ICES WGBOSV REPORT 2011

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

14 – 16 March 2011

Nantes, France

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

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Executive summary

The 2011 meeting of the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) was hosted by Ifremer in Nantes, France with Daniel Masson and Laurence Miossec as hosts and Tracy McCollin as chair. In total there were 30 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 two participants by correspondence. The participants were from Belgium, Canada, Egypt, Estonia, Finland, France, Germany, Greece, Italy, Spain, Sweden, the United Kingdom, Lithuania, the Netherlands, Norway and Portugal. There were contributions by correspondence from Croatia and the United States of America. Apologies were received from Richard Rivkin (Canada) who was unable to travel at the last minute.

The purpose of this meeting was to discuss issues relating to the transport of non-native species *via* shipping. These included reporting on the status of shipping vector research, discussing methodologies relating to ballast water treatment facilities, discussing matters relating to the sampling strategies under consideration at the International Maritime Organization (IMO) and providing information regarding climate change and the impact on shipping routes such as the Northwest Passage. Updates of the output from the previous year's meeting were also given.

The approach taken during the meeting was to allow time on the first day of the meeting for the participants to update the group on relevant research being undertaken in each country. The day was then completed by a series of more in depth talks in relation to shipping vector research. The second day consisted of updates regarding work from the previous year's meeting that had been completed intersessionally and discussions regarding the outcome and future use of this work. The second half of the day was then given over to more detailed presentations regarding sampling and test facilities and the day was ended with a discussion on arrangements for the meeting next year. The third day was a joint meeting with WGITMO and the agenda was arranged to discuss items of relevance to both groups and the morning was an even split between presentations and more detailed discussions regarding the Terms of Reference.

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 discussions. 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 for the group, some of which will be completed intersessionally. One of these actions is for the group to contribute to the Correspondence Group on Sampling that will report to the IMO at the 16th session of the Bulk Liquids and Gases subcommittee in January 2012. The chair of the WGBOSV will coordinate the responses to request for information and submit them on behalf of the working group.

1 Opening of the meeting

The meeting was opened at 09.00 on 14th March, 2011 with Tracy McCollin welcoming participants. This was followed by words of welcome from Philippe Goulletquer of Ifremer. Philippe gave a brief overview of the work of Ifremer and the work being carried out to revise the French National Strategy in accordance with the Convention on Biological Diversity and the European Action Plan. The presentation gave information regarding the new regional integrated approach and the development of a data sharing system as well as the creation of a foundation for biological diversity research.

2 Adoption of the agenda

The agenda (Annex 2) was structured on the basis of the Terms of Reference contained in ICES Resolution 2010/2/ACOM29 as shown below and was adopted with minor changes as unfortunately Richard Rivkin had to cancel so his presentation was removed from the agenda.

Gemma Quilez Badia, Spain was appointed as rapporteur.

3 WGBOSV Terms of Reference

2010/2/ACOM29 The ICES/IOC/IMO **Working Group on Ballast and Other Ship Vectors** (WGBOSV), chaired by Tracy McCollin, UK, will meet in Nantes, France, 14–16 March 2011, with a back to back meeting with the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) on the morning of the 16, 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 1 April, 2011 to the attention of ACOM.

On the 10th March, 2011 a message was received from SCICOM Chair, Manuel Barange, and ACOM Chair, Jean-Jacques Maguire regarding new Terms of Reference that were to be added to all Expert Groups (see Annex 3). These were:

In relation to the Marine Strategy Framework Directive:

- Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF;
- Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

In relation to the Strategic Initiative on Area Based Science and Management:

- take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP) http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf
- provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes.
- identify spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc.

As these terms of reference arrived just before the group was about to meet the request was added to the SharePoint site and the group were updated at the beginning of the meeting. Although the group had no time to prepare for these Terms of Reference it was agreed some initial discussion could be had in relation to how the group felt they could provide input into this process and this took place during the joint meeting with WGITMO. The chairs of both groups (Tracy McCollin and Henn Ojaveer) gave a brief overview of the Marine Strategy Framework Directive Steering Group (MSFDSG) and the Strategic Initiative on Area Based Science and Management (SIASM) and had made available all the relevant information on the SharePoint site.

4 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.

4.1 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 and ballast water sampling and analysis in order to support the ongoing work at IMO.

This Term of Reference was achieved by each of the participants giving an overview of the relevant research in each of their countries. This could either be as an informal verbal contribution or as a more detailed presentation. A brief summary is provided for each country and, where available, more detailed information is contained with the National Reports in Annex 6. There were also more detailed presentations given

in relation to this Term of Reference throughout the meeting and brief summaries of these are included at the end of the section.

4.1.1 Belgium

There is currently no work on ballast water in Belgium. However, there has been a study carried out on fouling of newly installed wind farms. Belgium is also in the process of trying to ratify the Ballast Water Management Convention.

4.1.2 Canada (see also National Report in Annex 5.1)

Canada continues to conduct extensive research on transport vectors, management strategies and risk assessment. There have been no reports of new ship-mediated invasive species in the last year, although monitoring programs are limited and assessment of taxa present in Canadian Arctic ports has just begun. Research studies include biological sampling of hull fouling, ballast water and ballast sediments associated with transoceanic vessels arriving to the four coasts of Canada (west, east, Arctic and Great Lakes), as well as for ballast water of domestic ships operating between Canadian ports. Experiments measuring rates of dilution of ballast water discharge into recipient port waters provide useful information for predicting establishment success of passive organisms transported by ballast water. Studies examining the biological efficacy of ballast water exchange and tank flushing management practices and the use of NaCl brine as an emergency ballast water treatment have been completed, while a combination management strategy utilizing exchange in combination with a ballast water management system to protect low salinity waters is under investigation. Risk assessments have been initiated for the commercial and recreational shipping pathways and the appropriateness of alternate ballast water exchange zones for vessel traffic to Newfoundland and Labrador and the Canadian Arctic have been reviewed. Finally, note that the Canadian Aquatic Invasive Species Network has been renewed for an additional five years.

4.1.3 Croatia (by correspondence, see Annex 5.2)

Croatia contributed a short report by correspondence which was presented by Tracy McCollin. There is a new project on ballast water treatment at the University of Dubrovnick based on using hydrodynamic forces and magnetic field. There is an ongoing monitoring of introduced species. A Regulation on Management and Control of the Ballast Water has been enacted by the Croatian Parliament in September 2007 and discussions regarding Ballast Water Exchange Zones are ongoing with Slovenia and Italy.

4.1.4 Egypt

Ballast water is proposed to be the main cause for having exotic species in different ecosystems. Also, Suez Canal in Egypt, which is a very important navigated route for all kind of ships, plays a vital role in Lessepsian migration. Many phytoplankton species in the Mediterranean Sea in Egypt have been recorded as invasive species through last decade and most of them are referring to the ballast water. A perspective plan has been set to monitor certain pathogenic bacterial strains in ballast water in order to judge the efficiency of ballast water treatment.

4.1.5 Estonia (see also National Report in Annex 5.3)

A handbook of non native species in Estonia will be published in 2011 (in Estonian) and this will also contain information on vectors and ecological impacts. A non native species monitoring programme was started last year based on sampling high risk area (port of Tallinn). Some reference stations were also included for comparison. No new species have been found in these high risk areas in 2010. Two recent papers on non native species issues have been published recently and these were added to the SharePoint.

Lanknov, H., Ojaveer, H., Simm, M., Põllupüü, M., Möllmann, C. 2010. Feeding ecology of pelagic fish species in the Gulf of Riga (Baltic Sea): the importance of changes in the zooplankton community. Journal of Fish Biology 77, 2268-2284.

Ojaveer, H., Kotta, J., Põllumäe, A., Põllupüü, M., Jaanus, A., Vetemaa, M. 2011. Alien species in a brackish water temperate ecosystem: annual-scale dynamics in response to environmental variability. Environmental Research (in press).

4.1.6 France (see also National Report in Annex 5.4)

In 2010 a small regional research action began in the port of La Rochelle : sampling the discharged ballast water in the port to assess the risk related to toxic phytoplankton introduction close to the most important oyster farming area in Europe.

Two companies intend to submit ballast water treatment system to IMO approval.

Hull fouling: French ship owner make a proposal to extend dry docking period from 5 to 7.5 years for some particular ships.

4.1.7 Germany (see also National Report in Annex 5.5)

Management and control of Invasive species

A "Platform for Information Exchange on Neobiota" has been established in the framework of the "Federal and Federal States Marine Montitoring Programme" the national body that takes care of the duties arising from national and international obligations.

In order to fulfill the requirements a bundle of studies for different obligations are in preparation. For the Wadden Sea an inventory study to provide an overview of the state of the art regarding neobiota will be tendered by the Wadden Sea Secretariat for the trilateral Wadden Sea Cooperation Area.

For the German EEZ the Federal Agency for the Environment and the Federal Agency for Nature Conservation prepared tenders for R&D-projects to prepare the implementation of the Marine Strategy Framework Directive (MSFD). It includes the development of concepts for indicators for the assessment and the respective monitoring aiming at an overall assessment of descriptor 2 (alien species) of the MSFD.

Ballast Water

The European Maritime Safety Agency (EMSA) funded a project regarding representative samplings of ballast water and options for indicative ballast water sample analysis. Stephan Gollasch was involved in this project and jointly undertook this work with Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia) (Annex 1)

Additional guidance regarding ballast water sampling for compliance control with the standards as set forth in Regulation D-2 of the IMO Ballast Water Management

Convention are being developed at IMO. This is currently done in a correspondence group which is led by Brian Elliott of EMSA.

This Interreg IVB funded Ballast Water Opportunity project will run another 2.5 years. 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. More details and an activity update at http://projects.nioz.nl/northseaballast/.

Hull Fouling

Germany was actively involved in the development of the IMO hull fouling guideline which was agreed at IMO Sub-Committee Meeting Bulk Liquid and Gases in February 2010. Vessels below 24 m in length will be addressed by a separate document to be developed by IMO working groups.

Risk Assessment Approaches

In the context of preparations for the implementation of the Ballast Water Management Convention a risk assessment was undertaken in the frame work of the Interreg IVB Ballast Water Opportunity Project (HELCOM MARITIME 9/2010 doc 7/1/INF. (http://meeting.helcom.fi/c/document_library/get_file?p_l_id=18816&folderId=1240530&name=DLFE-43228.pdf)).

In order to obtain experience in the application of risk assessments the German Maritime and Hydrographic Agency launched a project on risk assessments for exemptions of ballast water management for selected harbours in the North and the Baltic Seas.

New species findings

Two new species were found in 2010, both likely being introduced by shipping, i.e. the amphipod *Melita nitida* which was found in the Kiel Canal and the Copepod *Skistodiaptomus pallidus* near Bremen.

4.1.8 Greece (see also National Report in Annex 5.6)

An update of the inventory of alien marine species from the coastal and offshore waters of Greece has added 47 new species bringing the total to 237; twenty one of the listed species were reported for the first time in 2009-2010. Twelve of the new reported species are ship transferred.

Spreading of alien species that were known from certain port areas into other port areas in Greece was reported for four species namely *Balanus trigonus, Chama aspersa, Pseudochama corbieri, Gastrochaena cymbium,* all of them being fouling species.

Increase of alien species number is more evident in SE Aegean (Dodekanisos area) and in the Saronikos and Thermaikos Gulfs (wider areas of Peiraias and Thessaloniki ports respectively).

4.1.9 The Netherlands (see also National Reports in Annex 5.7)

North Sea Ballast Water Opportunity Project (NSBWO; EU - Interreg North Sea), coordinated by NIOZ, 2009-2013 (Facilitate ratification of the IMO BWM Convention; www.NorthSeBallast.eu) (NL Participants: ports, shipping, technology developers, science, policy, Environmental NGOs). Organised workshops 2010-2011: hands-on

detection, National implementation, specific BWM systems conditions: chlorine, Inert gas, modelling for prevention/early warning strategy, BW exchange strategy & consultation, dissemination; co-operation with other regions, project expanding. Credo of NSBWO: Coherence, harmonisation, and transparency and open access to and exchange of information. Ballast Water testing studies, co-ordinated and based at NIOZ, since 2002, ongoing. Several systems tested for certification, many pilot tests on developing systems, development of advanced analytical methods and long-term studies, optimising BW testing protocoals. BW-Mesocosm studies done at IMARES. NL ratified BWM Convention spring 2010. Bio-invasion from hull fouling quantification study; World-wide IMO Model Course Marine Environmental Awareness for mariners developed by ProSea Foundation (http://www.prosea.info).

4.1.10 Norway (see also National Report in Annex 5.8)

The background for increased interest in the Northern sea routes was briefly outlined, and a proposal for an ocean-going workshop for the study of BW biota was proposed at the BOSV-meeting

Norwegian Institute for Water Research (NIVA) has been involved in testing of Ballast Water Management System (BWMS) since 2002. NIVA has established a centre for land-based testing according to IMO-requirements, located at Oslofjord south of Oslo. Land-based testing of BWMS for type approval is carried out by Ballast-Tech NIVA AS, a company fully owned by NIVA. NIVA has carried out 11 fullscale land based tests for type approval (5 technologies for G9 and 6 technologies for G8), 8 small scale testing for basic approval (5 technologies for G9 and 3 for G8) and 3 ship board testing projects for G8 (i.e. 14 shipboard test cycles in total). The designated administration for approval of BWMS will be the Norwegian Maritime Directorate and the designated body Det Norske Veritas. To run a BWMS test site facility, many research studies have been carried out at NIVA and are still going on to establish and improve sampling and analysis methods according to G8/G9, and further ETV protocol (US coast Guard/EPA, 2010) and California Performance Standards (2008). The last three on going research projects at NIVA are for the first one study on establishment of a PCR method to analyse ballast water for toxicogenic V. cholera, in collaboration with the Norwegian Defence Research Establishment (FFI). The second one is the bacterial regrowth potential in ballast water treated with different disinfection methods, i.e. UV irradiation, ozonation, chlorination, in collaboration with the Norwegian School of Veterinary Science. The third one is the study of *Tetraselmis suecica* (algae species) dose response curves for UV and ozonation treatment with different analysis methods and in different water quality. NIVA participate in several harmonization effort as the sampling and analysis methods harmonization working group initially organised by IMO/Globallast, for intercalibration of the test water preparation method, sampling and analysis methods for each organism group and insurance quality (QAPP, QMP) between all test facilities in the world (Europe, USA and Asia). The last working group occurred in Singapore in November 2010 and NIVA will be the chairman for the next one in Turkey in November 2011.

A first attempt of mapping/monitoring of marine alien species in a more systematic way in Norwegian marine waters has been conducted. (Rapid Assessment Inventories) This study is cooperation between the University of Bergen and IMR.

The Norwegian Environmental Department has made bylaws effective from July 1, 2010, implementing the first part of the Ballast-water Convention. The bylaws regulate BW exchange (depth/distance from shore) but does not make any treatment (e.g. compliance with a D2 standard) mandatory. The Norwegian "species databank" has

initiated work in 2010 on a revision of the alien species list of 2007. Simultaneously the risk assessment has been developed into a more generic tool. Both ecological damage and spreading capacity is evaluated and expressed as a "risk matrix". A new "alien species list" will be finalised in 2011 and published in 2012. The "Norwegian species database" is an open access database with several reference- and GIF-tools. http://www.biodiversity.no/frontpage.aspx?m=23

4.1.11 Portugal (see also National Report Annex 5.9)

The legal framework in Portugal on Alien species is currently under revision. The 1999 Decreto-Lei nr. 565/99, 21 December, which defines the legal restrictions to the introduction in nature of exotic species did not consider marine species. The revised document is being produced by the Institute for Nature Conservation and Biodiversity (ICNB). It revises concepts on alien species status, includes reference to ballast water indicating that the IMO and ICES guidelines are to be applied, and includes a list of marine species and their status.

The Decreto-Lei nr. 235/2000 on Marine pollution, considers introduction of organisms that may affect the environment within the concept of marine pollution.

The Azores and Madeira Archipelagos have additional regional regulations.

The European Union marine environmental policy (Marine Strategy Framework Directive) has been transposed into the Portuguese law and published as Decreto-Lei nr. 108/2010 on October 2010.

There is one ongoing Project (INSPECT-2008-2011) aiming at identifying marine alien species in Portuguese estuaries and coastal areas and assessing patterns of distribution and abundance, vectors and invading potential. The project is coordinated by the University of Lisbon and the other partners include the University of Évora and the University of Açores, ICNB, Institute for Ports and Maritime Transport (IPTM) and the Nature Conservation NGO (LPN). Data compilation on alien species of phytoplankton, macroalgae and invertebrates, based on the literature and results obtained within the project, produced a list of 68 species, mainly associated with ballast water and fouling. Analysis of the maritime traffic to and from Portuguese ports suggests Portugal as a ballast water donor to other European areas. The traffic to and from the Azores archipelago is dominated by traffic with mainland Portugal and between the islands, and suggests the Azores as an exporter of ballast water to mainland Portugal. Work developed within the project involved a variety of sampling strategies and methods, including surveys in major ports and recreational marinas (benthic samples and sediment corers collected by scuba diving), ballast water and sediment sampling in operating vessels and 1 vessel in dry dock, and collecting box corers on the Portuguese continental shelf for the study of the dinoflagellate fossil record. Results from the project, have allowed the identification of new areas of distribution for many of the alien species already reported in the literature, in both mainland Portugal and the Azores archipelago, and have also added new species to the list, for instance the dinoflagellate *Ostreopsis siamensis*. These results are being used to produce the marine alien species list on the revised version of Decreto-Lei nr. 565/99.

4.1.12 Spain (see also National Report in Annex 5.10)

No projects on ballast water are currently ongoing in Spain.

Two recent publications (Ramos Esplà *et al.*, 2010 and Guardiola *et al.*, 2010, see National Report) have indicated the presence of two introductions, which might have

been introduced by shipping activity. These are: the mollusc *Bursatella leachii* and the sponge *Paraleucilla magna*.

The mollusc *Bursatella leachii* was found in 2009 in Mar Menor (in SE Spain, Mediterranean coast). The population numbers of this species fluctuate sporadically. *Bursatella leachii* is a circumtropical species, widespread along the temperate water of the Indo-Pacific and Atlantic Ocean, and common in the eastern Mediterranean. Its mode of introduction to the Mediterranean could have been either by ships from the tropical Atlantic or via the Suez Canal.

The sponge *Paraleucilla magna* was found in 2000 off the coast of Blanes (in NE Spain, Mediterranean coast). The introduced calcareous sponge *Paraleucilla magna* has proliferated along the western Mediterranean during the last decade. It is resistant to pollution and seems to be a structurally important species of the fouling community. *Paraleucilla magna* prefers to settle on mussel shells and may affect their growth, forcing local shellfish farmers to invest much effort in decreasing sponge growth. It originates from the SW Atlantic, and both bivalve farming and shipping are the most probable vectors of introduction into the western Mediterranean.

4.1.13 United Kingdom (see also National Report in Annex 5.11)

There are several projects ongoing in the United Kingdom, some of which are coming to an end and the results are in the process of being analysed and written up. There are four projects being carried out in relation to transport vectors. The Scottish Association for Marine Science is currently writing up the results of a project that assessed the interaction on boat hulls between disturbance frequency and resistance of marine communities to invasion. The work involved placing settling panels in a marina and carrying out a disturbance phase (i.e. dislodgement of a known amount of fouling) at set time intervals over 24 weeks. Initial results suggest that a greater number of species became established on the panels with the highest disturbance frequency. Two hull fouling sampling projects are underway, carried out by Marine Scotland Science and the Marine Biological Association of the UK. These two projects use a variety of sampling methods such as dry dock visits, diver surveys and visiting marinas when the recreational vessels are taken out of the water at the end of the season. A further study carried out by the Marine Alien II consortium involved deploying settling panels in 23 marinas around the UK and examining differences in settlement depending on marina location, design and environmental (water flow, temperature and salinity) conditions. Further work has been carried out in relation to the *Didemnum vexillum* introduction into areas of the UK. Initial attempts at eradication in Wales appeared successful but re-infection occurred. It is not currently decided whether a further eradication will be attempted. In other areas it has been decided not to go ahead with eradication and the focus will be on pathway management.

4.1.14 United States of America (by correspondence, see also National Report in Annex 5.12)

There are two ongoing studies in the U.S. relating to ballast water 1) Undertaken by the National Research Council, sponsored by the U.S. Environmental Protection Agency (U.S. EPA) and the U.S. Coast Guard (USCG) this project focuses on invasion theory and risk of invasion under different discharge standards, 2) undertaken by the USEPA Science Advisory Board, sponsored by the USEPA Office of Water and supported by the USCG this project focuses on the capability of current technology to meet different levels of treatment.

The United States submitted three documents on methods used by the States and ships for sampling ballast water discharges. The methods will allow the U.S. to evaluate compliance with the D-2 standard under the Ballast Water Management Convention, Annex 5.12 provides further details of these papers. Three documents in relation to ballast water legislation and/or regulation were highlighted, 1) Ballast Water Discharge Standard Update from the U.S. Coast Guard, 2) management report compiled by the Great Lakes Ballast Water Working Group (BWWG), 3) Environmental Verification Report of the U.S. Environmental Protection Agency, U.S. Coast Guard, and U.S. Naval Research Laboratory entitled Generic Protocol for the Verification of Ballast Water Treatment Technology. Details regarding these reports are contained within the Annex 5.12 and some are available via the SharePoint site.

