GloBallast Partnerships

Guidance on Best Management Practices for Sediment Reception Facilities under the Ballast Water Management Convention

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The GloBallast Partnerships Programme is a co-operative initiative of the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the International Maritime Organization (IMO) to assist developing countries to reduce the transfer of harmful aquatic organisms and pathogens in ships' ballast water and sediment and to assist the countries in implementing the International Convention on Ballast Water Management. For more information, please visit http://globallast.imo.org.

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Disclaimer

This publication has been prepared by GloBallast to serve as guidance to those who are planning to carry out sediment management in the context of Ballast Water Management. It has been drafted with the specific needs of the countries participating in the GloBallast Partnerships Programme in mind. The publication is not a protocol for sediment management; it rather intends to present experiences and lessons learned.

Although all possible efforts have been made to provide a comprehensive and accurate document, its main purpose is to provide a discussion of the relevant concepts and lessons learned, and neither the GEF-UNDP-IMO GloBallast Partnerships Project nor FIT take responsibility for the implications of the use of any information or data presented in this publication. Therefore, the publication does not constitute any form of endorsement whatsoever by the GEF, UNDP, IMO, GEF-UNDP-IMO GloBallast Partnerships or FIT, and individuals and organizations that make use of any data or other information contained in the Monograph do so entirely at their own risk.

Executive Summary

This Monograph has been prepared through collaboration between the GEF-UNDP-IMO GloBallast Partnerships Program and the Florida Institute of Technology. It responds to requests from partners and countries of the GloBallast Project for better and more accessible/comprehensible information and guidance on sediment reception facilities within the context of article 5 of the Ballast Water Management (BWM) Convention.

The intention of this Monograph is to serve as a guidance manual for creation and operation of sediment reception facilities in member countries as described in article 5 of the BWM Convention. This monograph represents a resource of basic information and experiences that will aid in the development of "Best Management Practices" (BMPs) to develop national management strategies for sediment reception facilities.

This document is divided into seven chapters. Chapters 1 and 2 provide an in-depth introduction describing the issue of unwanted invasive species and the role sediments in ships' ballast tanks play in their spread. Chapter 3 describes the role and proposed function of sediment reception facilities within the context of the BWM Convention. Chapter 4 details options available to member countries for safe disposal of sediments received at their facilities. The document then discusses, in Chapter 5, the possible approaches and available tools that can be utilized to facilitate the secure disposal of sediment. Chapter 6 presents BMPs for establishing and running sediment reception facilities. A suggested template for action items required when establishing a SRF is included in the Annex. These BMPs were developed by drawing on the expertise of the authors and contributing collaborators, as well as experiences from current sediments management activities practiced at selected shipyards. Chapter 7 provides guidance for establishing a sediment reception facility in accordance with the Convention. A summary of BMPs for sediment reception facilities created in the context of the BWM Convention is provided in the Annex at the end of this report, giving a focused information base for management strategies.

This Monograph is based on numerous sources of information that are listed in the references section. In addition, the listed BMPs are composed partly of experience-based practices that were observed on site visits to shipyards located in the Great Lakes (United States), Europe, and the Adriatic Sea region.

Glossary & Abbreviations

BMPs	Best Management Practices
BWM	Ballast Water Management
BWMP	Ballast Water Management Plan
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
NIS	Non-indigenous Species

1

Introduction

Article 38(a) of the Convention on the International Maritime Organization established the Marine Environment Protection Committee (MEPC) and designated it as the body to develop international conventions for the prevention and control of marine pollution. The International Conference on Ballast Water Management for Ships, held in February 2004, adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments (known as the Ballast Water Management – BWM – Convention). Regulation A-2 of the BWM Convention requires that discharge of ballast water shall only be conducted based on approved Ballast Water Management Plans (BWMPs) in accordance with the provisions of the related Annex to the Convention.

It was noted by the Organization that the inclusion of "sediments" in the BWM Convention was causing some confusion amongst parties regarding procedures for handling sediments in ballast water. To this end, article 5 of the Ballast Water Management Convention provides that each Party to the Convention will undertake to ensure sediment reception facilities are available to those ships requiring that service. Also, that the ports and terminals designated by that Party where cleaning or repair of ballast tanks occurs, are adequately built and operated to safely collect and dispose of sediments, considering the guidelines developed by the Organization. In addition, it noted that reception facilities shall operate without causing undue delay to ships and shall provide for the safe disposal of sediments that does not impair or damage the environment, human health, property or resources of those of other states. To provide further advice on ballast water sediments management, the Ballast Water Review Group of the MEPC developed guidelines in 2006 for facilities that would receive ballast tank sediments. These Guidelines for sediment reception facilities (G1) were adopted by resolution MEPC.152(55) in October 2006.

Figure 1 Ship during ballast water operations, GloBallast.

Article 5 of the Convention and the G1 Guidelines basically address the management of sediments from ships' ballast tanks. The management of this material is significantly different than management schemes for ballast water itself. The Convention addresses and clearly defines ballast water management and guidelines for creating a BWMP. Options for managing ballast water include: exchange in open ocean areas, on-board ship treatment or discharge at shore-side facilities. The Convention and the Guidelines for its implementation will enter into force on 8 September 2017.

