5 Others

(see Handbook of Invasion Vectors, prepared by WGITMO and published as ICES Cooperative Research Report)

- 5.1 Biology
- 5.2 Treatment
- 5.3 Sampling
- 5.4 Legislation/Regulations

B Invasive Species Management

- 6 Eradication Programmes
- 7 Management and Control of Invasive Species

C Risk Assessment Approaches

D Occurrence of New Ship-mediated Introduced Species

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Economic (quantify if possible)

Ecological

F Other Relevant Information

Presentations (BW R&D Forum, WMU, Malmo, Papers submitted to WMU Journal)

G References

Marcel Veldhuis (in press) The Ballast Water Management “old” and “new” technologies: the current status. (WMU Journal).

Frank Fuhr, Jan Finke, Peter Paul Stehouwer & Marcel Veldhuis (in press) Factors influencing organism counts in ballast water samples and their implications for compliance control. (WMU Journal).

Peter Paul Stehouwer, Marcel Veldhuis & Frank Fuhr (in press) A novel approach to determine ballast water vitality and viability after treatment. (WMU Journal).

N.H.B.M Kaag, A.C. Sneekes & E.M. Foekema (in press) The Use of Mesocosms in Risk Assessment of Active Substances in Ballast Water Treatment. (WMU Journal).

5.10 European Union – European Maritime Safety Agency

Author:

Brian Elliott, presented by Tracy McCollin

Ballast Water Management Briefing No. 1:

EMSA’s Ballast Water Action Programme

On the 10th and 11th November 2008, EMSA organised a workshop entitled:

Implementing the Ballast Water Management Convention (BWM) – the EU dimension. At this workshop the Member States suggested an extensive list of activities that could be undertaken to help them ratify the IMO Ballast Water Convention, and contribute to the interim ballast water management strategies being developed by the four Regional Sea Conventions surrounding Europe.

The feasibility of these proposals were assessed and analysed by EMSA in order to propose a list of actions that could be undertaken at the European Level. The results of this analysis were then submitted to DG TREN and DG ENV in April 2009.

Following the advice given by the European Commission in their response of 27th July 2009, EMSA has revised the original proposals and formulated a new Action Programme, which will focus its ballast water work in the near future. This work programme consists of 9 Actions as highlighted below.

EMSA will

1. Prepare a review of the ballast water risk assessment methodologies and the different ballast water management measures available to the Member States and the Regional Seas Conventions;
2. Review the need for further guidance on: data collection on ship’s ballast water exchange and on invasive species in ports; the granting of exemptions; and, the identification and implementation of additional measures, following the completion of Action 1;
3. Produce a joint briefing note (EMSA/DG Environment/DG TREN) on the relationship between approval for ballast water technologies that use active substances under the existing Biocides Directive, the proposed Biocides Regulation and the IMO Ballast Water Management Convention’s Guidelines;
4. Host a workshop to identify how a joint EU ballast water sampling strategy can be developed;

5. Investigate how funding can be obtained to “Develop a technical co-operation and short term secondment programme to enhance cohesion and parity on ballast water sampling and analysis within the Member States”;
6. Investigate how ballast water management information and best practice can be shared electronically between all Member States;
7. Actively participate in the North Sea Ballast Water Opportunity project;
8. Maintain liaison with DG Environment and the European Environment Agency over the introduction of non-indigenous species through ballast water discharge, to ensure that there is continuity between this Action Programme and the European Communities work on invasive species. EMSA will also react to requests for input into these programmes when necessary; and,
9. Maintain a watching brief on developments at the IMO and within the Member States, and contribute to the important work of the Regional Seas Conventions. EMSA, through the European Commission, will also react to requests for input into these programmes when necessary.

EMSA look forward to working with each of the Member States, DG TREN and DG Environment on this issue and will circulate further details of the workshop referred to in Action 4 in the very near future.