There are now three fully-operational independent ballast water management system Test Facilities in the US: the Maritime Environmental Resource Center (University of Maryland, Chesapeake Bay), Great Ships Initiative (Northeast Midwest Institute, Lake Superior) and Golden Bear (California Maritime Academy, San Francisco Bay).

4.1.15 Factors associated with hull fouling: a 3-coast perspective from Canada.

Hugh MacIsaac and Francisco Sylvester.

Hull fouling presents a common and sometimes dominant vector for introduction of alien invasive species (AIS) to marine coastal waters. No hull fouling studies have been conducted in Canada prior to a study undertaken by the Canadian Aquatic Invasive Species Network (CAISN), which sampled 20 vessels arriving to each of Halifax, Vancouver and Great Lakes ports. Patch samples were collected from across the hull and niche areas of all vessels, and all exterior surfaces were videotaped in-water. Vancouver had higher propagule pressure and colonization pressure than did Halifax. Ships entering the Great Lakes had high abundances of species, though virtually all of them are incapable of living in fresh water or are already present in the Great Lakes. Species in marine ports (both native and introduced) are almost entirely different from those present on ships, which indicates either continuing invasion risk or inability of some hull fouling species to colonize coastal marine ports. Niche areas on vessels including the leading and trailing edges of the rudder and the propeller tended to have much higher species accumulations (colonization pressure) than the main hull.

4.1.16 Assessing the risk of introducing non native species to Scotland via biofouling

Tracy McCollin and Lyndsay Brown.

Marine Scotland - Science is undertaking a research project to assess the biofouling on vessels arriving in Scottish waters. The overall aim of the project is to obtain information regarding which species are being transported *via* biofouling and whether particular vessels e.g. recreational or commercial, or voyages e.g. UK based or international, pose a higher risk of introducing non native species.

The Scottish Government funded Biofouling project has involved the collection of samples from commercial vessels by visiting dry docks to sample the hulls and other areas of vessels that are subject to reduced water flow e.g. sea chests, propellers, rudders. The docks are visited immediately the dock has been drained i.e. prior to the vessel being washed down, and Marine Scotland staff use a cherry-picker lift to access the hull and protected "niche" areas of fouling. These areas are photographed,

ranked in terms of the level of fouling and samples of all the different types of fouling taken by using a paint scraper. To date, one dry dock in Aberdeen has been visited on several occasions to collect samples and there are plans to visit other dry docks in Scotland in order to obtain samples from as wide a variety of vessels as possible.

The second aspect of the project involves using the Marine Scotland - Science dive team to take samples from vessels that trade in Scottish ports but would be too large to use the dry docks. The dive team aim to use a series of in water methods (e.g. video cameras, small suction devices and scrapers) to record and sample biofouling on vessels. The combination of these methods will enable samples to be collected from a variety of vessels from different origins.

The sample analysis is ongoing and to date no new non native species have been detected. The results of the biological analysis will be combined with information on vessel type and usual voyage pattern to assess whether it is possible to assign levels of risk for introducing non native species.

4.1.17 Seaweed introductions: studies on vectors and cryptogenic species.

Frederic Mineur.

The marine flora on European shores has been surveyed by generations of phycologists since around two centuries. From that time, any new conspicuous introduction of exotic species could be detected. At the present day, around 130 species of macroalgal species are believed to have been introduced into Europe. More than 50% of these introductions occurred during the last 40 years. Apart from Lessepsian migrations, the most common evoked vectors in seaweed introductions into Europe are hull fouling and shellfish transfers. Generally, deduction of vectors of introductions is mostly made *a posteriori*, according to the potential sources present at the vicinity of the site of first observation. Some survey and experimental results, focusing on macroalgal introductions, are presented. A survey of hulls, both in for in-service cargo ships, and recreational yachts, showed a high predominance of cosmopolitan, opportunistic species (e.g. *Ulva* spp and Ectocarpoid species), and a few Ceramiales species (Rhodophyta) with a more restricted distribution. On the other hand, shells of oysters involved in routine transfers exhibit a large range of species, with cosmopolitan, indigenous and alien species. Therefore it is likely that hull fouling (which does not include some overlooked vector such as maritime structures) has been largely overestimated as a vector of transfer for macroalgae (at least during the period previous to the ban of TBT).

Finally, a phylogeographical study of the genus *Ulva*, a genus constituted of mostly cosmopolitan species, show that some species exhibit the pattern of invasive species, with rare haplotypes having a restricted distribution (in the putative region of origin), in contrast with the few abundant haplotype showing a worldwide distribution. Such cryptogenic species may constitute a 'bottom of the iceberg' in terms of macroalgal species, and vectors such as hull fouling have certainly played in import role in their dispersal.

4.1.18 Network approaches to study of aquatic nonindigenous species in Canada: CAISN I and CASIN II.

Hugh MacIsaac.

Canada's science agency – Natural Sciences and Engineering Research Council (NSERC) – funds comprehensive programs of research that are considered to be national priorities. Between 2006-2011, NSERC funded a research network called the Canadian Aquatic Invasive Species Network (CAISN), that includes 34 faculty members drawn from universities and federal Fisheries and Oceans labs across Canada, plus partners including Fisheries and Oceans Canada, Transport Canada, provincial governments, shipping and aquaculture industries, and NGOs. The network had three research priorities:

1) vectors and pathways
2) factors affecting establishment success
3) risk assessment.

Projects were conducted across eastern and western Canada, and the Great Lakes and included >20 projects. Common sampling teams collected all needed samples in three geographic areas, with samples couriered to individual labs for analysis. This approach is cost-efficient, allows a comparative approach to vector strength in different areas, and allows simultaneous analysis of a large number of taxonomic groups (e.g. viruses, bacteria, dinoflagellates, diatoms, benthic and planktonic invertebrates in ballast water). Results allowed CAISN to prioritize the need for management actions in different regions of the country regarding hull fouling, ballast water management etc.

In 2011, a new network, CAISN II, will commence activities. This network includes ~50% different composition in participating principal investigators (30), though many of the partners are the same. Priorities for the network include:

1) Early Detection
2) Rapid Response
3) Effects of multiple stressors involving aquatic invasive species
4) Managing Uncertainty

This network will conduct its activities across the same three geographic areas plus the Arctic. In sum, these two networks will train 90 MSc, PhD and PDFs, dramatically increasing Canada's expertise in the invasion field. These networks also provide science-based advice to government and industry to more effectively manage invasion vectors and manage invasion problems in Canada.

4.1.19 Summary of discussions in relation to National Reports

The National Reports and associated presentations summarised a lot of useful information and updated the group on several areas of research. It was particularly interesting to hear from representatives of countries such as Egypt and Portugal who were attending the meeting for the first time.

The presentations led to some discussions within the group. Treatment methods such as using NaCl brine as an emergency treatment method, using ballast water exchange in combination with treatment and information regarding ballast water treatment testing facilities were discussed. There was interest in the use of brine as a treatment method and questions regarding how the discharge of this was handled. In Canada (where this is a suggested treatment) the regulations allow this although there may

be some restrictions in terms of the maximum salinity that is allowed to be discharged. However, this can be dealt with by diluting the discharge. There was also a brief discussion regarding the use of ballast water treatment and ballast water exchange in combination in order to protect freshwater ports. Initial indications are that this is likely to provide a higher level of protection for ports in freshwater and the Canadian government is suggesting this may be a way forward for certain areas of operation.

The group also discussed the problem of accurately identifying phytoplankton species and also the problems associated with ascertaining whether the species is native or non native. It was agreed that this was a particular problem for microscopic species as it is difficult to know in most cases whether the species has been identified incorrectly in the past, was present in low abundances or is a new introduction. This problem also extends to sampling ballast water and the correct identification of the species present, which can be very time consuming and difficult. The group's discussion highlighted the problems related to the "small" size categories of non native species introductions and this must be kept in mind when deciding whether a species is introduced or not and accepted that in many cases this will not be possible to know for sure.

The issues of risk assessment came up in many of the presentations with many countries developing risk assessment procedures for specific purposes e.g. as part of the Ballast Water Opportunity project and in Germany a project to carry out risk assessment for exemptions of ballast water management for selected harbours in the North and the Baltic Seas has been set up. The group discussed this briefly and it was decided that it would be useful to have a more in depth discussion at the next meeting and it was suggested that this be added to the Terms of Reference for the group in 2012.

Testing facilities in the Netherlands and Norway were also discussed briefly with an overview of the type of facility and the work that was carried out at each. More detailed discussions were had when dealing with Term of Reference c) when discussing sampling and subsequent analysis of the samples.

Some members of the group also discussed the problems they had had in gaining access to vessels to carry out sampling of the ballast water. This led to suggestions from other members of the group with long term experience of sampling vessels as to the best way to approach this problem. It was acknowledged that each country will likely have different protocols but suggestions such as getting the port authority, shipping agents and in some cases, ship owners, involved, was highlighted as was the importance of dealing directly with the captain or chief officer when on board the vessel.

4.2 Term of Reference 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.

This Term of Reference was achieved by inviting participants from the relevant organisations to attend the meeting and by having the IOC and IMO as umbrella organisations for the Working Group. However, financial restrictions have limited travel for many people and this affected the number of people that were able to attend the meeting and many regular representatives were unable to attend. Henrik Enevoldsen, representing the IOC, sent his apologies and stated that there was still a

strong interest in the IOC maintaining links with the group. Henrik has also been instrumental in disseminating information regarding the group *via* the IOC network and this has resulted in participants from Japan and Egypt attending the meeting either this year or in the past. Dandu Pughiuc, of the IMO, also contacted the chair prior to the meeting. This was in response to the request (MEPC 61-2-13, see Annex 6) that was sent on behalf of the Working Group to the Marine Environment Protection Committee at the IMO to request a more formal co-operation between the Working Group and ICES based on the ongoing informal agreement that has been in place for many years. The outcome of this was that the IMO were content for the current arrangement to continue and for IMO to be one of the umbrella organisations of the group. Any updates on ongoing research provided by the WGBOSW can be communicated to IMO through ICES and suggestions from IMO to the Working Group's agenda or Terms of Reference, could be made either by correspondence or by direct participation of IMO representatives as might be necessary.

Members of the Working Group are involved in the work of many of the other organisations listed above and were happy to provide updates as and when necessary regarding work that may be relevant to the Working Group and to provide information regarding the Working Group report to these organisations.

There was no participation from PICES this year and therefore no update regarding Working Group 21.

4.3 Term of Reference 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.

The initial discussion regarding this Term of Reference was in relation to the document that was initiated at the group's meeting in Hamburg in March, 2010 and worked on intersessionally by a sub group. This resulted in a document (BLG 15-5-8, see Annex 7) that was submitted on behalf of the Working Group to the Bulk Liquids and Gases Sub Committee (BLG) at their 15th meeting at IMO headquarters from 1-11th February, 2011. The paper was formally introduced by the chair of the Working Group (Tracy McCollin) and was sent to the Ballast Water and Biofouling Working Group for further discussion along with other relevant submissions. However, the formal discussions within the Working Group concentrated on other issues and there was no time to discuss sampling and analysis strategies in any detail during this time. It was decided that a correspondence group co-ordinated by Brian Elliott from the EC should be set up to discuss the issue intersessionally. The initial discussions would be based on papers submitted by the EC as a starting point for the text and other papers, such as the one submitted on behalf of WGBOSV, would also be taken into consideration. The chair provided this background information and asked the group what the way forward should be.

There was general agreement that the work involved in getting the submission ready for the BLG meeting had been substantial and that the Working Group should continue to contribute to the discussions on this matter at IMO. It was agreed that statisticians should continue to be involved in the discussions as they had at the meeting in Hamburg. One of the main outcomes of the work required in putting the BLG document together was that there was a lack of data to use to confirm the models suggested by the statisticians. After some discussion the main outcomes were:

- The chair, Tracy McCollin, should contact ICES to request statistical assistance with this task. There had previously been a working group dealing with statistical issues and it was felt that this may be an issue that could be dealt with by members of this group. It was agreed that the request would have to be quite specific and target the correct people and it was agreed there would need to be input from the members of WGBOSV that had helped put the original paper together.
- The statisticians that were involved in putting together the BLG paper should put together a list of the requirements for a data set that could be used to test the suggested models.
- WGBOSV were also keen to contribute to the intersessional correspondence group on sampling and analysis co-ordinated by the EC and to be submitted to BLG 16 in January 2012. The chair, Tracy McCollin, would contact the co-ordinator Brian Elliott to let him know that the group will be contributing to the discussion.

The remainder of the work for this Term of Reference was achieved by two presentations given by Stephan Gollasch (Germany) and Stephanie Delacroix (Norway) on representative sampling, indicative analysis and an overview of NIVA's testing facilities.

The main points from the presentation on representative sampling were:

- The recommended sampling time is 10 minutes for each sample
- Do not sample during the first or last 5 minutes of the discharge
- Two or more samples should be taken and at least one sample from each ballast tank with a different origin

For the >50μm size range 500 litres should be taken and then this should be concentrated to 100ml. For the <50μm and >10μm size range five litres from a continuous drip feed should be taken and an unconcentrated subsample of approx 60 ml be taken for transportation. For the bacteria one litre from the five litre drip sample can be used.

For the indicative analysis there were a range of suggestions taking into account that no one method is likely to be suitable for all organisms. It was suggested that it may be most effective to carry out indicative analysis for one group of organisms e.g. phytoplankton using a method such as Pulse-Amplitude Modulated Fluorometry (PAM), if this indicates high numbers then test e.g. zooplankton using stereomicroscopy or bacteria using a hand held fluorometer until enough evidence is collected to indicate whether a more detailed D-2 compliance test is required.

This was then followed by an overview of the work carried out at the NIVA testing facilities in Norway and the research that has been undertaken to validate the methods used to test the ballast water treatment technologies. The methods presented were the fluorescence vital stain CFDA, dilution culture and growth on agar plates. Each of these methods had advantages and disadvantages depending on the type of the ballast water treatment technology tested (oxidants or UV treatment). The conclusion was that vital stain method can be used for non culturable species but should not be used as a stand alone method for testing of Ballast Water Management System (BWMS) based on UV technology because of the UV delay effect on the cell activity that induced many false positive with CFDA method.

The Working Group's discussion after the presentations focussed on the statistical problems with sampling small populations and the problems of sampling on board a vessel. There was also agreement that there is currently no one method that can be used for all parts of the D-2 standard in either land based or ship board testing. Work is currently ongoing to try and overcome these problems. The European Maritime Safety Agency (EMSA) is continuing work on developing a protocol based on the ship based work carried out by Stephan Gollasch and Matej David and funded by EMSA. Several relevant documents detailing the statistical problems and other considerations for sampling were also put onto the SharePoint site to inform these discussions.

4.4 Term of Reference d)

Continue and elaborate the cooperation with PICES WG 21.

There was no participant from PICES this year and therefore no update regarding Working Group 21 (WG21). Henn Ojaveer (Chair of WGITMO) had tried to contact the chair of WG21 for an update prior to the meeting but had had no response. The chairs of both WGBOSV and WGITMO will update the groups as and when information regarding WG21 becomes available.

4.5 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 e.g. impacts of Northwest Passage.

Anders Jelmert (Norway) gave an overview of shipping operations and Arctic sea routes and indicated that ice free summers in this area is likely to mean an increase in shipping and a possible new route for the transport of non native species. Although there is still uncertainty regarding how much of this area will become available for shipping it is likely that there will be more traffic in this area than previously. A recent Arctic Shipping Summit in Helsinki in April 2010 discussed several issues in relation to this possibility but non native species were not mentioned. Anders therefore suggested that it might be feasible to suggest an ocean going workshop to investigate the survival of species on such a passage. He suggested that this would be suitable for an ICES-PICES co-operation and also suggested some possible sources of funding. This suggestion was put to the WGBOSV for input and feedback.

The group discussed the suggested proposal and there was generally positive feedback and a feeling that such a project could provide useful information. The overall outcome was that if it seemed probable that funding would be available then a project proposal would be put together and any of the group that was interested in participating could do so.

4.6 Term of Reference f)

Collaborate with other ICES/IOC Expert Groups as appropriate (e.g. Working Group on Harmful Algal Bloom Dynamics WGHABD).

The main collaboration that was undertaken in response to this Term of Reference was an outcome from the 2010 WGBOSV meeting in Hamburg. During this meeting a request from the IOC Intergovernmental Panel of Harmful Algal Blooms (IOC IPHAB) that requested information regarding the transport of harmful phytoplankton species in ballast water was discussed. This request had also been sent to the

Working Group on Harmful Algal Bloom Dynamics (WGHABD) and the chair of that group (Joe Silke, Ireland) and the chair of WGBOSV (Tracy McCollin) had discussed the request prior to their meetings and agreed to raise it and then feed back the response to ICES. Both groups agreed that the information that had been requested would serve a useful purpose and the outcome was a workshop (Workshop on harmful phytoplankton that could potentially be transported or introduced by ballast water WKHABAL) that was held at ICES headquarters in Copenhagen from 14-15th October, 2010. Tracy McCollin attended on behalf of WGBOSV and co-chaired the meeting with Joe Silke from WGHABD. The final report was placed on the WGBOSV SharePoint site for the group members to consult and an overview of the report was given. The executive summary is copied below.

4.6.1 Executive summary from WKHABAL

The ICES Workshop on harmful phytoplankton that could potentially be transported or introduced by ballast water (WKHABAL) met in Copenhagen, Denmark from 14-15th October, 2010 and was attended by 11 participants from Denmark, Ireland, Sweden, the United Kingdom and the United States of America. The purpose of the meeting was to identify phytoplankton that could be transported via shipping vectors so that potential future invasive species could be identified and the risk managed.

The group produced two lists of phytoplankton, one marine and one freshwater based on the IOC –UNESCO Taxonomic Reference List of Harmful Micro Algae and on the Great Lakes Invasive Species List respectively. The marine list focussed on known toxic species and also included some nuisance (but non toxic) species, the freshwater list was focussed on species known to have been transported by shipping but that were not necessarily problem species in terms of toxicity. The difference in the focus of the lists was owing to the availability of information. These lists were then expanded to include information regarding the characteristics of the species that may make them more likely to survive a long journey in a dark ballast tank. This included characteristics such as cyst forming ability and whether the species was phototrophic or heterotrophic. Where this information is known it could help identify which species were more likely to survive transport in ballast tanks.

In addition to the lists the group also prepared background information that is contained in the body of the report to support the information in the table. This included a case study of a toxic marine dinoflagellate that may have been introduced by ballast water and more detailed background to the freshwater species list.

The group acknowledged that there is a lack of information for many species and that this limits the amount of detail that can be provided for some species. However, these lists are a good starting point and can be updated and adapted as more information and feedback from users is incorporated.

4.7 New Terms of Reference provided to the group prior to the meeting.

In relation to the Marine Strategy Framework Directive:

- *Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF;*
- *Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.*

In relation to the Strategic Initiative on Area Based Science and Management:

- *take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial Planning in Practice (WKCMSP) http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf*
- *provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes, identifying spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc.*

These Terms of Reference had been provided to all Expert Groups by the chair of SCICOM, Manuel Barange and the chair of ACOM, Jean-Jacques Maguire with a request that the Expert Groups consider them during their meetings. In the case of WGBOSV these were sent the week before the meeting so there was no time for participants to prepare any input. All relevant information was placed on the SharePoint site prior to the meeting and an e-mail sent around the participants to encourage them to read through these. At the opening of the meeting it was agreed that the WGBOSV would set aside some time to discuss how the work of the group could contribute to these Terms of Reference although it was accepted that, given the short notice and time constraints, this could not be an in depth discussion but could give an overview of the group's view on the issues.

A brief overview of the Marine Strategy Framework Directive (MSFD) and the Strategic Initiative on Area Based Science and Management were given by Tracy McCollin (Chair of WGBOSV) and Henn Ojaveer (Chair of WGITMO) during the joint meeting of the groups. For the purposes of WGBOSV the Terms of Reference relating to the MSFD was the area where the group felt they would be able to have the most input and the discussion was focussed on this aspect of the new Terms of Reference.

The discussion within the group focussed on the importance of preventing non indigenous species from being introduced as the most important step as once something is established it is difficult to control or eradicate. Sergej Olenin (Lithuania) updated the group on the joint ICES and JRC report that was completed for Descriptor 2 under his chairmanship (non indigenous species introduced by human activities are at levels that have do not adversely alter the ecosystems) and emphasised that non indigenous species are likely to have to be taken into account for nearly all the descriptors. He also highlighted that it is difficult to take non indigenous species into account and that methods need to be developed. The group then discussed the problems relating to assessing the impact of non indigenous species and the use of monitoring programmes. The need for baseline studies was also highlighted as was the use of management to avoid or minimise the spread of species. The overall conclusion of the discussions was:

- Prevention is very important and systems should be put in place to prevent the introduction of species in the first place.
- Vectors and pathways need to be managed to minimise or prevent spread of already established species.
- Baseline and ongoing long term monitoring are required.