It is understood that a significant amount of matter settles out in ballast tanks during transit, and is not discharged routinely along with the bulk of the ballast water. This material (sediment) must be handled separately by ships, as it remains isolated from normal ballasting operations. In situations where sediments accumulate in ballast tanks to levels that hinder ships' operations (limiting cargo that can be transported), they must be removed during normal maintenance operations in shipyards. In addition, sediments may accumulate in ballast water tanks to the point where structural inspections cannot take place. In this instance, ships will also request service to remove enough of the sediments so that tank inspections can be made. It is common for sediments to simply be relocated into other ballast tanks to allow for the inspection, as it is usually considered unnecessary to remove sediments because their total volume is not sufficient to hinder the freight carrying capacity of the ship.

The Organization, realizing the limitations associated with sediments management, developed article 5, regulation B-5 and Guidelines (G1) to address sediments management. Sediments management is also discussed in Section B: Management and Control Requirements for Ships, and specifically, in regulation B-5 that notes: "*All ships shall remove and dispose of sediments from spaces designated to carry ballast water in accordance with the provisions of the ships' ballast water management plan.*" The approaches for sediments removal from ships' ballast tanks can be first segregated into categories of: 1) at-sea disposal (performed by ships' crew); and 2) disposal provided by shipyards (performed by shipyards' staff or agents). If disposal is performed at sea, the process will be governed by an acceptable BWMP in accordance with the Convention, and this approach is beyond the scope of this guidance document. This Monograph will focus on the approach of sediments removal and disposal from ships' ballast tanks while in a party-designated shipyard.

It is important to note that article 5 deals only with shipyards that will be servicing ships to remove sediments from ballast tanks. In this regard, the Convention do not speak to exact procedures and regulations associated with the operation of sediment reception facilities. Instead, they address general operational considerations such as the sediment removal service causing undue delay to the ships' normal activities. It is noted in the Convention that the Organization assumes shipyards will follow all appropriate regional, national and local regulations governing the handling, transport and disposal of ballast tank sediments. However, the Organization realizes no standards or protocols currently exist to deal with the handling and disposal of sediments that pose a threat of introducing unwanted species. It is anticipated that Parties to the Convention will begin working with their national and regional agencies, in concert with the Organization, to establish operational guidelines for handling, storage and disposal of sediments from ships' ballast tanks.

BOX 1

- Ballast tank sediments management schemes must be included in a ship's overall Ballast Water Management Plan as per regulation B-5 of the Convention.
- Sediments management schemes are only applicable when ships are in Party-identified ship repair yards. Treatment or removal of ballast tank sediments is *not* required during normal ballasting and de-ballasting operations.
- The Convention requires Member States to identify reception facilities for ballast tank *sediments removal/treatment only*. These are usually located in shipyards that provide ballast tank cleaning services. The Convention does not require Member States to create reception facilities for ballast water.

2

Characteristics of Ballast Sediments

2.1 BALLAST SEDIMENTS DEFINED

The composition of ballast sediments varies among ships, depending greatly on the sediment content of the ballast water taken up and the condition of the tank itself. In general, ballast sediments contain eight major constituents (FMSR 2015; Maglić et al. 2016):

1. Clay: particles 2 µm or less

Clay is derived from natural rock or soil and is typically dominated by silicate minerals with traces of metal oxides and organic matter. Depending on other constituents, clay can appear white, gray, brown or red. Clay is frequently taken up and deposited in ballast tanks due to its small particle size. Most clays exhibit a plastic behavior when wet, and dry to form hard, brittle deposits. Clay left undisturbed in ballast tanks can become compressed and difficult to remove.

2. Silt: particles 2 – 63 µm

Silt consists mostly of quartz and feldspars. Its consistency is floury when dry and slippery when mixed with water. In ballast tanks, silt is usually found suspended in water or settled as a loose layer on top of heavier sediment particles. Like clays, silt is easily taken up with ballast water.

3. Sand: particles 63 µm – 2 mm

Sand is granular with a gritty texture and usually consists of either quartz or calcium carbonate, depending on the geographic location. Particle color varies greatly, including white, brown, yellow, orange, pink, red and black.

4. Larger soil particles: over 2 mm

Larger particles like gravel are infrequently found in ballast tanks. Their uptake during ballasting usually occurs only when the suction point is close to the sea floor, or when they are suspended by water mixing and strong currents (e.g. at river mouths where fresh and saltwater merge).

5. Products of corrosion processes in the tanks and associated piping

Ballast tanks undergo corrosion over time as the metals are oxidized. Rust and other corrosion products are sloughed from the tank surfaces and fall to the bottom. Partial filling of ballast tanks can accelerate corrosion and sloughing as surfaces are exposed to more oxygen and are scoured by sloshing water as the ship is underway.

