Ministry of Transport, Public Works and Water Management
North Sea Directorate

Ballast Water Management in the North-East Atlantic

Report to aid decision making on Ballast Water in OSPAR BDC

November 19th, 2002

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Executive summary

A diverse range of alien species has so far been introduced to the OSPAR region posing a treat to ecology and economy. The rate of these introductions has increased especially during the last two decades. Ballast water has been termed a major vector for these introductions. The harm these introductions have caused, and may cause in future indicate the urgent need to develop risk reducing measures.

The OSPAR Biodiversity Committee (BDC) has taken upon itself to study the need for working on Ballast Water issues within OSPAR and its implications. In its convention (Annex V), OSPAR has stated that any shipping related aspects can only be taken up after approval, and under guidance of IMO. The developments at IMO, combined with different regional aspects of the North East Atlantic, warrant OSPAR to consider in detail its possible role on ballast water in accordance with international law.

The current report outlines different roles and activities OSPAR can undertake to facilitate regional implementation of (IMO) ballast water regulations (existing and future) to prevent the occurrence of problems associated with ballast water. Tasks could include setting up a ballast water information clearinghouse, running public awareness campaigns, joining legal forces, coordinating bio-invasions research and generally avoid duplication of efforts. OSPAR may consider setting up a coordination unit to facilitate regional cooperation on these points. Promoting awareness of the issue with the public and with industry can greatly enhance success of implemented measures.

In shallow coastal areas or a semi-enclosed sea (such as the North Sea), the efficiency of Ballast Water Exchange (BWE) is limited. For this reason OSPAR, could consider specific measures for ships performing BWE on routes to the convention area. Setting up regional risk assessments tools may also aid in the further work of parties on the refinement of international measures.

In light of the problems associated with BWE, such as alternative treatments in regional seas alternative ballast water management and/or treatment techniques that can effectively be applied in shallower waters need to be developed and their use encouraged. Stimulating innovation by increasing industrial awareness of the possible market can be an important tool. Currently there is no single treatment option that meets significant standards of reduction, inactivation or kill of organisms. A combination of methods (tool box) may in the near future result in cost-effective management options. It is important for OSPAR to remain critical to the use of treatment technologies based on their effectiveness and possible side effects. As an example, the application of chemicals or biocidal agents for ballast water treatment should be regarded with great concern, and probably not be pursued in light of the development of other alternatives.

In the report it is recommended that OSPAR start on short notice to implement the necessary arrangements in order to give full effect to the coming IMO convention as soon as possible. The IMO Assembly Resolution 868(20) can be used as a guideline for these activities. While doing so, OSPAR parties can cooperate in the finalisation of the draft legal instrument.

Contents

Abbreviations

AQIS	Australian Quarantine and Inspection Service
BWE	Ballast Water Exchange (in open ocean)
BWM	Ballast Water Management
BWMP	Ballast Water Management Plan
BWRB	Ballast Water Record Book
BWRF	Ballast Water Reporting Form
BWT	Ballast Water Treatment
BWWG	Ballast Water Working Group (at IMO)
CBD	Convention on Biological Diversity (UNEP)
DSS	Decision Support System
EEZ	Exclusive Economic Zone
GEF	Global Environment Facility
GloBallast	Global Ballast Water Management Programme
HELCOM	Helsinki Commission
IACS	International Association of Classification Societies
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IOC	International Oceanographic Committee
ISM	International Safety Management
JAMP	Joint Assessment and Monitoring Programme
MEPC	Marine Environment Protection Committee (of IMO)
MOE	Mid-Ocean Exchange (of ballast water)
OSPAR	Oslo Paris Commission
PSSA	Particular Sensitive Sea Area
SGBOSV	(ICES/IOC/IMO) Study Group on Ballast Water and Other Ship Vectors
SOLAS	(Convention on) Safety of Life at Sea
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
USCG	United States Coast Guard
UV	Ultra Violet irradiation
WGITMO	(ICES) Working Group on Introductions and Transfers of Marine Organisms
WHO	World Health Organization

1 Introduction

Movements of non-indigenous species between ecosystems are considered today to be the most important threat to biodiversity after habitat destruction[1].

Aquatic non-indigenous species arrive in new habitats either by natural means (e.g. distribution with water currents) or by human mediated vectors (e.g. shipping, aquaculture). Today, human mediated introductions are an increasing source of species invasions. Possibly the first invasion into the OSPAR region was the soft shell clam *Mya arenaria* likely being introduced with solid ballast during Viking times as a result of their shipping activities to North America.

Certain ship voyages, including short term shipping traffic within e.g. the North Sea, pose a risk to transport species not being able to migrate by natural means. A good example is the connection of two freshwater ports. Species would not be able to migrate from one of these freshwater ports to another as the higher saline water between the ports poses a migration barrier.

The total number of non-indigenous species in the OSPAR area in 1998 was estimated to be 133 of which the majority was unintentionally introduced. This list included organism like fish, algae, molluscs, etc. Successful invaders tend to spread and in total 60 non-indigenous species were found in more than one OSPAR country[2].

1.1 Rationale

The Biodiversity Committee of OSPAR recognized that human mediated introduction of non-indigenous species have an unwanted impact and that measures may need to be considered within OSPAR to minimize the risk of future species invasions[3]. OSPAR therefore accepted the offer of the Netherlands to prepare a document for the OSPAR Biodiversity Committee (BDC) on how OSPAR should take this issue forward, in light of the draft IMO convention[4]. The current report is meant to support discussion in BDC regarding the appropriateness of action within the framework of OSPAR on regional ballast water issues.

1.2 Reading Directions

The report has in its first chapter outlined the problem and the need for action. The next chapter provides detailed background information on the issue of ballast water and the possible role of OSPAR. Chapter 3 covers solutions, such as legal measures, risk reducing measures and ballast water treatment (BWT) options. Chapter 4 provides an analysis of tools that may fall under the remit of OSPAR. The last chapter provides a discussion of the issue and a possible work programme for the consideration of OSPAR BDC.

This document is intended as a basis for discussion, and does not intend to provide (altered) interpretations of international law, or the OSPAR Convention.

[1] OSPAR 01/06,

[2] update of IMPACT 96/6/1 List of Alien Species in the OSPAR Convention Area

[3] OSPAR 01/06

[4] summary record OSPAR BDC 2001

2 Background

2.1 Ballast Water Invasions

Species have been transported with ballast water and associated sediments since water was commonly used as ship's ballast in the 1870s. Ballast water is needed to stabilise and trim the vessel and to submerge the propeller. Organisms are unintentionally pumped on board when taking up water and are transported over natural migration barriers. Natural barriers vary from oceanic masses / currents to salinity barriers (e.g. between fresh water ports). During voyages, most organisms die during the first week in ballast tanks, but some individuals may survive voyages of several months duration[5]. When discharged upon arrival some organisms may colonise areas beyond their native range and may cause unwanted impacts on native species and threaten ecosystem functions, public health and economic activities such as tourism, fishing or aquaculture.

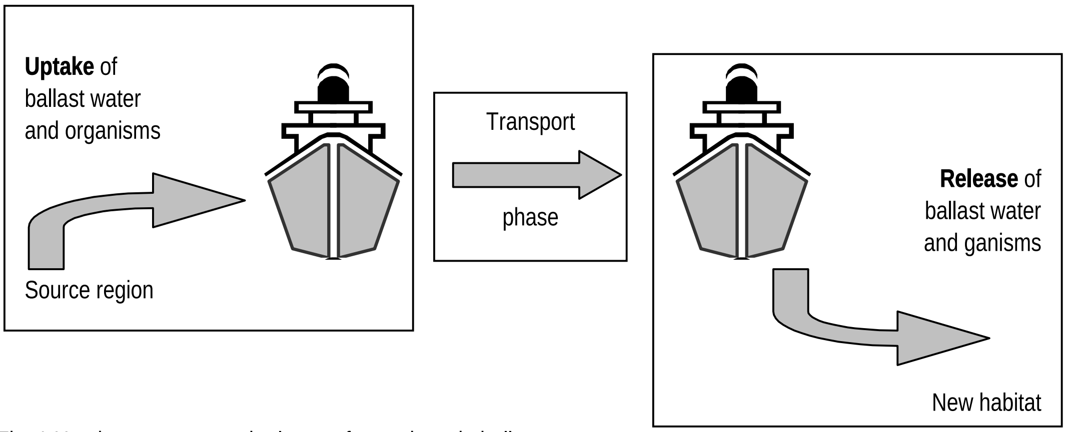


Fig. 1 Uptake, transport and release of organisms in ballast water.

It has been estimated that the commercial world fleet annually carries 3 to 12 billion tonnes of ballast water world-wide, indicating the dimension of the problem. The urgency to take action is indicated by the recognition in different international fora (International Maritime Organization (IMO), 5th North Sea Ministers Conference, Helsinki Commission (HELCOM), International Council for the Exploration of the Sea (ICES), International Oceanographic Committee (IOC), United Nations Environment Programme (UNEP) and the World Health Organization (WHO)).

2.2 Examples

Striking examples of aquatic invaders with significant impact are the Zebra mussel (*Dreissena polymorpha*) in the North American Great Lakes, the Comb jelly *Mnemiopsis leidyi* in the Black Sea and the toxin producing plankton algae *Pfiesteria piscicida* first recorded in European waters in 2002.

The zebra mussel *Dreissena polymorpha*, was introduced in the North American Great Lakes in the middle of the 1980s. The likely introducing vector is ballast water. Densities can be found up to 100.000s individuals per square meter. In addition its behaviour to settle on any hard bottom can cause clogging of fishing gear and urban as well as industrial water intakes. Annually, several 100 Million US$ are spent to mechanically clean submerged hard substrates[6].

[5] Carlton et al. 1995, Gollasch 1996, see Appendix I Invasion Myths

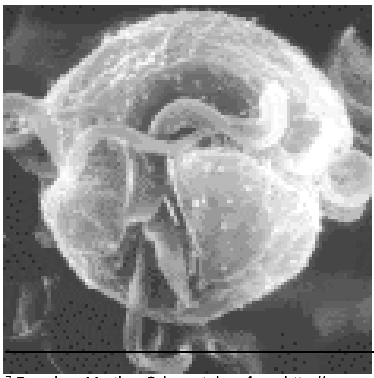
[6] Leppäkoski 1984, 1994, Ruiz pers. comm.

Fig. 2 The Zebra mussel *Dreissena polymorpha* (adult size approx. 2,5 cm)[7].

The comb jellyfish *Mnemiopsis leydii* reduced the fisheries production in Black and Azov Seas due to predation upon larval fish. In the end of the 1980s the loss in harvest was calculated to be more than US$ 240 Million annually. Following its invasion of the Black Sea, the comb jelly reached the Marmara and Mediterranean Seas, but here mass developments are not reported (yet). The species has spread even further in the region and was very recently found in the Caspian Sea[8]. In the same way as in the Black Sea juvenile fish populations in the new habitats may be threatened in the future.

Fig. 3 The comb jellyfish *Mnemiopsis leydii* (adult size approx. 10 cm)[9].

Another new invader in Europe is the **toxin producing plankton alga *Pfiesteria piscicida*** recently found in European waters (Norway), which, most likely, originates from the Atlantic seaboard of North America. This species could possibly be transported and introduced via ballast water or tank sediments. During its complex life cycle the size ranges from 5 to 450 µm, resting stages are 7-60 µm in diameter. *P. piscicida* and other dinoflagellates have been responsible for estuarine fish kills along the U.S. Atlantic coasts and have further caused concern with regard to human health as researchers were negatively impacted during their work with toxic cultures in experimental set ups. Effects include a suite of symptoms as narcosis, skin and eye irritation, headaches, breathing difficulty, kidney and liver dysfunction, short-term memory loss, muscle cramps and gastrointestinal complaints. Most of the acute symptoms are reversible over time[10].



[7] Drawing: Martina Orlova, taken from http://www.zin.ru/projects/invasions/gaas/index.html

[8] Gomoiu et al. 2002, Öztürk 2002

[9] http://www.enature.com/ads/popup/mem_pop_up.asp

[10] http://www.pfiesteria.org/pfiesteria/lifecycle.html, Burkholder et al. 1993

Fig. 4 The phytoplankton alga *Pfiesteria piscicida*[11]

2.3 Awareness

The above clearly outlines the potential problems that invaders may cause in an environment. In order to minimise the risk of future invasions and its negative impacts, concerted action needs to be undertaken with the aim to reduce the number of species being transported and released. Public awareness regarding the ballast water issue has lead to political pressure and consecutive action (e.g. legislation) in some countries. In the OSPAR area the degree of awareness varies greatly and political pressure has so far been limited to a few countries.

2.4 OSPAR in relation to Ballast Water

In principle environmental regulation for the shipping sector is formed within IMO. UNCLOS clearly identifies the IMO is the regulatory agency in shipping issues. Annex V to the OSPAR Convention covers all human activities identified as having (potentially) adverse effects on marine ecosystems and biodiversity in the North East Atlantic, but it contains a special provision with regard to questions related to international shipping. Article 4(2) of Annex V to the OSPAR Convention provides that:

> *Where the Commission considers that action under this Annex is desirable in relation to a question concerning maritime transport, it shall draw that question to the attention of the International Maritime Organization. The Contracting Parties who are members of the International Maritime Organization shall endeavor to cooperate within that Organization in order to achieve an appropriate response, including in relevant cases that Organization's agreement to regional or local action, taking account of any guidelines developed by that Organization on the designation of special areas, the identification of particularly sensitive areas or other matters.*

This provision was included in Annex V to avoid duplication of action that is or can be prescribed under other international agreements or by other international organizations, including in particular the IMO. The issue of international shipping is not *a priori* excluded from the scope of the Annex, but the OSPAR Commission is required to bring the issue first to the attention of the IMO and to rely on action taken by the Contracting Parties that are Members to the IMO within that Organization to achieve an appropriate response. This response can include action by the IMO itself, but it can also involve “that Organization’s agreement to regional … action”. Annex V thus leaves room for regional action in respect of international shipping and ballast water management and control, provided the IMO has previously agreed to it. This agreement can be granted through the normal IMO procedures or through the inclusion of relevant provisions in IMO instruments. A provision allowing for regional co-operation is contained in article 16 (Regional Co-operation) of the current draft of the International Convention for the Control and Management of Ships’ Ballast Water and Sediments. It provides that:

> *In order to further the objectives of this Convention, Parties with common interests to protect the marine environment in a given geographical area shall endeavor, taking into account characteristic regional features, to enhance regional co-operation including the conclusion of regional agreements consistent with this Convention for preventing and minimizing the transfer of harmful aquatic organisms and pathogens through ships’ ballast water. Parties shall seek to co-operate*

[11] http://udel.edu/~ibyellow/project5.html

with the Parties to regional agreements to develop harmonized procedures to be followed by Parties to the different agreements concerned.