- Exemptions under the IMO Ballast Water Convention will require a risk assessment based on which species are present so this information will be needed to carry out such assessments.
- Information regarding which species may be introduced may also be required.

The WGBOSV can provide input on shipping vectors and methods of managing these to reduce risk and may be able to provide some information regarding which species may be transported *via* these vectors in order to assess the risk associated with each in different areas. The close links the group has with IMO would also mean that information could be provided regarding what new international agreements are being developed to reduce the risk of introducing non indigenous species.

4.8 Other issues of relevance to WGBOSV and WGITMO

During the meeting there were a few issues which did not come under a specific Term of Reference but were of relevance to both groups and these were:

- The possibility of a joint ICES/CIESM/PICES Symposium organised about every 2-3 years. The group generally supported this but highlighted that this should have a different emphasis to the current International Conference on Marine Bio invasions and the International Conference on Aquatic Invasive Species.
- Several members of the group felt that the National Report format for WGBOSV should be updated and it would be better to not have records of new species included as this is information for WGITMO and the duplication of information is confusing.

5 Closing of the meeting

The meeting closed at lunchtime on 16th March, 2011 after the joint meeting with WGITMO. The chair thanked the hosts at Ifremer for their work in organising the meeting and providing the 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 taking notes and assisting participants with the SharePoint during the meeting.

Annex 1: List of participants

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

14 – 16 March 2011

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Annex 2: Agenda

AGENDA

ICES IOC IMO WORKING GROUP ON BALLAST AND OTHER SHIP VECTORS

Ifremer Centre Atlantique, Rue de l'Ile d'Yeu, B.P. 21105 , 44311 Nantes

14th March – 16th March, 2011.

SUNDAY 13th MARCH

An informal pre-meeting evening meal (at your own cost) has been organised for Sunday evening. Meet at 19.30 in the lobby of the Hotel La Perouse. (3 Allée Duquesne (cours des 50 Otages) 44000 Nantes France Tél. : +33 (0)2 40 89 75 00). We will then walk a very short distance to the Restaurant Hippopotamus 7 allée des Tanneurs (cours des 50 otages) : http://www.hippopotamus.fr/resto/nantes-centre-12753937709863.html.

MONDAY 14th MARCH

08.30 Setting up computers and meeting room

09.00 Opening of the Meeting

elcoming remarks

Philippe Goulletquer, (Ifremer, Prospective & Scientific Strategy Division in charge of Marine Biodiversity)

Tracy McCollin (Chair)

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.

Belgium	Francis Kerckhof
Canada	Sarah Bailey
Croatia	Marijana Pecarevic/Josip Mikus (by correspondence)
Estonia	Henn Ojaveer
Egypt	Ehab Beltagy

11.00 - 11.30 Coffee break

France	Daniel Masson
Germany	Stephan Gollasch/Manfred Rolke

Greece	Argyro Zenetos
Lithuania	Sergej Olenin

13.00 – 14.00 Lunch

Spain	Gemma Quilez Badia
Netherlands	Cato ten Hallers-Tjabbers/Andrea Sneekes
Norway	Stephanie Delacroix
Portugal	Ana Amorim
UK	Tracy McCollin
US	Judy Pedersen (by correspondence)

15.00 -15.30 Coffee break

15.30

Factors associated with hull fouling: a 3-coast perspective from Canada. Hugh MacIsaac and Francisco Sylvester.

Assessing the risk of introducing non native species to Scotland via hullfouling. Tracy McCollin.

17.00 Close of first day's meeting

TUESDAY 15th MARCH

09.00 Announcements

09.30 ToR a and c

Update on submission of ICES document to MEPC 61. **Tracy McCollin**

Update on ICES submisson to the International Maritime Organization (IMO) BLG meeting 7-11th February. **Tracy McCollin**.

General discussion regarding the paper and the outcome of the BLG 15 meeting and whether the group wants to go forward with producing a peer reviewed paper. **Group**.

General discussion in relation to ToR c. **Group**.

11.00 -11.30 Coffee break

11.30 ToR e.

The northern Sea –Route: climate, technology and a role for BOSV? **Anders Jelmert**.

General discussion.

13.00 -14.00 Lunch

Results of EMSA Study on Representative Ballast Water Sampling and Indicative Analysis of Ballast Water Samples. **Stephan Gollasch & Matej David**

Update on NIVA activities in relation to testing facilities. **Stephanie Delacroix**

General discussion

15.00 – 15.30 Coffee break.

15.30 Arrangements for meeting in 2012

- Terms of Reference
  - With particular reference to requirements regarding Marine Strategy Framework Directive (see folder on SharePoint)
- Meeting venue
- Actions for coming year
- Suggestions for contributions to the meeting

17.00 Close of second day's meeting

WEDNESDAY 16th MARCH

Joint meeting with WGITMO

09.00 Opening of the meeting

Welcoming remarks

Lucay Han-Ching, Director of Nantes Center, Ifremer.

Tracy McCollin and Henn Ojaveer.

Logistics

Introduction of Participants and Guests.

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

Marine Strategy Framework Directive and role of both BOSV and ITMO (see folder on SharePoint)

ToR f

Update on the collaboration with the WG on Harmful Algal Bloom Dynamics (WGHABD) and the outcome of the joint workshop on harmful phytoplankton that could potentially be transported or introduced by ballast water (WKHABAL). **Tracy McCollin**

ToR d

Cooperation with PICES WG 21.

11.00 – 11.30 Coffee break

Seaweed introductions: studies on vectors and cryptogenic species. **Frederic Mineur**

Discussion regarding Fred's project and possible collaboration with WGBOSV and WGITMO.

Network approaches to study of aquatic nonindigenous species in Canada: CAISN I and CAISN II. **Hugh MacIsaac**

Any other issues of interest to both groups

12.30 Closing WGBOSV and concluding remarks

13.00 – 14.00 Lunch

Working Group on Introductions and Transfers of Marine Organisms (WGITMO)

Modern molecular and imaging approaches to identification of aquatic nonindigenous species in Canada. **Hugh MacIsaac and Aibin Zhan**.

Overview on the EU MSFD JRC/ICES TG2 Non-indigenous species report. **Sergej Olenin**

15.00 – 15.30 Coffee break

BINPAS – online bio invasion impact/biopollution assessment system: call for cooperation. **Sergej Olenin**

ToR e: Identify the criteria used by ICES countries to develop lists of high, moderate and low risk for intentional introductions and for those introduced species already established and prepare a final report.

ToR c: Review and draft a compilation of existing monitoring activities and programs with the goal of avoiding duplications. A draft summary will be prepared for next year.

Results of the ongoing monitoring programme in Finland. **Maiju Lehtiniemi and Lauri Urho**

Status of alien species monitoring in Estonia. **Henn Ojaveer**.

Lithuanian lessons learnt. **Sergej Olenin**.

17.00 Close of the day

Annex 3 New Terms of Reference

ICES
CIEM

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

General Secretary
Dr Gerd Hubold

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To: Science and Advisory Expert Group Chairs

Our Ref: JJ/MB/vp/mo B.10 10 March 2011

Dear Expert Group Chairs,

As you well know, ICES wants to better integrate its scientific and advisory work to meet the challenges of implementing an ecosystem approach. Today, we want to bring to your attention two groups that have been created jointly by ACOM and SCICOM, the **Marine Strategy Directive Framework Steering Group** (MSFDSG) and the **Strategic Initiative on Area Based Science and Management** (SIASM). These two groups need input from Expert Groups to meet their objectives.

The **MSFD** is cross-cutting and will have implications for most of ICES work. We would like EGs to identify and briefly describe the work streams of relevance to the Descriptors with particular emphasis on linkages that could be made between fish stock and ecosystem/environmental monitoring and assessments.

From the MSFDSG, the following ToRs will be added to all EGs during 2011:

- Identify elements of the EGs work that may help determine status for the 11 Descriptors set out in the Commission Decision (available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:232:0014:0024:EN:PDF;
- Provide views on what good environmental status (GES) might be for those descriptors, including methods that could be used to determine status.

The main objective of the SIASM is to demonstrate to ICES clients, Member Countries and stakeholders that ICES has the expertise and facilities to deliver solid, robust and independent science and advice on marine area based management and spatial planning.

From SIASM, the following ToRs will be added to all EGs for 2011:

- take note of and comment on the Report of the Workshop on the Science for area-based management: Coastal and Marine Spatial

Planning in Practice (WKCMSP)
http://www.ices.dk/reports/SSGHIE/2011/WKCMSP11.pdf

- provide information that could be used in setting pressure indicators that would complement biodiversity indicators currently being developed by the Strategic Initiative on Biodiversity Advice and Science (SIBAS). Particular consideration should be given to assessing the impacts of very large renewable energy plans with a view to identifying/predicting potentially catastrophic outcomes.
- identify spatially resolved data, for e.g. spawning grounds, fishery activity, habitats, etc.

Your input to these groups is important. We would appreciate your responses either through your EG meeting reports, or directly to the contacts below if your EG has already met in 2011. Queries regarding the **MSFDSG** should be addressed to Claus Hagebro of the ICES Secretariat (Claus@ices.dk) and those regarding **SIASM** to Søren Anker Pedersen also at the ICES Secretariat (sorenap@ices.dk), as the first port of call.

Thank you very much for your cooperation.

Sincerely,

Manuel Barange,
Chair, ICES Science Committee

Jean-Jacques Maguire,
Chair, ICES Advisory Committee

Annex 4: 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 Lisbon, Portugal from 12–14 March 2012, with a back to back meeting with the Working Group on Introductions and Transfers of Marine Organisms [WGITMO] 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 and ballast water sampling and analysis in order to support the ongoing work at IMO. Discuss the methods and procedures used at test facilities and invite participation from operators of such facilities to attend the meeting.

b) Taking into account current risk assessment and pathway management methodologies, recommend principles for risk assessment under IMO Guidelines for risk assessment under Regulation A-4 of the BWM Convention (G7).

c) Further discuss and evaluate the sampling strategies under consideration at IMO and provide comment to relevant IMO committees and their correspondence groups. Solicit experts statistical advice to support this work.

d) Re-establish and elaborate the cooperation with PICES WG 21,

WGBOSV will report by 13th April, 2012 to the attention of the ACOM.

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 IOC on these 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) and the Working Group on Harmful Algal Bloom Dynamics (WGHABD). There is also a link to PICES Working Group 21.
Linkages to other organizations:	The work of this group is closely linked to work carried out by the European Maritime Safety Agency (EMSA), the International Maritime Organization (IMO) and the Intergovernmental Oceanographic Commission (IOC).

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. See Wells *et al*. (in press); a second publication is being prepared.

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

1.2. Ballast Water Treatment

TITLE: *Examination of ballast water exchange plus treatment to achieve enhanced protection of low salinity waters*

DESCRIPTION: Canada is exploring a combination treatment strategy (using both ballast water exchange and a ballast water management system) as a means to provide enhanced protection for low salinity waters, like the Great Lakes. The theory behind the combination strategy is outlined in a document submitted to the IMO (BLG 15/5/7). Land-based testing has been initiated to examine the concept and further land-based and/or shipboard testing is planned for 2011.

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

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 for 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). See Bradie *et al*. (2010) for results from laboratory trials; results of shipboard trials have been submitted for peer review.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca; Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

1.3. Ballast Water Sampling

TITLE: *Ballast Water Sampling at Canadian Arctic Ports*

DESCRIPTION: The introduction of aquatic invasive species 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 introductions to the Arctic because melting of the polar ice cap will allow increased vessel access to Arctic waters. An Arctic sampling study was conducted in 2009-10 at the most active ports (Churchill and Deception Bay) in order to quantify propagule pressure by ballast water to the ports. Publication of results is expected in 2012.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca; Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.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 aquatic invasive species from Eastern Canadian ports) and spread (between lakes). The St. Lawrence River has been identified as an area of interest, and a ballast water sampling study was conducted in 2009-2010 to examine species composition and to quantify the level of risk. The results are currently being analyzed and a publication is anticipated in early 2012.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca; Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

1.4. Ballast Water Legislation/Regulations

TITLE: *Evaluating Efficacy of Ballast Water Exchange and Flushing Management Regulations.*

DESCRIPTION: A series of studies which evaluate the biological efficacy of ballast water exchange and tank flushing as a means to minimize ballast-mediated introductions have been completed. The management strategies appear to provide robust protection of freshwater ports in the Great Lakes, while efficacy for coastal marine ports is variable. See Bailey *et al.* 2011, Briski *et al.* 2010, and Briski *et al.* (in press).

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca; Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

TITLE: *Review of Alternate Ballast Water Exchange Zones for vessel traffic to Newfoundland and Labrador and the Canadian Arctic*

DESCRIPTION: Transport Canada requested scientific advice from Fisheries and Oceans Canada on two proposed and one current site for ABWEZs for commercial transoceanic vessel traffic enroute to Newfoundland and Labrador, Hudson Bay and the western Canadian Arctic via the Beaufort Sea. The Science Advisory Report for this project is now available online.

PROJECT LEADER: Cynthia McKenzie – Fisheries and Oceans Canada. Cynthia.mckenzie@dfo-mpo.gc.ca; Kimberly Howland – Fisheries and Oceans Canada. Kimberly.Howland@dfo-mpo.gc.ca

TITLE: *An ecological and oceanographic assessment of alternate ballast water exchange zones in the eastern Arctic*

DESCRIPTION: Scientific information and advice is required to assess the ecological risk of introducing non-indigenous species into Canadian Arctic waters in the event that foreign vessels bound for Arctic ports need to conduct emergency ballast water exchange in designated alternate ballast exchange zones (ABWEZs) within the Canadian Exclusive Economic Zone (EEZ).In 2010-11 an assessment for the Eastern Arctic was initiated; the immediate area surrounding the existing Hudson Strait and Lancaster Sound ABWEZs and the waters to the east that span these two zones but are within the Canadian EEZ were considered. The assessment involves evaluating the relative risks of ballast exchange along major shipping routes based on oceanographic modelling of particle dispersion and the identification of areas with ecological, economic and/or cultural significance. The assessment will be continued in 2011-12. A peer-reviewed publication is expected by 2013.

PROJECT LEADER: Kimberly Howland – Fisheries and Oceans Canada. Kimberly.Howland@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 lower Canadian Ports*

DESCRIPTION: A study investigating the importance of hull fouling to Canada's lower coasts (West, East and Great Lakes) has been completed. Results indicate that hull fouling is an important vector for coastal marine ports, but poses much lower risk to freshwater ports. See Sylvester and MacIsaac (2010) and Sylvester *et al.* (in press).

PROJECT LEADER: Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

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 was initiated in 2010 at the most active port (Churchill) in order to quantify propagule pressure by hull fouling to the ports. Sampling will continue in 2011.

PROJECT LEADER: Sarah Bailey – Fisheries and Oceans Canada. Sarah.bailey@dfo-mpo.gc.ca; Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

2.4. Hull Fouling Legislation/Regulations

3. Sediments
3.1. Biology of Sediments

TITLE: *Discharge of ballast sediment residuals during deballasting procedures: A potential vector for the transfer of AIS?*

DESCRIPTION: Ships cannot completely empty their ballast tanks due to structural and pumping limitations and, as a result, some ships may accumulate significant quantities of sediment after several years. This study addresses the existing knowledge gap concerning residual ballast sediments as a vector for the transfer of AIS. To date, propagule pressure associated with ballast water and sediments has been calculated as the product of the quantity of ballast water or sediments discharged x the density of organisms in the ballast water or sediments x the proportion of these that are viable. However, we do not know what proportion of sediments and associated organisms are released during deballasting procedures. To address this question, we sampled a commercial bulk carrier following two consecutive trans-oceanic voyages. The objectives of this study were to 1) measure at regular intervals the concentration of suspended particulate matter (SPM) in the ballast water that was being pumped out to estimate the quantity of sediments released; 2) examine in situ sediment dynamics by mapping the distribution of sediments and organisms; 3) measure the quantity of sediments remaining in the tank to estimate the proportion of sediments released; and 4) assess the depth-dependent viability of diapausing invertebrates and dinoflagellate cysts.

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

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

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 was conducted in accordance with a national standard developed for sampling sea-chests for AIS. The project was completed in 2010. A publication is expected in 2011.

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

TITLE: *NSERC Canadian Aquatic Invasive Species Network II*

DESCRIPTION: The national network consisting of some of the world's leading researchers, explorers and innovators in the field of aquatic invasive species has received funding for an additional five years. A coordinated set of comprehensive studies are planned, directed at four research themes pertaining to Aquatic Invasive Species (AIS): i) early detection strategies; ii) rapid response strategies; iii) AIS as part of multiple stressors affecting aquatic ecosystems; and iv) reducing uncertainty in prediction and management.

PROJECT LEADER: Hugh MacIsaac – Canadian Aquatic Invasive Species Network hughm@uwindsor.ca

TITLE: *Monitoring for NIS at Canadian Arctic Ports*

DESCRIPTION: Although most exotic species introductions have occurred in southerly latitudes where there is the greatest shipping activity, the combination of global warming, resource exploitation and the resulting increase in Arctic shipping activity are expected to increase the risk of exotic species introductions to Arctic waters in the near future. The objective of this project is to develop an inventory of existing biota and environmental conditions in areas of the Arctic with the highest risk for introduction by exotic species (high traffic ports) with the goals of establishing a baseline for further monitoring and early detection of NIS. The ports of Churchill and Tuktoyaktuk were sampled for zooplankton, benthic invertebrates and environmental data and taxonomic identifications/analysis of results were completed in 2010-11. Publications are expected in 2011. Further port survey work will be conducted in Iqaluit and Churchill in 2011-12.

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

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 is 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. Risk Assessments for the Canadian Arctic and Great Lakes have been completed and publication is anticipated in 2011. Documents for the East and West coasts, as well as a national perspective will follow. 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

TITLE: *National risk assessment of recreational boats*

DESCRIPTION: The goals of this ongoing project are to: a) identify/characterize the invasive species being introduced or redistributed (secondary spread) by this often overlooked vector, b) characterize vector activity in Canadian waters (including international arrivals), and c) conduct a vector-based risk assessment. Data collection including both dockside/dive surveys to characterize invasive species on recreational boats and distributed/online surveys to characterize boater movements and behaviours has been ongoing in BC for three years. Similar activities in other parts of Canada recently have been established or are planned to start in coming years. This project will contribute to Canada's plan to establish vector-based risk assessment guidelines (as above).

PROJECT LEADER: Thomas Therriault - Fisheries & Oceans Canada, Thomas.Therriault@dfo-mpo.gc.ca

D Occurrence of New Ship-mediated Introduced Species

E Impact of Introduced Species

Economic (quantify if possible)

Ecological

F Other Relevant Information

G References

Bailey SA, MG Deneau, L Jean, CJ Wiley, B Leung and HJ MacIsaac. 2011. Have ballast water policies for the Great Lakes reduced the risk of ship-mediated aquatic invasions? Environmental Science and Technology 45:2554-2561.

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Briski E, S Ghabooli, SA Bailey and HJ MacIsaac. (In press). Degradation of invertebrate dormant eggs collected in ballast sediment of ships. Diversity and Distributions accepted 07 March 2011.

Briski E, ME Cristescu, SA Bailey and HJ MacIsaac. 2010. Efficacy of 'saltwater flushing' in protecting the Great Lakes from biological invasions by invertebrate eggs in ships. Freshwater Biology 55: 2414-2424.

Fisheries and Oceans Canada. 2010. Review of alternate ballast water exchange zones for vessel traffic to Newfoundland and Labrador and the Canadian Arctic. Canadian Science Advisory Secretariat, Science Advisory Report 2010/026. Available online at: http://www.dfo-mpo.gc.ca/csas-sccs/publications/sar-as/2010/2010_026-eng.htm

Gray D and HJ MacIsaac. 2010. Do zooplankton eggs remain viable despite exposure to open-ocean ballast water exchange: evidence from in situ exposure experiments. Canadian Journal of Fisheries and Aquatic Sciences 67:256-268.

Kipp R, SA Bailey, HJ MacIsaac and A Ricciardi. 2010. Transoceanic ships as vectors for nonindigenous freshwater bryozoans. Diversity and Distributions 16: 77-83.

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

Sylvester, F. O. Kalaci, B. Leung, T. Therriault, A. Lacoursière-Roussel, F.M. Choi, Cathryn C. Murray, M.A. Bravo and H.J. MacIsaac. (In press). Invasion vectors: can simple models explain a complex problem? Journal of Applied Ecology

Wells M, S Bailey and B Ruddick. (In press) The dilution and dispersion of ballast water discharged into Goderich Harbor. Marine Pollution Bulletin accepted 02 March 2011.

5.2 Croatia (by correspondence)

Josip Mikuš and Marijana Pećarević

University of Dubrovnik, Dubrovnik, Croatia

Ballast Water Projects

New project on ballast water treatment at the University of Dubrovnik was presented to Croatian Institute of Technology (HIT). Suggested research includes treatment using hydrodynamic forces and magnetic field.