6. Parts of protective coatings

Ballast tanks are often painted with protective coatings, usually epoxy, to slow corrosion. However, when the underlying metal eventually begins to corrode, a pit or crack is formed in the paint. Small pieces of paint can become dislodged and mixed with the sediment. Like corrosion products, these coating particles are often removed by sloshing water in partially-filled tanks.

7. Non-living organic material

Ballast sediments accumulate non-living organic material when it is taken on during ballasting, or when organisms die in the tanks and sink to the bottom. Ocean water naturally contains non-living organic matter in the form of dead plants and animals, along with their molts and excretions. Some of the largest contributions of organic matter can occur when a ship takes up water containing a dense population of living organisms, such as an algae bloom.

8. Living organisms

While some organisms die in transit and contribute to the non-living organic material, others survive in ballast sediment for days or months. Bacteria, algae, crustaceans, snails, worms, fish and many other groups of organisms have been found living in ballast sediments. Because they are transported with the ship, these species are some of the most likely to invade new aquatic environments and cause environmental and economic harm. The following section provides more information and details research conducted on organisms living in ballast sediments.

2.2 LIVING ORGANISMS IN BALLAST SEDIMENTS: BACKGROUND AND RISKS

2.2.1 Ballast Sediments and Biological Invasions

Over 80% of world trade is conducted by ships (UNCTAD/RMT 2016). Increased maritime traffic and the development of new shipping routes (Seebens et al. 2013; Muirhead et al. 2015) mean that our oceans are connected more now than ever before. Part of this connection involves the transport of organisms, in ballast tanks and on ship hulls, to foreign locations where they would normally never occur. If the organisms are released and survive in the new location, they are called exotic, non-native, or non-indigenous species (NIS). Some NIS are transported to areas that lack any natural means to control their population growth, such as parasites or predators. Resilient NIS that reproduce rapidly and expand their range can become invasive and threaten native wildlife, coastal industry and human health.

Ships have a long history of transporting NIS in their ballast, carrying different organisms as the types of ballast have evolved. For example, the first invaders to the Laurentian Great Lakes were mostly plants grown from seeds transported in solid ballast. With the increased use of liquid ballast in the 20th century, non-indigenous algae and invertebrates became more abundant (Ricciardi & MacIsaac 2000; Colautti et al. 2003). After ballast water exchange regulations were implemented, the growing use of “no ballast on board” (NBOB) ships appears to have aided invasions by bottom-dwelling invertebrates (Holeck et al. 2004). The ballast tanks of NBOB ships are considered empty, but studies have shown that they can carry an average of 60 tons of sediments filled with organisms that are not flushed like ballasted ships (Colautti et al. 2003).

BOX 2

Altogether, it is estimated that over 100 million tons of sediments are being transported annually by ships (Endresen et al. 2003).

In addition to active organisms, ballast sediments can carry viable resting stages. Many aquatic invertebrates produce dormant resting stages that vary in form and can occur at different times during the life cycle of the organisms (Cáceres 1997; Bailey et al. 2005a). Cysts, eggs and other dormant stages are produced to withstand inhospitable conditions, and can remain viable through substantial changes in the environment within a ballast tank. For example, Gray & MacIsaac (2010) found that dormant eggs from freshwater zooplankton remained healthy in tank sediments despite exposure to salt during mid-ocean ballast water exchange.

In an extensive summary of research conducted by several European countries, Gollasch and colleagues (2002) reported a total of 288 species collected from ballast sediments of ships visiting ports in England, Germany, Norway, Scotland, Sweden and Wales. These studies and others have found that the diversity of species living in ballast sediments is high, and some groups are more prevalent than others. Three of the most abundant groups include bacteria and viruses, microscopic algae and invertebrates. The following sections detail the major findings from research conducted on these groups and spotlight some particularly harmful species that may be transported in ballast sediments.

2.2.2 Bacteria and Viruses

SPOTLIGHT 1

Scientific name: *Vibrio cholerae*

Photo from: Dartmouth Electron Microscope Facility

Aquatic systems contain more bacteria and viruses than any other group, making them the most transported organisms in ballast tanks (Drake et al. 2007). One of the more notorious members of this group to be found in ballast water is the pathogenic bacterium *Vibrio cholerae*, responsible for human cholera epidemics. Based on its survival in natural sediments (Hood & Ness 1982), *Vibrio cholerae* may be successfully transported, along with other harmful bacteria and viruses, in ballast sediments as well as water.

In a survey of bulk carriers arriving at Chesapeake Bay ports, Drake et al. (2007) measured the concentrations of bacteria and viruses in ballast water, residuals (sediments and associated water) and biofilms to estimate the number of organisms delivered to the estuary. Total abundances of bacteria and viruses were greatest in the ballast water portion due to its large volume. However, residuals contained the highest bacterial and viral concentrations per liter. The authors estimated that 6.9×10^{14} bacteria and 3.1×10^{16} viruses were delivered in residuals per ship.