Further information on this work plan and the proposed timescales for these actions can be obtained from:

Brian Elliott, Tel: +351 21 1209 469
Senior Project Office for Environment Protection, Fax: +351 21 1209 261
Marine Environment, Training and Statistics,
EMSA
E.Mail: Brian.Elliott@emsa.europa.eu

30th October 2009

Annex 6 Request from ICES for a formal agreement between ICES and IMO regarding participation of IMO in WGBOSV.

TEXT FOR ICES TO SUBMIT TO IMO.

The International Council for the Exploration of the Sea (ICES) and the International Maritime Organization (IMO) have a long tradition of working in collaboration on issues related to the transfer of non native species *via* ballast water and shipping vectors. ICES specifically deals with these issues through the Working Group on Ballast and Other Ship Vectors (WGBOSV) and the chairs of this group have worked closely with colleagues at IMO and through the GloBallast Programme to ensure that the Terms of Reference of the group reflect ongoing issues at IMO and produce outputs that are of use to the discussions within the Ballast Water and Biofouling Working Group and Ballast Water Review Group.

The WGBOSV currently has ICES and the Intergovernmental Oceanographic Commission (IOC) of UNESCO as the umbrella organisations of the group and the current and past chairs of the WGBOSV have sought to formalise the contribution of IMO to the work of the group in order to maximise the benefit to ICES, IOC and IMO. The participation of IMO in the WGBOSV has been on an informal basis for a number of years (since 1996) and through the contribution of GloBallast. There are close links between the groups with several members of WGBOSV also attending and contributing to the plenary discussions within IMO and as part of the Ballast Water and Bio-fouling Working Group.

ICES WGBOSV has submitted several papers to the IMO, often in response to requests from IMO for information in relation to specific issues.

At the meeting of the Study Group on Ballast Water and Other Ship Vectors (the name of the group prior to obtaining Working Group status in 2004) in March 2002 in Gothenburg, Sweden the group responded to a request from Mr. Michael Hunter, Chairman of the Ballast Water Working Group, for scientific input regarding approval testing of ballast water treatment techniques. The group considered the outcome of an ad hoc group that met during the evenings at MEPC 47 and the recommendations of the GloBallast 1st International Ballast Water Treatment R&D Symposium held in March 2001. The SGBOSV submitted MEPC 48/2/9 outlining the outcome of their discussions. These included support for using representative taxonomic groups for shore-based trials and stressed the importance of adopting a standard that offered some level of risk reduction over a large geographical area.

At the meeting of the Study Group in Vancouver, Canada from 24-25th March, 2003 Mr. Michael Hunter requested specific information regarding the abundance of phytoplankton and zooplankton in ballast water at the end of voyages and advice regarding the level of reduction required to reduce the risk of introducing non native species. This issue was discussed at the meeting and continued with intersessional work and resulted in the submission of MEPC 49/2/21 to facilitate the discussions on the development of a discharge standard. This paper was instrumental in decisions behind the development of the D2 standard within the Ballast Water Management Convention.

During the WGBOSV meeting in Arendal, Norway from 14-18th March 2005 the group discussed the issue of the draft Guidelines for risk assessment (G7). The group submitted a paper (MEPC 53/2/10) with an outline of the considerations that would be required when deciding whether it would be possible to carry out risk assessments in order that vessels travelling between specified ports or locations would be exempt from ballast water management. This document was considered during the discussion of the draft G7 Guidelines and provided valuable input to the development of the document.

The submissions resulted from extensive collaboration between scientists from all over the world and represented some of the best knowledge in these areas. These papers have provided important input to the discussions at IMO and have helped a consensus to be reached on difficult and technical issues.

A formal agreement is sought by ICES and the IOC to allow the IMO Secretariat to liaise with, and participate in, the WGBOSV and to identify priorities regarding the specific Terms of Reference of the Group that would be of direct benefit to the IMO.