This article allows the OSPAR Commission to adopt regional programs and measures for preventing and minimizing the transfer of harmful aquatic organisms and pathogens through ships' ballast water, provided they are consistent with the Ballast Water Convention.

Annex V only provides restrictions on (regulatory) action with regard to international shipping under the Annex itself. It does not preclude action with regard to international shipping under Annex IV to the OSPAR Convention dealing with the joint assessment of the quality status of the marine environment in the region. These assessments are holistic in scope and include data on all human activities, including shipping. Certain aspects of shipping and the problems related to ballast water have already been addressed in the Quality Status Reports for the North-East Atlantic as a whole and for the individual sub-regions that were presented in 2000.

OSPAR and the IMO concluded an Agreement of cooperation in 1999[12].

Most countries agree that a universal global approach in shipping regulation is preferred to maintain a "level playing field" for the sector. With regard to the issue of ballast water it has however been realised that regional implementation, or refinement of international law may be necessary to adequately address unique circumstances in certain regions.

The differentiation in the implementation of international regulations, or unilateral legislation on a geographical level lower than the North East Atlantic region, may create additional problems and would therefore not be beneficial. In order to avoid unwanted effects OSPAR is an appropriate organization to harmonise the development of ballast water related measures in the North East Atlantic region. OSPAR has a tradition in addressing e.g. environmental matters and is therefore a logical organisation to assess its role on addressing the issue of ballast water mediated introductions.

The OSPAR Commission has given recognition to the potential hazards of non-indigenous species[13].This section briefly outlines the response of OSPAR so far, and other regional institutions relevant to ballast water.

2.4.1 OSPAR response so far

At IMPACT 1996, based on a questionnaire, Sweden presented a summary on national activities concerning non-indigenous species in the Convention Area. As a result IMPACT 1996 made a number of proposals concerning non-indigenous species e.g. include reports on non-indigenous species into the Quality Status Reports of the Convention Area. The monitoring of non-indigenous species will also be included in the Commissions Joint Assessment and Monitoring Programme (JAMP). Further, IMPACT asked the International Council for the Exploration of the Sea (ICES) to consider a reporting format for non-indigenous species.

2.4.2 Regional Response so far

Various authorities and working groups connected to the North East Atlantic region have responded to ballast water and related issues. These include the ICES, HELCOM and the International Conference on the Protection of the North Sea.

As early as the 1970s ICES started to consider species invasions as problematic issue. As a result the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was formed. This group deals with planned introductions (e.g. oysters for aquaculture) and unwanted imports of associated disease agents and parasites. The Group developed a Code of Practice recommending appropriate quarantine measures to be taken in donor and recipient country to avoid the unwanted introduction of non-target species (new version to be published in 2003). In

[12] OSPAR Agreement 1999-15 and IMO Doc. A 21/26 of 17 July 1999

[13] IMPACT 96/6/1, OSPAR01/6

the middle of the 1990s ballast water became more and more into focus and the ICES/IOC/IMO Study Group on Ballast Water and Other Ship Vectors (SGBOSV) was formed. SGBOSV meets annually and offers the opportunity to exchange information, develop contacts and to jointly plan research cooperation.

HELCOM administrates the Convention on the Protection of the Marine Environment of the Baltic Sea Area. At its 16th meeting in 1995 HELCOM considered the issue of unwanted organisms in ballast water as a matter of the highest priority. HELCOM adopted a Baltic Strategy related to harmful marine organisms in Ballast water (www.helcom.fi). Furthermore, HELCOM encouraged the Contracting Parties to apply the IMO Assembly Resolution on ballast water (see below).

At the 5th International Conference on the Protection of the North Sea (Bergen, Norway, 20–21 MARCH 2002) the Ministers agreed:

i) to actively support the development of the International Convention for the Control and management of Ships' Ballast Water and Sediments, and work towards its finalization in 2003, and its rapid entry into force[14].;

ii) to take coordinated action within IMO to establish adequate mitigation and control measures for the North Sea under the framework of the coming pre-said IMO Convention, and to support OSPAR work on regional matters regarding ballast water;

iii) to take urgent coordinated steps to reduce the problem of spreading of non-indigenous invasive organisms to and within the North Sea in accordance with international law and in order to fully implement IMO Guidelines (Resolution A.868(20)), in the light of the forthcoming International Convention for the Control and Management of Ships' Ballast Water and Sediments, and decide upon national and/or regional measures by, if possible, the end of 2004 taking into account the progress within IMO. Such measures could, *inter alia,* include monitoring programmes, information exchange, early warning systems, combating actions, control and enforcement; and

iv) to enhance and support actively research on and the development of treatment technologies, decision support systems, and other issues related to preventing the spreading of non-indigenous organisms via ships ballast water and sediments and to cooperate in those activities.

2.4.3 OSPAR Role

Even taking into account the legal limitations, based on the above, OSPAR may be an appropriate organization to coordinate implementation of measures for the management and control of ballast water in the North East Atlantic region. This possible role will be further analysed and discussed in this report. Initiatives within OSPAR should in any case be consistent with international law (including IMO) and take account of the existing knowledge of biology with an emphasis on threats to biodiversity.

[14] at MEPC48 (Fall 2002) it was suggested to work towards the finalization of the Ballast Water Convention as soon as possible. However, the relevant Diplomatic Conference planned for 2003 may need to be delayed to Spring 2004 enabling the working group to substantially improve the instrument at MEPC49 (Summer 2003).

3 Towards Solutions / Solution Toolbox

This chapter gives a list of different tools that can be used to address the ballast water problem. These solutions are grouped in three categories: international legal framework, risk assessment methodology and treatment as well as management options.

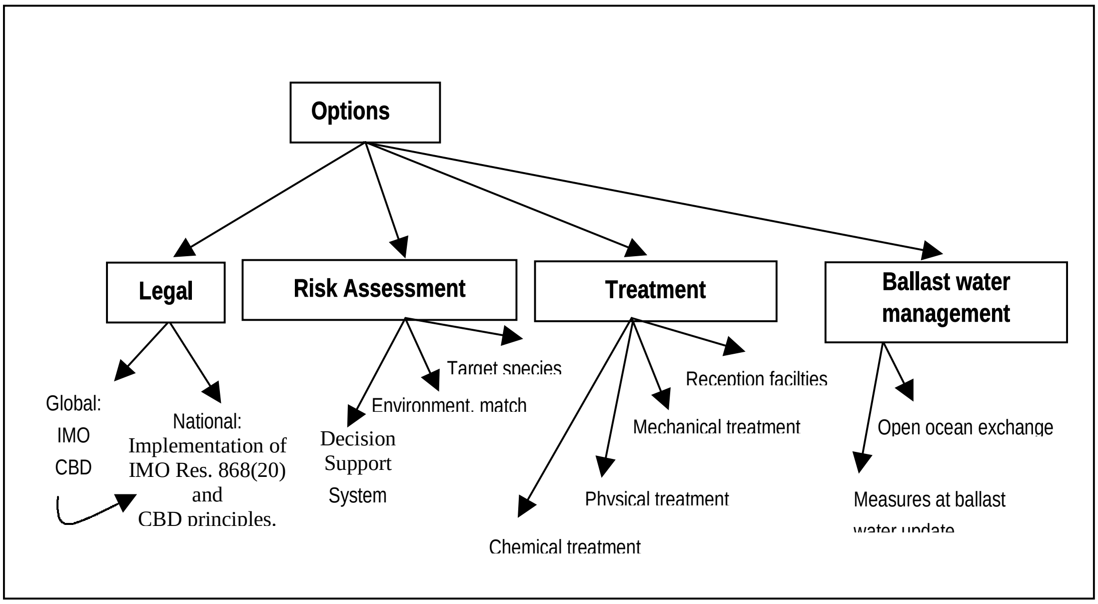


Fig. 5 Ballast water tools according to legal initiatives, risk assessment methodology, treatment options and ballast water management.

3.1 International Legal Framework

Relevant to international law, three categories of requirements can be identified: port-, flag-, and coastal state requirements. Until today most requirements on ships in international (IMO) conventions and other instruments focus either on a port or flag state approach.

The response to the ballast water problem has so far been developed on two different levels: globally and nationally as outlined below.

3.1.1 Global Response

The global approach largely results from work within IMO and statements in the Convention on Biological Diversity (CBD) within the framework of UNEP.

International Maritime Organization
The global response is coordinated within the framework of IMO. Its Marine Environment Protection Committee (MEPC) addresses issues concerning the protection of the oceans.

MEPC had a specific interest in the field of unwanted introduced species by ballast water. Australia was the first country to bring the ballast water problem into focus and has played a key part at IMO in proposing the development of the control mechanisms for the release of ballast water in the early 1990s. MEPC has formed the Ballast Water Working Group (BWWG) to consider research information and solutions proposed by Member States of the IMO and by non-governmental organisations. The BWWG concluded that voluntary guidelines were the appropriate first step in addressing this problem. MEPC adopted guidelines by resolution in 1991, and in 1993 these were adopted by the IMO Assembly under resolution A.774(18) entitled "International Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships Ballast Water and Sediment Discharges". In 1997 A.774(18) was replaced by the Resolution A.868(20) "Guidelines for the Control and Management of Ship's Ballast Water to Minimise the Transfer of Harmful Aquatic Organisms and Pathogens".

In resolution A868/20, IMO has put forward guidelines to limit the movement of organisms by ballast water world-wide, which include:

- informing ships of areas where ballast water uptake may be avoided due to the presence of harmful algal blooms and known unwanted contaminants,
- precautionary procedures when taking on ballast water in shallow areas,
- exchange of ballast water at sea as far as possible from the coast,
- ballasting with freshwater,
- discharging ballast water and sediments to on-shore facilities (if available), as well as
- provisions for ballast water reporting forms.

The guidelines further recommend not to ballast at night (bottom living organisms may migrate towards the water surface more likely being pumped onboard), in shallow areas and during algal blooms.

The disadvantage of the IMO Assembly Resolution A.868(20) is that its implementation is seen as voluntary by most parties. Therefore not many countries have implemented its provisions.

The BWWG at IMO is currently developing an IMO Ballast Water Convention as a stand-alone instrument. The BWWG is scheduled to present the final draft of the Convention to MEPC in 2003 and a diplomatic conference for its adoption is planned for 2003 or early in 2004 as suggested during MEPC48 (Fall 2002). The convention includes many of the elements that are also present in IMO resolution A.868/20. In addition this Convention aims to put in place a uniform guideline to ballast water management and is likely to include prescribing technical solutions to the problem (3.3 Treatment Options), and the possibility of port entry requirements or coastal state prescriptions. The concepts introduced for regional implementation include ballast water discharge control areas and ballast water uptake/exchange areas. The text of these regulations is however still very much under discussion.

Convention on Biological Diversity

CBD was negotiated in the framework of UNEP as a binding instrument emerging from the 1992 Rio "Earth Summit". Its implementation requires both global and local response. Each government has to review its legislative instruments and policies to ensure that these will not contradict this Convention. The Convention is enforceable on all Parties that ratified it. This is in contrast to the Agenda 21 or Rio Declaration which are also outcomes of the "Earth Summit". The latter are not enforceable, or "soft law" instruments. In June 1992 CBD was opened for signature and it entered into force in December 1993. Today 186 countries have become Parties. One primary objective of the Convention on Biological Diversity is to encourage and enable all countries to conserve biodiversity. Biodiversity includes ecosystems, species and genetic strains. CBD contracting parties agreed to prevent the introduction of non-indigenous species and to initiate control or eradicate alien species that threaten ecosystems, habitats or species[15], [16], [17], [18].

3.1.2 Unilateral Responses

Unilateral voluntary and mandatory regulations or recommendations aiming to minimize the introduction of species with ballast water have been implemented in various regions (18 countries, Appendix II). Most of these regulations are of a voluntary nature and favour the open ocean exchange of ballast water. Some countries (e.g. Argentina, Chile and China) however require chemical treatment (chlorination) of ballast water when outbreaks of human pathogens (e.g. Cholera) are known in the area of origin of the ballast water.

[15] www.biodiv.org

[16] Shine, Williams & Gundling 2000

[17] http://www.zin.ru/projects/invasions/tableais.htm

[18] Rennie, H.G. Implementing the Convention on Biological Diversity (http://www.waikato.ac.nz/wfass/subjects/geography/rep/biodiversity/bio_article.html)

It is important to note that many of the existing legal instruments relevant to species invasions do not mention the vectors, such as shipping and ballast water, explicitly. These instruments include laws for the protection of (marine, coastal) environments, quarantine laws, laws for prevention of water pollution, fishery laws, laws on the management and use of the Sea etc. Appendix II of this report lists these instruments that mention human mediated species introductions and emphasise on the vector shipping.

New Zealand and Australia were the first countries to implement voluntary ballast water guidelines in the late 1980s and early 1990s. Australia was the driving force to establish and contribute to the Ballast Water Working Group at the IMO MEPC in the early 1990s.

Different European countries recommend to follow the IMO guideline for voluntarily exchange of ballast water in open seas.

3.2 Risk Analysis

Risk analysis is the process whereby an attempt is made to quantify the risk of certain introductions of unwanted species. In general the risk is a combination of the probability of colonisation and the possible consequences of such colonisation. Thus, the risk may be unacceptably high even in cases where the colonisation probability is low.

So far different approaches have been sought, mostly with the aim to support decision making. Below the validity of risk analysis is discussed and the process of decision support systems is explained. This description is followed by two different basis for risk analysis (target species approach, environmental matching) and a description of the use of risk analysis in the OSPAR region so far.