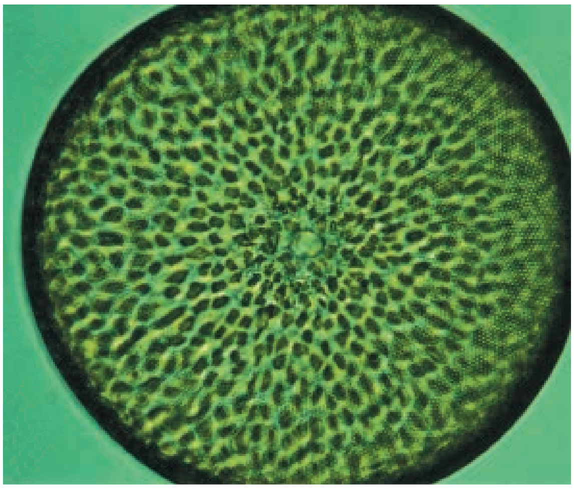
Mimura and coauthors (2008) measured colony-forming units (CFU) of bacteria collected from ballast tanks of a liquefied natural gas carrier travelling from Japan to Qatar. Bacterial samples collected from sediments and grown on agar plates in the laboratory formed over 15 million CFUs per milliliter. Colonies grew more abundantly from sediments than from water samples.

Results from these studies provide evidence that ballast sediments can be major sources of transport for bacteria and viruses. Because sediments often house such high concentrations of these microbes, it is important to manage the total volume of sediments transported in ballast tanks.

2.2.3 Microscopic Algae

SPOTLIGHT 2

Scientific name: *Coscinodiscus wailesii*



Single-celled microscopic algae, especially diatoms and dinoflagellates, are found in abundance in both freshwater and marine ecosystems. These microalgae are important oxygen-producers and food sources for a variety of organisms. However, they can reproduce rapidly under certain conditions to form dense blooms that threaten the environment, economy and human health. The diatom *Coscinodiscus wailesii* is one NIS that is transported by ballast and has formed problematic blooms in many locations worldwide.

In 1977, Boalch and Harbour reported that mucus produced by the introduced diatom in Plymouth, UK was so dense that it clogged nets and restricted trawling. Originally restricted to the tropical Pacific and western Atlantic oceans, the diatom is now globally distributed and is known to negatively impact fisheries, aquaculture and the health of native species (Edwards et al. 2001; Fernandes et al. 2001). Like many other microalgae, the planktonic *C. wailesii* produces resting cells that sink to the sediments and can remain viable without sunlight for over three months (Nagai & Manabe 1994; Nagai et al. 1995; Nagai et al. 1996; Nagai & Imai 1999). It is probable that this species and many others with similar life cycles are transported long distances in ballast sediments.

Photo by: Debra K. Gale

In a survey of sediments from ships arriving on both coasts of Canada, Villac and Kaczmarska (2011) found up to 100,000 diatoms per gram of sediment. High diatom concentrations were detected in ships undergoing transoceanic voyages with ballast exchange, as well as those moving intra-coastally with and without ballast exchange. Up to 40 species per tank were discovered, including resting stages and dividing cells. Among the inventoried diatoms were three toxin-producing species and 24 species apparently new to the coast on which they were recorded. Laboratory culture of ballast slurry (sediments and residual water) led to the growth of diatoms, including species not originally detected. Some of these cultures grew to over 16 times their original concentration in a seven-day period, providing evidence that diatoms transported in ballast sediments can successfully reproduce if released into waters where favorable conditions exist.

Villac et al. (2013) identified diatoms in ballast sediments of ships arriving at Canadian ports on the Atlantic and Pacific coasts and the Great Lakes. A total of 307 species were recorded, including marine, freshwater and brackish diatoms, some of which formed resting stages or appeared to be actively dividing. The list contained species not yet recorded in Canadian waters, including 70 species new to the Pacific coast, 60 to the Atlantic and 12 to the Great Lakes.

Hallegraeff and Bolch (1992) surveyed 343 cargo ships arriving at 18 Australian ports and showed that 65% of the ships contained significant amounts of sediments, up to 100 tons per ship. All ships contained diatoms, including the globally problematic *Coscinodiscus wailesii* and two species not native to Australian waters. Resting spores of 53 dinoflagellate species were detected, including several that were successfully germinated in the laboratory to produce living cultures. Found in the sediments of 16 ships were toxic dinoflagellates known to contaminate shellfish and pose serious threats to fisheries and human health. One ship harbored over 300 million cysts, many of which germinated in the lab to produce toxic cultures. The authors cautioned that ballast exchange is only partially effective at removing cysts in sediments, and discouraged ships from ballasting during dinoflagellate blooms.

In a study of ballast sediments collected from eight oil tankers arriving in Finland, Pertola and colleagues (2006) found microalgae in 90% of the samples. Among the list were at least 50 species of dinoflagellates, diatoms and other microalgae, all successfully germinated in the laboratory. Many species reproduced at both cool and warm water temperatures, suggesting that some microalgae transported in ballast sediments can become established in ports at multiple latitudes.

Casas-Monroy et al. (2011) sampled sediments from 65 cargo ships arriving from continental and intercontinental routes to Canadian ports in Quebec, New Brunswick and Nova Scotia. Potentially viable dinoflagellate cysts were present in sediments of all ships, but were highest in those travelling continentally without ballast water exchange. A total of 14 species were non-indigenous to Canada, including four toxic species.