The WGBOSV also regularly coordinates with the PICES Working Group 21 on Non-indigenous Aquatic Species. With ICES, IOC and IMO as umbrella organizations and liaison with PICES, the WGBOSV has a unique and global position to deliver scientific advice and reviews regarding ballast and other ship vectors.

Having IMO contribute to the work of the WGBOSV will ensure that the ongoing discussions and developments at IMO are reflected in the Terms of Reference of the group and this will result in a focussed output that is beneficial to both organizations. An arrangement such as this will mean that the group is better able to respond to specific scientific questions raised during the discussions at IMO and that the ongoing work of the WGBOSV will provide a valuable link between the policy and scientific knowledge. There will also be an added benefit of closer links between the work carried out by GloBallast and the remit of the WGBOSV.

Action requested of the Sub-Committee

The Committee is invited to note the above information and respond as it deems appropriate.

Annex 7 Request from the IOC Intergovernmental Panel on Harmful Algal Blooms.

5.7 HARMFUL ALGAE AS INVASIVE SPECIES

- 1) C. McKenzie (Canada) introduced the topic and summarized the activities and achievements of the ICES-IOC-IMO Working Group on Ballast and Other Ship Vectors (WGBOSV). She noted with regret that the group had not submitted its reports from 2007 and 2008. She recalled that the Panel through Recommendation IPHAB-VII.4 had requested the WGBOSV to actively contribute to the process of developing the IMO guidelines for implementation of the IMO Ballast Water Convention.
- 2) The Panel reviewed the WGBOSV 2009 (Washington D.C, 9–11 March 2009) Terms of Reference and the resulting draft ballast water sampling manual. The terms of reference were to: (i) critical review and report on the status of shipping vector research with an emphasis on new developments in ballast water treatment technology, risk assessment, ballast water sampling devices, and selection of ballast water exchange zones; (ii) make a global review of shipping vectors through the participation of representatives from ICES, IMO, IOC, PICES; (iii) comment on the final draft of the ICES Code of Best Practice for handling Hull Fouling on Vessels; (iv) review draft ballast water sampling and port survey methodology Code of Practice; and (v) provide data on how climate change may alter distribution of alien introduced species and shipping operations.
- 3) To more accurately assess the achievements and focus of the Working Group on Ballast of Ships and other Vectors (WGBOSV) the panel requests that the reports from previous WGBOSV be submitted and also request that the WG Chairperson attend IPHAB-X to report on achievements, focus and future activities.
- 4) The Panel decided to review at IPHAB-X the achievement of the WG and advice on its future direction.
- 5) The Panel endorsed the co-sponsorship of the Working Group for 2010–2011 and urged IOC to ensure representation at the meetings of the WGBOSV.
- 6) The Panel recognized the difficulty of identifying an “invasive” phytoplankter or even providing lists of native phytoplankters so that future invasive species could be identified. The Panel also recognized that a list of harmful phytoplankton that could potentially be transported or introduced by ballast water is extensive and that it is complex or not possible to predict the likelihood of an introduced species becoming established in a new region.
- 7) The Panel concluded by acknowledging that there is a need to develop advice on the phytoplankters most likely to be successful as invasive species, the size of inoculums and conditions that would result in an invasive species. The risk of an invasive species having a negative impact on ecosystem health or the human uses of the ecosystem is determined by the combination of the probability of a species being introduced, its survival and spread, and impact. Therefore, priority should be given during the review to those phytoplankton species that are known to be or have a high probability of transport by ballast water, high survival (cysts/spore formation) and high ecological or economic

impact. The intent is thus to be able to assess risk associated with incoming ballast water that has not been exchanged. The list would be a watch list or an indication of high risk waters where specific HAB species are known to occur and cause problems. A top ten or twenty of high risk phytoplankton species that would not be world-wide, but region or climate-zone specific.