3.2.1 Discussion of the validity of risk analysis

Scientists have tried to mathematically assess the invasion rate of non-indigenous species since a very long time. Darwin[19] estimated that, in average, 5% and Williamson[20] that 10% of the introduced species may form self-sustaining populations in their new habitats. This 10%-rule was mainly based on introductions to terrestrial ecosystems[21]. The general 10%-rule was revised pointing out that the quote is not strictly "10", but actually ranges from 5 to 20 in the suitable habitat[22]. In general it has been termed impossible to indicate whether a system will be more resistant or open to bio-invasions[23]. Further, human mediated accidental introductions of aquatic species are believed to be unpredictable[24].

After controversial discussions scientists agreed that in general all ecological communities are open to bio-invasions at any time. A risk analysis should therefore be seen as indicative guidance only, lacking a solid scientific basis so far. But it should be possible to list gradations (e.g. intensively visited harbours have a larger change to receive new alien species). Table 3 of Appendix V further indicates that more enclosed areas, like the Baltic and Mediterranean Seas, have a higher number of invaders possibly due to less water exchange with the ocean or as result of ballast water releases in unique shipping pattern.

Since the mid 1990s Australia is the driving force in risk assessment, followed by North American and European initiatives. Recently the IMO/UNDP/GEF Global Ballast Water Management Programme (GloBallast) launched a Risk Assessment initiative involving all its six

19 Darwin 1900

20 Williamson 1989

21 Holdgate 1986; Simberloff 1986, 1989; Williamson & Brown 1986

22 Williamson 1996

23 Williamson 1996

24 Zaitsev & Mamaev 1997

demonstration sites: Sepetiba (Brazil), Dalian (China), Mumbai (India), Kharg Island (Iran), Saldanha (South Africa) and Odessa (Ukraine)[25].

3.2.2 Decision Support System

When planning to reduce the risk of future species introductions with ships there are two basic options:

(a) apply regulations and/or measures on all incoming vessels, or

(b) select vessels that carry high risk ballast water.

Because in most regions it is not feasible to inspect and sample all incoming vessels, an assessment may be performed based on indicators of risk. A risk analysis based decision support system assesses whether or not a ship poses a risk for species introductions. This reduces the number of vessels that may be inspected, or that need to undertake action.

Decision support systems may be based on a target species approach, or environmental matching (see further below). If the presence of target species is estimated to be likely, or the environmental match between donor and recipient region is high, measures need to be applied to reduce the risk of introductions. These measures may include ballast water exchange or treatment.

Australia uses a Decision Support System (DSS) to evaluate the risk posed by each incoming vessel. The DSS provides a tank-by-tank risk assessment based on information supplied by the ship's master. It enables the quarantine authority / ship´s master to determine if the vessels ballast water poses a risk of introducing exotic species into Australian waters.

The risk assessment component of the Australian DSS takes into account criteria such as the port of ballast water uptake (climate and species composition), treatment of the ballast water before discharge, species tolerance and estimated survival rates during the voyage. The survival rate is estimated from sampling ballast tanks, length of the journey and the daytime of the ballast water uptake (daily migration of species in the water column)[26]. High-risk ballast water will require treatment and/or management by a method acceptable to the Australian Quarantine and Inspection Service (AQIS).

3.2.3 Target Species

Australia and USA have prepared lists of harmful and unwanted target species whose unintentional introduction with ballast water should be avoided. The target species list provides a rough, but robust analysis of the risk that ballast water poses (3.2.2 Decision Support System). The main purpose of the Australian target list is to avoid spreading of unwanted species within the country by (a) slow down of secondary introductions in domestic trade and (b) minimise future introductions by international shipping. The list will be modified periodically as new information is available[27].

In the USA the target species list is entitled "America's Least Wanted" and focuses on those non-native species that were introduced and are threatening natural environments. Aquatic and terrestrial species are listed. It is stated that further spread of this already introduced species should be avoided[28].

[25] http://globallast.imo.org

[26] Hayes 1997

[27] Paterson 1996; Hayes pers. comm.

[28] Nature Conservancy 1998

3.2.4 Environmental Matching

One alternative to a species specific approach is an environmental matching assessment between recipient and donor region as carried out in USA, the GloBallast Programme, Germany, Nordic Countries and the Det Norske Veritas EMBLA Project. The environmental match between regions will not necessarily represent the biological capabilities of the species but provides a best guess on the risk of species establishment.

The limiting factor for a successful introduction is largely linked to the species flexibility in terms of temperature and salinity tolerance, habitat selection and food. As result species from similar latitude (i.e. similar climate) and similar water bodies in respect of salinity will have a greater chance for establishment. If the source region and port of discharge are ecologically comparable the risk of species introductions is relatively high, i.e. higher as the 10%-rule indicates (see 3.2.1 Discussion of the validity of risk analysis).

Table 1. Colonisation probability of invaders, according to matching salinity in donor and recipient region[29].

	DONOR region		
RECIPIENT region	Fresh water	Brackish water	Salt water
Freshwater	High	medium	Low
Brackish water	medium	high	High
Salt water	Low	high	High

The recently launched risk assessment approach of the Global Ballast Water Management Programme[30] includes e.g. ship arrival pattern according to the source region of the ballast water followed by an analysis of the environmental match of donor and receiving habitats.

Table 2. Colonisation probability of nuisance invasive species, according to matching climate in donor and recipient area[31].

	DONOR region			
RECIPIENT region	Arctic& Antarctic	Cold-temperate	Warm-temperate	Tropics
Arctic & Antarctic	high	medium	Low	low
Cold-temperate	medium	high	Medium	low
Warm-temperate	low	medium	High	medium
Tropics	low	low	Medium	high

3.2.5 Risk Assessment in the OSPAR Region

During the German shipping study (1992 – 1996) all non-native species sampled from the ballast water, tank sediments and ship hulls were characterised according to an estimated probability of establishment in German waters. The potential for an establishment was estimated in accordance with the scheme developed by Carlton[32] comparing the salinity tolerance of the species and the salinity conditions of the receiving waters (Table 1). In addition a comparable scheme structure was employed to take account of the climate in the area of origin (donor area) and the potential recipient area (Table 2). A combination of both schemes enabled an initial risk analysis[33].

[29] modified after Carlton 1985

[30] http://globallast.imo.org

[31] modified after Gollasch 1996

[32] Carlton 1985

[33] Gollasch 1996

The initiative on "Risk Assessment of Marine Alien Species in Nordic Waters"[34] studied the application of risk assessment models to Nordic Countries. A semi-quantitative model (low - medium - high risk) was applied to vectors of introduction and target organisms. The tentative list of parameters influencing ballast water introductions included: characteristics of donor and receiving ports or geographical areas (environmental match), vessel ballasting characteristics, BWT, voyage route and duration, and target species.

The most comprehensive risk assessment initiative in the OSPAR region so far has been initiated by Det Norske Veritas (Norway). The programme, entitled EMBLA, has formed a ballast water risk management tool with European focus, but the potential to be used on a global scale. The basis of EMBLA is a software package, that uses vessel data to provide information to ports and vessels on the risk of ballast water introductions per voyage. It includes: port or country specific lists of target species, ballast water logs for tracking of ballast water history and its origin, ballast water risk assessment, identify target areas (hot spot regions) from where harmful aquatic species are likely to be introduced by shipping, and recommend most relevant and efficient risk reducing measures and their performance[35].

3.3 Treatment Options

In the course of the IMO Convention it is assumed that ballast water management and control will likely be based on the principle or risk reduction. The reason that a 100% barrier of future species introductions is currently not deemed possible, is that technology is not expected to be available to reach this level in the near future. Two basic types of measures are under consideration:

(a) ballast water management (ballast water exchange at sea, use of reception facilities) and
(b) ballast water treatment (mechanical, physical and chemical).

3.3.1 Ballast Water Exchange

The basis for ballast water exchange is that the water loaded in ports is exchanged for deep oceanic water. Its risk reduction principle is based on exchanging coastal waters with a high organism density with a high probability of colonisation, with open ocean water that usually contains fewer organisms and individuals have a lower chance of survival in coastal areas. This procedure is widely believed to be currently the only feasible ballast water management method available to existing ships, as generally the procedure does not require alterations of the ship. The exchange process has also been recommended in case a vessel sails between two fresh water zones (ports or regions), the change in salinity will limit species survival significantly.

Geographically, open ocean exchange has been defined as to take place in waters deeper than 500m, more than 200nm off the coast (based on the UNCLOS Exclusive Economic Zone (EEZ) concept). Because of the possible ineffectiveness of the procedure in other locations, the BWWG at IMO is currently discussing other geographic areas where open ocean exchange may need to take place. The options considered are currently, specifying specific areas for ballast water exchange, limiting the procedure to outside the EEZ or within an agreed upon distance from shore.

Three methods are considered as appropriate to carry out the mid-ocean exchange: (a) empty/refill, (b) continuous flow-through of ballast water and (c) dilution method (=continuous flushing). The water replacement efficiency during water exchange will largely depend on the ballast tank design, safety requirements, sea conditions, amount of water pumped and the pumping system design.

It has to be noted that organisms are not homogenously distributed inside ballast tanks as many tend to concentrate near the substratum (tank walls and tank bottom sediments). Flow through ballast exchange experiments proved retention of phyto- and zooplankton from the source port

[34] Gollasch & Leppäkoski 1999

[35] http://projects.dnv.com/embla/

in the bottom layer of the tank after exchange[36]. Studies have proven that three times volumetric exchange of ballast water results in approximately 95% removal of viable algal cells and approximately 60% removal of zooplankton organisms. A removal of 95% of organisms would not eliminate the risk of species invasions as millions of specimens are still contained in the remaining 5% of the ballast water[37]. In phytoplankton the inoculation size to introduce a new species is about 1,000 cells[38]. However, a 90-100% reduction of source port taxa was achieved following the flow through method (Table 3).

The movement of ballast water in the tanks affects the trim, stability, bending moment or shear forces acting upon the hull of the ship. Therefore ballast water operations have a strong effect on the safety and manoeuvrability of the vessel. In line with the Safety Of Life At Sea (SOLAS) Convention and the International Safety Management (ISM) Code, ballast water exchange operations fall under the responsibility of the captain and must be documented. A ships master will therefore not perform ballast water exchange on all voyages and under all conditions. In a submission[39] to IMO MEPC, the International Association of Classification Societies (IACS) states that performing Ballast Water Exchange may cause transitory non-compliance with SOLAS on certain vessels or voyages. Different accidents have in the past already been attributed to faulty ballast water operations (e.g. hull breaches).

Table 3. Efficiency of organism removal for various ocean exchange options[40].

Exchange method	% organisms removal	Reference
continuous flushing	>95 (phytoplankton)	Rigby & Hallegraeff 1994; Rigby et al. 1997
continuous flushing	<90 (coastal organisms)	Ruiz & Hines 1997
continuous flushing	96 (phytoplankton)	IMO MEPC 1998
dilution method	86-96 (phytoplankton)	Villac et al. 2001
flow through	90-100 (selected taxa)	Taylor & Bruce 2000
empty/refill, 1 tank volume	67 (plankton), estimated	Locke et al. 1993
empty/refill, 1 tank volume	48 (phytoplankton)	Dickman & Zhang 1999
empty/refill, 3 tank volumes	>95 (coastal organisms)	Ruiz & Hines 1997

3.3.2 Reception Facilities

The possibility of land-based reception facilities for ballast water has often been suggested for the treatment of ballast water. The reception facility would need to be placed in certain areas of ports and receive the water from vessels. After treatment, taking into account quarantine regulations, the water could either be discharged, or given back to departing ships. Land-based facilities could provide an acceptable means of control, as the treatment equipment will have less technical (volume) limitations. Port reception facilities do however appear to have very high costs involved e.g. for pipework and storage facilities as drawbacks. Ships would also need to be installed with appropriate fittings in order to connect to a port reception facility. Besides the necessary infrastructure investments and adaptations to vessels, port reception facilities may prolong port time of vessels. This delay will be caused when vessels can no longer load and perform ballast water operations concurrently. It has further been suggested to use a tanker (e.g. a phased out single hull tanker) or barge as floating ballast water reception facility in order to increase flexibility of ballast water operations in ports. The ballast water to be discharged could be pumped to this vessel located along side the discharging vessel. In this way ballast

36 Taylor & Bruce 2000

37 Taylor et al. 2002, Villac et al. 2001

38 Hallegraeff pers. comm.

39 IMO MEPC 48/2/7

40 Taylor et al. 2002

water operations could still run parallel to unloading and loading[41]. The drawbacks of reception facilities make this option less likely in the near future, but the draft IMO instrument currently includes provisions related to port reception facilities.

3.3.3 Mechanical Removal of Species

Mechanical technologies are based on particle-size or specific weight to separate or remove organisms from the ballast water. To its advantage mechanical treatment (e.g. filtration, cyclonic separation, sedimentation and flotation) does not generally produce any unwanted environmental side effect. However, smaller organisms are not easy to remove in this manner. First testing of mechanical techniques indicate a varying efficiency up to 99% removal of larger zooplankton and up to 94% removal of phytoplankton and smaller zooplankton[42].

3.3.4 Physical Inactivation of Species

Physical treatment options for ballast water focus on changing the physical properties or hydrodynamic characteristics to kill or inactivate the taxa present as well as on the removal of organisms (e.g. heat treatment, cooling treatment, Ultra Violet (UV) irradiation, ultrasonics, electrical removal of species in ballast water, electrochemical BWT, gas super-saturation). Although a number of physical techniques have been investigated, the most promising options currently available are heat treatment and UV irradiation. Preliminary results indicate a possible effectiveness of physical techniques varying from >90% effectiveness for phytoplankton species and 100% for all human pathogens except resting stages[43].

3.3.5 Chemical and Biocidal Inactivation of Species

Chemical and biocidal treatment has been named as a possibly effective way to treat ballast water. A large number of chemical disinfectants and biocidal agents are commercially available that have been used successfully for many years in land-based potable and wastewater treatment applications. Although the probable effectiveness of chemicals/biocidal agents for treatment is undisputed, its application to ballast water is incomparable to a land based situation. In the land based application of chemicals/biocidal agents, the influent of treatment is always known to a high degree of certainty. Therefore the dosage of chemicals or biocidal agents can be adjusted to reach optimum treatment and minimise impacts on the environment. With BWT, each operation of ballast water will be different, and it is likely that it is necessary to apply a high dosage of chemicals or biocidal agents to meet treatment requirements under all situations. Besides this, the treated ballast water will need to be discharged into the natural environment more or less directly after treatment, reducing the control over the effects. Although there is extensive testing ongoing for possible residues, the long-term accumulating effects of using chemicals/biocidal agents are largely unknown. In addition to environmental concerns, health and safety problems related to storage of chemicals, costs, compatibility with cargo carried on board as well as direct and indirect hazards of handling chemicals by crew members have been raised.