In a subsequent study, the same authors (Casas-Monroy et al. 2013) investigated the abundance and diversity of dinoflagellate cysts from 147 ships visiting the east and west coasts of Canada and the Great Lakes. Differences in the abundance of cysts were seen among the ships, with the highest concentrations found in ships arriving on the east coast without prior ballast water exchange. These results demonstrate how some ships can pose a higher risk of transporting NIS than others.

2.2.4 Invertebrates

SPOTLIGHT 3

Scientific names: *Carcinus maenas and Charybdis hellerii*

Invertebrates have probably been studied more than any other group of organisms transported in ballast. Active and dormant stages of many marine and freshwater invertebrates have been found living in ballast sediments. Two of the more recognized marine invaders detected in ballast sediments are the European green crab *Carcinus maenas* and the Indo-Pacific swimming crab *Charybdis hellerii* (Gollasch et al. 2002).

The European green crab is a voracious predator that has impacted the native shellfish populations in the communities it has invaded (Grosholz & Ruiz 1995 and included references). The ability to live in a wide variety of habitats has allowed *C. maenas* to thrive in many locations outside of its native range along the Atlantic coast of Europe. The Indo-Pacific swimming crab has successfully invaded many areas, including the Gulf of Mexico, Mediterranean, Caribbean and western Atlantic Ocean from the United States to Brazil (Dineen et al. 2001 and included references; McMillen-Jackson 2008). Like the European green crab, *C. hellerii* preys on a wide variety of species and can thrive in many habitats.

Photo of Carcinus maenas from: CSIRO under license (creativecommons.org/licenses/by/3.0)

The viability of dormant invertebrate eggs was investigated using samples collected from 9 ships operating in the Great Lakes (Bailey et al. 2003). Eggs of 17 different invertebrate species were identified. Light was found to have no effect on hatching, indicating that eggs could potentially hatch in dark ballast tanks. Hatched organisms would then have a greater probability of being introduced to port waters during de-ballasting.

A survey of 39 NBOB ships entering the Great Lakes revealed that the ships carried an average of 14 tons of residual sediments in their ballast tanks (Bailey et al. 2005a). Invertebrate resting stages were found in all samples, including 76 species of rotifers, bryozoans, cladocerans and copepods. Non-indigenous species were found in 32% of ships, consisting of 21 species of rotifers and cladocerans that successfully hatched in the laboratory from collected ballast sediments.

Bailey and colleagues (2005b) found that the hatching success of resting stages was lower inside ballast tanks than under more optimal laboratory conditions. The authors submerged traps containing dormant eggs in ballast water of ships transiting the Great Lakes. Typically, less than 1% of all eggs hatched. While these results suggest that the risk of species introductions from a single port visit by one ship is small, the authors stressed that invasion risk is likely to increase as the result of the large fleet of ships undergoing multiport operations in the region. Furthermore, resting stages expelled during de-ballasting could experience more hospitable conditions that may increase hatching success.

Duggan et al. (2005) collected residual sediments and water from 38 NBOB ships entering the Great Lakes. A total of 110 species were detected from sediments in over 90% of sampled ships, with densities up to 19,911 individuals per kilogram of sediment. These species included nematodes, annelid worms, rotifers, bivalves, hydrozoans and a variety of arthropod groups. Twelve species were not indigenous to the Great Lakes, including some that were already well established.

Wonham and colleagues (2005) modelled the potential for ballast sediments to aid in the invasion of NIS to the Great Lakes. The authors focused on NBOB ships, which often contain substantial volumes of sediments and comprise over 90% of the ships transiting the region. The model simulations showed that organisms that produce dormant eggs have sufficient time, under normal ship operations, to hatch from ballast sediments and be released during routine de-ballasting. These results highlighted the need for ballast water treatment to be conducted as late as possible prior to de-ballasting to reduce the risk of releasing live organisms that may have hatched and become suspended during transit.

In an investigation of organisms collected from the ballast sediments of a ship in Poland, Radziejewska et al. (2006) found several species, including a wide variety of nematodes. The presence of egg-carrying females suggested that organisms transported in the sediments were healthy and likely to reproduce.

Bailey et al. (2007) identified 160 species from ballast sediments of 39 ships visiting ports in the Great Lakes, including 22 freshwater species not previously recorded in the region. The authors suggested that more dormant stages exist inside ballast tanks than active living organisms because conditions are not optimal. Resting stages in the sediments were also found to have reduced hatching success with the increased salinity of the ballast water. These results indicate ships that have undergone ballast water exchange at sea likely pose a lower risk of introducing NIS to freshwater ports.

Drake and Lodge (2007) sampled sediments from 41 ships in the Great Lakes that had been emptied of ballast water. A total of 34 species were found, including seven not previously detected in the Great Lakes. The authors found that the abundance and diversity of organisms in the sediments was not affected by ship age, season or ballast water age.