- 8) The Panel requested IOC and ICES to request the WGHABD, in collaboration with WGBOSV, to consider this matter and in particular to determine whether: (i) it was possible to identify species of phytoplankton, especially HAB species (and their characteristics) which are more likely to be successful as invasive species, and have significant potential ecological or economic impact; (ii) there are particular characteristics of coastal waters which favour the establishment of invasive phytoplankters.

Request from GESAMP (see following pages)



GESAMP
Joint Group of Experts on the
Scientific Aspects of Marine
Environmental Protection

GESAMP 37/12
11 February 2010
ENGLISH ONLY

37th session
Agenda item 12

ANY OTHER BUSINESS:

**ESTABLISHING EQUIVALENCY IN THE PERFORMANCE TESTING
AND COMPLIANCE MONITORING OF EMERGING ALTERNATIVE
BALLAST WATER MANAGEMENT SYSTEMS (EABWMS)**

Request to GESAMP for assistance with peer review

Submitted by GLOBALLAST

Background

1 The GESAMP Office has received a request by the GEF-UNDP-IMO GLOBALLAST PARTNERSHIPS PROJECT for a peer review by GESAMP of the GIA-GLOBALLAST Study on Establishing Equivalency of Emerging Ballast Water Management System. A summary of the Study and the official request is attached in Annex I of this document.

Action requested of GESAMP

2 GESAMP is invited to comment on this document as it deems appropriate

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ANNEX I**Request to GESAMP for assistance with peer review****Background**

GloBallast Partnerships is a GEF-UNDP-IMO funded programme to assist mainly developing countries with the implementation and ratification of the Ballast Water Management Convention (2004). The Programme Coordination Unit (PCU), which oversees all activities at the global, regional and national levels, is part of the Marine Environment Division of IMO. For more information, visit <http://globallast.imo.org>.

The GloBallast PCU is also the Secretariat of the Global Industry Alliance (GIA), where a number of shipping majors have come together to support activities that can facilitate and catalyse efforts regarding ballast water management, with the main aim of ensuring that the industry can comply with the Convention in a timely and cost-effective manner.

The GIA is supporting a number of activities, one of which is an independent study/review on how to establish equivalency in performance testing and compliance monitoring of emerging alternative Ballast Water Management systems. The BWB Convention sets a performance standard (Regulation D-2) for ballast water management, which the treatment technologies, currently being developed, must meet. In addition, the convention also allows for "other methods" than treatment to be used, as long as they can provide the same level of protection to the environment, human health, etc. (see Regulation B-3, paragraph 7). However, there is currently no mechanism for how to compare the very different types of management options, and how to scientifically prove equivalency in terms of environmental protection.

The GIA therefore commissioned a study to a) provide an overview of the alternative systems currently being developed; and b) provide some guidance on the possibilities for establishing equivalency between the alternative methods and those tested to meet the D-2 performance standard.

The study

The study was performed by two consultants (Professor Peilin Zhou, University of Strathclyde, and Dr. Rob Hilliard, independent consultant, Australia). The draft report was recently presented to the Global R&D Forum on Emerging Ballast Water Management Systems, Malmö, Sweden, 26-29 January 2010. The study consists of a desk-top review of alternative ballast water management concepts for which sufficient information was available in the public domain and, an assessment of possible approaches to establish equivalency.

The intention of this study is to provide an overview of the current status of alternative systems development and a starting point for discussions on equivalency. It is expected that the results of these discussions will later be fed into the IMO processes (BLG and MEPC) to complement the discussions on the regulatory aspects, such as the structure and format of the approval process for alternative BWB systems.

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More specifically, the project objectives were to:

- .1 Identify and describe emerging, near-future alternative BWM systems, and contrast their operational characteristics with those of present-day BWM options and requirements (i.e. conventional BW exchange, shipboard BW treatment, discharge to reception facility, disposal of ballast tank sediments);
- .2 Determine what potential risks the identified emerging options may pose to ship safety, crew health, the aquatic environment (including its marine wildlife, fisheries and other natural resources), property, and human activities (economic, recreational and aesthetic values); and
- .3 In the context of aquatic bioinvasion risk reduction/minimization, determine the scientific basis for establishing equivalency between the emerging alternatives and existing G8/G9 approved systems, with respect to their appropriate performance standard(s), system testing and the type approval process, and compliance monitoring by a port State(s).