The injection during ballast water uptake seems to be an appropriate option to apply and dose the chemical/biocidal agent. In cases where ballast water in cargo holds would be treated with chemicals, these tanks would have to be cleaned intensively before cargo could be loaded in the same tanks[44]. Costs involved in the use of some chemicals/ biocidal agents, operating dispersal mechanisms and material costs are not clear yet, but may be comparable to other options[45]. Biocidal agents suggested to treat ballast water include e.g. ozone, hydrogen

[41] AQIS 1993; Taylor & Rigby 2001

[42] Taylor & Rigby 2001, GloBallast Programme 2002

[43] GloBallast Programme 2002

[44] Carlton et al. 1995

[45] Müller 1995, Müller & Reynolds 1995, Rigby et al. 1993, Rigby & Taylor 2001

peroxide, chlorination, ozonation, electrolytically generated metal ions, de-oxygenation, pH and salinity adjustment as well as organic biocides[46].

[46] Ridgway & Safarik 1991, Bolch & Hallegraeff 1994, Voigt 2000, Fuchs (Degussa) pers. comm., GloBallast Programme 2001

4 Possible Tools for OSPAR

This chapter provides details on ballast water management tools, that are relevant for the consideration of OSPAR in concordance with international law. The first section of this chapter focuses on the implementation of IMO regulations (Assembly Resolution 868(20), the planned Convention) or the refinement of these regulations on a regional level. Setting more stringent measures (under UNCLOS art. 196) is also considered. The second section of this chapter provides an analysis of these tools to support decision making by BDC.

4.1 Description of Tools

The various tools outlined below are divided into legal / administrative, geographical measures and scientific options.

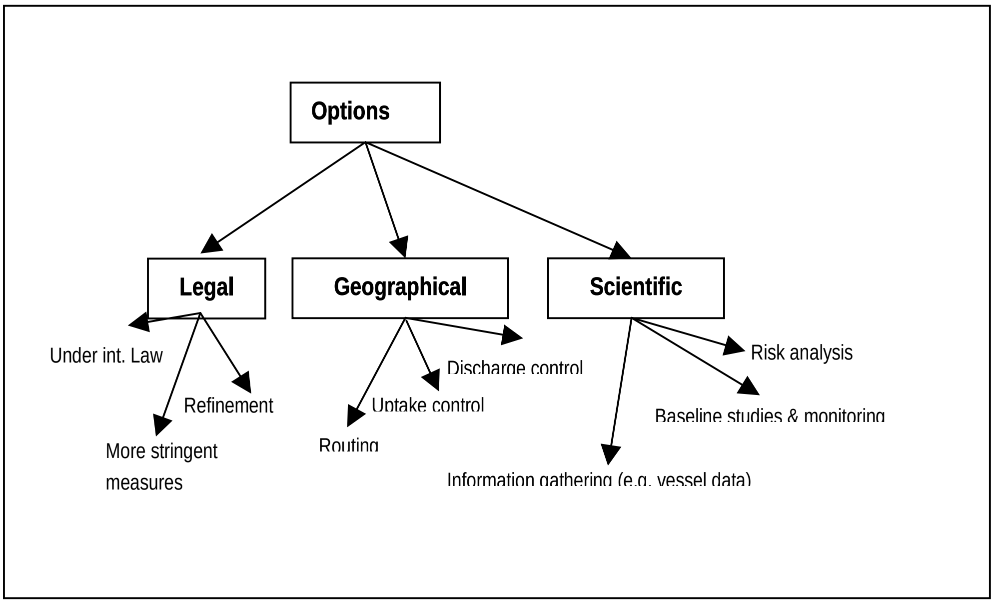


Fig. 6 Tools according to legal, geographical and scientific options.

4.1.1 Administrative options under resolution A868/20

The IMO resolution outlines the use of different administrative tools in order to a) gain more information on ballast water operations and b) make future enforcement possible. The draft IMO Convention on Ballast Water builds further along these lines. These two instruments suggest the following administrative tools:

- Ballast Water Management Plan (BWMP);
- Certification and inspection;
- Ballast Water Record Book (BWRB);
- Ballast Water Reporting Forms (BWRF);
- Risk analysis and early warning systems.

No matter what kind of treatment or management tool to avoid species invasions will be applied, safety for crew and ship is of paramount importance. Therefore, IMO will probably recommend not to undertake any form of ballast exchange unless it is included in the ship's BWMP and approved by the certified ship's Classification Society via the ship's “Trim and Stability” booklet. The BWMP may further outline control personnel responsible for the ballast water handling and crew training.

As already outlined in the IMO Assembly Resolution 868(20) it is recommended to implement early warning systems to make the ship master aware of disease outbreakes and the occurrence of harmful organisms likely being transported in ballast water. Early warning systems could be aided by remote sensing as algal bloom may be identified when analysing satellite images. Relevant information could than be forwarded or made available to ship masters.

It may be recommended that OSPAR considers to support its parties in collecting information on ballast water movement and management. This will support any measure the parties will need to take under the coming IMO convention, and increase awareness amongst relevant stakeholders. The following actions could be coordinated:

- Parties to require BWMP and BWRB;
- Ballast water reporting forms can provide relevant information to be used to assess risk, and to tailor future measures;
- Parties may consider their position regarding ship inspections, and enforcement of coming IMO regulations.

Information gathered within the above mentioned suggestions can further support risk analysis and early warning systems.

4.1.2 Geographical options

In regional seas, the effectiveness of ballast water exchange is deemed less than when performed in open sea. Scientific studies have shown that in regional seas (e.g. North Sea) ballast water exchange is not very effective[47]. The reason for the lower efficiency lies in the characteristics of the water in regional seas. On the most part there is strong mixing in the column and across the water body resulting in waters with very coastal characteristics. Therefore, ships calling North Sea ports may need to exchange their ballast water in deeper regions such as the open Atlantic Ocean. Regional seas should therefore be considered as areas where ballast water operations are not effective, and alternative ballast water management techniques may need to be developed. In the OSPAR Convention Area ballast water exchange used alone may not be an appropriate means to reduce the risk of species invasions.

Where open-ocean exchange is not possible, elaboration of international requirements within regional agreements may become applicable, particularly within jurisdictions of party states. The options considered are currently, specifying specific areas for ballast water exchange, limiting the procedure to outside the EEZ or within an agreed upon distance from shore. As a regional body OSPAR may be an appropriate body to aid its parties in choosing the right strategy in their approach to this issue. Seas at Risk recommend in their contribution OSPAR 01/6 not to wait until the IMO Ballast Water Convention is agreed upon, but to start the development of management plans according to the IMO Assembly Resolution 868(20).

In summary there are two basic principles under consideration. One is to identify areas were ballast water operations (i.e. exchange of water, discharge of water) is permitted. In contrast the second approach outlines areas were ballast water operations are prohibited. In effect this may include pristine or protected areas as well as areas where ballast water uptake would be problematic as e.g. outbreakes human pathogens or harmful algae are known to occur.

The current text in draft Section C of the Ballast Water Convention includes additional measures for parties wishing to add to the basic principles of the Convention. It is clearly stated that affected neighbouring countries should be consulted indicating the need for a regional approach. Further, it is recommended to implement early warning systems to notify mariners of areas where ballast water operations should be avoided. However, a general agreement to accept this approach was not yet reached at the most recent MEPC meeting in Fall 2002 (MEPC48). It was further stated that all ballast water management areas shall be consistent with international law, i.e. UNCLOS. The establishment of ballast water management shall not

[47] McCollin pers. comm., ICES SGBOSV 2002

limit the rights and duties of a government under international law nor the legal regimes of straits used for international shipping[48].

Special concerns are expressed in case shipping routes meet Particular Sensitive Sea Areas (PSSA). Originally this environmental protection initiative focussed on the prohibition to discharge oil contaminated water. However, it may be found that prohibiting ballast water discharges near or in protected areas can add to the protection of those areas. The 60 proposed sites[49] for protection in the North Sea are mostly located in the coastal regions and cover approx. 900,000 hectares. One example is the Wadden Sea as outlined in the trilateral Wadden Sea Plan adopted in 1997. Ballast water exchange zones need to be identified enabling ships to carry out water exchange in other areas. A proposal to identify the Wadden Sea as IMO approved PSSA was submitted during MEPC48.

In the OSPAR region it is doubtful that ballast water exchange zones can easily be identified as the largest part of the area are shallow water bodies (e.g. the North Sea) and adjacent to protected marine habitats. However, it may be suggested to establish exchange zones for ballast water in the open Atlantic seaboard of Europe covered by the OSPAR area. Ships from overseas and the Mediterranean Sea intending to discharge ballast water that originates outside the OSPAR area could then be asked to exchange the ballast water in these zone(s). However, short regional voyages will have to be addressed separately. Vessels travelling from e.g. Sweden to the Netherlands cannot feasibly be asked to travel through these ballast water exchange zones not being located on the usual shipping route. As outlined above these shipping routes should not be excluded from any ballast water measure and here treatment options may be a recommended approach to reduce the risk of species invasions.

4.1.3 Additional Treatment

OSPAR parties could consider the level of protection to be decided upon within IMO as insufficient or inappropriate for its waters. They could consider agreeing within OSPAR, and under IMO approval, to request additional treatment of ballast water by ships calling at ports in the OSPAR Convention area. Under this approach it is important to distinguish two scenario's: one that means that port states offer provisions for this additional treatment (consistent with the draft IMO Ballast Water Convention[50]), or as "more stringent measures" (article 3.3 of the draft convention). These options are analysed below.

Technical Facilities Land-based
Land-based facilities for ballast water reception, storage or treatment are continuously considered. These systems could be operated twofold: (a) as reception facility for ballast water with appropriate treatment systems or (b) as donor facility for pre-treated ballast water to ships. However, concerns were expressed, especially in larger ports, that the installation of pipeworks to connect piers with the treatment facility might be disadvantageously high. To solve this problem, the facility could be installed on a ship that may go alongside of the arriving vessel that needs to discharge ballast water (see 3.3.2 Reception Facilities).

The availability of land-based BWT facilities may be an effective option and OSPAR may therefore consider to assess the implementation of relevant facilities in certain ports under its jurisdiction in an initial test phase. Test sites should be chosen carefully, especially taking into account the likeliness of suitable ships (i.e. ships carrying smaller amounts of ballast water) to arrive at these sites. At present, it must however be noted that the potential disadvantages of land based facilities will probably outweigh their usefulness.

Onboard Treatment
As outlined in earlier sections (3.3 Treatment Options) several options to treat ballast water are considered and currently heat treatment, mechanical removal of organisms in combination with UV treatment, and chemical treatment of ballast water are considered as the most promising

48 MEPC 48/WP.15

49 Sites of Community Importance (SCI) Progress Report 5th International Conference on Protection of the North Sea, Bergen, 2002

50 MEPC 48/WP.15 (Section C)

approaches. OSPAR may either consider certain treatment technologies too harmful for its waters, or as providing insufficient protection.

Concerns have been raised regarding chemical / biocidal treatment as it is unclear how residual components of treatment chemicals/biocides may pollute the environment. Further, health and safety problems related to the storage of chemicals/biocides onboard, compatibility with cargo carried onboard as well as direct and indirect handling of chemicals by crew members are of concern. Especially long-term effects are largely unknown. For that reason chemical or biocidal treatment should be regarded with great concern, and possibly not be permitted in light of the development of other options. However, in certain countries chemical treatment of ballast water is already required, mainly to avoid the introduction of human disease agents and pathogens. Despite the unknown environmental, safety and handling aspects monitoring need to be carried if such chemicals/biocides are discharged in OSPAR waters. OSPAR should keep a close watch on the effect of such chemicals/biocides for ballast water treatment, and should consider, if necessary, a possible ban of chemical /biocidal BWT in its waters. Such an approach would be consistent with the OSPAR chemicals policy goals.

Requesting more effective equipment (i.e. setting higher standards) from vessels poses many difficulties. To name a few, vessels may need to install different types of equipment, or need differing survey and certification regimes. The main difficulty to analyse this possibility further is however the current lack of detailed information on different techniques for ballast water treatment. Currently it may therefore be considered too early to request more effective equipment (higher standards).

A more predictable point is the possible ineffectiveness of ballast water exchange. It is possible that ships entering the ports of OSPAR parties may not have been able to perform ballast water exchange on a large number of voyages, or that effectiveness of ballast water exchange is low for other reasons. In that case OSPAR may consider to not longer accept ballast water exchange as a protection for its waters, but to request on board treatment on all voyages. As with other more stringent measures (see previous paragraph), OSPAR should study in detail the technical and economic consequences before taking such a measure.

4.1.4 Science and Risk analysis

Scientific knowledge is a key issue when considering biological invasions. Relevant research initiatives carried out in the OSPAR region are described in detail in Appendix IV and Table 2 of Appendix V.

A powerful role for OSPAR could be to promote further research in the field of risk assessment, baseline studies, information gathering of e.g. vessel data and shipping pattern, ship sampling programmes, relevant monitoring of the environment, considerations of PSSAs, early warning system and eradication plans after species invasions.

OSPAR could take a coordinating role to facilitate research initiatives to avoid duplication of efforts and to optimise mutual benefit of existing research initiatives and relevant established working groups.

4.2 Analysis of Tools

Table 4 provides details on the type of tools considered above, and how these are dealt with by the IMO Assembly Resolution 868(20) and the planned IMO Ballast Water Convention. The possible role of OSPAR, or individual OSPAR parties are shown in the table. The six types of tools considered here are of administrative nature, route and ballast prescriptions, treatment measures (land-based and onboard systems) as well as scientific initiatives. Further, the table includes already implemented tools and indicates the rationale to deal with certain tools on a regional and national level.

The tools implemented to date in the OSPAR region, are on a national level and focus only on scientific measures, such as ship sampling and early warning systems.

The list below is meant as a set-up for discussion, OSPAR and/or its parties may consider any of the following points, and add or subtract from the list. However, it is suggested that OSPAR may be an appropriate umbrella organization to especially deal with coordinating and identifying regional aspects of ballast water management. These aspects may include (initiating) prescriptions of shipping routes and ballast water handling areas within the OSPAR region. Further dealing with different onboard treatment systems and relevant research initiatives could be facilitated by OSPAR (see below).