Monitoring of introduced species

Monitoring of introduced species is still part of regular national scientific projects accepted by Ministry of Science, Education and Sport. In the Southern Adriatic there is an open sea sampling station near island of Lokrum. Analyses of samples can indicate input of non-indigenous planktonic species from Mediterranean.

Ballast Water Management and Croatian regulations

The Regulation on Management and Control of the Ballast Water has been enacted by Croatian Parliament in September 2007. This regulation enacts the principles and methods in managing and controlling of the ballast water in floating objects during their stay or voyage in Croatian part of the Adriatic Sea.

Ballast Water Exchange

Discussion about Ballast Water Exchange Zones is still on with Slovenia and Italy (Trilateral Commission). There was an interruption in trilateral discussion because of implementation of Croatian Ecological and Fisheries Protection Zone (Croatian: Zaštićeni ekološko-ribolovni pojas, ZERP) to member countries of the EU.

5.3 Estonia

Author(s) and contact details:

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Estonian Marine Institute, University of Tartu. Lootsi 2a, 80012 Pärnu. Estonia

A Transport Vectors. No research projects neither carried out nor planned.

B Invasive Species Management. No relevant activities in marine waters neither ongoing nor planned.

C Risk Assessment Approaches. No risk assessment approaches applied

D Occurrence of New Ship-mediated Introduced Species. No new invasions reported in 2010.

E Impact of Introduced Species. No economic evaluations performed. New evidences of ecological impacts are reported in the WGITMO report for 2011.

F Other Relevant Information

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 established and is currently active. According to the current information, Estonia is planning to ratify the IMO BWC in 2013.

Monitoring of alien species in marine waters started in 2010. Field sampling for zooplankton and macrozoobenthos (by using HELCOM methodologies) was carried out in the high-risk area of new invasions in the country – Muuga Bay Port of Tallinn.

Draft of the 'Handbook of aquatic alien species in Estonia' was prepared (in Estonian). The book will be expectedly published in the first half of 2011.

5.4 France

Author(s) and contact details: Daniel MASSON ; Daniel.Masson@ifremer.fr

A Transport Vectors

- Results of ongoing research project(s):

  PHYCOPORT (regional research action, in CPER project contract between State and Region Poitou-Charentes); IFREMER; Project coordinator: Christian Bechemin (Christian.Bechemin@ifremer.fr); action duration: 2010-2013; key objectives: collect data on discharged ballast waters in La Rochelle port, for regional decision makers and port authorities awareness.

  Methods:

  Seawater samples are collected by pumping and filtration (20µ) along the hull when ship deballasts; then subsamples are examined on inverted microscope to detect the foreign phytoplankton species, particularly those known to produce toxins.

  First results, although masked by local spring blooms let appear some species along hulls not present in the middle of the port at the same date.

Some improvements will be made, particularly a comparison between ballast and deballasted waters, sampling along ships in waiting areas.

Another topic will be researched: presence of Vibrio bacteria, especially pathogenic strains.

- Planning of new research project(s)

1. Ballast

1.1. Biology of Ballast Water

1.2. Ballast Water Treatment:

Two French companies are (seem to be) on the move to submit ballast water treatment systems to IMO basic approval. The first, using active substances submitted his product to experiment in EFFORTS FP6 program. Tested in laboratory, in pilot scale system and aboard ship, this substance is effective against bacteria and phytoplankton, and degrades rapidly (some hours) ; La Carbona *et al.*, 2010

The second , using physic systems is just at the beginning of the process.

In Saint Nazaire University, a thesis is on its way about ballast water treatment by filtration with membranes.

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:

A proposal is made by a French shipowner to increase the period between two dry dock inspections/careenages: from 5 years to 7.5 years. Limited to large container carriers, dedicated to long travels, less than 7.5 years of age, with good ship management and auto polishing coating. Inspections (of sea chests, e.g.) will be made afloat, in ports, without interruption of the commercial activity.

This proposal is presently examined by the French Administration.

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

1 Eradication Programmes
2 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

G References:

La Carbona, S.; Viitasalo-Frösen, S.; Masson,D.; Sassi,J.; Pineau,S.; Lehtiniemi,M.; Corroler,D.; Efficacy and environmental acceptability of two ballast water treatment chemicals and an alkylamine based biocide; Science of the Total Environment 409 (2010) 247-255

5.5 Germany

Author(s) and contact details:

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Stephan Gollasch sgollasch@aol.com

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

A project is planned in cooperation with Canadian experts to test the efficacy of ballast water exchange in combination with ballast water treatment. The planned project start is in summer 2011.

1.2. Ballast Water Treatment

The Federal Maritime and Hydrographic Agency (BSH) is responsible for the type approval of ballast water treatment systems in Germany and has currently approved two systems. Various others are at different stages of the approval process.

Gollasch is involved in onboard performance tests of several ballast water treatment systems.

1.3. Ballast Water Sampling

EMSA Study

The European Maritime Safety Agency (EMSA) funded a project regarding representative samplings of ballast water and options for indicative ballast water sample analysis.

Stephan Gollasch was involved in this project and jointly undertook this work with Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia).

The executive summary of the findings is attached as Annex 1 and the full report may be downloaded from the EMSA homepage at

http://www.emsa.europa.eu/ go to Environmental Protection (left box left on page).and Ballast Water (right box on page).

IMO

Additional guidance regarding ballast water sampling for compliance control with the standards as set forth in Regulation D-2 of the IMO Ballast Water Management Convention are being developed. This is currently done in a correspondence group which is led by Brian Elliott of EMSA.

1.4. Ballast Water Management

Ballast Water Opportunity

This Interreg IVB funded study will run another 2.5 years. 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.

Germany is responsible for WP2 (BSH) and WP4 (GoConsult). A summary of the work ist provided in Document HELCOM MARITIME 9/2010 doc 7/1/INF (http://meeting.helcom.fi/c/document_library/get_file?p_l_id=18816&folderId=1240530&name=DLFE-43228.pdf) and in Annex 2. More details and an activity update at http://projects.nioz.nl/northseaballast/

Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS) is a European Commission Seventh Framework Programme (FP7) project.

The VECTORS project will inform the development and implementation of forthcoming strategies, policies and regulations such as the International Maritime Organization Convention on Ballast Water Management, the EU Maritime Policy and the EU Marine Strategy Framework Directive. For more details see http://www.marine-vectors.eu/ and Annex 3.

2. Hull Fouling

Germany was actively involved in the development of the IMO hull fouling guideline which was agreed at IMO Sub-Committee Meeting Bulk Liquid and Gases in February 2010. Vessels below 24 m in length will be addressed by a separate document to be developed by IMO working groups.

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

1 Eradication Programmes
2 Management and Control of Invasive Species

Platform for Information Exchange on Neobiota

The issue neobiota in the marine environment including the coastal areas and the harbours attracts growing interest world wide. In the meantime it is taken on by international fora like IMO, OSPAR, HELCOM. European regulations like the EU Water Framework Directive and the EU Marine Strategy Framework Directive include provisions for neobiota and since the Wadden Sea has been placed on the list of UNESCO's World Heritage Sites neobiota receive growing attention. Recognizing that against the background of the varied fora and regulations in Germany different official bodies are busy with the subject and that the information exchange between these bodies could be enhanced a "Platform for Information Exchange on Neobiota" has been established in the framework of the "Federal and Federal States Marine Montitoring Programme" the national body that takes care of the duties arising from national and international obligations. Involved in the group are representatives from different federal agencies, federal state agencies and research facilities.

Inventory study to provide an overview of the state of the art regarding neobiota,in the Wadden Sea

At the 11th trilateral governmental Wadden Sea Conference (Sylt, Germany March 2011), the three Wadden Sea states decided to develop a common strategy for dealing with alien species introductions in the Wadden Sea, taking account of the request of the UNESCO World Heritage Committee and the Ballast Water Management Convention (BMW Convention).

In order to obtain an overview into the current status regarding neobiota an outline for a trilateral inventory was formulated.

An inventory study shall provide an overview of the state of the art regarding neobiota, as a basis for the development of a trilateral strategy on neobiota for the trilateral Wadden Sea Cooperation Area. Furthermore, the inventory shall provide recommendations for the main elements of a trilateral strategy.

The study will consist of an inventory part and an analysis part:

R&D-project on certain aspects according to the implementation of the MSFD

The German Federal Environment Agency on behalf of the Federal Ministry for the Environment, Nature Protection and Nuclear Safety to fund a R&D-project on certain aspects of the implementation of the MSFD. The overall task is to develop concepts for the assessment and monitoring of selected "pressure descriptors" of the Marine

Strategy Framework Directive. One work package will be dealing with non-indigenous species (descriptor 2) and has the following objectives:

1) Developing a working definition of non-indigenous / invasive species

2) Checking whether all or only some of the three indicators listed in the EU Commission Decision should be considered in national monitoring;

3) Making selected indicators ready for use by suggesting quantitative targets and respective monitoring programmes

4) Evaluating how the selected indicators could be combined to an overall assessment of descriptor 2 and how descriptor 2 would feature within an overall assessment of "Good Environmental Status".

The German Federal Agency for Nature Conservation on behalf of the Federal Ministry for the Environment, Nature Protection and Nuclear Safety is currently preparing a tender for several project clusters in order to develop a basis for the fulfilment of the requirements arising from different European and international frameworks, with a focus on the German EEZs. One of these project clusters will have the task of implementing the benthos monitoring programme in the German EEZ. As the Federal Nature Conservation Act as well as the EU Marine Strategy Framework Directive requires the assessment of non-indigenous species in the German North and Baltic Seas this will be one of the monitoring compartments within this cluster. Key tasks of the project are therefore

- to (further) develop and implement a screening procedure for early detection and spreading of marine non-indigenous species as well as the determination of trends in the newly appearing non-indigenous species in the German North Sea and Baltic;
- development and application of indicators for the assessment of pathways and vectors as well as for trends of introductions of non-indigenous species within the framework of the EU Marine Strategy Framework Directive
- evaluation of existing data from environmental impact studies relevant for the assessment of the status of non-indigenous species in the German EEZ of the North sea and the Baltic.

C Risk Assessment Approaches

Ballast Water Opportunity

In the framework of this project (see above) a risk assessment study for North Sea shipping was jointly prepared by Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia).and Stephan Gollasch and the executive summary is appended as Annex 2. A further structure for the implementation of its findings and the result of subsequent discussions is contained in Document HELCOM MARITIME 9/2010 doc 7/1/INF

German Federal Maritime and Hydrographic Agency

The German Federal Maritime and Hydrographic Agency currently tenders a research project on risk assessments for ship voyages between harbours in the North Sea and in the Baltic. Based on a compilation of available risk assessment approaches and the availability of the information about environmental conditions and the prevailing species composition risk assessment should be carried out for selected harbours in the North Sea and in the Baltic.

Helsinki Commission – Baltic Marine Environment Protection Commission (hereafter referred to as HELCOM)

The 2010 HELCOM Moscow Ministerial Meeting adopted HELCOM Guidance on how to distinguish between high and low risk – a risk of secondary spreading of alien species through ballast water and sediments – by ships engaged in intra-Baltic voyages. The Guidance has been developed to support transparent and consistent risk assessments for regional ship voyages and to allow a unified Baltic Sea system on exemptions from applying ballast water management in accordance with Ballast Water Management Convention Regulation A-4.

The Guidance, however, has not been tested yet on real cases, and there is a growing need to gain the knowledge among national administrations and provide best practices on how to conduct and/or evaluate and consult risk assessments as set in the Ballast Water Management Convention.

To test the Guidance, HELCOM MARITIME 9/2010 and HELCOM HOD 34/2010 agreed on conducting the project "Pilot risk assessments of alien species transfer on intra-Baltic ship voyages".

Stephan Gollasch is involved in this project and will jointly undertake this risk assessment study with Erkki Leppäkoski (emeritus, Abo Akademi, Turku, Finland) and Matej David (University of Ljubljana, Faculty of Maritime Studies and Transport, Portoroz, Slovenia).

The project duration is December 2010 to December 2011. The project will co-operate closely with the project being tendered by the Federal Maritime and Hydrographic Agency.

D Occurrence of New Ship-mediated Introduced Species

Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
Chaetoceros circinalis	March 2010	Already known for Kattegat and Beltsea but first records for: Kiel Bight and Mecklenburg Bight	unknown		Norbert Wasmund, Leibnitz Institute for Baltic Sea Research, Seestr.15, 18119 Warnemünde, GERMANY
Chaetoceros pseudobrevis					
Alexandrium pseudo-gonyaulax	10.08. 2010	Already known for Kattegat and Beltsea but first records for station: "Heiligendamm" Position 54° 08,55′ N 11° 50,00′ E	unknown		
Pseudosolenia calcar-avis	since 29.9. 2010				
Melita nitida	2010	Kiel Canal	shipping		Reichert, and Beermann 2011
Skistodiaptomus pallidus	2010	Bremen	ballast water		Brandorff 2011

* 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

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Annex 1

EMSA Study

TESTING SAMPLE REPRESENTATIVENESS OF A BALLAST WATER DISCHARGE AND DEVELOPING METHODS FOR INDICATIVE ANALYSIS

Stephan Gollasch and Matej David

The objectives of this project included to find methods to overcome one of the biggest hurdles in sampling for enforcement of the International Convention for the Control and Management of Ships' Ballast Water and Sediments2004 (BWM Convention) that is facing a Maritime Administration: the issue of how to take a sample being representative of the whole ballast water discharge. Secondly, the question was also how to conduct an indicative analysis of ballast water. The project was organised in two parts aiming for

- Part 1: To develop a sampling protocol that obtains a representative sample of the whole discharged ballast water; and
- Part 2: To develop methods for indicative analysis/sampling that provides "clear grounds" for stopping a discharge and/or enforcement action.

Two vessel voyages were undertaken to meet the objectives. Furthermore, the tenderers undertook a comprehensive Internet research on possible methods for indicative analysis of ballast water samples), and tested selected methods on-board during these voyages.

Part 1 Sample representativeness

During all the tests undertaken for this part of the contract, the water was sampled during uptake and discharge. The water flow being sampled was split into two flows. One used to take samples over the entire pumping event and the second to take three random samples.

The results show that different approaches in the sampling process influence the results regarding organism concentrations. The organisms in the discharge are affected in different ways, therefore the selection of the "wrong" sampling approach may influence the compliance control result. The organism concentrations in the ballast water discharge may therefore be underestimated, and a "faulty" ballast water treatment system (BWTS) could be recognised as compliant. Conversely organism concentrations may be overestimated, and a BWTS complying with the D-2 Standard may fail in compliance tests.

It should be noted that a certain level of pragmatism is required during on-board ballast water compliance control sampling especially when larger volumes of water need to be sampled. This is especially relevant to sample for bigger organisms, and attempts should be made to avoid negatively impairing organism survival during the sampling process. Compliance control sampling teams are unlikely to have large water collecting tanks (>1000 litres) available during the sampling event and will probably need to work with nets to concentrate the sample during the sampling procedure.

During this study it was observed that sampling duration (i.e., length of the sampling process), timing (i.e., in which point in time of the discharge the sampling is conducted), the number of samples and the sampled water quantity are the main factors that influence the results regarding organism concentrations.

Recommended sampling duration

The results show that bigger organisms are negatively affected by longer sampling times. Considering that the results show that a shorter sampling time is still representative, the recommended sampling time of a sample taken during the tests in a sequential sampling is approximately 10 minutes. Longer sampling times result in an underestimation of the viable organism concentration in the discharge, especially for bigger organisms.

Recommended sampling timing

The results also show that organism concentrations may vary considerably if the sampling is conducted at the very beginning or at the very end of the discharge process because of the patchy distribution of organism inside ballast water tanks. It is not recommended to take a sample at the very beginning (i.e., the first 5 min) or at the very end of the discharge (i.e., the last 5 min), as an underestimation as well as an overestimation of organism concentrations may be expected. Based on this it is recommended that the sampling is conducted randomly anytime in the middle of the discharge, starting after 5 minutes from the start of discharge and ending 5 minutes before the end of the discharge.

Recommended number of samples

Organism concentrations in all organism groups vary due to the patchy distribution of organisms inside the ballast water tanks, hence a single 10 minutes sequential sample may underestimate or overestimate the concentration of organisms being discharged. The results also show that an average of organism concentrations from 2 random samples from sequential sampling provides very similar results to the average of the 3 random samples. Based on this it is recommended that sampling is conducted by undertaking at least 2 random samples, which are analysed immediately after each sampling event has ended, and that the organism concentration results are averaged.

Recommended sampled quantity

In this study sequential sampling was conducted over periods of 10 and 15 minutes with the flow rate averages ranging mainly between 30 and 45 litres per minute. To obtain the most representative results it is recommended that:

- for the bigger organisms 300 to 450 litres should be filtered and concentrated;
- for the smaller organisms a "continuous drip" sample totalling to approximately 5 litres (i.e., collect approximately 0,5 litre of sample water every minute during the entire sampling time duration, or collect about 0.5 litre of sample water every 30 to 45 litres sampled, depending on the flow rate) should be taken. The resulting 5 litres of sample water should be subsampled after mixing in two sets of samples, one alive and another preserved. We recommend sub-sample volumes of 60 to 100 ml;
- for the bacteria, a sample of approximately 1 litre should be taken as a subsample after mixing from the 5 litre "continuous drip" sample.

Other recommendations

It is also assumed that the sampling flow rates may influence the results. Lower flow rates obtained by partially closed valves of the sampling line may damage organisms, and a similar negative effect may be caused by to strong flow rates affecting mainly the filtering process of the bigger organisms. Hence, the flow rate, or "valve" effect, may cause an underestimation of the organism concentration as organisms may die

during the sampling process. To avoid this negative influence it is recommended that the valve at the sampling point is opened as much as possible, however it should not exceed the flow rate of 50 litres/min, so that the water pressure is not too high during sample concentration, as this may impair organism survival.

Sampling logistics feasibility

Different types, sizes and cargo profiles of vessels trigger very different ballast water discharge profiles and times. Ballast water discharge may be conducted "at once" or "in sequence", lasting from approximately one hour (e.g., fast discharge of two tanks in parallel on e.g. container vessels), up to several days depending on the length of the cargo operation (e.g., tankers, bulk carriers and sometimes general cargo vessels load cargo during several days, hence the ballast water operation is frequently conducted in sequence over the time of cargo operation).

It is important to take this factor into account as it is difficult to imagine that the PSC officer and/or sampling team would stay on-board the vessel for several days. Considering the above recommendations on representative sampling, sampling of at least 2 random samples is feasible and is relatively easy, while sampling over the entire time of the ballast water discharge would be very difficult if long sampling times are required over several days or during night time (i.e., cargo operations are regularly conducted also in night shifts, but PSC officers may only be available at day shifts).

The challenge may become to obtain a representative sample of the whole discharge, when the vessel will be discharging ballast water from more than one ballast water uptake location. In such cases it is recommended that at least 1 sequential sample per uptake source is taken. If a tank was filled from multiple sources this does not trigger necessity for 2 or more samples

Part 2 Methods for indicative sample analysis

Various methods for indicative analysis of the three organism groups of the Ballast Water Performance Standard of Regulation D-2 of the BWM Convention were considered. In total 8 methods for phytoplankton, 6 methods for zooplankton and 11 methods for bacteria were evaluated for their use in indicative ballast water sample analysis. The pros and cons of the methods selected are presented in Chapter 5 with a summary in Chapter 5.12.

For a ballast water sample to be analysed, certainly, as a very first step, sampling needs to be conducted. The ballast water sampling guideline does not address explicitly how indicative sampling would need to be undertaken. Implicitly, indicative analyses could be conducted on a sample, or on a part of a sample, taken during the complete D-2 compliance control sampling process, or just on a stand-alone sample.

It is important to understand that indicative sampling may be focussed only on one group of organisms (i.e., smaller and bigger organisms or bacteria). While results from each of these organism groups may give an indication that a BWTS is not performing properly, from our experience of on-board sampling, it easily can happen that, e.g., bacteria and smaller organisms would be within acceptable limits, however bigger organisms may be in too high concentrations to meet the D-2 Standard, or vice versa.

Different groups of organisms in general require different sampling approaches (e.g., in general bigger organisms require bigger water quantities to be sampled than when focussing on smaller organisms), as there are relatively lower concentrations of bigger organisms in the water than the smaller ones. Therefore, indicative sampling

methods may be very different for each organism group, differing in e.g. sample duration, timing, volume, and at which sampling point it was taken.

It would be very difficult to predict in advance which group of organisms to focus on to identify possible non-compliance with the D-2 standard, as this would require a risk assessment conducted in advance. Hence, from this perspective it would be most helpful to use a sampling method which would allow conducting analyses on all organism groups. This would also offer a step-by-step process, where one analyses method may be applied first. If this shows some indication or even does not give an indication of non-compliance, another sample analysis method can be applied (e.g., start with the fastest available analysis method, and proceed with the next available method).

Nevertheless, noting all the above and after the tests and analyses conducted during this study, supported by experience and results from previous voyages, we recommend that for indicative ballast water sampling, one sequential sample is taken using the same sampling methodology as for a full D-2 compliance test (as described in subchapters).