The request to GESAMP

The GIA, through the GloBallast PCU, intends to publish the report in the GloBallast Monograph Series. Before doing so, GloBallast PCU would like to ask GESAMP to review the report, to ensure that it is consistent, logical and scientifically substantiated for publication as a GloBallast Monograph.

Timeline

GloBallast PCU would like to initiate the final editing and typesetting as soon as possible. Therefore, it would be highly appreciated if GESAMP could accommodate this request and provide comments before the end of March 2010. An executive summary of the report is attached to this request.

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GEF / IMO / UNDP GloBallast Partnerships Program
Global Industry Alliance (GIA)

Draft Technical Review - Summary

Establishing Equivalency in the Performance Testing
and Compliance Monitoring of Emerging Alternative
Ballast Water Management Systems (EABWMS)

Prepared for the GBP Global Industry Alliance by
Robert Hilliard¹ and Peilin Zhou²

25 January 2010

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GBP Ref.: IMO TC/0093-03-2290

Opinions expressed in this summary are not necessarily those of the GIA, GBP or IMO

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SUMMARY

Regulation B-3.7 of the ballast water management (BWM) Convention allows for the approval of alternative BWM methods, provided they can be shown to provide equivalent protection to the environment as existing approved methods, particularly ballast water treatment (BWT; Regulation D-2). The potential cost-effectiveness of alternative BWM methods has become increasingly recognised by parts of the global shipping community, with a number of concepts involving innovative hull designs and modifications being subject to appraisal, research and development activities over the past decade.

Several emerging alternative methods are approaching the point where more formal guidance on their safety evaluation, performance testing and compliance monitoring is needed. In fact none can provide a recognised alternative until it can be Type Approved following a performance testing regime that is accepted as equivalent (if not directly comparable) to an existing performance standard such as D-2, including the G8/G9 Guidelines for testing and approving BWT systems (modified as appropriate for testing the equivalent performance of alternative methods).

In response to these developments, the GloBallast Partnerships (GP) program with support from its Global Industry Alliance (GIA) partners arranged for an independent technical review of the emerging Alternative Methods, with the aim of facilitating discussion on their safety, performance testing and compliance monitoring requirements at the workshop on Emerging Alternative Ballast Water Management Systems (EABWMS) on 26 January 2010. Workshop outcomes and recommendations will be included the final report.

This summary of the draft review provides a backgrounder to workshop participants. It lists the various alternative concepts to 'conventional' BWM that have been emerging in recent years, and identifies approaches to their approval. Some will require new performance testing methods other than those current listed in the G8 Guidelines, so as to demonstrate their equivalence to the criteria of the D-2 standard and thus achieve a Type Approval by an Administration. In fact determining what performance benchmark(s) are suitably equivalent to the D-2 criteria will be important for Type Approving alternative methods that use a 'continuous flushing' process. Without a suitable benchmark it will not be possible to commence appropriate performance testing regimes or identify what compliance monitoring will be required for a type approved alternative system that is installed on a ship. For an alternative method that uses one or more chemicals, the G9 Procedure for assessing their acceptability with respect to ship safety, human health and the environment will also be relevant.

The following three tables provide a summary of the draft technical review. Table S-1 lists the emerging alternative BWM methods that were identified, and shows their key features including potential pros and cons. Table S-1 also shows that the various methods fall into two main groups - a 'No-ballast/Zero Discharge' group and a 'Continuous Flushing' group. Table S-2 shows the relationship of each alternative to the level of BW risk management, the nearest BWM procedure/s presently included in the Convention, and identifies the performance testing needs for confirming the equivalent risk. Table S-3 takes a look at the potential compliance monitoring requirements and options for port State control.