It is recommended that OSPAR may place special emphasis on the appropriate implementation of existing tools under international law and to aid its parties to comply with these tools. In addition it could serve as platform to identify, coordinate and finally implement (after IMO approval) certain aspects of ballast water management. To take account of special circumstances in the OSPAR region as e.g. the involvement of several jurisdictions along the coasts of one sea, OSPAR may supervise relevant initiatives to make sure that regional measures are consistent with international law.

In the OSPAR Convention Area ballast water exchange may not be an appropriate means to reduce the risk of species invasions. Scientific studies have shown that in regional seas (e.g. the North Sea) ballast water exchange is not very effective[51]. The reason for the lower efficiency lies in the characteristics of the water in regional seas. On the most part there is strong mixing in the column and across the water body resulting in waters with very coastal characteristics. Therefore, ships calling for North Sea ports may need to exchange their ballast water in deeper regions such as the open Atlantic Ocean. Regional seas should therefore be considered as region where ballast water operations show limited effectiveness, and alternative ballast water management techniques may need to be developed. In the light of stimulating innovation in technology, OSPAR may have a role in increasing market awareness of the need for environmentally sound treatment technology.

Table 4. Tools under Consideration
(C = covered, I = implemented, D = development, P = possible)

Regulation Tools	IMO Assembly Resolution 868(20)	IMO Ballast Water Convention in prep.	Regional approach	National approach
Administrative				
- reporting forms	**C**	**C**		
- BWM plan	**C**	**C**		
- BW record book	**C**	**C**		
- Certification / inspection		**C**		
Route Prescription				
- exclusion of port entry			**P**	**P**
- Ballast Water Management Control Areas			**P**	**P**
Ballast prescription for uptake and discharge				
- areas for discharge of ballast		**D**	**P**	**P**
- areas for MOE		**?**	**P**	**P**
- conditions (disease outbreakes, HAB, PSSA, weather)	**C**	**C**	**P**	**P**
- no uptake and discharge of ballast water		**D**	**P**	**P**
Technical facilities land-based				
- port reception facilities (land-based and ship)		**D**	**P**	**P**
- alternate ballast		**?**	**P**	**P**

[51] McCollin pers. comm., ICES SGBOSV 2002

On board treatment				
- MOE	**C**	**C**		
- treatment		**C**		
- exclusion of certain techniques (e.g. chemicals)			**P**	**P**
- prescription of techniques (e.g. require a 20 μm filter)			**P**	**P**
Science / risk assessment				
- sampling vessels		**C**	**P**	**P/I**
- monitoring environment			**P**	**P**
- PSSA			**P**	**P**
- early warning system			**P**	**P/I**
- risk assessment		**C**	**P**	**P**
- eradication plan (past invasion)			**P**	**P**

5 Conclusions

Ballast water is an environmental problem on the convergence of shipping and ecology. The IMO is the appropriate body for dealing with shipping on a global scale. It addresses ballast water through the formation of an international convention. OSPAR is a regional convention that focuses on the protection of the marine environment in the North East Atlantic. The current draft IMO convention foresees regional implementation and specification. OSPAR could be seen as an umbrella organization to coordinate and implement these measures on a regional scale. It is recommended that OSPA place special emphasis on the appropriate implementation of existing tools under international law and to aid its parties in compliance.

5.1 Specific Regional Aspects

The unique situation in the North East Atlantic, with a large shallow area, an intensive short sea where several jurisdictions have coastlines along one sea, clearly outlines the need for regional cooperation in the ballast water issue. OSPAR, as the regional environmental protection convention, can be a suitable forum to coordinate relevant initiatives to make sure that regional measures are consistent within this region. Regional cooperation regarding ballast water issues is needed in a multidisciplinary approach involving (at least) scientific, legal, maritime and environmental authorities. This cooperation is necessary to avoid the disadvantages of differing regimes within a small area and ensures an effective solution to the problem.

At the 5th International Conference on the Protection of the North Sea, March 2002 (Bergen Declaration), the Ministers invited OSPAR to investigate how to best monitor introduced species and genetically modified organisms and further to support OSPAR´s initiative on regional matters regarding ballast water issues.

The Parties of the Convention on Biological Diversity at their 6th meeting in 2002 (the Hague) reflected the importance of national and regional strategies and action plans and the need for international cooperation to address the impacts of introduced species to biodiversity[52].

5.2 Possible Work Programme for BDC

In order to adequately address the ballast water issue, it is recommended that OSPAR BDC may consider organisational (Table 5) and environmental as well as scientific measures (Table 6) for inclusion in its work programme. The focus of these items is the regional implementation of (coming and existing) international regulations and guidelines under IMO, and the evaluation of the necessity for more stringent measures consistent with international law.

The suggestions for the work programme for OSPAR BDC that are outlined below are not intended to be work to be carried out by the OSPAR secretariat. They are suggestions that could be started and/or coordinated by OSPAR, but can be executed by its parties. On the side, it should be mentioned that a coordinating unit within OSPAR may be beneficial, depending on the amount of work OSPAR may decide on.

5.2.1 Organizational measures

It becomes clear that after 10 years of studying invasion biology in Europe that the “problem” of biological invasions is not well understood by various institutional and political authorities, including the scientific arena and the public (see Appendix V Inventarisation in the OSPAR area). The tasks for OSPAR could include, setting up organisational and administrative tools, joining legal forces, coordinating bio-invasions research, identifying knowledge gaps and avoiding duplication of efforts. Innovation can be increased by raising awareness in the water treatment industry of the market potential of new ballast water treatment technology. More specifically the possible activities are listed in table 5.

[52] OSPAR 01/6

Table 5 Organizational measures

- Appoint a lead agency on ballast water per OSPAR party
  (as in focal points list in Appendix III)
- Appointing a regional coordinator / a coordination unit for ballast water in the OSPAR region
- Develop regional ballast water management plans
- Initiate/coordinate a public awareness campaign
- Promote the implementation of IMO Assembly Resolution A868(20)
- Encourage the parties to require ballast water reporting forms - according to the existing IMO guidelines and the draft convention - for vessels entering their ports, and to establish a routine for submitting the received reports to OSPAR JAMP for use in e.g. activity assessment and for input to databases etc.
- Start requiring ballast water management plans for ships flying the flag of OSPAR parties
- Call upon OSPAR parties to take concerted action at IMO in developing the draft convention on ballast water, using its approach to the TBT issue as a model
- Monitor the use of chemicals/biocides in BWT and take appropriate action (within IMO/other) if deemed necessary
- Consider the commitments made by the North Sea countries at the 5th North Sea Conference (March 2002)

The implementation of IMO Assembly Resolution A868(20) includes many tools that may aid in the preparation for the coming IMO convention on the management and control of ships ballast water and sediments. OSPAR may consider to require ballast water management plans and ask ship masters to document ballast water details using a ballast water reporting form. It is recommended to discuss within OSPAR how to co-operate in the implementation and enforcement of the Convention.

It is recommended that OSPAR parties take concerted action at IMO in developing the draft convention on ballast water, in an approach similar to the formation of the AFS convention.

5.2.2 Environmental and scientific measures

The inventarisation of scientific activities related to ballast water in the OSPAR region shows that knowledge is scattered within and between OSPAR Parties (see Appendices). It is therefore recommended to strengthen scientific coordination, to avoid the duplication of efforts and to spent research funds in effectively. OSPAR may have an organisational role in this respect, especially if the approach of a regional ballast water coordination unit is considered. The unit may then deal with e.g. standards to approve BWT systems, testing of BWT measures, ship sampling programmes, risk assessments and eradication and management programmes. As result an early warning programme could be established to minimise the secondary spread of harmful non-indigenous species in the OSPAR region.

It is recommended to summarize the scientific results of all research initiatives in the OSPAR region to identify knowledge gaps and to prepare coordinated action plans. As a first step a database could be created outlining shipping patterns, port sampling programmes and an inventarisation of non-indigenous species in the OSPAR region.

Further, coordinated efforts could be made to identify appropriate ballast water exchange zones taking PSSAs within the OSPAR region into account.

Table 6 Environmental and scientific measures.

- Create a regional coordinating unit (see Table 5)
- Support the development of global standards to approve BWT systems by creating joint activities or projects
- Coordinated efforts could be made to identify appropriate ballast water exchange areas and no discharge areas taking into account sensitive sea areas within the OSPAR region
- Provide input to, and stimulate support for, the development of relevant research initiatives, such as ship sampling programmes, risk assessment, testing of BWT measures, databases of invaders, eradication and management programmes

- Initiate/coordinate the undertaking of baseline surveys (by parties) for ports in the OSPAR region using a standard sampling system. Relevant sampling protocols as developed in Australian and North American port surveys as well as in the framework of the GloBallast Programme may be considered
- Set up a regional risk assessment tool that can build on survey data, vessel movement data and other relevant information
- Initiate/coordinate the establishment of an early warning system on the occurrence of (potentially) harmful species likely being transported in ballast water
- Develop a database on non-indigenous species in the OSPAR region that may then be linked to existing databases
- Take, in relation to its work programme, advantage of existing expert networks

5.3 Where to start?

On the whole, efforts on ballast water management in the OSPAR region would greatly benefit from regional cooperation. Giving a person, or entity, a responsibility in doing this is important. As a first start, it is recommended that OSPAR works to initiate and coordinate the development and implementation of the administrative requirements according to the IMO Assembly Resolution A868(20). These will make the implementation in the region of the coming IMO ballast water convention much easier, and enhance the regions capability to learn about ballast water management. OSPAR may then actively support its parties in the implementation of the upcoming IMO Ballast Water Convention. Special area measures under the IMO convention could be coordinated by OSPAR.

Research initiatives related to ballast water would largely benefit from regional cooperation and coordination. Currently the initiatives are hampered by a duplication of efforts which could be avoided. The scientific community has established effectively working networks and for further benefit it is suggested that OSPAR may contribute to, and take advantage of, these existing initiatives as appropriate.

An international early warning system and appropriate risk assessment is necessary to better identify the distribution of species of concern. This mechanism is needed to better assess the effectiveness of management measures in place, and additional measures that may be needed. It can be considered if this could be linked to already existing early warning programmes e.g. on the composition and concentration of toxic plankton species and levels on toxins in mussel tissue (OSPAR QSR 2000).

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Appendix I Invasion Myths

Fact is that shipping continues since centuries and that ballast water is in use for more than 100 years. Having said that some questions, formerly entitled "Invasions Myths" (Carlton pers. comm.), arise:

- "**Every species what could have been introduced is here by now!"**
This is simply not the case. The "window of introduction" theory explains that all factors need to be tolerable enabling a successful species introduction. These factors include e.g. temperature, salinity, food availability, lack of predators and the number of specimens for a founder population. It is believed that a successful invasion is only enabled when all these factors involved form the right environment for the new invader. However, the factors listed are highly flexible and one can easily think of thousands of theoretical combinations. It is unlikely that all optimum conditions enabling the invasions occurred already in combination with the release of a sufficient number of individuals to form a self-sustaining population.

- "**Why do we need to go active right now?"**
The number of invaders was increasing towards the end of the last century. Several investigations have shown that since 1950s the number of new records of invaders have clearly increased. Further new free trade agreements and ship improvements (larger and faster ships result in more frequent ship arrivals) may possibly increase the invasion rate even further.

- "Invasions are part of nature and would happen anyway. The only thing we do is to speed up the process."
As above this is simply not true as there is no natural means to transport a species from e.g. USA to Australia. Biogeographical textbooks describe the Pacific Ocean as a migration barrier as the duration of the larval phase of zooplankton organisms is too short to enable a distribution across the Pacific with natural means. Human mediated vectors are essential here.

- "Humans should not interfere with species distributions."
As most scientists, invasion biologists know that biological components and their interaction in an environment are not a stable process. It was agreed that initiatives should not be undertaken to hinder natural migration activities of species. However, human mediated introductions should be kept to a minimum as matter of a precautionary approach. Case histories have shown severe, unwanted impacts of invaders being introduced unintentionally with e.g. ballast water. Natural migrations and human mediated introductions should clearly be treated separately.

- "**Only 10% of the invasions have a significant impact."**
A statement what refers to the "10"-rule. The rule was originally postulated based on invasion histories in terrestrial habitats. The figure was revised frequently. No matter how detailed these revisions were it has to be noted that every invasion has its impact. In some cases the impact is quite clear, in other instances the impact is not as obvious. Further, in many cases an impact is noted when the invader forms a mass development what may occur long time after the initial introduction.

- "**Phytoplankton species are not matter of discussion as these species are distributed world-wide anyway."**
It was documented that the number of phytoplankton blooms was increasing during the last two decades world-wide. It was suggested that this is supported by biological invasions. The recent first record of the potentially toxin producing phytoplankton algae in the North Sea is a good indication that we should be prepared for additional invaders of this kind.

- "**Keep the ballast water onboard as long as possible as the species will die out."**
Although many species die during the first days in ballast tanks, scientific studies have shown that even after 116 days living zooplankton can be found in ballast tanks[53] and under certain circumstances zooplankton species even reproduce in ballast tanks[54]. Scientists showed that

[53] Gollasch 1996

[54] Lenz et al. 2000

the exchange of ballast water could increase the species diversity of ballast tanks, especially in many domestic shipping routes, where no deep water exchange zones occur[55]. Further, some plankton species are enabled to form resting stages that survive unfavourable conditions for years. Therefore, keeping ballast water onboard for longer periods of time is not a measure to significantly reduce the risk of species invasions.

[55] Forbes & Hallegraeff 2001

Appendix II Ballast water regulations

(modified after wwww.intertanko.com, McConnell (in prep.) & Gollasch 1997).