When taking one sequential sample, the sampling time is short and the sample analysis could be conducted with a range of different methods. The results obtained from this approach can also represent very solid grounds for different actions PSC may have available in case of indicated non-compliance with the D-2 standard, e.g. (a) from an indication that more tests are needed and to proceed to complete full compliance D-2 tests, (b) to send a vessel to a designated ballast water discharge area, (c) require to discharge the ballast water in a port reception facility, or even (d) to ban a ship from further ballast water discharge, all depending on the result obtained. For instance, if the concentration of organisms identified is just above the D-2 standard, this would be an indication possibly requiring further tests. However if much higher concentrations of organisms than the D-2 standard are identified, a ship may be banned from continuing the ballast water discharge.

We also believe that in certain occasions it may be required not to take a sample from the ballast water discharge line as G2 recommends. This can only be done while the ballast water is pumped overboard. Should a vessel carry ballast water from areas known to contain outbreaks, infestations, or populations of Harmful Aquatic Organisms and Pathogens (e.g., toxic algal blooms) sampling ballast water from the discharge line while being discharged should be avoided. Should non-compliance be proven in such a case the water may have already been pumped overboard and pose a risk to the environment, human health, property or resources. Instead we recommend that in such cases an indicative ballast water sample is taken directly from the ballast water tank prior to discharge. Although such sampling methods may not be representative of the whole discharge an indicative compliance control analysis is enabled without discharging the ballast water.

Annex 2

Ballast Water Opportunity (Interreg IVB Project)

Ballast Water Risk Assessment for intra North Sea Shipping

Matej David and Stephan Gollasch

This risk assessment study focuses on intra North Sea shipping routes located inside the same bioprovince. The three different risk assessment approaches as outlined in IMO Guideline G7 were evaluated for their applicability in the region.

The biogeographic risk assessment approach of G7 is not applicable as the ballast water movements considered here are not undertaken between different bioprovinces.

It became clear that essentially needed data (i.e., on already introduced species in the North Sea ports) are missing to undertake a species specific and target species risk assessment as no port baseline surveys were undertaken yet. However, a target species selection process may be conducted yet based upon selection criteria outlined in the chapter 2.3.1. Target species can thereby be identified, but a risk assessment based upon target species is only possible with the knowledge on their occurrence in ballast water donor areas – highlighting the need to undertake port baseline surveys. It should further be noted and as outlined also in IMO G7 as the number of species included in the target species approach the number of low risk scenarios decreases, this is why the target species approach should focus on the most dangerous or most potentially harmful species, which should further be selected on a bioregional scale also noting unique water conditions such as freshwater environments.

The risk assessment based upon environmental match is also enabled. When considering this option it should be noted that the water salinity is the key feature in this approach. It should be noted that the more environmental parameters are being included the lesser robust and reliable becomes this assessment which is in conflict with the precautionary principle. The salinity is believed to be a relatively solid indicator for species compatibility and survival in a new environment, and on the other side, this information is relatively easy available for ballast water source and discharge areas. A high risk is assessed should the salinity match between ballast water donor and recipient regions, e.g., marine to marine, marine to brackish or freshwater to brackish environments. A mismatch of salinity, i.e., waters with at least 29 psu difference, e.g., freshwater to marine, indicates a lower risk. This general approach however needs a bit caution in regards to human bacteria, which in general does not survive in high salinity water, but may survive as in a host animal or debris.

A combination of both, the target species approach together with an environmental match are to be considered. Should the selected target species occur in the ballast water donor area and the ballast water donor and recipient ports show matching salinities, a high risk is assessed. However, if a mis-match of salinity (difference higher than of 29 psu) is identified between source and recipient ports, the ballast water may be identified as low risk. All this low risk scenarios are acceptable only provided the ballast water is in no instance mixed with other ballast water from other sources (e.g., brackish).

Annex 3

Vectors of Change in Oceans and Seas Marine Life, Impact on Economic Sectors (VECTORS) is a European Commission Seventh Framework Programme (FP7) project.

VECTORS will elucidate the drivers, pressures and vectors that cause change in marine life, the mechanisms by which they do so, the impacts that they have on ecosystem structures and functioning, and on the economics of associated marine sectors and society. VECTORS will particularly focus on causes and consequences of invasive alien species, outbreak forming species, and changes in fish distribution and productivity. New and existing knowledge and insight will be synthesised and integrated to project changes in marine life, ecosystems and economies under future scenarios for adaptation and mitigation in the light of new technologies, fishing strategies and policy needs. VECTORS will evaluate current forms and mechanisms of marine governance in relation to the vectors of change. Based on its findings, VECTORS will provide solutions and tools for relevant stakeholders and policymakers, to be available for use during the lifetime of the project. The project will address a complex array of interests comprising areas of concern for marine life, biodiversity, sectoral interests, regional seas, and academic disciplines as well as the interests of stakeholders. VECTORS will ensure that the links and interactions between all these areas of interest are explored, explained, modelled and communicated effectively to the relevant stakeholders. The VECTORS consortium is extremely experienced and genuinely multidisciplinary. It includes a mixture of natural scientists with knowledge of socio-economic aspects, and social scientists (environmental economists, policy and governance analysts and environmental law specialists) with interests in natural system functioning. VECTORS is therefore fully equipped to deliver the integrated interdisciplinary research required to achieve its objectives with maximal impact in the arenas of science, policy, management and society.

The geographic focus is put on the western Mediterranean, North and Baltic Seas.

The specific objectives of VECTORS include:

- To collate understanding of the different current and potential future pressures and vectors of change in the marine environment;
- To better understand the mechanisms of changes in marine life and the role of human activity;
- To determine the impacts of changes in marine life on ecosystems, their structure and functioning, the services they provide, as well as the economic and societal implications
- To project the future changes and consequences of multi sectoral human activity in the marine environment under future possible scenarios of adaptation and mitigation
- To synthesise the derived information into innovative predictive management tools and strategies targeted to different policy makers and other stakeholders

The existing alien species databases generated during the EU-funded DAISIE and IMPASSE projects will be updated and the databases will further be modified and expanded to meet the VECTORS needs. The project will also contribute to ballast water management, risk assessments and decision support systems.

The project is coordinated by Melanie Austen, Plymouth Marine Laboratory, United Kingdom and has a duration of 4 years. In total the project is structured in 8 Work Packages with 37 partners being included to contribute more than 1600 person months during the project duration. The overall requested financial EU contribution is ca. 12.5 Mill €.

5.6 Greece

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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

1. Ph.D Kalogirou S.: see Kalogirou *et al.*, 2010

Temporal and spatial variation in density, biomass and body size of littoral fish species associated with near shore *Posidonia oceanica* meadows were studied throughout an annual cycle in an area of eastern Mediterranean. Among the species encountered, eleven were found to be non indigenous of Indo-Pacific origin, three of them using segrasses 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 (Kalogirou *et al.*, 2010).

2. PhD Tsiamis K. , University of Athens: as in 2010 report

see Tsiamis & Bellou, 2010 & Tsiamis *et al.*, 2010.

3. UNEP RAC/SPA: *Feasibility study in setting up a regional mechanism for collecting, compiling and circulating information on invasive non-indigenous species in the Mediterranean.* see Zenetos & Polychronidis, 2010 and Zenetos *et al*, 2010

4. The ELNAIS (Hellenic Network for Aquatic Invasive species) currently includes 237 alien marine species and is regularly updated.

- 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

1 Eradication Programmes
2 Management and Control of Invasive Species

C Risk Assessment Approaches

D Occurrence of New Ship-mediated Introduced Species

Following the review by Zenetos *et al.* (2009) on marine alien species in

Greek Seas, 47 additional species are reported in Zenetos *et al.*, 2011, bringing the total to 237, which is a 24.4% increase. Twenty one of the listed species were reported for the first time in 2009-2010, whereas 21 species (mostly Polychaeta) although they existed in the literature, had never been classified as aliens previously.

Of these, nine species (Table 1) were reported within 2010, while three more overlooked in previous inventories, presumably ship mediated are added to the check list of Greek alien species.

Table 1. List of new alien species in Greek waters introduced via shipping

(Pol=Polychaeta, Mol=Mollusca, Rho=Rhodophyta, For=Foraminifera, Din-Dinophyta)

	Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
Pol	*Marphysa disjuncta*	1983	Evvoikos	Shipping/ fouling	established	Simboura *et al.*, 2010
Pol	*Pseudopolydora paucibranchiata*	2005	Evvoikos	Shipping/ fouling	established	Simboura *et al.*, 2010
Pol	*Chaetozone corona*	1982	Ionian Sea	Shipping/ fouling	Cryptogenic /established	Simboura *et al.*, 2010
Pol	*Paraprionospio coora*	1983	Lesvos isl.	Shipping/ fouling	cryptogenic	Simboura *et al.*, 2010
Pol	*Lumbrineris perkinsi*	1990s	Evvoikos	shipping	established	Arvanitidis, 1994
Mol	*Cardites akabana*	2008	Thermaikos	shipping	questionable	Manousis *et al.*, 2010
Rho	*Apoglossum gregarium*	2009	Ionian Sea	shipping	established	Tsiamis & Bellou, 2010
Rho	*Anotrichium okamurae*	1973	Dodekanisos	shipping	questionable	Gerloff & Geissler, 1974
Rho	*Chondria pygmaea*	unknown	Ionian Sea	via Suez / shipping	unknown	Tsiamis *et al.*, 2010
For	*Cymbaloporetta plana*	2001	Kyklades	via Suez / shipping	cryptogenic / established	Koukousioura *et al.*, 2010
For	*Triloculina fichteliana*	2006	Saronikos	via Suez / shipping	cryptogenic / established	Koukousioura *et al.*, 2010
Din	*Prorocentrum triestinum*	2000	Thermaikos	shipping	unknown	Nikolaidis *et al.*, 2005

* 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

Spreading of alien species that were known from certain port areas into other port areas (Table 2).in Greece was reported for the following species which are all fouling species.

Balanus trigonus reported from Thermaikos Gulf: Zenetos *et al.*, 2009

Chama aspersa reported from Evvoikos in 2007: Ovalis & Zenetos, 2007

Gastrochaena cymbium reported from Saronikos in 1974: Tenekides, 1989

Pseudochama corbieri reported from Saronikosin 1939: Ralli-Tzelepi, 1946

Table 2. List of ship tranferred species (Cru=Crustacea, Mol=Mollusca)

	Taxon	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	Reference
Cru	*Balanus trigonus*	2010	Saronikos	shipping	est	Zenetos *et al.*, 2011
Mol	*Chama aspersa*	2010	Saronikos	shipping	est	Zenetos *et al.*, 2011
Mol	*Chama aspersa*	2008	Thermaikos	shipping	est	Manousis *et al.*, 2010
Mol	*Pseudochama corbieri*	2006	Thermaikos	shipping	est	Manousis *et al.*, 2010
Mol	*Gastrochaena cymbium*	2008	Thermaikos	shipping	est	Manousis *et al.*, 2010

F Other Relevant Information

Aquaculture

Marteilia refringens is a parasite which affects the digestive system of several bivalve species, inducing physiological disorders and eventually results in death. The first report in Greece dates back to 1997 from oyster beds in Thermaikos Gulf (Angelidis *et al.*, 2001). According to the Directorate General of Veterinary Services in Athens there have been five outbreaks of the disease in farmed mussels across Greece until November 2010.

Introductions attributed to Climate change

Increase of species in the SE Aegean has been evidenced due to spreading of Indo-Pacific species established in the Levantine Sea. In addition some rarely found species previously seem to be now well established (Table 3).

Table 3. Alien marine species established in Greek waters within 2010

Species	Taxon	Source
Enchelycore anatina (Lowe, 1839)	Fish/Osteichthyes	Kalogirou, 2010
Tylerius spinosissimus (Regan, 1908)	Fish/Osteichthyes	Corsini-Foka *et al.*, 2010
Seriola fasciata (Bloch, 1793)	Fish/Osteichthyes	Zenetos *et al.*, 2011
Hypnea cornuta (Kützing) J. Agardh 1851	Rhodophyta	Tsiamis *et al.*, 2010
Sarconema scinaioides Børgesen, 1934	Rhodophyta	Tsiamis *et al.*, 2010
Cassiopea andromeda (Forsskål, 1775)	Cnidaria/Scyphozoa	Zenetos *et al.*, 2011
Gastrochaena cymbium Spengler 1783	Mollusca/Bivalvia	Manousis *et al.*, 2010
Pseudochama corbieri (Jonas, 1846)	Mollusca/Bivalvia	Manousis *et al.*, 2010
Chromodoris annulata (Eliot, 1904)	Mollusca /Gastropoda	Zenetos *et al.*, 2011
Sepioteuthis lessoniana Lesson, 1830	Mollusca/Cephalopoda	Zenetos *et al.*, 2011

G References

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5.7 The Netherlands

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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 water (*www.NorthSeaBallast.eu*)

Ballast Water Opportunity Project (NSBWO; EU - Interreg North Sea), co-ordinated by NIOZ, 2009-2013 & Ballast Water testing studies, co-ordinated and hosted by NIOZ, since 2002, ongoing.

1.1 Biology of Ballast Water

NIOZ in cooperation with University of Groningen, Cytobuoy and Zebra Bioscience:

- Background studies on detection of microorganisms present in ballast water, viability and long-term survival of micro organisms in ballast water.
- Papers presented at EMSA sampling workshop (Lisbon); ACI BWM Conference (London)
- Research on extended BWM testing, behaviour of organisms on continued exposure (Papers presented at ICAIS 2010, San Diego)

IMARES, Wageningen UR

N.H.B.M. Kaag (klaas.kaag@wur.nl), A.C. Sneekes (andrea.sneekes@wur.nl)

- Interreg NSBWO. Mesocosm Ballast Water study:
  Risc analysis of discharged ballast water is based upon model calculations (MAMPEC) using NOEC's from laboratory-bioassays. Exposure in mesocosms is more environmentally realistic, comprises more species and offers the opportunity to assess recovery of the community. In comparison with 'traditional' mesocosm studies, where the active substance is specifically dosed, a discharge is simulated by replacing a certain amount of the water with treated 'ballast water' (with a specific concentration of the active substance). The effects of the discharge on the community and the subsequent recovery is monitored during 8 weeks.

1.2 Ballast Water Treatment

BWM certification testing ongoing at NIOZ,

- 2 BWM systems Type Approval finalised 2010
- Extensive pilot scale testing on several BWM systems or parts thereof.
- Participation in BW Experts Groups (NL Ministry of Transport and IMarEST, UK)
- Co-operation on certification trajectories and protocols with governments of Germany, UK, Netherlands as well as those of U.S., Greece

BWM certification testing toxicity at IMARES, Wageningen UR

- G9 testing of active substances for 3 BWMS
- G8 testing for 1 BWMS using inert gas
- Additional testing with toxic ballast water to be treated and research using TIE techniques (Toxicity, Identification and Evaluation) to identify the source of pollution. IMARES, (Report C122/10)
- Viability determinations of barnacle cyprid larvae that survived a chlorine dose using a barnacle settlement test. IMARES, (Report C103/10)

1.3 Ballast Water Sampling

- Advanced studies on refining detection methodology and background studies (in cooperation with GoConsult).
- Organisation of detection workshop on different micro organism size classes (as part of BWO, closed workshops on invitation only),
- - > 50 micron autumn 2010
- - 10-50 micron March 2011
- - <10 micron autumn 2011

1.4 Ballast Water Legislation/Regulations

- Netherlands ratified the BWM Convention in early 2010
- Netherlands leads North Sea policy development of a ballast water exchange strategy (as part of the BWO project)
- Netherlands Ministry of Transport has been running a Ballast Water Expert Group that meets once a year in support of policy development

2 Hull Fouling

Maritime Campus Netherlands

(IMARES, Wageningen UR and TNO Industry and Technique)

B. Bolman (bas.bolman@wur.nl)

- Bio-invasion from hull fouling project :
  The Maritime Campus Netherlands has started up a project to quantify species transfer with hull fouling. The Bio-Invasion project aims to build a knowledge base on bio-invasion risks, mechanisms, legislation and management measures. To achieve this aim we are identifying existing regulations, risk models and measures on a worldwide level. We are also identifying which knowledge is lacking to build suitable risk models. In addition technological innovations will be considered that facilitate the control of bio-invasion risks.

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)

Awareness:

- The last four years, The ProSea Foundation and the Dutch IMO delegation (The Ministry of Infrastructure and Environment) have developed an IMO Model Course Marine Environmental Awareness. This Model Course will now serve as a blueprint for training of officers and other personnel on board of sea going ships world wide. (http://www.prosea.info)

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

Written reports:

- Brink, A.M. van den; Wijsman, J.W.M. **2010**. High risk exotic species with respect to shellfish transports from the Oosterschelde to the Wadden Sea. YERSEKE : IMARES, (Rapport C025/10)
- Fey, F., van den Brink, A.M., Wijsman, J.W.M. & O.G. Bos. **2010**. Risk assessment on the possible introduction of three predatory snails (Ocinebrellus inornatus, Urosalpinx cinerea, Rapana venosa) in the Dutch Wadden Sea. Report C032/10, IMARES, Texel/Wageningen
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- Van den Brink, A. & J.W.M. Wijsman. **2010a**. High risk exotic species with respect to shellfish transports from the Oosterschelde to the Wadden Sea. Report C025/10. IMARES, Wageningen.
- Van den Brink, A. & J.W.M. Wijsman **2010b**. Fresh water immersion as a method to remove Urosalpinx cinerea and Ocinebrellus inornatus from mussel seed. Report C020/10. IMARES, Yerseke/Wageningen.

D Occurrence of New Ship-mediated Introduced Species

No new invasive species have been identified in 2010 for the Netherlands, Europe (www.werkgroepexoten.nl).

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

Increase in abundance of *Mneniopsis leidyi* during 2010 no economic damage yet.

Economic (quantify if possible)

Ecological

F Other Relevant Information

G References

Websites:

www.werkgroepexoten.nl

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Reports:

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Older relevant reports:

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5.8 Norway

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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
    - o Ocean-going Workshop for the Northern Sea Route. Briefly outlined and proposed at the BOSV-meeting in Nantes, march 13-15.

1 Ballast water

The International Convention for the Control and Management of Ships Ballast Water & Sediments was adopted by the International Maritime Organization (IMO) in 2004, which implies that the worlds fleet must invest in approved technology for treatment of their ballast water before discharge. Norwegian Institute for Water Research (NIVA) has been involved in testing of Ballast Water Management System (BWMS) since 2002. NIVA has established a centre for land-based testing according to IMO-requirements, located at Oslofjord south of Oslo.

Land-based testing of BWMS for approval according to IMO requirements are carried out by Ballast-Tech NIVA AS, a company fully owned by NIVA. In addition, the Centre offers the following services:

- small-scale and pilot-scale tests of biological efficiency and ecotoxicity tests of BWTS
- shipboard testing in accordance with IMO guidelines
- ecotoxicological testing and assessment for basic approval

The designated administration for approval of BWMS will be the Norwegian Maritime Directorate and the designated body Det Norske Veritas.

1.1 Biology of Ballast Water

Ongoing research projects:

- Studies for establishment of a PCR method to analyse ballast water for toxicogenic V. cholera. NIVA and Norwegian Defence Research Establishment (FFI)
- Studies on bacterial regrowth potential in ballast water treated with different disinfection methods, i.e. UV irradiation, ozonation, chlorination. Bacteria studied: Vibrio cholerae, V. parahaemolyticus and heterotrophic bacteria. NIVA and Norwegian School of Veterinary Science
- Study of Tetraselmis suecica (algae species) dose respons curves for UV and ozonation treatment with different analysis methods in seawater. NIVA.

1.2 Ballast Water Treatment

NIVA has carried out full scale land-based tests for approval according to IMO-requirements, and small scale testing for basic approval according to IMO. Number of technologies tested by NIVA:

- 11 technologies tested in full scale land based tests for type approval according to IMO requirements: 5 for G9 and 6 for G8
- 8 technologies tested in small scale land based tests for basic approval according to IMO requirements: 5 for G9 and 3 for G8
- Ship board tests: 3 G8 (14 shipboard testing)

1.3 Ballast Water Sampling

- In the full-scale test facility, samples are collected from the well mixed tanks of influent water and treated water, and not from the pipes. We believe that sampling from the tanks guarantee high water homogeneity and representative samples.

- Shipboard testing: results from shipboard testing for Type Approval show non homogen distribution of organism in vessels's water ballast tanks, NIVA.

Presentation by NIVA of these results, both for land based and shipboard testing, at the Sampling workshop organised by EMSA in February 2010, Portugal.