Briski et al. (2011) sampled ballast sediments from 19 ships visiting the Atlantic and Pacific coasts of Canada and the Great Lakes. All samples contained at least one dormant egg per gram of sediment. The degradation of eggs was monitored to determine how long these dormant stages could remain viable in ballast tanks. The authors found that degradation varied among species, but some organisms showed no visible signs of deterioration after one year. This study provides evidence that species can be transported alive in ballast sediments for extended periods of time, increasing their ability to invade new areas.

Finally, Sutherland and Levings (2013) detected residual ballast sediments in 19 out of 27 ships sampled at Vancouver, British Columbia. The authors investigated the relationship between organism abundance and a variety of factors, including the: visibility of the overlying water in the ballast tanks, voyage length and ballast water exchange. All factors affected the composition of species found in the ballast sediments. The highest numbers of NIS were found in tanks of ships travelling coastally and not undergoing ballast water exchange, representing a high invasion risk category.

3

The Role and Function of Sediment Reception Facilities

3.1 GENERAL REQUIREMENTS FOR SEDIMENT RECEPTION FACILITIES

Article 5 of the Convention stipulates that sediment reception facilities, identified by each Party to the Convention, shall safely remove and dispose of ballast tank sediments and not create any negative environmental or health effects to other states or their resources. In addition, all identified reception facilities shall undertake sediment removal from ballast tanks in a timely manner, and not cause any undue delay to ships' normal activities. Each Party undertakes to ensure that sediment reception facilities are available to all ships requesting service, as far as practicable, and notify the Organization about the location and availability of each facility.

3.2 PROVISIONS OF SEDIMENT RECEPTION FACILITIES

Sediment reception facilities will be specialized, and therefore will be designed for the specific service of removing, storing and disposing of sediments from ships' ballast tanks. These design provisions are unique, and there is not a legacy of previous designs upon which to draw benefits of experience. Based on stipulations in article 5 of the Convention, it is possible to consider general attributes that such facilities will need to exhibit. The following paragraphs outline, in general terms, fundamental considerations that should be incorporated during the design and installation of a dedicated sediment reception facility.

The design of each sediment reception facility will need to consider local, regional and national regulations governing many aspects of its operation. Like most existing shipyards, health, safety, and environmental regulations are in effect to protect workers and local environments from harm or damage during normal operations. It is important for Parties to coordinate design of sediment reception facilities with regional environmental agencies to assure implementation of effective regulatory measures intended to prevent introduction of unwanted species into the environment.

The sites that are selected for installation of sediment reception facilities should be within or near existing shipyards because this service will normally be included during other ship modifications or repairs. If such sites are not available, reception facilities should be located within or near an existing port. The site must be accessible to large trucks to transport solid and semisolid sediments from the facilities to the planned disposal sites. Because of the limitations associated with removal of sediments from ballast tanks, the process will be labor-intensive, but extensive dry docking facilities will not be required for this service. It is recommended that any reception facility be designed such that transporting vehicles (trucks) will have access near the ship and docks. If conveyor facilities are utilized, a section of the dock should be constructed so that any drainage or spillage of ballast tank sediments in the area cannot flow back into the water. Based on the limited experience of shipyards that have removed ballast tank sediments, this service is not common, and it is not anticipated that extensive sediments management procedures will increase significantly after the Convention comes into force. Therefore, sites where sediments reception facilities are constructed will generally not require extensive new infrastructure or additional permanent equipment. It is anticipated that the required equipment and labor be outsourced primarily when a ship has requested the service.

The actual collection, handling, and transport of sediments from ballast tanks will likely be a straightforward, labor-intensive process involving the physical removal of solid or semisolid sediments from the tanks and their transport to dockside collection facilities. The limited experience of shipyards that have provided this service has shown the process is most effectively managed by outsourcing collection and removal rather than attempting to make the necessary resources continually available. The safest and most effective method of physically removing sediments from ballast tanks appears to be manually handling the material in a solid or semisolid form. If pressure cleaning or liquids are added to the sediment to transport them ashore, a complex sediment separation process will be required to remove the water. In addition, the possibility of water contamination around the sediment reception facility increases if the sediments are handled as liquids or slurries. Some shipyards have found that sediments are more easily transported from a ship by cutting an access through the hull and utilizing a horizontal conveyor that securely moves the solid sediment material from the ballast tanks to facilities on the dock. The design of these reception facilities must consider the projected mass of sediments to be removed from each ship. Limited experience indicates that relatively small amounts of sediment (a few tons) are removed during a typical cleaning process. However, in regions where ships are ballasting in shallow, turbid waters, sediment loads can be much higher (hundreds of tons). It is anticipated that ships visiting the sediment reception facilities will be based within the region that the facility is intended to serve. Therefore, it is likely that ships visiting a facility will have similar sediment loads, and therefore a facility can be designed appropriately for the handling of the anticipated amount of material.

Sediment reception facilities will need the capacity to store the collected sediment on-site in a secure location. This will likely be a temporary storage area until the material can be transported to its permanent disposal site. Based on limited experience, it is anticipated that the equipment required for handling this sediment once it is in storage can be outsourced on a job-by-job basis. Some shipyards utilize sealed metal containers (dumpsters) to hold the sediments temporarily, but these may not be an optimum solution if the reception facility will be handling larger volumes of sediments. In those cases, infrastructure must be built that will prevent the sediments from contaminating the surrounding water and allow for collection and removal via mechanized equipment.