Region	Regulation	Comment
Belgium	The Belgian law of 20 January 1999 on the protection of the marine environment in marine areas under Belgian jurisdiction forbids the intentional introduction of non-indigenous species in the marine environment without special license (Art. 11, §1). The unintentional introduction of non-indigenous species via ballast water of ships can be prohibited by royal decree (Art. 11, §2).	since 1999
Ireland	Considerations to implement IMO A.868(20). The proposal to regulate the ballast water discharge at the oil terminal of Bantry Bay was not implemented as it would have contravened Maritime laws and was deemed impractical, with potential for causing oil spills.	Voluntary
Netherlands	Considerations to implement IMO A.868(20).	Voluntary
Norway	The Norwegian Ministry of the Environment has recently instructed the Norwegian Maritime Directorate to develop a proposal for a national regulation to prevent spreading of alien and harmful organisms through ships ballast water and sediments. The regulation shall be based on the IMO Resolution A.868(20) and the draft IMO ballast water convention text. The proposal shall be delivered to the Ministry within 2002. Public hearing and adoption is planned for 2003. The Maritime Directorate was also asked to identify voluntary measures which could be implemented immediately and possible incentives to stimulate good environmental practice. Further, the Directorate was asked to consider if it could take the lead of an expert group on regional cooperation on ballast water measures, to be established by Sweden as a following up of the Bergen Declaration from the 5th North Sea Conference in 2002.	Adoption anticipated in 2003
Spain	Considerations to implement IMO A.868(20).	Voluntary
Sweden	It is recommended by national Swedish law to follow IMO A.868(20).	Voluntary
United Kingdom	Compliance with IMO A.774 (18) was requested by 10 of 66 ports. A national quarantine procedure on ballast water management is used in 4 of 66 ports. Most of the ports apply the regulations related to operational safety. IMO Assembly Resolution A.868(20)	
Orkney Islands	Orkney Islands Council, Scapa Flow port - Flotta Terminal.	Mandatory, prior 1998
Black Sea	Convention on the Protection of the Black Sea. Emptying of segregated, un-contaminated ballast water is permitted (refers to oil pollution). No uniform enforcement in the region.Vessels calling for the port of Odessa are requested to exchange their ballast water before entering the Black Sea. Relevant ballast water operations shall be recorded in the ship logbook.	
Israel	Notice to Mariners No. 4/96: Ships calling for the port of Eilat must exchange their ballast water outside the Red Sea. Vessels that visit other Israeli ports must exchange any ballast water that has not been taken on in open ocean, beyond the continental shelf or freshwater current influence (advanced questionnaire since 2000).	Mandatory, since 1996

Canada **Great Lakes**	Great Lakes Water Quality Agreement: Bi-national agreement dealing with water pollution (including ballast water).	1972 (amended 1987)
Iles-de-la-Madeleine	Notices to Mariners No. 995: Restrictions for the Grande Entrée Lagoon of the Iles-de-la-Madeleine: Discharge of ballast water within 10 nautical miles around the Island is prohibited unless the ballast water was exchanged in a designated area off Canada's east coast not closer to shore than 5 miles.	1982
St. Lawrence River	Canadian guidelines for controlling ballast water discharge into the Great Lakes: Vessels transiting the Eastern Canadian Region have to exchange ballast collected	1989

and the Great Lakes (inbound)	in foreign harbours or near coastal waters for saltwater ballast from open ocean. The exchange of the ballast water has to be carried out if the required port of call lies west of 63° W longitude. If BWE is not feasible ships are permitted to exchange their ballast in a "backup exchange zone" within the Laurentian Trough of the Gulf of St. Lawrence east of 63° W longitude in water depths greater than 300 m.	Voluntary. (Note that mandatory US regulations apply past Massena in New York state, USA.)
Vancouver	Vancouver has become the first Canadian port to require a complete BWE of all incoming ships from abroad on a voluntary basis if the vessels carry ballast water in excess of 1,000 tonnes. Any vessel unable to provide information as requested is not permitted to discharge ballast and has to depart and exchange the ballast water in the outgoing current of the Juan de Fuca Strait.	1997 (voluntary phase), from 1998 mandatory
nation-wide	Voluntary guidelines replaced by national guidelines applying to all areas of the country taking lessons learned during voluntary phase.	2000
Great Lakes / St. Lawrence	Proposed Regulation Harmonise Canadian and US Great Lakes requirements, including requirements to use a code of best ballast water management practices for NOBOB´s (no ballast onboard) including coastal voyages for ships entering the Great Lakes, use of salinity verification method and no safety exemptions.	Adoption anticipated in 2003
USA	The proposed timeline for USCG Federal Ballast Water Management Programme (FBWMP) (after McDowell & Cassell 2002) **Changes to FBWMP** **Notice of proposed rule making** **Final rule** Penalties for not providing ballast water report forms Winter 2002 Fall 2003 Mandatory national BWM programme (incl. BWE) Fall 2003 Summer 2004 BWT standard Winter 2003 Fall 2004 Protocol for approval of shipboard installations of experimental BWT units Interim: Winter 2002	
Great Lakes	Non-Indigenous Aquatic Nuisance Prevention and Control Act: The Act established ballast water management guidelines for vessels entering the Great Lakes.	Mandatory since 1992
Great Lakes	Ballast Water Management for Vessels Entering the Great Lakes as Coast Guard Notification.	1992
Great Lakes and Hudson River above the George Washington bridge.	US Code of Federal Regulations, US Nonindigenous Aquatic Nuisance Prevention and Control Act: Complete BWE, outside US EEZ, in a depth of more than 2000 metres.	Mandatory: Great Lakes – May 1993; Hudson River – December 1994
Ships calling outside the Great Lakes ecosystem	National Invasive Species Act (NISA): Vessels are expected to exchange ballast water at sea before entering US waters and ports. BWE is required outside the EEZ, not less than 200 nautical miles from any shore, and in waters more than 2,000 meters deep, before entering waters of the state.	1996. Since 1999 voluntary compliance. Mandatory anticipated 2004 (see above)
California	California Assembly Bill 703 California State Lands Commission, United States Coast Guard. The Bill went into affect January 1st 2000 and sunsets on January 1st 2004. A new	2000 voluntary BWE mandatory reporting

	programme is expected to take its place thereafter. BWE is required for ships that will be discharging ballast water into Californian waters after operating outside the EEZ. Alternative ballast water treatment is approved on a ship-by-ship basis.	
Oakland	Ballast water regulation based upon IMO Resolution A868 (20).	Mandatory reporting until July 1st 1999, mandatory BWE from July 1st 2000.
Washington State	State Programs Washington Substitute House Bill 2466 (SHB 2466) SHB 2466 went into effect July 2000 and has since than been amended several times. Ships operating outside the EEZ must carry out BWE before discharging ballast water into state waters. Additionally ships in coastal traffic travelling within 200 nm offshore in certain regions (state defined common waters, e.g. inland waters around Vancouver Island and Oregon) must carry out BWE at least 50 nm offshore before discharging ballast water into state waters. Ballast water report forms are required for all ships discharging ballast water from outside state defined common waters. Further an interim treatment standard (95% removal/kill of zooplankton and 99% removal/kill of phytoplankton and bacteria has been set in Washington.	Mandatory since 2000
Maryland State	Maryland General Assembly, House Bill 1305 Reporting required for vessels entering Maryland waters from outside the U.S. EEZ, and State guidelines that are consistent with the federal guidelines for other vessels entering Maryland waters. Forms are used to monitor compliance with the federal and State guidelines.	Mandatory since 2000
Oregon State	Oregon State Senate Bill 895 (SB895) The Bill went into affect on January 1st 2002. Ships operating outside the EEZ must carry out BWE. Ships travelling outside state defined regions must carry out BWE before entering state defines common waters (between 50 degrees North Latitude and 40 degrees North Latitude). In contrast to Washington SHB 2466 no minimum offshore distance requirements for BWE are given. Ballast water report forms are required for all ships from outside state defined common waters.	Mandatory since 2002
Argentina Buenos Aires	Direccion Nacional de Sanidad de Fronteras, del Ministerio de Salud Publica (quarantine authorities from the Ministry of Public Health). Affects ships arriving from areas where cholera is endemic. In-tank treatment by adding chlorine to ballast water through air pipes. The regulations designates coastal areas in which discharge of ballast water will be prohibited.	Mandatory since 1990
Brazil	Ballast water reporting and inspection requirements are in place under a Sanitation Law Directive (Brazilian National Sanitary Surveillance Agency (ANVISA)). These include documentation (ballast water form) prior to entry into port. Ballast water discharge likely to pose a risk to human health or the environment requires permission. The Ministry of Health issued a policy statement regarding its policy approach to implement the IMO Guideline A.868(20).	Mandatory since 2001

Chile	Chilean Navy; Division for Maritime Territory and the Merchant Marine, Maritime Safety and Operations Department. Chilean Declaration. Order for preventive measures to avoid transmission of harmful organisms and epidemics by ballast water. (Ships coming from zones affected by cholera or a similar epidemic of human pathogens have to renew the ballast water at a minimum distance from the coast of 12 nautical miles or carry out an in-tank chemical treatment (based on Chlorine) prior to discharge.)	Mandatory since 1995
South Africa	South African Transport Service Act 65 (applicable by virtue of the Legal Succession to the South African Transport Services Act 9 of 1989): The Act of provides the control of waste discharges in port areas. Waste is described as “stones, gravel, ballast, cargo dirt, ashes, bottles, rubbish ...”. However, the reference to ballast may originate from times when solid ballast was used.	1987

China	Ballast water is mentioned in two national instruments: (a) the Regulations Governing the Prevention of Pollution from Ships (Revised Environmental Protection Law) and (b) the Frontier Health and Quarantine Law of the People's Republic of China. If the area of ballast water origin is listed by the World Health Organization as infected with human pathogens, the Chinese Health Authority requires a chemical ballast water treatment using Chlorine based biocides prior discharge in Chinese ports or waterways (Pughiuc & Dianrong 1998).	2000
Australia	Australian Quarantine and Inspection Service (AQIS). Australian Ballast Water Management Advisory Council: Guidelines are based on the IMO A.774(18) modified according IMO A.868(20). Affects all ships from overseas ports >25m in length. All ports affected. Acceptable methods: - BWE in deep ocean areas: (1) Tanks to be drained until pump suction is lost (2) Flow through method (3 x tank volume pumped through) (3) Dilution method (4) Compliance regime in agreement with AQIS - In-tank treatment agreed with AQIS (heat treatment) BWE should be undertaken in case a vessel carries high risk ballast water (see DSS below) and intends to discharge ballast water in Australian ports or waters. BWE should be conducted in deep mid ocean water as far as possible from shore outside the Australian 12 nautical mile limit. BWE at sea must be undertaken to a minimum 95% volumetric exchange and should be carried out in water greater than 200 m in depth. Where BWE could not be undertaken due to safety reasons the Master should report this to AQIS as soon as possible and prior to entering Australian waters. AQIS Officers will conduct ballast water verification inspections on-board vessels to ensure compliance with Australia's ballast water management requirements (www.aqisgov.au/shipping).	1992 voluntary compliance, mandatory reporting since 1998
	Australian Agricultural Council Australian Coastal Ballast Water Guidelines affecting domestic shipping	1991
	Australian Quarantine and Inspection Service (AQIS). Australian Introduced Marine Pests Advisory Council. Ballast Water Management Decision Support System (DSS). The DSS assesses the biological risk of specific target taxa on a vessel by voyage basis and went 'live' on 1 July 2001.	2001

New Zealand	Ministry of Fisheries: Import Health Standard (IHS) IHS under quarantine legislation under the Biosecurity Act 1993 prohibits ballast discharge in New Zealand waters until permission has been given by an inspector. Options to satisfy inspector include; (1) 95% volumetric exchange, (2) withhold discharge, and (3) Ballast water treatment by approved technique (not available yet).	Mandatory from 1998

Appendix III Contact Details of Focal Points

Full contact details of focal points relevant to OSPAR BDC, IMO MEPC and biological invasions research.

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Appendix IV Studies on Bio-invasions and Related Issues in the OSPAR Region

This list of ballast water related studies was compiled according to the input received from the questionnaire mailed to relevant experts of all OSPAR parties, reports of recent scientific meetings, the GloBallast Ballast Water Treatment R&D Directory 2002 and a recently published book on bio-invasions[56]. However, this list does not claim to be fully comprehensive.

Belgium

- Study of the potential role of transportation of ships ballast water on the geographical extension of blooms of toxic algae (Vanden Broeck 1995, MSc thesis, G. Houvenaghel, Universite Libre de Bruxelles). Ship sampling study.
- Ballast Water: The situation in Belgium (F. Kerckhof, 2002 Report of ICES/IOC/IMO SGBOSV). Desk study.

Denmark

- Ship sampling study (T. M. Sørensen, MSc-thesis (J. T. Christensen), University of Aarhus, Institute of Biological Sciences, Dept. of Marine Ecology). Laboratory and shipboard study.
- Ballast Water - the situation in Denmark (J. Sanderhoff, MSc-thesis (J. T. Christensen), Department of Marine Ecology, University of Aarhus, 2002 Report of ICES/IOC/IMO SGBOSV). Desk study.
- Introduced Species in the Nordic Countries (Weidema I. R. (ed) 2000). Desk study.
- Global Environment Facility (GEF) Baltic Sea Regional Project managed by J. Thulin (ICES), HELCOM and International Baltic Sea Fishery Commission (IBSFC).

Finland

- Introduced species in the Baltic Sea and its coastal ecosystems (Leppäkoski, E. 1984). Desk study.
- Non-indigenous species in the Baltic Sea (Leppäkoski, E. 1994). Desk study.
- Risk assessment of marine alien species in Nordic waters (Gollasch, S. & E. Leppäkoski 1999). Desk study.
- Pilot study on the ballast water invader *Cercopagis pengoi* (E. Lahdes, FIMR). Desk and laboratory studies.
- Non-indigenous species in Europe – distribution, impacts and manage-ment. Eds: Leppäkoski, E., Gollasch, S. & S. Olenin (2002). Desk study.
- The Baltic Sea - a field laboratory for invasion biology. Leppäkoski, E., Olenin, S. & S. Gollasch (2002). Desk study.

France

- Study on the spread of the alga *Sargassum muticum* (T. Belsher, IFREMER, Brest).
- Control methods on the slipper limpet *Crepidula fornicata* (M. Blanchard, IFREMER, Brest).
- The microbial component in ballast water (D. Masson, IFREMER, La Tremblade). Ship sampling study.
- Project on onboard ballast water treatment (IFREMER and Ministry of Transport). D. Masson, IFREMER, La Tremblade. Practical study.
- Risk assessment of noxious organism introductions by ballast water on French coasts (D. Masson, IFREMER, La Tremblade). Desk study.
- Open Atlantic coast of Europe - A century of introduced species into French waters. Goulletquer, P., Bachelet, G. Sauriau, P.G. & P. Noel (2002) Desk study.