1.4 Ballast Water Legislation/Regulations

- Norway was one of the first country to ratify the BWM Convention 2004. The Norwgian Environmental Department has made bylaws effective from july 1, 2010, implementing the first part of the Ballast-water Convention. The bylaws regulates BW exchange (Depth/distance from shore) but does not make any treatment (e.g. compliance with a D2 standard) mandatory. http://www.lovdata.no/for/sf/nh/th-20070702-0850-0.html , and amended 2010. http://www.sjofartsdir.no/no/Regelverk2/Rundskriv/RSR-04-2010-Fastsettelse-av-forskrift-om-undersokelse-stansing-og-bording-av-utenlands-skip/

- NIVA coordinates the technology testing with national classification societies, i.e. DNV for Norway, Lloyd's for UK, BSH for Germany, CCS for Kina, etc. to guarantee that the procedures, quality assurance and testing are in accordance with requirements, IMO Guidelines, 2008 (G8 and G9 (IMO).

- NIVA is taking part in the initiative from GloBallast/IMO to harmonise sampling and analysis method among different test facilities from Europe, US and Asia. Workshops on intercalibration were arranged in Malmø 2010 and Singapore 2010. NIVA will chair the next workshop in Turkey in November 2011. One of the

intentions of the group is to propose some recommendations to IMO for revised G8 and G9 guidelines.

- NIVA prepared a report to US Coast Guard/EPA with advices and recommendations for the ETV protocol establishment. NIVA will try to implement procedures for sampling and analysis in accordance with the ETV protocol (2010) and the California Performance standards (2008).

2 Hull Fouling

NIVA will start with two projects on hull fouling treatment technology in collaboration with two industrial companies.

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
5.1 Biology
5.2 Treatment
5.3 Sampling
5.4 Legislation/Regulations

B Invasive Species Management

1 Eradication Programmes.

Nothing to report for shipping vectors as such, but first regional "Action plan against alien harmful species" has been finalised for the counties of Oslo and Akershus (combined) Anon (2010). The Action plan will be evaluated and updated, and ship-transported NIS will be included if/when appropriate.

2 Management and Control of Invasive Species

A first attempt of mapping/monitoring of marine alien species in a more systematic way in Norwegian marine waters has been conducted. (Rapid Assessment Inventories) This study is a cooperation between the University of Bergen and IMR.

C Risk Assessment Approaches

The Norweian "species databank" has initiated work in 2010 on a revision of the alien species list of 2007. Simultaneously the risk assessment has been developed into a

more generic tool. Both ecological damage and spreading capacity is evaluated and expressed as a "risk matrix". A new "alien species list" will be finalised in 2011 and published in 2012. The "Species database is an open access database with several reference- and Gif-tools.

5.9 Portugal

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A Transport Vectors

- Project INSPECT- PTDC/MAR/73579/2006. Introduced marine alien species in Portuguese estuaries and coastal areas: patterns of distribution and abundance, vectors and invading potential. October 2008 – September 2011. Principal contractor: Centre of Oceanography, Foundation of the Faculty of Sciences of the University of Lisbon (CO/FCUL); PI: Maria José Costa; website: http://projectos.lpn.pt/inspect

Project INSPECT involves several partners: (i) Universities of Lisbon, Évora, and Azores; (ii) Institute for Nature Conservation and Biodiversity (ICNB); (iii) Institute for Ports and Maritime Transport (IPTM); (iv) Nature Conservation NGO (LPN).

The major tasks of this project include (1) a comprehensive literature review on non-indigenous marine and estuarine species and on maritime traffic routes that include Portuguese harbors, (2) port surveys focused on phytoplankton and zooplankton, and on macroalgae and invertebrates from both mobile and hard substrates (3) building a guideline document to support managers and decision-makers on the allocation of resources to prevent and/or mitigate the impacts of invaders and (4) raising public awareness for the threats of alien species' introductions. The main objectives are:(1) Identify marine alien species and their invasive status; (2) Investigate major vectors of introduction, namely ballast water, hull fouling, live bait, aquarium trade and aquaculture; (3) Study the role of the Azores Islands as a donor area of marine alien species for mainland Portuguese estuaries and coastal areas; (4) Evaluate if environmental conditions in Portuguese estuaries favour or inhibit invasions; (5) Determine the importance of intraregional transport and other vectors compared to ballast water; (6) Identify priority species and/or areas for control or mitigation purposes;(7) Communicate scientific results to the general public to promote stakeholders commitment in prevention and remediation of adverse impacts of alien species

1. Ballast

1.1. Ballast Water Sampling

Within project INSPECT, between 2009 and 2011 several vessels from international traffic arriving to the Lisbon port have been sampled for ballast water and 1 vessel from regional traffic within mainland Portugal has been sampled for both ballast water and sediments in dry dock. Major difficulties in communication with ship authorities and crew, together with technical difficulties in accessing ballast tanks have made the rate of success very low (<50%).

Regarding the samples analyzed for dinoflagellate cysts both samples from the regional ship in dry dock and one of the ships sampled in 2009 had very high numbers of cysts of the PSP producer *Gymnodinium catenatum*, suggesting ballast water had been collected recently along the Portuguese coast.

1.2. Ballast Water Legislation/Regulations

The Decreto-Lei nr. 235/2000 on Marine pollution considers introduction of organisms that may affect the environment within the concept of marine pollution. The Azores and Madeira Archipelagos have additional regional regulations. Portugal has signed the OSPAR convention and the International Convention for the Control and Management of Ships Ballast Water & Sediments.

2. Hull Fouling

2.1. Hull Fouling Sampling

Within project INSPECT samples have been collected in 2009 from the hull of a ship in dry dock.

3. Sediments

3.1. Sediment Sampling

Within project INSPECT samples have been collected in 2009 from the ballast tanks of a ship in dry dock.

3.2. Sediment Legislation/Regulations

Portugal has signed the International Convention for the Control and Management of Ships Ballast Water & Sediments.

4. Others

4.1. Biology

4.2. Treatment

4.3. Sampling

4.4. Legislation/Regulations

In Portugal the Decree-Law nr. 565/99, 21 December 1999, defines the legal restrictions to the introduction in nature of exotic species. It forbids in general the intentional or unintentional introduction of specimens of non-native species mainly in terrestrial ecosystems. The decree-law is currently under revision to better clarify certain concepts related to the introduction of exotic species, and to expand the list of species to include marine exotic species, currently not included. These lists are built based on research projects under the responsibility of Institute for Nature Conservation and Biodiversity (ICNB) one of the partners of the above mentioned Project INSPECT. Regarding ballast water the new document recommends that the IMO and ICES guidelines be applied.

In addition to the decree 565/99, there are regional resolutions applied in the Azores archipelago (nr 148/98, 25 June 1998) to restrict the spread of exotic species and in Madeira archipelago (regional Decree-law nr. 27/99/M) to restrict the transportation and position of non-indigenous species.

B Invasive Species Management

C Risk Assessment Approaches

Within project INSPECT maritime traffic routes that include Portuguese harbours were investigated and a detailed characterization of those routes with emphasis on the harbours of Ponta Delgada, Lisbon and Aveiro was carried out. The analysis of the frequency of international arrivals, the list of ships coming from possible donor areas, time at sea and an estimation of the annual volume of discharged ballast water were some of the parameters used to determine the potential for introduction of non-indigenous species through ballast water. The import-export trade-balance indicates a low theoretical invasion pressure of Portuguese waters through this pathway, compared to other regions in the world, and suggests Portugal as a ballast water donor.

Future work will include a first attempt to quantify the potential risk of introduction of pelagic organisms in Portuguese coastal waters considering the characteristics of the maritime traffic in the main Portuguese ports. The European model developed by S. Gollasch will be applied to traffic data from several ports in mainland Portugal, Azores and Madeira.

D Occurrence of New Ship-mediated Introduced Species

Taxa	Year of first record	Location of first record	Possible introduction vector*	Invasion Status**	References
Gymnodinium catenatum Graham	1981	Mainland Portugal (SW coast)	Ballast water	Established (recurrent HABs)	Estrada, 1995
Gymnodinium microreticulatum Bolsch, Negri & Hallegraeff	1999	Mainland Portugal	Ballast water	Established	Amorim *et al.* 2001
Ostreopsis cf. *siamensis* Schmidt	2008	Mainland Portugal (Sines)	Unknown	Unknown	Amorim *et al.*, 2010
Pseudo-nitzschia multistriata (Takano) Takano	2003	Mainland Portugal (Aveiro)	Unknown	Established	Churro *et al.* 2009
Anotrichium furcellatum (J. Agardh) Baldock	1970	Mainland Portugal	Ballast water; Fouling	Established	Ardré, 1970
Antithamnion densum (Suhr) M.A. Howe	2009	Mainland Portugal (N coast)	Unknown	Unknown	Araújo *et al.*, 2009
Antithamnion diminuatum Wollaston	1989	Azores	Unknown	Established	Athanasiadis & Tittley, 1994
Antithamnion pectinatum (Montagne) J.Brauner	1989	Azores	Unknown	Established	Athanasiadis & Tittley, 1994
Antithamnionella	1974	Madeira	Ballast water;	Established	Levring, 1974

spirographidis (Schiffner) E.M. Wollaston			Fouling		
Antithamnionela ternifolia (J.D. Hooker & Harvey) Lyle	1970	Mainland Portugal (S coast)	Ballast water; Fouling; Aquaculture	Established	Ardré, 1970
Asparagopsis armata Harvey (+ estadio *Falkenbergia rufolanosa*)	1928	Azores	Ballast water; Fouling; Aquaculture	Established	Schmidt, 1931
Asparagopsis taxiformis (Delile) Trevisan de Saint-Léon	1928	Azores	Ballast water; Fouling; Aquaculture	Established	Schmidt, 1931
Bonnemaisonia hamifera Hariot	1989	Azores (Faial, Graciosa and Flores)	Fouling	Established	Athanasiadis & Tittley, 1994
Dasya sessilis Yamada	2009	Mainland Portugal (N coast)	Aquaculture	Established	Araújo *et al.*, 2009
Gracilaria vermiculophylla (Ohmi) Papenfuss	2005	Mainland Portugal (S coast)	Aquaculture	Established	Rueness, 2005
Grateloupia turuturu Yamada	2009	Mainland Portugal (N coast)	Unknown	Established	Araújo *et al.*, 2009
Neosiphonia harveyi (J. Bailey) M.-S. Kim, H.-G. Choi, Guiry & G.W. Saunders	2009	Mainland Portugal (N coast)	Ballast water; Fouling; Aquaculture	Established	Araújo *et al.*, 2009
Scageliopsis patens Wollaston	1989	Azores (Faial and São Miguel)	Fouling	Established	Athanasiadis & Tittley,1994
Symphyocladia marchantioides (Harvey) Falkenberg	1971	Azores (Santa Maria, Sâo Miguel and Graciosa)	Fouling	Established	Ardré *et al.*, 1974
Caulerpa webbiana Montagne	2002	Azores (Faial)	Ballast water;, Fouling	Established	Cardigos *et al.*, 2006
Cladophoropsis membranacea (Hofman Bang ex C.Agardh) Børgesen	1973	Azores	Unknown	Established	Cardigos *et al.*, 2006
Codium fragile spp. *fragile* (Suringar) Hariot	1993	Azores (São Miguel e Corvo)	Ballast water; Fouling; Aquaculture	Established	Neto, 1994
Colpomenia peregrina Sauvageau	1951	Portuguese coast	Ballast water; Fouling; Aquaculture	Established	Palminha, 1951
Endarachne binghamiae J. Agardh	1995?	Azores (Faial, Pico, São Miguel and Terceira)	Fouling	Established	Tittley & Neto, 1995
Sargassum muticum (Yendo) Fensholt	1994	Mainland Portugal (N coast)	Ballast water; Fouling; Aquaculture	Established	Rull Lluch *et al.*, 1994
Undaria pinnatifida	2009	Mainland	Ballast water;	Established	Araújo *et al.*,

(Harvey) Suringar		Portugal (N coast)	Fouling; Aquaculture		2009
Blackfordia virginica Mayer, 1910	1984	Mainland Portugal (Mira estuary)	Ballast water;, Fouling	Established	Moore, 1987
Gonionemus vertens A. Agassiz, 1862	<1700	Mainland Portugal	Ballast water; Fouling; Aquaculture	Established	Edwards, 1976
Tubularia crocea (Agassiz, 1862)	1989	Azores (Faial)	Fouling	Unknown	Cornelius, 1992
Tubularia indivisa Linnaeus, 1758	1989	Azores (Faial)	Fouling	Unknown	Cornelius, 1992
Branchiura sowerbyi Beddard, 1892	2009	Azores (S. Miguel)	Unknown	Unknown	Raposeiro *et al.*, 2009
Ficopomatus enigmaticus (Fauvel, 1923)	1979	Mainland Portugal (Santo André lagoon)	Ballast water;, Fouling	Established	Cancela da Fonseca *et al.*, 1989
Hydroides elegans (Haswell, 1883)	2000	Azores	Fouling	Unknown	Morton & Briton, 2000
Spirorbis marioni (Caullery & Mesnil, 1897)	1979	Azores (S. Miguel, Faial)	Fouling	Unknown	Zibrowius & Bianchi, 1981
Tricellaria inopinata Ambrogi, 1985	2004	Mainland Portugal Ria de Aveiro	Fouling	Established	Marchini *et al.*, 2007

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

F Other Relevant Information

The European Union's marine environmental policy (Marine Strategy Framework Directive) has been transposed into the Portuguese law and published as Decreto-Lei nr. 108/2010 on October 2010 (issuer: Ministério do Ambiente e do Ordenamento do Território -Environment Ministry). This decree-law defines the action plan and a calendar for Portugal to develop ways of ensuring that the Portuguese seas have good environmental conditions as indicated by the action plan of the Marine Strategy Framework Directive.

The implementation of this decree-law will be coordinated by the Portuguese Water Institute (INAG), in collaboration with the following Portuguese entities:

- the environmental departments of the Autonomous Regions of the Azores and Madeira
- the Task Group for Maritime Affairs
- the Task Group for the Extension of the Continental Shelf
- the Hydrographic Institute
- the Directorate-General for Maritime Authority
- the National Institute for Biological Resources
- the Directorate-General for Fisheries and Aquaculture
- the Portuguese Environmental Agency
- the Institute for Nature Conservation and Biodiversity
- the River Basin Administrations.

All information on the marine environmental strategies and their programs of measures will be published on INAG's website.

INAG is also accountable for informing the European Commission, the Portuguese Environmental Agency and the OSPAR Commission Secretariat and any member states interested in the Portuguese marine environmental strategy.

Portugal is responsible for implementing the directive in two sub regions of the marine region North-east Atlantic: (1) the Bay of Biscay and the Iberian Coast, in cooperation with France and Spain, and (2) the Macoronesian biogeographical region, in cooperation with Spain. At the national level Portugal is now organizing the cooperation between the different entities. At the regional cooperation level, a meeting with the other regional EU countries (France and Spain) is going to take place on the 23rd March.

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5.10 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
Bursatella leachii	2009	Mar Menor (Murcia, SE Spain) (37° 44' 03"N, 0° 46' 30"W) Mediterranean coast	Either by ships from the tropical Atlantic or via the Suez Canal	Established and Spreading	Ramos Esplà *et al.* 2010
Paraleucilla magna	2000	Blanes (NE Spain) (41° 39' 18"N, 2° 49' 43"E) Mediterranean coast	Aquaculture or Shipping fouling	Invasive and Spreading	Guardiola *et al.*, 2010

* Duplication with WGITMO report if the vector is unknown

** When spreading see details in Section E

E Impact of Introduced Species

Ragged sea hare (***Bursatella leachii***) densities can at times become so great as to negatively impact commercial shrimping operations.

The rapid colonisation pattern and the remarkable abundance of *Paraleucilla magna* along the western Mediterranean suggest that it is an invasive species. In other in-

vaded regions (such as the Mar Piccolo of Taranto, in Italy) prefers to settle on mussel shells, affecting their growth, therefore, forcing local shellfish farmers to invest much effort in decreasing this sponge growth. It is also resistant to pollution and seems to be a structurally important species of the fouling community.

F Other Relevant Information

G References

Guardiola, M., Froster, J., Ageli, G. & Uriz, M.J., 2010. Temporal variation in connectivity and genetic structure among populations of a foreign calcareous sponge in the western Mediterranean: approaching the invasive capacity of the species. p. 152. In: *Abstracts XVI Simposio Ibérico de Estudios de Biologáa Marina,* Alicante, España, 6-10 September 2010.

Ramos-Esplá, A.A., Izquierdo, A., Vázquez, M., Lozano, F. and Giménez-Casalduero, F. 2010. Introducciones recientes de especies de afinidades cálidas en el litoral del SE Ibérico. p. 271. In: Bayle Sempere, J.T. *et al.* (Eds), *XVI Simposio Ibérico de Estudios de Biología Marina.* Libro de resúmenes. Universidad de Alicante.

5.11 United Kingdom

Author(s) and contact details:

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t.mccollin@marlab.ac.uk

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. Hull Fouling

1.1. Biology of Hull Fouling

Assessing the interaction on boat hulls between disturbance frequency and resistance of marine communities to invasion

Scottish Association for Marine Science, Scottish Marine Institute, Dunstaffnage, Oban, Argyll, PA37 1QA

Liz Cook and Chris Beveridge

ejc@sams.ac.uk

The physical removal of species from a boat hull, either through deliberate cleaning or just accidental dislodgement in the course of daily operations, can provide new areas for colonisation by native and invasive species. The frequency of this physical removal (or 'disturbance') can influence the diversity of marine communities, with low and high frequencies promoting the lowest species diversity. Low biodiversity, however, is thought to play a role in increasing the susceptibility of a community to invasion. The interaction between disturbance and invasion resistance by marine communities was examined experimentally between April and October 2009 in three marinas in the Clyde Sea, south-west coast of Scotland: Largs, Clyde Ardrossan and Troon, known to contain established populations of invasive species. Settlement panels, made to a similar specification as modern recreational boat hulls, were used as artificial substrata. The panels were initially allowed to colonise naturally for eight

weeks (April-May), followed by a disturbance phase, where the panels (n = 168) were manipulated with different disturbance frequencies for 24 weeks (May-October). These included; no disturbance (control) and a disturbance every 12th, 10th, 8th, 6th, 4th and 2nd weeks. The species abundance and diversity were recorded from photographs taken at monthly intervals throughout the 'disturbance phase'. Four invasive non-native species, out of the seven species known to be established in the marinas, were recorded on the settlement panels; the bryozoan *Tricellaria inopinata*, the Japanese skeleton shrimp *Caprella mutica*, the colonial tunicate *Botryloides violaceus* and the barnacle *Austrominius modestus*. All these species had become established on the panels by week 10 of the disturbance phase and remained attached until the end of the experiment. A significantly greater number of invasive species became established on the panels at Clyde marina at the highest disturbance frequency (i.e. every 2nd week) compared with the low (every 12th week) and medium (every 8th week) disturbance frequencies. However, the results require further analysis and the paper will be presented at the World Biodiversity Conference in Aberdeen in September 2011. This work was funded by the Esmee Fairbairn Foundation and the NERC Oceans 2025 programme.

1.2. Hull Fouling Sampling

Assessing the risks of transporting non native species to Scotland *via* biofouling on vessels.

Marine Scotland – Science, Marine Laboratory Aberdeen, 375 Victoria Road, Aberdeen, AB11 9DB

Tracy McCollin and Lyndsay Brown.

t.mccollin@marlab.ac.uk and brownl@marlab.ac.uk

This is a three year project that will end in March 2012.

The aim of this work is to obtain information regarding which species are being transported *via* biofouling and whether particular vessels e.g. recreational or commercial, or voyages e.g. UK based or international, pose a higher risk of introducing non native species.

The Scottish Government funded project has two main aspects:

1. Dry docks

The dry docks are visited immediately the dock has been drained i.e. prior to the vessel being washed down. Areas such as the hull, sea chests, propellers, rudders are photographed, ranked in terms of the level of fouling and samples collected using a paint scraper.

2. Dive surveys

The Marine Scotland - Science dive team take samples from vessels that trade in Scottish ports but would be too large to use the local dry docks. In water methods (e.g. video cameras, small suction devices and scrapers) are used to record and sample biofouling on vessels.

The sample analysis is ongoing and no new non native species have been detected. The biological analysis will be combined with information on vessel type and voyage pattern to assess whether it is possible to assign levels of risk for introducing non native species.

Survey of hull fouling of leisure craft, SW England

Marine Biological Association of the UK, Citadel Hill Laboratory, Plymouth PL1 2PB, UK

John Bishop, Christine Wood and Anna Yunnie

jbis@mba.ac.uk, cwo@mba.ac.uk, ayunnie@sb-roscoff.fr

Project runs 2009-2011

The hulls and related external underwater surfaces of yachts, motor cruisers and small commercial craft in one Plymouth marina were inspected immediately after each vessel was hauled out for maintenance during the autumn/winter periods of 2008-9, 2009-10 and 2010-11, and samples of the encrusting animals taken for identification. Sixty-three boats were sampled during the first two haul-out periods and the preserved specimens examined. Amongst these, a mean of 3.8 non-native species of sessile animal per vessel was recorded. Within this data set, seventeen yachts in the 9-12 m length range that had been anti-fouled within one year of our inspection were found to have a mean of 4.1 non-native species of sessile animal per boat. The propeller, prop shaft and the base of the keel were found to be particularly commonly fouled, in keeping with previous findings concerning 'niche areas'. (Part-funded by the Esmée Fairbairn Foundation within the Marine Aliens II consortium.)