Table S-1: Features of the Emerging Alternative BWM Methods identified by the Review

Alternative Method (potential equivalent performance)	Main feature(s)	Benefits	Potential Penalties	Likely best-suited ship type/s
<u>No ballast/Zero discharge</u> Zero ballast (Eliminates risk; avoids all BWM Convention requirements)	Novel hull designs or solid ballast TEUs provide unladen stability without need for any seawater ballast tanks	Avoids all costs associated with BWM. No chemicals used.	Higher hull construction costs, and/or possible operational costs related to increased hull drag or the logistics of moving solid ballast containers	(a) New ro-ro pax, container, car or livestock carriers & other 'high cargo volume' ships; (b) Existing container ships
Storm ballast only (variable; needs to meet D-2 if discharges in port or other jurisdictional shelf waters)	Novel hull design needs only two tanks for temporary storm BW that is not discharged in port*	Avoids costs of installing and operating a large BWT system for large carriers**	Higher hull construction cost and wider beam (possible berth access/facility constraints); loss of cargo if storm BW is retained for port entry.	New liquid and dry bulk carriers
Internal FW ballast (needs to meet D-2 when eventually discharged for inspection, depending on location)	Freshwater that is shifted from tank to tank, and never routinely discharged in port*	Avoids costs of installing and operating a BWT system.	Reduced cargo capacity, no capacity to make air-draft adjustments; how to discharge for a tank inspection / survey...	Existing and new container ships, ro-ro pax, liners, livestock carriers
Potable ballast (needs to meet D-2 at point of discharge, depending on location)	Only drinking water is added to clean tank/s, allowing it to be discharged in port*	Avoids costs and loss of hull space for installing a BWT system on a small ship.	Cost of potable water production or purchase, then maintaining adequate quality in onboard tank/s	Super yachts, CTVs, cruise liners, small livestock carriers, some pax and military vessels
<u>Continuous flow:</u> Longitudinal Trunks (meets D-1; may achieve equivalence to D-2 for certain routes)	Replacement of DB ballast tanks with buoyancy trunks to improve flushing without use of pumping	Avoids costs of installing and operating a large BWT system**; and may also improve propulsion efficiency	Higher hull build cost, but this may be offset by a gain in propulsion efficiency. Need to apply antifouling coating on permanently immersed components.	New bulk carriers
Ship Buoyancy Control (meets D-1; may achieve equivalence to D-2 for certain routes)	Tailored conversion of DB-side tanks to form buoyancy compartments with weirs for improving flushing without pumps	Avoids costs of installing and operating a BWT system	Multiple below water valves may cause high installation and operational costs to maintain hull strength	Existing and new cargo ship types

			and ship safety	
AUBAFLOW <i>(meets D-1; may achieve equivalence to D-2 for VLCCs on certain routes)</i>	Enhanced blue water BWE without use of pumps, best suited for transoceanic voyages	Avoids costs of installing and operating a large BWT system**	Insufficient data but potentially increased hull resistance, and potential for localized sediment accumulation in tanks	Existing and new VLCCs
Loop Ballast Exchange <i>(improves AUBAFLOW performance for achieving same goals)</i>	Enhanced blue water BWE without use of pumps, best suited for transoceanic voyages	Avoids costs of installing and operating a large BWT system**	<i>[insufficient published data found to assess for the draft report]</i>	Existing and new tankers and VLCCs

* for the purposes of Table 3-1, 'port' includes the jurisdictional internal and coastal waters of a State.

** 'Costs' include potentially substantial increases in fuel consumption and GHG emissions to meet the additional power requirements of large BWT systems.