Germany

- Ship sampling study on ballast water, tank sediments and hull fouling, 1992-1996 (S. Gollasch, H. J. Lenz, H.-G. Andres & M. Dammer, Institute for Marine Research, Kiel, and University of Hamburg). Desk, laboratory and shipboard study.

[56] Leppäkoski et al. 2002

- Various studies on the polychaete invader *Marenzelleria* sp. (A. Bick and D. Schiedeck, Rostock University, Institute for Baltic Sea Research). Desk, field and laboratory studies.
- Summary of ballast water treatment options for IMO (S. Gollasch 1997). Desk study.
- Ship sampling study on ballast tank sediments (MSc Thesis T. Wittling, University of Hamburg). Desk, laboratory and shipboard studies.
- European Union concerted action "Introductions with ships". 1997-2000 Coordinated by H. Rosenthal and S. Gollasch, Institute for Marine Research, Kiel. Desk, laboratory and shipboard studies.
- Bilateral research study on survival of species in ballast water within the Canadian-German bilateral research agreement. 1999 – 2001 (M. Gilbert & S. Gollasch). Shipboard study.
- International full scale testing of mitigation techniques for ballast water, 2001 - 2003. (C. Bahlke, GAUSS, Bremen). Desk, laboratory and shipboard studies.
- Project on treatment options of ballast water. Project starts in Fall 2002, partly funded by EU, involving partners from Germany, Portugal, Norway and United Kingdom (Fernandez, TTZ Bremerhaven, Germany). Laboratory and shipboard studies.
- Development of a ballast water treatment plant, 2000-2003 (Röpell, Hamann Wassertechnik & M. Voigt, Dr. Voigt Consulting). Laboratory and shipboard studies.
- Environmentally sound treatment option for ballast water: Peraclean® Ocean (R. Fuchs, Degussa. 2002 Report of ICES/IOC/IMO SGBOSV). Laboratory and shipboard studies.
- Introduced marine species of the North Sea coasts. Reise, K., Gollasch, S. & W. J. Wolff (2002). Desk study.
- Biological invasions into German waters: An evaluation of the importance of different human-mediated vectors for non-indigenous macrozoobenthic species. Nehring, S. (2002) Desk study.
- Preventive treatment and control techniques for ballast water. Taylor, A., Rigby, G., Gollasch, S., Voigt, M., Hallegraeff, G., McCollin, T. & A. Jelmert (2002) Desk study.
- Artemia Testing Standard for chemical treatment options. (M. Voigt in Webster & Raaymakers 2002) Laboratory studies.

Ireland

- Assessment of discharges of shipping ballast water in Ireland, D. Minchin, 1996, ICES CM 1996 E11, 13pp. Desk study.
- The significance of ballast water in the introduction of exotic marine organisms to Cork Harbour, Ireland (D. Minchin & J. Sheehan, 1998, ICES Co-op. Rep. 224: 12-23). Desk study.
- Various studies on the spread of the recently introduced Zebra mussel *Dreissena polymorpha* (D. Minchin). Desk, field and laboratory studies.
- Reducing risk of exotic species establishment and transmissions in port regions (D. Minchin, 2001 Report of ICES/IOC/IMO SGBOSV). Desk study.
- Exotics of coastal and inland waters of Ireland and Britain. Minchin, D. & C. Eno (2002). Desk study.
- Vectors, how exotics get around. D. Minchin & S. Gollasch (2002. Desk study.
- Ballast water and the EU Water Framework Directive (D. Minchin, 2002, Report of ICES/IOC/IMO). Desk study.

The Netherlands

- Viability of organisms after an oceanic voyage (National Institute for Coastal and Marine Management, Middelburg and AquaSense/Tripos, Amsterdam (Tripos 1997). Laboratory and shipboard studies.
- Origin of ballast water discharged in Dutch ports (AquaSense 1998a, b). Desk study.
- Study on diversity of plankton organisms and their survival potential in Dutch waters 1998 – 2000 (L. P. M. J. Wetsteyn, National Institute for Coastal and Marine Management, Middelburg). Laboratory and shipboard studies.
- Ballast water research in Dutch ports (B. Wetsteyn and M. Vink, 2001 Report of ICES/IOC/IMO SGBOSV). Desk study.
- Global market analysis of ballast water treatment technology (H. Schilperoord & F. Tjallingii, 2001, Royal Haskoning). Desk study.
- Invasions by alien species in inland freshwater bodies in western Europe: The Rhine Delta. (van der Velde, G., Nagelkerken, I., Rajagopal, S. & A. bij de Vaate 2002) Desk study.
- Introduced marine and estuarine species in The Netherlands. W. J. Wolff (2002, in print). Desk study.

- General patterns in invasion ecology tested in the Dutch Wadden Sea: the case of a brackish-marine polychaetous worm. Essink, K. (in prep). Desk and field studies.
- Feasibility Study on the Development of a Ballast Water Treatment Technique, Phase 1: Standards for Ballast Water Treatment (F. Tjallingii, 2001, IWACO/Royal Haskoning). Desk Study
- Feasibility Study on the Development of a Ballast Water Treatment Technique, Phase 2: Application Review of Ballast Water Treatment Techniques (M. Hensen, 2001, Royal Haskoning). Desk Study
- Feasibility Study on the Development of a Ballast Water Treatment Technique, Phase 3. (H. A. Schilperoord Royal Haskoning Nederland B.V.). Desk study.
- Development of the Japanese Oyster in the Ems Estuary 1998-2001 (P. Tydeman, H.L. Kleef & J. de Vlas, 2002. Werkdocument RIKZ/OS/2002.601x.
- Risks of ballast water for and through the North Sea. Ballast water as risk factor for the introduction and dispersal of pathogens for fish, crustaceans, and molluscs. Report National Institute for Fisheries Research (S.J. de Groot & P. van Banning 1998).
- Introductions of marine and estuarine species: development of a model describing the invasion process. (Ph.D study by Deniz Haydar, supervision Prof. Wim Wolff. Project started in 2002. Planned termination in 2006).

Norway

- The ports of western Norway – Bergen, Eikefet, Ågotnes, Mongstad and Sture. H. Botnen, V. Skjævested & H. Hagen. In: Gollasch, S. & E. Leppäkoski (eds.) Initial risk assessment of alien species in Nordic coastal waters. Nord 1999:8. Nordic Council of Ministers, Copenhagen. Desk study.
- An integrated ballast water risk management tool – EMBLA, ongoing since 1997 (A. B. Andersen & H. L. Behrens (Det Norske Veritas, Høvik). http://projects.dnv.com/embla/). Desk study.
- Ozone treatment of ballast water, 1999-2001 (Andersen, Dragsund and Johannessen, Det Norske Veritas, Høvik). Laboratory study.
- The Sture ship sampling project at UNIFOB, Section of Applied Environmental Research, High Technology Centre, Bergen (Botnen et al. 2000a). Laboratory and shipboard studies.
- Macro and micro organisms in ballast tank sediments, UNIFOB, Section of Applied Environmental Research, High Technology Centre, Bergen (Botnen et al. 2000b). Laboratory and shipboard studies.
- Pilot survey for introduced species in the tidal zone at Kårstø, Sture and Mongstad, western Norway (H. Botnen, UNIFOB, Section of Applied Environmental Research, High Technology Centre, Bergen. Botnen et al. 2001a, 2001b and 2001c). Field study.
- Pilot survey for introduced species in the tidal zone at Kårstø, Sture and Mongstad, western Norway (H. Botnen, UNIFOB, Section of Applied Environmental Research, High Technology Centre, Bergen. Botnen et al. 2001a, 2001b and 2001c). Field study.
- OptiMar Ballast Systems (H. Nilsen, Stavanger). Laboratory and shipboard studies.
- Study on microbial component in ballast tank sediments (A. Jelmert, Institute of Marine Research, Austevoll Aquaculture Research Station, Storebø and University of Bergen). Laboratory and shipboard studies.
- Application of gas supersaturation to remove organisms in ballast water (A. Jelmert, Institute of Marine Research, Austevoll Aquaculture Research Station, Storebø and Enger, Forinnova A/S, Bergen). Laboratory study.
- Full scale verification of ballast water treatment by ozonation with Barbership Management. 2001. Contact: Aage Bjørn Andersen or Sarah Danielsson, Det Norske Veritas, Høvik.
- Study on the new amphipod invader *Caprella acanthogaster* (A. Jelmert, Institute of Marine Research, Austevoll Aquaculture Research Station, Storebø). Field study.
- Research on the distribution and impact of the King Crab (*Paralithoides camtschatica*) (J. Sundet, L. Jørgensen, Norwegen Institute of Fisheries and Aquaculture, Tromsø and K. Jørstad, S. Ohlsen, Institute of Marine Research, Bergen). Desk, laboratory and field studies.
- Research on the non-native red alga *Polysiphonia harveyi* and *Caulacanthus ustulatus* in Norway (J. Rueness, Oslo University).
- Introduced Marine Organisms in Norwegian Waters, Including Svalbard. Hopkins, C. C. E. (2002). Desk study.

- Handling of ballast water – Statoil-Melkøya (A. B. Andersen, S. M. Bakke, H. Sletnes, G. Gravir, L. H. Larsen (Akvaplan- NIVA)). Contact: Aage Bjørn Andersen or Siri M. Bakke, DNV, Høvik.
- Feasibility study Statoil-Melkeøya LNG. Ballast water treatment development – 9 activities. Ongoing. Contact: Aage Bjørn Andersen or Egil Dragsund, DNV, Høvik.
- Inventory for global ballast water exchange. 2002. Contact: Øyvind Endresen, Det Norske Veritas, Høvik.
- Ballast Water Treatment by Oxidation. 2002. Labscale test in corporation with Down Stream Services, Bergen, Norway. Contact, Aage Bjørn Andersen, Det Norske Veritas, Høvik.
- Scoping study for formal safety assessment of ballast water management. Contact: Aage Bjørn Andersen or Sarah Danielsson, Det Norske Veritas, Høvik.
- The model group concept. 2002. Contact: Gerd Petra Haugom, DNV Research, Høvik. http://projects.dnv.com/embla/Documents/Model_ Group_Concept.pdf
- The BIOMARE project (http://www.biomareweb.org) S. Cochrane, Akvaplan-niva, Polar Environmental Centre, Tromsø.
- Experiments with fouling panels in harbours (H. Botnen, UNIFOB, Section of Applied Environmental Research, High Technology Centre, Bergen). Field study.
- The systematics, taxonomy and biogeography of selected marine worms (Polychaeta; Serpulidae) invading via fouling and ballast water. Ph.D/doctorate project of Toril Loennechen Moen.

Spain

- The Port of Barcelona’s Ballast Water Programme (A. Palau, 2001 Report of ICES/IOC/IMO SGBOSV). Desk study.
- Review of Non-native Marine Plants in the Mediterranean Sea. Ribera Siguan, M.A. (2002). Desk study.

Sweden

- Inventory of alien species in the Swedish marine environment (including vectors) (Jansson 1994). Desk study.
- Studies on the infestation rate of the Eel nematode *Anguillicola crassus* in European eel (J. Thulin, Institute of Marine Research, Lysekil and J. Höglund, National Veterinary Institute, Uppsala).
- Various studies on the macro alga *Sargassum muticum* (distribution, variation in biomass, associated fauna, growth) (J. Karlsson Gøteborg University). Desk and field studies.
- Pilot shipping study in 1996 of phytoplankton in ballast water and of cells hatched from ballast tank sediments (A. Persson, B. Karlson, I. Wallentinus, Dept of Marine Botany, Göteborg University; Persson 2001, 2002, in press, Gollasch et al. in press)). Laboratory and shipboard studies.
- Ballast water handling on ships calling Swedish ports. (Anon. 1998a). Desk study.
- Ballast Water Transport in Swedish Waters. (Anon. 1998b). Desk study.
- Desk study of the ports of the Stenungsund area, west coast of Sweden. (A. Godhe & I. Wallentinus 1999)
- Inventories of introduced algae and vascular plants including vectors in ICES countries (Wallentinus 1999) and in Europe (Wallentinus in press). Desk study.
- First regional survey of benthic dinoflagellate cysts in recent sediments from the Swedish west coast (A. Persson et al. 2000) providing background data for comparisons with ballast releases. Field and laboratory study.
- Underwater technology and biological interfaces (A. Zolotarevski, Malmö Högskola, project started in 2000) with financial support from the KKS (The Knowledge Foundation, Sweden). Cooperation with R. Baier, Center for Biosurfaces, Buffalo, USA. Laboratory and shipboard studies.
- Swedish Research Project “AQUALIENS” - Aquatic alien species - where and why will they pose a threat to the ecosystem functions and economy? Financed by SEPA for 5 years, started May 2002 (I. Wallentinus, E. Willen and M. Appelberg, 2001 Report of ICES/IOC/IMO SGBOSV, Wallentinus et al. 2002). Desk and laboratory studies.
- BenRad Marine Technology’s ballast water purifying system (M. Isaksson, BenRad Marine Technology AB, Stockholm and S. Gorton, Wallenius Rederierna AB, Stockholm. 2002 Report of the ICES/IOC/IMO SGBOSV). Desk and laboratory studies.

- J. Ellis Ph.D. student at SSPA, Göteborg, is involved in the EU-programme MARTOB, in which SSPA is a partner.

Switzerland

- Study on alien species in the Rhine River at Basel (started 2001, U. Sieber, Swiss Agency for the Environment, Forests and Landscape, Bern and P. Rey, HYDRA, Konstanz, Germany). Desk study.
- Latest electrochemical water treatment technology for ballast water disinfection (L. Pupunat, Ph. Rychen, M.A. Fontecha Camara, W. Haenni, B. Klaus and P. Rossi (Tanksystem, Bulle and Centre Suisse d'Electronique et de Microtechnique (CSEM), Neuchatel, 2002 Report of the ICES/IOC/IMO SGBOSV). Desk and laboratory studies.