If hydraulic processes are to be utilized for removal of sediments from ballast tanks, then secured transport piping must be installed to prevent leakage around the ship or docks. Commercial vacuum apparatus could be utilized to remove liquefied sediment, but such material will need costly and continual removal by trucks. Slurried sediments could be contained in vacuum equipped trucks, but that would require excessive handling and transport due to the high water content. If a large area is available near a shipyard where sediments are being handled, it is possible that hydraulically-removed sediment could be stored safely for long periods of time, assuring that any unwanted species have been inactivated. Experience has shown that it is unlikely that large areas of land suitable for creating holding ponds will be available close to shipyards or any active port. Without these holding ponds nearby the reception facility, the slurry of sediment will need to be continually trucked offsite. Sediment reception facilities anticipating small volumes of sediments from ballast tanks could implement a secure hydraulic (vacuum) extraction system. In this situation, only limited truck hauling of sediments would be anticipated.

The intent of article 5 of the Convention is to minimize harm to the environment surrounding sediment reception facilities during construction and operation. For this intention to be realized, minimum site modifications and construction should be planned. Harm to the environment could be reduced by using a processing facility that either: (1) removed small amounts of sediments hydraulically and deposited them directly into secured trucks that left the site for permanent disposal; or (2) removed sediments without the addition of water and placed them in secure, temporary containers to be accessed by trucks for permanent disposal. The largest threat to neighbouring states and the environment from construction and operation of these facilities may occur if large holding ponds or other water treatment systems were constructed to treat slurried ballast tank sediments.

Sediment reception facilities should be designed and constructed keeping in mind issues associated with human health, worker safety, and ease of maintenance. Experience has shown that the sediment removal and handling processes in such facilities will involve extensive human resources, and rigorous safety measures are required to ensure the wellbeing of this workforce. Most shipyards around the world currently operate under governmental health and safety regulations, so these issues should be well understood for any sediment reception facilities. Extra training will need to be provided by these facilities regarding invasive species so the workforce understands the threats associated with ballast tank sediments.

3.3 TREATMENT, HANDLING AND DISPOSAL OF RECEIVED SEDIMENTS

Ballast sediment reception facilities must be designed to safely transport sediments from ships' ballast tanks to a secure disposal site, or similar area remote from the shipyard and the reception facility. It is anticipated that shipyards with ballast sediment reception facilities will not have space to create secure landfills for disposal of these sediments. It is also prudent to locate the disposal site as far from the water as possible to limit the potential introduction of NIS to the local environment. Therefore, the ballast sediment reception facilities will essentially remove sediment from ships' ballast tanks and transfer it offsite to the permanent disposal facility. Experience has shown that most of these operations will be outsourced because this service is not required on a large scale. Therefore, the reception facility itself should assure that safe and secure handling and temporary storage systems are provided to the workforce that will be responsible for transferring the sediments from the ships' ballast tanks to the remote disposal site.

Most sediment reception facilities will not provide permanent disposal of ships' ballast sentiments within the shipyard or near the port. Therefore, the reception facilities should be designed to secure sediments removed from ships for the period that they remain onsite. The facility should be designed to minimize the storage time within the shipyard or near a port. Shipyards that currently provide sediments removal services store sediment onsite for only the period of time required for testing to take place. Most operational facilities truck the sediments to landfills. Regulations for disposal in landfills require some analysis of the material to be disposed, such as toxicity and other issues that limit environmentally sound landfilling.

In cases where large volumes of sediments will be collected hydraulically from ships, some dewatering processes will likely be required within the shipyard. The design and operation of these processes will be a challenge for the shipyard, and will require new standards to be enacted by the port State to assure the treatment is removing all unwanted species before discharge of the liquid material. This approach is deemed to be the least effective sediment management technique.

3.4 CAPABILITIES OF A SEDIMENT RECEPTION FACILITY

The capabilities of any designated sediment reception facilities should be fully clarified. It is anticipated that any designated facilities will serve regional shipping interests, and therefore the dynamics of sediment loading and ship types should be relatively similar. However, because of a lack of experience dealing with this service, it will be difficult to predict the actual volumes of sediments that will need to be removed.

As noted above, it is anticipated that sediment reception facilities will utilize temporary human resources for much of the sediments extraction process. Therefore, the time required to extract the sediments will vary with the volumes to be removed. In addition, shipyards currently providing this service bring in differently-sized workforces to remove different volumes of sediments. It is anticipated that sediment reception facilities will be designed with the capacity to handle large volumes of sediments, but these facilities should anticipate that most projects will be smaller in volume.

Sediment reception facilities should have the capability of providing sediments removal services in a timely manner. Normally, ships will include this service in regularly scheduled maintenance periods for the ship, and current practice shows that this additional service does not delay the overall maintenance schedule. Reception facilities should have the capability of scheduling sediments removal projects up to one year ahead of the actual service date.