Table S-2: Relationship to BWM risk management, nearest applicable BWM procedure/s included in the Convention, and requirements to confirm acceptability of equivalent risk

Type of Alternative Method	Relationship to risk management and nearest applicable BWM procedure(s)	Requirements to confirm acceptable equivalent risk ¹	Other suggested requirements
Zero BW	<u>Risk Elimination</u>	N/A	N/A
Storm BW only	<u>Risk Minimisation</u> Requires decision-taking system by: (a) Discharge location: If uptake then discharge is completed on high seas or same area, or is retained onboard [no mixing] until returned to same -> no further management required (A-3.4/5 <i>Exception</i>), else (b) Treatment: if BW not returned to same area or mixed, use small BWT system (D-2), else discharge to (c) Land-based BW Reception Facility	Performance testing not required. Guidelines on bio-geographic extent of 'same area' required, to help define size and boundaries and assess risk of this method	Ship's BWM Plan to specify permitted areas and non-mixing requirement for any unmanaged discharge. All BW ops logged in BWRB
Internal freshwater BW	<u>Risk Prevention:</u> Avoids discharges and associated BWM needs (e.g. compliance testing to D-2), <u>until</u> an eventual discharge is needed for tank inspection or Class survey. If tank water tests shows non-compliance (e.g. human pathogen/s), then treat by dosing to achieve D-2, or else discharge in high seas? <i>[Q: Is discharge of permanent FW in a high seas or designated BWE area, without testing for human pathogens, an acceptable equivalent risk?]</i>	Tank water testing or performance testing may be required. <i>Example: if discharge to offshore seawater area is sought, supporting evidence needed (e.g. test results from internal FW ballast tank samples from existing ships?)</i>	Ship's BWM Plan may need to specify what tank sampling and testing is needed before discharging in offshore, coastal, port or inland waters, and what dosing or other treatment option/s are permitted.
Potable BW	<u>Risk Minimisation:</u> Discharges should meet D-2 standard and be environmentally acceptable, if approved system (including storage ballast/trim tank)	Performance testing data required from supplier of water	Guidelines to help vendors obtain approval for their

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Type of Alternative Method	Relationship to risk management and nearest applicable BWM procedure(s)	Requirements to confirm acceptable equivalent risk ¹	Other suggested requirements
	are operated correctly re. type and level of disinfection. <i>[Q: should discharge of untested Potable BW on high seas be formally accepted as low equivalent risk (D-2), and also an acceptably low environmental risk re. possible presence of residuals/by-products?]</i>	maker, to show environmental effects are acceptably low to obtain G9 approval. <i>(types and levels of residuals / by-products)</i>	potable water system/s (drawing on experience of G9 work to date re. residuals/by-products) <i>Provide a tailored and 'fast-track' Type Approval procedure?</i>
Continuous flushing by Buoyancy Control²	<u>Risk Minimisation:</u> Alternative BWM method Method may approach D-2 on many blue-water trans-oceanic routes. Occurrence in shelfal waters of phytoplankton blooms by potentially toxic species (<i>esp. in well-known, listed and often satellite-monitored upwelling areas</i>) is an issue that needs addressing May merit ship and route-specific risk-based Exemption/s (A-4) for blue-water routes, using the G7 Risk Assessment Guidelines. May merit approval as an Alternative Method under B-3.7 for particular transoceanic routes and ship types, with risk assessment based on G7 Guidelines that could be suitably extended.	Approval as Alternative Method should use a risk-based equivalent performance testing regime (<i>in line with approvals for specific ship and route Exemptions from BWM; Reg. A-4</i>). To encourage development / investment, use a two-step approval process? (<i>e.g. an 'Initial Approval' from MEPC if application is supported by sound theoretical argument, supported by risk assessment following principles in G7 Guidelines, and results from computer simulations, models, numerical analyses and empirical evidence, plus benchmark/s proposed for performance testing and compliance testing. Ship safety, health and environmental side-effects also to be covered. The G7 Guidelines show RA procedures to be followed for A-4 exemptions. These can help form basis of the RA that identifies and compares the performance benchmark/s proposed for the Alternative Method against the quality of discharges treated to D-2, with respect to the concentrations and types of organisms and microbes predicted to occur in the discharge of BW subjected to the Alternative Method.</i>	
Enhanced BWE by Continuous Dilution	<u>Risk minimisation:</u> Alternative BWM method Method may approach D-2 on many long-distance blue-water voyages by VLCCs. May merit VLCC and route-specific risk-based Exemptions (A-4) for long blue-water routes, using the G7 risk assessment Guidelines. May merit approval as an Alternative Method under B-3.7, for VLCCs operating particular transoceanic routes	<i>Performance testing should include adequate numerical modelling and simulations, supported by pertinent empirical evidence wherever practical, such as tank tests, models and operational sampling and testing of existing BWE methods on same or similar ship type/s.</i> <i>Modify Regulation D-4 to allow Prototype testing? Full-scale prototypes would greatly assist in method development, performance testing and new ways for compliance monitoring</i>	