United Kingdom

- Scottish ballast water and sediments project, 1994-1997 (carried out at FRS Marine Laboratory Aberdeen, Scotland (Macdonald 1998, Macdonald and Davidson 1998). Desk, laboratory and shipboard studies.
- Disinfection of ballast water – a review of potential options (Müller & Reynolds 1995, Lloyds Register, Croyden). Desk study.
- Non-native marine species in British waters: a review and directory (N.C. Eno, R.A. Clark and W.G. Sanderson 1997). Desk study.
- Transport of phytoplankton in the ballast water of vessels using the Port of Southampton (S. Belson, Maritime Research Centre, Southampton Institute). Desk. laboratory and shipboard studies.
- Marine organisms transported in ship's ballast to England and Wales, 1996 - 1999 (T. McCollin, J. Hamer & I. Lucas, School of Ocean Science, University of Wales, Bangor). Desk, laboratory and shipboard studies.
- Local ballast water management project. Impacts of ballast water in the Moray Firth, 1999-2000 (B. Leyshon, Moray Firth Partnership, Inverness, Scotland). Desk study.
- Efficiency of ballast water exchange in regional seas, 1999 – 2003 (T. McCollin, FRS Marine Laboratory in Aberdeen). Desk, laboratory and shipboard studies.
- Scoping study for a formal safety assessment, 2000 (UK Maritime and Coastguard Agency website at http://www.mcga.gov.uk). Desk study.
- United Kingdom compliance with ballast water regulations, 2000 – 2002 (S. Welch, I. Lucas & J. Hamer School of Ocean Science, University of Wales, Bangor). Desk study.
- The MARTOB Project (E. Mesbahi and G. Quílez-Badia, Newcastle University, Newcastle upon Tyne, 2002 Report of ICES/IOC/IMO SGBOSV). Desk, laboratory and shipboard studies.

Appendix V Inventarisation in the OSPAR area

In order to provide BDC with an overview of activities and relevant information a questionnaire has been sent out to all OSPAR parties during July 2002 asking to contribute to this report. The questionnaire had three objectives:

(a) identification of contact persons (focal points) for ballast water issues relevant to OSPAR BDC, IMO MEPC and in research activities,
(b) list completed and ongoing ballast water studies, including ship sampling programmes, risk assessments, inventories of non-indigenous species etc., and
(c) provide the status of legal initiatives on ballast water (i.e. guidelines in preparation or implemented).

1. Focal Points

The provided focal point contacts are named in Table 1. A detailed address list is attached as Appendix III. The list of focal points is meant to improve future cooperation relevant to ship-mediated species introductions within the OSPAR area.

Table 1. Focal point contacts relevant to OSPAR BDC, IMO MEPC and research on bio-invasions (for full contact details see Appendix III).

OSPAR Party	BDC (OSPAR)	IMO MEPC	Research
Belgium	Jan Haelters	Paul Defevere	Francis Kerckhof
Denmark	Anne-Grethe Ragborg	Ivan Andersen	Jens Tang Christensen
EU	Jose Rizo	Jacques de Dieu	Astrid Schlewing
Finland	Eeva Liisa Poutanen	Mirja Ikonen	Erkki Leppäkoski
France	Philippe Maire	Michel Weizmann	Daniel Masson
Germany	Henning von Nordheim	Hans Thilo	Stephan Gollasch
Iceland	Stefan Asmundsson	Kristján Geirsson	Sigmar Arnar Steingrimsson
Ireland	Jacqueline Doyle	Mr. S. McLoughlun	Dan Minchin
Luxembourg	Jean-Marie Ries	Paul Hansen	n.n.
the Netherlands	Peter Heslenfeld	Frans Tjallingii	Bert Wetsteyn
Norway	Arne Eggereide	Sveinung Oftedal	Helge Botnen, Anders Jelmert
Portugal	Fátima Brito	Jorge Semedo	n.n.
Spain	Javier Pantoja	Gracia Albuquerque Lopez	Jordi Vila
Sweden	Kjell Grip	until Feb. 2003 Johan Graberg, thereafter Charlotte Ottosson	Inger Wallentinus
Switzerland	Ulrich Sieber	Jacques Ducrest	Ulrich Sieber
United Kingdom	Linda J. Smith	Sharon Wort & Mike Hunter	Tracy McCollin

1.1 Focal Points OSPAR BDC and IMO MEPC

In total 13 OSPAR parties were actively involved in the OSPAR BDC meeting Nov. 2001 (Belgium, Denmark, EU, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom) and six attended the BWWG at IMO MEPC48 (October 2002) (France, Germany, the Netherlands, Norway, Spain and United Kingdom)[57]. The named

[57] MEPC-IBWWG 1/WP.1

persons may be contacted regarding cooperation on a policy level. The large presence of OSPAR countries at BWWG can be taken as a good indication of the importance that bio-invasions have been given within the OSPAR area.

1.2. Focal Points for Research

The identified focal points for science are those involved in international working groups on scientific matters. In addition to the above mentioned scientists as focal points it is recommended to note that several scientific working groups and/or networks exist within the OSPAR Convention Area. It is recommended to take advantage of these initiatives especially when planning new research proposals for mutual benefit and to avoid the duplication of efforts.

- **European Research Network on Aquatic Invasive Species** (ERNAIS)
  The key objectives the ERNAIS network include to create a network facilitating cooperation and information exchange within invasion biologists European-wide, to develop an international database on aquatic alien species and to document the impact caused by invaders. Almost 60 scientists from more than 20 European countries join this initiative (http://www.zin.ru/projects/invasions/gaas/ernaismn.htm).
- **Non-Indigenous Estuarine and Marine Organisms** (NEMO) Working Group 30 of the Baltic Marine Biologists. The establishment of NEMO in the mid-1990s indicates the growing academic interest in bio-invasions. Key objectives include the collection and summarisation of information on non-indigenous aquatic plants and animals in the Baltic Sea. Data on non-native species are available as Baltic Sea Alien Species Database at http://www.ku.lt/nemo/mainnemo.htm.
- **Nordic Network on Introduced Species** focuses on the establishment of a Nordic network of people working as scientists or as administrators within the field of introduced species (http://www.sns.dk/natur/nnis/).
- **Study Group on Ballast Water and other Ship Vectors** (of ICES/IOC/IMO) (see 2.4.2 Regional Response so far) and
- **Working Group on Introductions and Transfers of Marine Organisms** (of ICES) (see 2.4.2 Regional Response so far).

2. Studies in the OSPAR Region

Various studies and publications related to biological invasions have been carried out in the OSPAR region. Table 2 provides details on research initiatives, shipping studies, inventories of non-native species, risk analysis, comprehensive desk studies, full scale testings of ballast water treatment options and more. The information compiled is based on the feedback on the questionnaire, reports of recent scientific meetings, the GloBallast Ballast Water Treatment R&D Directory 2002 and a recently published book on bio-invasions[58].

Almost 100 studies relevant to biological invasions, predominantly desk studies, were completed or are ongoing in OSPAR Parties (see Appendix IV).

2.1. Ballast Water and Tank Sediments

The first study on ships` ballast water in the OSPAR region was carried out in Germany from 1992-1996. Shortly thereafter, until 1998, new shipping studies were initiated in Scotland, Belgium, Norway, England and Wales, Sweden, the Netherlands and in 1997 an EU funded Concerted Action was launched involving six countries and the IMO.

During the shipping studies on ballast water, vessels sampled in European ports ranged from small cargo vessels of <1,000 deadweight tonnes (dwt) to very large crude carriers (VLCCs) of >300,000 dwt. The ballast water sampled originated from more than 200 different regions world-wide, but predominately from the northern hemisphere. The principal objective of most studies was to identify the variety of species transported in ballast water tanks (most studies focussed on ballast water, but some included tank sediment sampling).

During almost 20 of the ship sampling studies considered here, more than 1500 ballast water and tank sediment samples were collected in total on more than 560 ships. The total number of

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taxa collected during all studies was more than 1,000 including e.g. bacteria, fungi, protozoans, algae, invertebrates and fishes of different life stages.

Table 2. Studies on bio-invasions and related issues in OSPAR Parties (for details see Appendix IV). (Number of studies x = 1 to 3, xx = 4 to 6, xxx = >6).

OSPAR Party	Desk studies	Laboratory studies	Ship sampling	Treatment option tests in laboratory	Treatment option tests onboard *
Belgium	x		x		
Denmark	x		x		
EU	x				
Finland	xxx	x			
France	xx	xx	x	x	
Germany	xxx	xxx	x	x	xx
Iceland					
Ireland	xxx	x			
Luxembourg					
the Netherlands	xxx	x	x	x	x
Norway	xxx	xxx	xx	xx	x
Portugal					
Spain	x				
Sweden	xxx	xx	x	x	
Switzerland	x	x		x	
United Kingdom	xxx	xx	xx	x	x

(* including ballast water exchange at sea)

2.2. Testing Treatment Options

Since the mid 1990s seven research initiatives on ballast water treatment were launched in the OSPAR area. The first practical studies on ballast water treatment measures were carried out by Norway and Germany in the mid 1990s. Project objectives included efficiency testing, environmentally soundness and practicability on board vessels. The treatment options studied include cyclonic separation, filtration, heat, UV, gas super saturation and chemical treatment (ozone, hydrogen peroxide based formulations and chlorine). Further, the efficiency of ballast water exchange was studied[59].

Full scale treatment projects comparing various ballast water treatment options are currently underway in Germany, the Netherlands, Norway and United Kingdom.

2.3. Inventories of Invaders

The first inventory of non-native species in the OSPAR region was undertaken by the Swedish Environmental Protection Agency in 1996 and 1997 in the framework on the IMPACT programme (see 2.4 OSPAR in relation to Ballast Water). It resulted in a list of about 100 species known as non-native. In 1998, 133 non-indigenous species were known to occur in the OSPAR area[60].

Recently (2002) a book was published as a first attempt to provide an overall picture of aquatic species invasions in Europe. The geographical scope is not limited to the OSPAR region, but stretches from Irish waters in the west to Volga River and the Caspian Sea in the east, the Mediterranean Sea in the south and the Arctic in the north. Not all parts of Europe could be covered extensively, as studies differed in depth and for some regions no relevant initiative was known (i.e. parts of the Atlantic coast of the Iberian Peninsula, southern coasts of the Mediterranean Sea as well as south eastern coasts of the Baltic Sea). The key objective of the

[59] GloBallast Programme 2002, see Appendix IV for projects in OSPAR region

[60] Gotjé et al. 1998, OSPAR QSR 2000

book was to summarize the current situation in Europe with an emphasis on the impact caused by non-native aquatic species (Table 3)[61].

Table 3. Number of aquatic invaders in European coastal waters with focus, but not limited to OSPAR Parties.

Region	Number of invaders	Reference
White Sea	5	Berger & Naumov 2002
Norway including Svalbard	45	Hopkins 2002
Baltic Sea	103	Weidema 2001, Leppäkoski et al. 2002, Jazdzewski & Konopacka 2002
North Sea	80	Reise et al. 2002
Ireland & Britain	79	Minchin & Eno 2002
Atlantic Coast of Europe (including the French coast of the British Channel)	104	Goulletquer et al. 2002
Mediterranean Sea (plants)	98	Ribera Siguan 2002
Central and eastern Mediterranean Sea	>350	Galil & Zenetos 2002, Occhipinti Ambrogi 2002
Marmara Sea	11	Öztürk 2002
Black and Azov Seas	53	Gomoiu et al. 2002
Caspian Sea	50	Aladin et al. 2002
The Rhine Delta (Dutch part)	85	van der Velde et al. 2002
German inland waters	35	Nehring 2002
Caspian-Volga-Baltic Corridor	106	Slynko et al. 2002

2.4. Risk Analysis

Risk analysing projects relevant to ballast water mediated species invasions are carried out in detail since the 1990s. Australia, severely suffering from bio-invasions, is the leading country in this field. Past initiatives in OSPAR Parties are more descriptive i.e. not quantifying the risk, but analysing the hazard bio-invasions pose to the environment. The currently running EMBLA project of Det Norske Veritas is probably the most quantitative in the OSPAR region (see 3.2.5 Risk Assessment in the OSPAR Region).

Risk assessment is a tool that can help determine specific risk in the region. It can aid in deciding whether additional measures need to be adopted as initiatives will outline the risk level for future invasions. High risk shipping routes or ports receiving ballast water from high risk areas may be identified enabling suitable measures to minimise species invasions. These high risk areas may be identified for all seas within the OSPAR region highlighting the need for an overall organisational body. It is therefore suggested that OSPAR is an appropriate organisation to facilitate risk assessment initiatives under its jurisdiction.

3. Legal Initiatives

OSPAR may especially have a role to support the regional implementation of coastal state requirements outlined in international law. It can also aid parties in fulfilling their port state and flag state requirements. However, the latter remains the first responsibility of the parties themselves. It is clear from the feedback of the questionnaire that regulations on ballast water are in its infancy in the OSPAR region. Considering the shipping pattern some countries believe that ballast water poses a limited risk to their environment (e.g. Iceland). In contrast species invasions receive increased public and scientific attention in other OSPAR Parties (e.g. Norway, Sweden and United Kingdom).

[61] Leppäkoski et al. 2002

In Norway this attention was prompted by a recent bloom of a harmful algae that negatively affected fish farms. As a result the Norwegian Ministry of the Environment has recently instructed the Norwegian Maritime Directorate to develop a proposal for a national regulation to prevent spreading of alien and harmful organisms through ships ballast water and -sediments. The regulation shall be based on the IMO Resolution A.868(20) and the draft IMO ballast water convention text. The proposal shall be delivered to the Ministry within 2002. Public hearing and adoption is planned for 2003. The Maritime Directorate was also asked to identify voluntary measures which could be implemented immediately and possible incentives to stimulate good environmental practice. Further, the Directorate was asked to consider if it could take the lead of an expert group on regional cooperation on ballast water measures, to be established by Sweden as a following up of the Bergen Declaration from the 5th North Sea Conference in 2002.

The majority of OSPAR parties neither has mandatory nor voluntary guidelines related to ballast water. Mandatory regulations exist for certain ports or regions in the OSPAR Convention area only (e.g. Orkney Islands) and are based on safety requirements or to avoid the discharge of oil contaminated ballast water, rather than to avoid biological invasions. Voluntary guidelines exist (e.g. Sweden) and mainly follow the principles of the IMO Resolution A.868(20). The majority of the OSPAR parties contribute and follow the discussion and development of the IMO Ballast Water Convention and globally await approved guidelines for implementation in their jurisdictional waters.

From the number of regulations in place in non-OSPAR Parties it becomes clear that other continents prioritise the importance of bio-invasions differently (see 3.1.2 Unilateral Responses and Appendix II Ballast Water Regulations).