Comparative study of settlement intensity and short-term fouling in UK marinas

The Marine Aliens II consortium

jbis@mba.ac.uk, Elizabeth.Cook@sams.ac.uk

Project practical work completed, data being analysed

Marine Scotland, the Scottish Association for Marine Science, the University of Bangor and the Marine Biological Association of the UK (all working within the Esmée Fairbairn Foundation-funded Marine Aliens II consortium) deployed Correx (corrugated plastic) settlement panels in 23 marinas in Scotland (E and W coasts), Wales (N and S) and SW England during summer 2009. Fouling was scored on panels deployed for 8 weeks (July-September) and settlement quantified on two sets of panels exposed for two weeks (weeks 1-2 and 7-8 of the 8-week study). Results are being interpreted in relation to water movement (estimated from plaster clod dissolution), salinity, and other environmental variables, to assess likely influences on the capacity of a given marina to act as a nursery for non-native species with the potential to be spread subsequently by hull fouling on leisure craft.

B Invasive Species Management

Eradication Programmes
Management and Control of Invasive Species

1. The response to the identification of *Didemnum vexillum* around the United Kingdom

Scotland

Marine Scotland, 28 Cunzie Street, Anstruther, Fife, KY10 3DF

Scottish Natural Heritage, Upper Battleby, Redgorton, Perth, PH1 3EW

Ellen Burt

Ellen.Burt@scotland.gsi.gov.uk

This project has been set up initially for a 1 year period.

The project was set up in September 2010 following the identification of *Didemnum vexillum* at 4 locations in the Firth of Clyde. The four separate sites lie within approximately 2.5km of each other and include a marina, a pier, a jetty where coal is imported from around the world, and yacht mooring buoys.

The main aims of the project include:

1. To raise awareness of *D. vexillum* and other non natives
2. Liaise with stakeholders and key industry representatives.
3. Set up a monitoring programme to detect the spread of *D. vexillum* beyond the Largs channel
4. Carry out research and identify research needs in coming years.
5. Identify potential sources of future funding for the project beyond September 2011.

Modelling work has been carried out to help predict the spread of *D. vexillum* in Scotland, this will be used to steer much of the project. Reports are currently being prepared regarding commercial shipping and recreational boating activity in the area. These reports will provide background information, highlight issues and the potential implications for *D. vexillum*.

Wales

Countryside Council for Wales Countryside Council for Wales, Maes-y-Ffynnon, Penrhosgarnedd, Bangor, Gwynedd, LL57 2DW

Gabe Wyn

g.wyn@ccw.gov.uk

The first year of the eradication attempt (completed May 2010) appeared to have been successful in significantly reducing the population of *D. vexillum*. However, monitoring in August 2010 discovered small colonies re-establishing across pontoons. Additional funding to 'mop up' these populations could not be found and, by September, small colonies had re-established over much of the previous range. CCW hypothesise that the reason for the high levels of re-establishment was the delayed start of works in winter 2009/10 which allowed larvae present in sea-water to re-colonise after the plastic wrapping had been removed from submerged structures.

Resources could not be made available to mount a full wave of control during the relevant treatment period, winter 2010/11, it is now planned that funds available in 20010/11 will be spent on a disinfection berth at the marina. The next available window for eradication is winter 2011/12.

Shellfish farmers (in Wales and Scotland particularly) have expressed concern over the potential impact of *D. vexillum*. The Mussel Farmers Association in Wales has provided £10k to help support the work in Wales.

England

Natural England, 1 East Parade, Sheffield, S1 2ET

Defra 1/08 Temple Quay House 2 The Square Temple Quay Bristol BS1 6EB

James Bussell and Simon Mackown.

James.Bussell2@naturalengland.org.uk and Simon.Mackown@defra.gsi.gov.uk

Natural England, Cefas and Fera were commissioned by Defra to produce a report reviewing the feasibility of, and providing recommendations for, managing *D. vexillum* in England. Based on this report, complete eradication in England is considered unlikely to be feasible and, if attempted, highly costly (i.e. >£2M).

Planned action:

- While eradication is unlikely to be feasible, doing nothing and allowing the species to spread rapidly is undesirable. Effort will be concentrated on reducing the risk of spread and re-invasion of *D. vexillum*. The option of delivering small scale rapid response in high priority areas (e.g. sensitive SAC areas) will remain, where feasible.

2. Reducing the risk of spread and re-introduction of *Didemnum vexillum*

Countryside Council for Wales Countryside Council for Wales, Maes-y-Ffynnon, Penrhosgarnedd, Bangor, Gwynedd, LL57 2DW

Gabe Wyn

g.wyn@ccw.gov.uk

A critical theme running through all of the management approaches is the need for substantially improved pathway management to reduce the risk of further spread and re-introduction. This will be of vital importance in preventing re-invasion in Wales, if eradication is successful, and to help contain the established populations in Scotland and England.

Recognising this, the GB Working Group has developed a report of recommendations to improve pathway management. While this has been specifically targeted towards *D. vexillum* to ensure it fits within the remit of the group, it has broader relevance across a wide range of marine taxa.

The report reviews a range of critical pathways relevant to the group's expertise and provides specific recommendations where relevant. The general recommendations of the report are:

- Review existing guidance on biosecurity and pathway management for this species (e.g. from Australia and New Zealand) and use to develop GB guidance for a wide range of relevant stakeholders.
- Improve awareness levels, which are generally low, and embed non-native species specific bioescurity principles among key stakeholders.
- Improve communication networks with relevant stakeholders.
- Develop all relevant guidance (e.g. biosecurity guidance, awareness and communications) in close partnership with stakeholders.
- Further research key factors effecting *D.vexillum* spread via relevant pathways to develop on the recommendations of the report and enable more effective prioritisation and management of this INNS.
- Maintain the option of targeted eradication in areas which will significantly reduce the spread of *D.vexillum*.

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)

A report on the Economic Cost of Invasive Non-Native Species on Great Britain has recently been issued and is available on the GB Non Native Species Secretariat's web-site: https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=59

Or

FE Williams, R Eschen, A Harris, DH Djeddour, CF Pratt, RS Shaw, S Varia, JD Lamontagne-Godwin, SE Thomas, ST Murphy. 2010. The Economic Cost of Invasive Non-Native Species on Great Britain. CABI: CAB/001/09.

F Other Relevant Information

A joint meeting of the Linnean Society of London and the Marine Aliens II consortium was held on the 10th February, 2011. The meeting was entitled "Controlling Marine Invasive Species by Targeting Vectors of Dispersal" and included Jim Carlton as a guest speaker. Further details can be found at www.linnean.org and www.marlin.ac.uk/marine_aliens.

There is ongoing work to fulfil the requirements for descriptor 2 of the Marine Strategy Framework Directive i.e. "Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem". There will be a series of workshops held to discuss how to determine Good Environmental Status for this descriptor.

The World Conference on Marine Biodiversity will take place in Aberdeen from 26-30th September, 2011. See http://www.marine-biodiversity.org/ for more information.

G References

5.12 United States of America

Author(s) and contact details: Judith Pederson1, Allegra Cangeosi2, Fred Dobbs3, Lisa Drake4, Mario Tamburri5, Richard Everett6

1MIT Sea Grant College Program, 292 Main Street E-38, Cambridge, MA 02139,
2Northeast/Midwest Institute, 50 F St. NW. Suite 950, Washington, DC 20001,
3Old Dominion University, Dept. of Ocean, Earth and Atmospheric Sciences, 4600 Elkhorn Ave., Norfolk, VA 23529,
4Naval Research Laboratory, , P.O. Box 1739, Key West, FL 33041,
5Maritime Environmental Resource Center, University of Maryland, and
6 Commandant (CG-5224), Attn (Dr. Richard Everett), U.S. Coast Guard, 2100 2nd St SW Stop 7126, Washington, DC 20593-7126

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 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.

Biology of Ballast Water

Ballast Water Treatment

There are two ongoing studies in the U.S. relating to ballast water (See Annex 1 and 2). One study currently underway is by the National Research Council, sponsored by the U.S. Environmental Protection Agency's (U.S. EPA) and the U. S. Coast Guard (USCG), and focuses on invasion theory and risk of invasion under different discharge standards (Annex 1). The other study is by the USEPA Science Advisory Board, sponsored by the USEPA Office of Water and supported by the USCG, and focuses on the capability of current technology to meet different levels of treatment (Annex 2). Both studies will inform the USCG and U.S. EPA's ballast water regulatory programs, and in the near term the U.S. EPA's upcoming revision of the Vessel General Permit, which must be renewed in 2013, and in the USCG's practicability review of standards, which will begin after the discharge standard regulation is published (currently on track for publication this year).

The United States submitted to the IMO three documents on methods used by the States and ships for sampling ballast water discharges. The methods will allow the U.S. to evaluate compliance with the D-2 standard under the Ballast Water Management Convention. The three documents are

Development of Guidelines and Other Documents for Uniform Implementation of the 2004 BWM Convention, submitted by the United States (full documents available on Share point).

Document 1. Information regarding methods for sampling and analysis of ship's ballast water

- Annex 1 focuses on the validation of counting accuracy of sparse organisms in ballast water, i.e. organisms larger than 10 mm in size. The document covers accuracy and precision of enumeration, distribution analysis, comparative analysis, provides results with microbeads, and discusses implications.
- Annex 2 focuses on sample volumes required for accurate determination of living organisms in water treated with ballast water management systems. They discuss issues related to volume, concentrating organisms, time, and statistical reliability.
- Annex 3 focuses on design and validation of an apparatus to capture organisms $\geq$ 50 μm in minimum dimension found in ship's ballast water

management systems. The experimental system uses filter bags to collect microbeads, effects of flow, velocity, surface areas, etc., conducted field trials with microbeads.

- Annex 4 compares methods used to enumerate living organisms < 50 μm and ≥ 10 μm. Approaches included using flow cytometry, filtered direct count, flow CAM, and Sedgwick-Rafter counting methods chamber,
- Annex 5 reports on a method to determine the number of living organisms ≥ 50 μm in treated ballast water by staining organisms combined with automated mobility assessments.

Document 2. Important considerations regarding methods and procedures for sampling and analysis of treated ballast water to quantify low concentrations of living organisms, submitted by the United States

- This short document discusses the importance of validation of methods describing both false positives and false negatives.

The issues of methods for determining live/dead status, differences in size, locations, time, etc. were also highlighted and are discussed more fully in the first listed document

Document 3. A method to determining the concentration of living protists in representative samples of water treated by ballast water management systems, submitted by the United States

- In the annex the document focuses on organisms less than 50 micrometers and greater than or equal to 10 micrometers. Discussions include need for status of organisms, vital stains, fluorescence, procedures for application and results.

Ballast Water Sampling

See above annexes for overview of sampling activities

Ballast Water Legislation/Regulations

This section covers both the U.S. Coast Guard rule-making, the U.S. EPA's study of the efficacy of ballast water treatment, and state regulations and/or studies.

Document 1. Ballast Water Discharge Standard Update from the U.S. Coast Guard

The U.S. Coast Guard has revised their expected publication date of the Ballast Water Discharge Standard rulemaking. It is now expected to publish in April 2011, rather than December 2010.

For more information, please review the project summary at the following webpage: http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201010&RIN=1625-AA32

Documents and public comments are located in the official rulemaking docket USCG-2001-10486. The following documents are available here for download as PDF files:

1. Notice of Proposed Rulemaking, 74 FR 44632 (28 Aug 2009)
2. White Paper - Ballast Water Discharge Standard
3. Phase 1 and Phase 2 Standards Implementation Schedule

The Ballast Water Discharge Standard Notice of Proposed Rulemaking (NPRM) was published in the Federal Register on August 28, 2009 for public review and com-

ment. The comment period for this proposed rule was extended from November 27 to December 4, 2009." http://www.uscg.mil/hq/cg5/cg522/cg5224/bwm.asp

Document 2. Management report compiled by the Great Lakes Ballast Water Working Group (BWWG).

The Great Lakes Ballast Water Working Group (BWWG) is comprised of representatives of the U. S. Coast Guard, Transport Canada – Marine Safety, the Saint Lawrence Seaway Development Corporation, and the Saint Lawrence Seaway Management Corporation.

Preventing the introduction of aquatic invasive species into the Great Lakes through stricter ballast water standards and a comprehensive enforcement policy is a top priority for the U. S. Coast Guard. In 2010, 100% of vessels bound for the Great Lakes Seaway from outside the Exclusive Economic Zone received ballast tank exams, through physical sampling or administrative review, on each seaway transit. In total, 7,754 ballast tanks were assessed during 415 vessel transits. Ships that failed to properly manage their ballast tanks were required to either retain the ballast water and residuals on board, treat the ballast water in an environmentally sound and approved manner, or return to sea to conduct a ballast water exchange. The BWWG anticipates continued high ship compliance rates for the 2011 navigation season.

A workshop was held by the EPA Mid-Continent Ecology Division to address these issues and inform legislation changes.

The goals of this two-day meeting were for participants to:

1. Gain a better understanding of the testing process/technology-verification procedures by touring the only freshwater testing facility in the world - the Great Ships Initiative (GSI);
2. Continue detailed discussions about Ballast Water Treatment System (BWTS) technology, verification strategies and policies; and

The group met to contribute formally to support the specific information needs of the pending internal WDNR Ballast Water Treatment Technology Report.

The full report is available on Share point.

Document 3. Environmental Verification Report of the U.S. Environmental Protection Agency, U.S. Coast Guard, and U.S. Naval Research Laboratory entitled Generic Protocol for the Verification of Ballast Water Treatment Technology

There was no summary of the report, below are the objectives and table of contents. The full report is available on share point.

Table of Contents

There are now three fully-operational independent ballast water management system Test Facilities in the US: the Maritime Environmental Resource Center (University of Maryland, Chesapeake Bay), Great Ships Initiative (Northeast Midwest Institute, Lake Superior) and Golden Bear (California Maritime Academy, San Francisco Bay).

Short update on state activities

Several states, especially in the Great Lakes region have updated their legislation on ballast water and/or are awaiting the U.S. EPA's new regulations.

Other Information:

1 Hull Fouling
1.1 Biology of Hull Fouling
1.2 Hull Fouling Treatment
1.3 Hull Fouling Sampling
1.4 Hull Fouling Legislation/Regulations

2 Sediments
2.1 Biology of Sediments
2.2 Sediment Treatment
2.3 Sediment Sampling
2.4 Sediment Legislation/Regulations

3 Sea Chests

Nothing to report for this section; although see pending legislation for California on hull fouling.

3.1 Biology of Sea Chests
3.2 Sea Chest Treatment
3.3 Sea Chest Sampling
3.4 Sea Chest Legislation/Regulations

4 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.

4.1 Biology
4.2 Treatment
4.3 Sampling
4.4 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. New invaders reported by WGBOSV should be also shared with WGITMO.

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 information is limited for marine organisms and ecological impacts are summarized in the WGITMO National Reports, 5 and 10 year summary reports, and Cooperative Research Reports have this information.

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

F Other Relevant Information

References:

Lemieux EJ, Drake LA, Robbins SH, Steinberg MK, Riley SC, Schrack EC, Hyland WB, Grant JF, Moser CS, Wier TP (2010) Design and preliminary use of a commercial filter skid to capture organisms ≥ 50 μm in minimum dimension (nominally zooplankton) for evaluating ships' ballast water management systems at land-based test facilities. Letter report 6130/1029 published by the Naval Research Laboratory, Washington, DC

Miller, AW, Frazier M, Smith GE, Perry ES, Ruiz GM, and Tamburri MN, 2011. Enumerating Sparse Organisms in Ships' Ballast Water: Why Counting to 10 is Difficult? Environ. Sci. Tech., in press.

ABSTRACT: To reduce ballast water-borne aquatic invasions worldwide, the International Maritime Organization and United States Coast Guard have each proposed discharge standards specifying maximum concentrations of living biota that may be released in ships' ballast water (BW), but these regulations still lack guidance for standardized type approval and compliance testing of treatment systems. Verifying whether BW meets a discharge standard poses significant challenges. Properly treated BW will contain extremely sparse numbers of live organisms, and robust estimates of rare events require extensive sampling efforts. A balance of analytical rigor and practicality is essential to determine the volume of BW that can be reasonably sampled and processed, yet yield accurate live counts. We applied statistical modeling to a range of sample volumes, plankton concentrations, and regulatory scenarios (i.e., levels of type I and type II errors), and calculated the statistical power of each combination to detect noncompliant discharge concentrations. The model expressly addresses the roles of sampling error, BW volume, and burden of proof on the detection of noncompliant discharges in order to establish a rigorous lower limit of sampling volume. The potential effects of recovery errors (i.e., incomplete recovery and detection of live biota) in relation to sample volume are also discussed.

Steinberg MK, First MR, Lemieux EJ, Drake LA, Nelson BN, Kulis D, Anderson D, Welschmeyer N, Herring P. Comparison of techniques used to count single-celled viable phytoplankton. Submitted to Journal of Applied Phycology

Steinberg MK, Lemieux EJ. and Drake LA. Determining the viability of marine protists using a combination of vital, fluorescent stains. Marine Biology-hard copy pending, currently online.

Annex 1. National Academy's Charge to the Committee on Assessing Numeric Limits for Living Organisms in Ballast Water.

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council

Water Science and Technology Board
Division on Earth and Life Sciences
May 2010

Committee on Assessing Numeric Limits for Living Organisms in Ballast Water

EPA and the U.S. Coast Guard have requested the NRC to conduct a study that will significantly inform their efforts to derive environmentally protective numeric ballast water discharge limits in the next Vessel General Permit. The study will take into account estuarine and freshwater systems, including the Great Lakes and other inland navigable waters, as well as the waters of the three-mile territorial sea, considering what implications their differing environmental and ecological conditions might have for the development of allowable concentrations of living organisms in discharged ballast water. Specifics tasks are outlined below.

1. Evaluate the state of the science of various approaches that assess the risk of establishment of aquatic nonindigenous species (NIS) given certain concentrations of living organisms in ballast water discharges.
   - What are the advantages and disadvantages of the available approaches?
   - Identify and discuss the merits and practical utility of other additional approaches of which the NRC is aware.
   - How can the various approaches be combined or synthesized to form a model or otherwise more powerful approach?
   - What are the data gaps or other shortcomings of the various approaches and how can they be addressed within the near and long term?
   - Can a "natural invasion rate" (invasion rates based on historic invasion rates), or other "natural" baselines, be reliably established, and if so, how? What utility might such baselines have in informing EPA's derivation of allowable numeric limits for living organisms in ballast water discharges? Can such baselines be established on a national basis, or would this need to be done on a regional or ecosystem basis?

2. Recommend how these approaches can be used by regulatory agencies to best inform risk management decisions on the allowable concentrations of living organisms in discharged ballast water in order to safeguard against the establishment of new aquatic NIS and to protect and preserve existing indigenous populations of fish, shellfish, and wildlife and other beneficial uses of the nation's waters.

3. Evaluate the risk of successful establishment of new aquatic NIS associated with a variety of ballast water discharge limits that have been used or suggested by the international community and/or domestic regulatory agencies.

The study is sponsored by the U.S. Environmental Protection Agency and the U. S. Coast Guard. The study director is Laura Ehlers (lehlers@nas.edu), WSTB senior staff officer. An expert committee of 9 members will meet three times over a 14-month period and produce a report in mid-2011; the members of this multidisciplinary committee are:

James T. Carlton, *Chair*, Williams College, Mystic, Connecticut
Gregory M. Ruiz, *Vice-chair*, Smithsonian Environmental Research Center, Edgewater, Maryland
James (Jeb) E. Byers, University of Georgia, Athens
Allegra Cangelosi, Northeast-Midwest Institute, Washington, DC
Fred C. Dobbs, Old Dominion University, Norfolk, Virginia
Edwin D. Grosholz, University of California, Davis
Brian Leung, McGill University, Montreal, Quebec
Hugh J. MacIsaac, University of Windsor, Windsor, Ontario
Marjorie J. Wonham, Quest University, Squamish, British Columbia

Annex 2. Charge to the U.S. Enviornmental Protection Agency's Science Advisory Board Review of the Availability and Efficacy of Ballast Water Treatment Technology for EPA's Office of Water and the United State's Coast Guard

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

July 1, 2010

OFFICE OF WATER

MEMORANDUM

SUBJECT: Science Advisory Board Review of the Availability and Efficacy of Ballast Water Treatment Technology for EPA's Office of Water and the United States Coast Guard

FROM: Linda Boornazian, Director
Water Permits Division
Office of Water

TO: Vanessa Vu, Director
Science Advisory Board Staff Office

This memorandum provides an introduction, background information, and specific charge questions to the Science Advisory Board (SAB) for their review of the status of ballast water treatment technology. To assist the SAB in their efforts, a member of my staff, in collaboration with other EPA and Coast Guard colleagues, has prepared a white paper titled "Availability and Efficacy of Ballast Water Treatment Technology: Background and Issue Paper" (hereinafter the "White Paper"). This paper provides additional background information and introduces the numerous documents we have provided to the SAB to assist in your analyses.