1 Assumes the economic, ship safety, health & environmental aspects are feasible and practical.

2 Systems using multiple inlet and outlet valves on the hull bottom may face challenges re. ensuring ship safety.

Table S-3: Suggested Compliance Monitoring approaches and procedures

Group	Type of Alternative Method	Types of Compliance Monitoring that port State Control may wish to take	Related Aspects
-	Zero BW	N/A	N/A
1	Storm BW	(a) Confirm that ship BWM operations are being conducted according to the Ship's BWM Plan and all have been logged in BW Record Book (BWRB). (b) If a small BWT system is present, check correct operation and sample discharge as/when necessary to check meets D-2 criteria. (c) Tank sediment avoidance measures and sediment inspections have followed B-5 requirements	Ship's BWM Plan to specify the allowable areas (and the non-mixing requirement) for any discharge that is not treated to D-2 or discharged at an approved BW Reception facility.
	Internal freshwater BW	(a) Procedures listed in Ship's BWM Plan for testing and/or dosing prior to discharge are being followed. (b) Check the salinity of internal BW stored in tanks, if ship intends to make a discharge in sensitive waters of port State control. (c) All BWM operations correctly logged in the BWRB	Ship's BWM Plan to specify allowable areas for discharge of non-tested internal BW, and sampling / testing procedure before discharge in port or inland waters, and approved treatment option/s if water is non-compliant.
2	Potable BW	(a) Confirm source/s of potable water meet the approval requirements in terms of shipboard monitoring and servicing (e.g. a certificate from supplier/vendor is onboard regarding DW quality). (b) Tank water may be sampled to confirm it meets D-2 standard, but only if ship intends to make a discharge in sensitive waters of port State control.	If an approved onboard water-maker is present, any stored water intended for discharge may also be sampled to test for by-products or residuals, according to advice in the type approval certificate pertaining to the disinfection method.
3	Continuous flushing by Buoyancy Control	(a) If the system is approved for specific routes and terminals only, confirm from the BW Record Book, bridge/engineering logs. (b) MOU/port State control records can provide cross-checks that BW uptake/discharge operations match the operational trading history of the ship. (c) If the installation certificate of the approved system also identifies specific areas, depths or other locations where continuous flushing is to be shut down for minimising biota/sediment entrainment, compare BW Record Book, system operation logs and deck logs to confirm.	System may be approved for particular transoceanic routes and ship type, as detailed in Installation Certificate and listed in Ship's BWM Plan.
	Continuous dilution by enhanced BWE	(d) For BW sampling to confirm it meets the performance standards defined in the Type Approval certificate, use relevant sampling points and testing procedures as listed in the Installation Certificate and in Ship's BWM Plan. (e) Tank sediment monitoring, inspections and performance targets, as where stated, are meeting	System may be approved for particular long transoceanic routes, loading/unloading terminals and ship type only, as noted in Ship's BWM Plan.

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Group	Type of Alternative Method	Types of Compliance Monitoring that port State Control may wish to take	Related Aspects
		criteria for tank sediment management.	