Background

Ballast water is typically drawn in from surrounding ambient water and used to assist with vessel draft, buoyancy, and stability. Almost all large vessels have ballast tanks dedicated to this purpose; some vessels may also ballast empty cargo holds. The ballast water discharge rate and constituent concentrations of ballast water from vessels will vary by vessel type, ballast tank capacity, and type of deballasting equipment. Under current U.S. regulation and permitting requirements (discussed in greater detail in the White Paper), there are existing best management practices to reduce the potential impacts of ballast water discharges. These include ballast water exchange and salt water flushing (collectively referred to as BWE).

While useful in reducing the presence of potentially invasive organisms in ballast water, BWE can have variable effectiveness and may not always be feasible due to vessel safety concerns. In order to make progress beyond use of BWE, establishing a standard for the concentration of living organisms in ballast water that can be discharged is necessary. The

United States Environmental Protection Agency (EPA) and the United States Coast Guard (USCG) both desire a stronger federal ballast water management program.

To help develop the next Clean Water Act Vessel General Permit (VGP), EPA needs an objective evaluation of the status and efficacy of ballast water treatment technologies and systems that are in existence or in the development process. A second major scientific question for regulatory agencies is to better understand and relate the concentration of living organisms in ballast water discharges to the probability of introduced organisms successfully establishing populations in U.S. waters. Given the complexity of the issues, EPA's Office of Water is seeking advice from the Science Advisory Board (SAB) on the first issue and the National Academy of Sciences' National Research Council (NRC) on the second issue. In Particular, EPA is seeking advice from the SAB regarding the availability and efficacy of ballast water treatment systems in neutralizing (killing) living organisms that might be discharged from ballast water tanks. For the other NRC study, EPA has requested that the NRC broadly assess and make recommendations about various approaches for assessing the risk of establishment of new aquatic non-indigenous species from ballast water discharges (see attachment 2 of the White Paper for the NRC charge).

Specific Charge in Evaluating the Efficacy of Ballast Water Treatment Technology

OW is seeking SAB advice in the following four general categories:

1. **Performance of shipboard systems with available effluent testing data**[1]

   1a. For the shipboard systems with available test data, which have been evaluated with sufficient rigor to permit a credible assessment of performance capabilities in terms of effluent concentrations achieved (living organisms/unit of ballast water discharged or other metric)?

   1b. For those systems identified in (1a), what are the discharge standards that the available data credibly demonstrate can be reliably achieved (e.g., any or all of the standards shown in Table 1 of the White Paper? Furthermore, do data indicate that certain systems (as tested) will not be able to reliably reach any or all of the discharge standards shown in that table?

   1c. For those systems identified in (1a), if any of the system tests detected "no living organisms" in any or all of their replicates, is it reasonable to assume the systems are able to reliably meet or closely approach a "no living organism" standard or other standards identified in Table 1 of the White Paper, based on their engineering design and treatment processes?

[1] EPA and the US Coast Guard have provided data they currently have to the panel on the attached CD. Where feasible, the panel is encouraged to find additional data if they have appropriate avenues to obtain those data.

2. Potential performance of shipboard systems without reliable testing data

2. Based on engineering design and treatment processes used, and shipboard conditions/constraints, what types of ballast water treatment systems (which may include any or all of the systems listed in Table 4 of the White Paper) can reasonably be expected to reliably achieve any of the standards shown in Table 1 of the White Paper, and if so, by what dates? Based on engineering design and treatment processes used, are there systems which conceptually would have difficulty meeting any or all of the discharge standards in Table 1 of the White Paper?

3. System Development

3a. For those systems identified in questions 1a and 2, are there reasonable changes or additions to their treatment processes which can be made to the systems to improve performance?

3b. What are the principal technological constraints or other impediments to the development of ballast water treatment technologies for use onboard vessels to reliably meet any or all of the discharge standards presented in Table 1 of the White Paper and what recommendations does the SAB have for addressing these impediments/constraints? Are these impediments more significant for certain size classes or types of organisms (e.g., zooplankton versus viruses)? Can currently available treatment processes reliably achieve sterilization (no living organisms or viable viruses) of ballast water onboard vessels or, at a minimum, achieve zero or near zero discharge for certain organism size classes or types?

4. Development of Reliable Information

4. What are the principal limitations of the available studies and reports on the status of ballast water treatment technologies and system performance and how can these limitations be overcome or corrected in future assessments of the availability of technology for treating ballast water onboard vessels?

Background Reading Materials

A more in depth introduction to these issues can be found in the attached White Paper, for which we have included both a hard copy and an electronic copy on the attached CD. In addition to the white paper and a copy of this memo, the CD contains three sets of documents. The first set of documents on that CD are summary reports produced by parties evaluating the availability of existing ballast water treatment systems or reports evaluating their potential efficacy. The second set of documents contains additional available test data and engineering information for specific ballast water treatment systems. The third set of documents primarily consist of International Maritime Organization papers and submissions, and were provided to serve as a reference library for the committee should the committee therein useful. Most of those documents have been prepared as reports for IMO as part of the "G9" review process (discussed in greater detail in White Paper). There is also an index file on the CD, which lists all of the document names and contains hyperlinks to the location of each file on the CD. Additionally, we have created an on-line docket which will contain all of the documents found on this CD: it is docket number EPA-HQ-OW-2010-0582 and can be accessed at www.regulations.gov.

Thank you for considering these important issues in your review. Your work will prove valuable as we move forward with federal ballast water regulation.

Attachments:

1. June, 2010 White Paper: Albert, R., Everett, R., Lishman, J., and Smith, D. (2010) Availability and Efficacy of Ballast Water Treatment Technology: Background and Issue Paper. Paper prepared to assist the Science Advisory Board Review of the availability and efficacy of Ballast Water Treatment Technology.
2. Compact Disc containing all documents referenced in Appendix IV of the above White Paper.

Annex 6 Document submitted to the 61st session of the Marine Environment Protection Committee at the International Maritime Organization

INTERNATIONAL MARITIME ORGANIZATION

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MARINE ENVIRONMENT PROTECTION COMMITTEE
61st session
Agenda item 2

MEPC 61/2/13
10 May 2010
Original: ENGLISH

HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Proposal for cooperation on matters relating to the transfer of invasive aquatic species by ships

Submitted by the International Council for the Exploration of the Sea (ICES)

SUMMARY

Executive summary:	This document contains a proposal to enhance and formalize the ongoing collaboration between ICES and IMO on matters relating to the transfer of invasive aquatic species by ships
Strategic direction:	1.2
High-level action:	1.2.1
Planned output:	1.2.1.2
Action to be taken:	Paragraph 8
Related documents:	MEPC 48/2/9, MEPC 49/2/21 and MEPC 53/2/10

Introduction

1 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 invasive aquatic species via ballast water and other ship vectors. Such issues are specifically addressed through the Working Group on Ballast and Other Ship Vectors (WGBOSV), which currently has ICES and the Intergovernmental Oceanographic Commission (IOC) of UNESCO as the umbrella organizations. IMO has contributed to the WGBOSV, on an informal basis, since 1996 and a number of links have been successfully established with several members of the WGBOSV also attending and contributing to the discussions within IMO.

2 The WGBOSV has submitted several documents to the IMO through ICES, often in response to requests for information in relation to specific issues.

3 At the meeting of the Study Group on Ballast Water and Other Ship Vectors (SGBOSV) – 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 for scientific input regarding the approval testing of ballast water treatment techniques. The SGBOSV 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 and submitted document 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.

4 At the meeting of the Study Group in Vancouver, Canada on 24 and 25 March 2003, the SGBOSV focused on specific information regarding the abundance of phytoplankton and zooplankton in ballast water at the end of voyages and formulated the advice regarding the level of reduction required to reduce the risk of introducing non-native species. This work continued intersessionally and resulted in the submission of document MEPC 49/2/21 to facilitate the discussions on the development of a discharge standard. This document was instrumental in the decisions behind the development of D-2 standard within the Ballast Water Management Convention.

5 During the WGBOSV meeting in Arendal, Norway from 14 to 18 March 2005, the group discussed the issue of the draft Guidelines for risk assessment (G7). The group submitted document 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 by the MEPC during the discussion of the draft Guidelines (G7) and provided valuable input to the development of these Guidelines.

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

7 It is believed that a formal agreement (e.g., Memorandum of Understanding) between ICES, IOC and IMO would enhance the existing collaboration and would assist the WGBOSV in identifying specific scientific aspects of particular importance to IMO and in providing the much needed link between policy and scientific knowledge. With ICES, IOC and IMO as umbrella organizations, the WGBOSV would be in a position to deliver cross-sectoral scientific inputs and reviews on global aspects relating to invasive species tranferred via ships' ballast water and hull fouling and effectively contribute to the work of the IMO.

Action requested of the Committee

8 The Committee is invited to consider the above proposal and decide as it deems appropriate.

Annex 7 Document submitted to the 15th session of the Bulk Liquids and Gases subcommittee at the International Maritime Organization

INTERNATIONAL MARITIME ORGANIZATION

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SUB-COMMITTEE ON BULK LIQUIDS AND GASES
15th session
Agenda item 5

BLG 15/5/8
10 December 2010
Original: ENGLISH

DEVELOPMENT OF GUIDELINES AND OTHER DOCUMENTS FOR UNIFORM IMPLEMENTATION OF THE 2004 BWM CONVENTION

Overview of statistical methods that could be used to verify compliance with the D-2 standard

Submitted by the International Council for the Exploration of the Sea (ICES)

SUMMARY

Executive summary:	This document provides information on statistical methods and background information that could be used to verify compliance with the D-2 standard. The need for further data to verify the suggested approaches is highlighted.
Strategic direction:	7.1
High-level action:	7.1.2
Planned output:	7.1.2.3
Action to be taken:	Paragraph 23
Related documents:	BLG 14/INF.6 and BLG 14/5/2

Introduction

1 The International Council for the Exploration of the Sea (ICES) ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV) met from 8 to 10 February 2010 to discuss ongoing issues related to vectors of introduction of non native species. One term of reference was to "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".

2 The WGBOSV reviewed several sampling approaches (including Pazouki *et al.*, 2009[1] and Miller *et al.*, submitted[2]) and discussed the statistical theory behind obtaining samples representative of the whole discharge or portion of the discharge for each of the methods and the effect of sample size on the ability to detect non-compliance. The group continued

1 Pazouki, K., Cabezas-Basurko, O., Mesbahi, E. and Kemp, J., 2009. Part B: Ballast Water Sampling: Methods, Analysis, Representativeness and Legal Issues. Newcastle University. Project No. RP577.

2 Miller, W., Frazier, M., Smith, G., Perry, E., Ruiz, G. and Tamburri, M. (submitted). Enumerating Sparse Organisms in Ships' Ballast Water: Why Counting to 10 is not so Easy. Environmental Science and Technology.

this work intersessionally after the meeting and this document provides an overview of the results of this work (see ICES, 2010[3] for all references).

3 The WGBOSV provides scientific opinion about three approaches to sampling ballast water for assessing compliance with the larger size category within regulation D-2 (less than 10 viable organisms per m^3 ≥ 50 µm in minimum dimension). These are flow integrated samples from the ballast discharge collected in three ways as follows:

.1 one continuous sample collected over the entire discharge time;

.2 multiple sequential (but non continuous) samples collected over the entire discharge time; and

.3 a single sample collected over a portion of the discharge time.

The continuous sample is collected throughout the entire discharge of a ballast tank or ship. Multiple sequential or single samples are where samples of known time duration are taken (e.g., 5, 10, 15 minutes). The timing of these samples should be determined by a recognized sampling protocol such as simple random sampling. Importantly, all sampling methods require that the instantaneous flow into the sample should be a constant proportion of the instantaneous flow in the ships' discharge line using an in-line sampling port following Guidelines (G2).

Basic assumptions

4 Based upon Miller *et al.*, the basic assumptions made when undertaking this work were that:

.1 all live and only live organisms within the sample were detected and counted;

.2 the entire sample is processed;

.3 an unbiased sampling method was used;

.4 the total discharge volume is large compared to the sample volume;

.5 interest lies in testing whether the mean density of organisms in the total discharge exceeds some threshold;

.6 only sampling error is considered; no observer error, for example;

.7 only the larger size category (≥ 50 µm) within regulation D-2 was considered; and

.8 sampling one organism does not affect the chance that another is sampled, e.g., organisms do not form chains or hook together.

It is acknowledged that these assumptions may need to be re-assessed once more data become available.

[3] ICES. 2010. Harmful Aquatic Organisms in Ballast Water – Overview of statistical methods that could be used to verify compliance with the D-2 standard. ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV). ICES CM 2010/ACOM:65.

5 From the final assumption, it follows that the discharge process can be treated as a non-homogeneous (or time varying) Poisson process.

Representativeness

6 The term representative has a variety of interpretations including unbiasedness and good coverage. Some of the confusion about the performance of different testing procedures is due to ambiguity in the definition of representativeness. As long as the sample comes from a ballast pipe with a sample port that collects a sample representative of the water flowing through the pipe, a representative sample can be collected.

Sample size

7 Sample size requirements depend on the confidence level and power required for the purpose, i.e. to prove that a vessel is in breach of the D-2 standard. This requires a high confidence, e.g., 95%, 99% or 99.9%, so that with high probability the vessel is in breach of the standard. If it is additionally required that ballast discharges with densities near to the standard are detected, i.e. densities of 50, 20 or even 12 organisms per m^3, then a high power is required to distinguish relatively low densities from the D-2 standard. These two issues are related. For a fixed sample size based on a random sample (see below), increasing the confidence level will mean higher sample counts will be required. To ensure that lower densities are detected when a continuous sample or multiple sequential samples are collected, the sample size, i.e. the volume sampled, must be increased if the confidence limits and volume analysed remain constant. The level of confidence and what density should be detectable are important considerations. Figure 1 in the annex illustrates the relationship between the level of confidence, power, organism density and volume sampled.

One continuous sample collected over the entire discharge time

8 In this case, one sample is taken continuously throughout the entire discharge process of a ballast tank and would be collected and processed as the discharge was taking place. Owing to the assumption outlined in paragraph 5, sampling through time gives sample counts that are a sample from a Poisson distribution with mean equal to the mean of the entire discharge.

9 This method is described and discussed in Miller *et al.* (submitted), which attempts to balance the analytical rigour and logistical reality in identifying what volumes of water can be reasonably sampled to yield accurate live counts of organisms ≥ 50 µm. They apply statistical modelling to a range of sample volumes and plankton concentrations and to calculate the statistical power of each combination to differentiate various zooplankton concentrations from the discharge standard of < 10 zooplankton per m^3. Assuming that sampling and analytical errors or biases are negligible, the results demonstrate that continuous, time integrated sampling provides statistical confidence with manageable sample volumes. For example, taking a 7 m^3 continuous sample from the discharge and enumerating all viable organisms the concentrated sample would allow densities of 14 organisms per m^3 to be distinguished from 10 organisms per m^3 with a power of 80%. Further details are contained within the Miller *et al.* paper.

Multiple sequential samples collected over the entire discharge time

10 In this case, samples are taken at different points throughout the discharge process, but are not collected continuously, resulting in a number of observed counts and associated sample volumes. By sampling the discharge through time, sample counts have a lower variability than isolated grab samples, but more variability than the one continuous sample discussed above (since the entire discharge is not covered).

11 For the same reason a continuous sample is Poisson distributed, each individual multiple sequential sample will have a Poisson distribution with different mean. If these means follow a gamma distribution, then the counts from multiple sequential samples will have a negative binomial distribution. This allows the calculation of appropriate limits for multiple sequential sampling. The variability of the means or the between sample variability will depend on the proportion of the ballast discharge sampled in each multiple sample: the greater the proportion, the more similar the sample means will be.

12 Three sampling approaches for collecting multiple sequential samples are as follows:

.1 simple random sampling;

.2 stratified random sampling; and

.3 systematic sampling.

13 For samples that cover a small proportion of the total discharge, stratified random sampling will increase sample coverage, e.g., by sampling randomly from the beginning, middle and end of the discharge. Systematic sampling, where (from a random starting position) samples are taken every hour, might be a suitable practical approach.

14 The between sample variability may not be estimated well based on three 15-minute samples, for example. A solution is to use a data set collected using the same sampling protocol to estimate a value for the between sample variability, which could be an upper bound on the expected variability. The between sample variability depends on the proportion of the ballast that is being sampled, and the length of time over which sampling takes place, and these aspects would have to be standardized as much as possible to obtain consistent and comparable estimates of the between sample variability.

15 Overall, this approach may be appropriate when the variability of the organisms in treated ballast water can be estimated based on suitable data (see paragraph 21) from ship-based tests, possibly augmented with land-based tests. Once a suitable estimate of variability is available then this approach may allow the confidence levels associated with the chosen volume of sample to be calculated and to determine the mean number of organisms that would indicate that D-2 standard has been exceeded. Initial calculations based on untreated water were carried out but without access to a large dataset with the numbers of organisms found in treated water the WGBOSV was unable to take this any further.

Single sample collected over a portion of the discharge time

16 This approach would be used to determine whether a given portion of water is not in compliance with the D-2 discharge standard. As with the other approaches, the sample collected would be representative of the water flowing through the discharge pipe. The data would be analysed as in the one continuous sample (i.e. following a Poisson distribution).

Discussion

17 Initial attempts to verify the applicability of these methods has been hampered by the lack of available, peer-reviewed data on which to base the calculations of variability. In order to verify these methods data on the number of organisms present in treated water is required. Although these data will produce a lot of zeros (if the BWMS is working) they can be used for verification of the proposed methods. Availability of data was particularly a problem for the multiple sequential samples and an accurate estimation of between sample variability was not possible.

Concluding remarks

18 The scientific opinion of the WGBOSV is that one continuous sample yields results for measuring the density of organisms that are representative of the entire ballast water tank and are able to determine non-compliance at a lower threshold than multiple samples. However, this may not always be practical.

19 Multiple sequential samples can be applied to determine non-compliance if the sample variability is known. Uncertainty about the sample variability may be compensated for by adding a safety factor to the variability.

20 Collecting a single sample over a portion of the discharge time would allow a port State to determine if part of the discharge water was in non compliance.

21 The level of assumed variability between samples is crucial with multiple sequential samples. In the long term this could be estimated from a data set that should have been collected following a known sampling protocol, so that routine ballast water samples can contribute to this data set. In the meantime, a higher factor of variability may be assumed to compensate for existing uncertainty. Such a data set should cover the range of conditions thought to affect the variability of organism density in ballast discharge. These include the following:

.1 temperature;

.2 salinity;

.3 geographical source of ballast;

.4 residence time in tanks;

.5 density of organisms in treated water;

.6 sample duration; and

.7 vessel type.

22 The level of assumed variability should be reassessed periodically as more data becomes available.

Action requested of the Sub-Committee

23 The Sub-Committee is invited to consider this document and take action as it deems appropriate.

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ANNEX

RELATIONSHIP BETWEEN LEVEL OF CONFIDENCE, POWER, ORGANISM DENSITY AND VOLUME

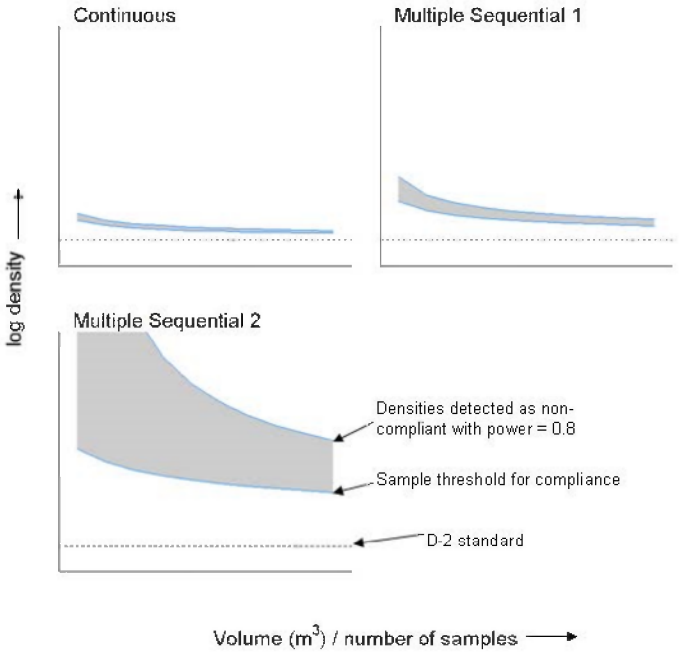

Figure 1: Illustration of the relationship between level of confidence, power, organism density and volume sampled

An illustration of the efficiency of two proposed sampling schemes. The figures for the multiple samples illustrate the effect of differences in sample variability with Sample 1 having a low variability and Sample 2 having a high variability. The D-2 standard is shown as a dotted line, the first line above this gives the sample threshold for compliance, if counts from a sample taken from the discharge are found to be above this line they will be non-compliant with 99% confidence. The next line relates to the density of organisms in ballast tanks, if organisms densities within the tank are above this line then non compliant counts in the samples will be detected with 80% power at 99% confidence, densities below this line are increasingly likely to give counts below the sample threshold.

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