It is anticipated that sediment reception facilities will provide the service in the same manner that other maintenance services are provided in routine shipyard visits, and the ship owners will be charged accordingly.

3.5 TRAINING

Personnel involved in a sediment reception facility will require training in safety issues, similar to that of any shipyard. Most shipyards require basic safety training for any onsite workforce member. In addition to this training, separate training will be required of workers in a sediment reception facility to acquaint them with the issues associated with the transport of NIS. Educational materials and computer-based training programs should be developed to assure that all workers are informed about the challenges associated with handling sediment that may contain potentially invasive species.

4

Options for the Disposal of Sediments

The options for disposal of sediments collected at a reception facility are limited by article 5 of the Convention. Disposal of this material will be in reference to the goal of preventing transfer of unwanted species, principally into the aquatic environment. Therefore “disposal” refers to either rendering the sediments free of active biological agents, or placing the sediments in an isolated area where propagation of unwanted species is not possible.

Many shipyards actively removing ballast sediments uniformly choose to dispose of the sediments by placing them in isolated landfills far away from the marine environment. In this case, care must be taken that the sediments do not contaminate dockside facilities, or migrate back into the water during handling and storage. Once this material is shipped away from the shipyard or port, the probability of biological activity within the sediments affecting the marine environment is very low. Utilizing this approach, the sediments are routinely tested for the presence of toxic materials that might leach through a landfill and contaminate underlying groundwater. Contamination of invasive species into groundwater is not a concern, thus placing sediment in a remote landfill appears to be an effective method of permanent disposal for sediments from ships’ ballast tanks. This disposal option for the sediment effectively precludes the need for analysing sediment for the presence of potentially invasive aquatic species. In fact, such analysis would be very complex, expensive, and time-consuming, thereby delaying the process and unnecessarily detaining ships in shipyards.

The above disposal option requires that sediments be in a solid or semisolid form (material that can be handled by mechanical equipment). If the sediments are removed from the ship hydraulically, different disposal methods must be considered. If the sediments are collected in a slurry or pumpable state, directly trucking this material to a secure landfill might not be the most cost-effective method for permanent disposal. Large volumes of water must be transported in this case, increasing the cost of disposal. An option to consider would be the availability of a municipal sewer that would receive this material and treat it at a wastewater treatment plant. While some studies (Cohen 2001) have examined the ability for wastewater treatment plants to handle ballast water discharges, none to date have evaluated the possibility of treating ballast sediments. It is not likely that a municipal wastewater treatment facility would accept the sediments, unless it could be diluted before it reaches the treatment plant.

A second option for disposal of slurried sediments from a reception facility is to hold this material either in secured open ponds, or large storage tanks. This would require a major investment for a shipyard or port, and would require vacant land that is usually not available around shipyards or ports. In addition, the water phase of the slurry must be discharged either back to the marine environment or the groundwater (which is also connected to the marine environment). This means that monitoring the effluent for any possible invasive species would need to be undertaken. There are currently no acceptable surrogate analyses available to easily determine if a discharge is free of biological activity that may pose an invasion risk. Therefore, an analysis of the material would need to monitor for a broad spectrum of organisms, which would be prohibitively expensive and time consuming.

An important aspect associated with the disposal of sediments from ships' ballast tanks is that of *responsibility* or *ownership* of the material. The ship will be responsible (and liable) for the sediment until it is safely (and legally) disposed. If the reception facility accepts the sediment, and assumes liability for disposing of the material, there will be a need to draft legal contracts defining liability (which will vary globally) to protect the different parties. If the reception facility handles the sediment removal and disposal processes in the same manner as a shipyard handles repairs, the service would be contracted (paid by the ship) and the disposal phase would be part of the service. The contractors offering this service to the shipyard (billed to the ship) would be responsible for ensuring the material is transported and disposed of in accordance with local and regional regulations. The contracting parties would need to draft effective legislation governing liability associated with the disposal of ballast tank sediments.

5

The Application of Available Tools

The practice of sediments removal and disposal is not well developed around the world. It is a service currently provided by some shipyards, usually to allow for inspection of ballast tanks. Shipyards that provide the service usually outsource it to contractors, as it is not a routine maintenance procedure for most ships. Therefore, there are no tools and approaches identifiable for this procedure. It is a labor intensive undertaking and mechanization of the process has not yet taken place on a large scale.

The available tools for a shipyard-based sediment reception facility will be minimal, as most of the sediments removal and transport processes will be handled by contractors hired by the shipyard for each individual service. In most cases, the sediments will need to removed from the ship manually (by shovel), as typical ballast tanks are non-geometrical and dispersed throughout the ship. This removal process requires a significant workforce trained to work in the challenging environment of a ballast tank. Specialized tools are not utilized in this part of the sediments removal process.

The sediments removed by workers into small containers must be removed from the ship. Specialized tools could be utilized to help speed the transport of sediments to secure dockside facilities. In some instances, large containers could be loaded on board the ship and conveyors installed within the ballast tank to lift sediment up to the main deck, where it can be deposited in secured containers, removed from the ship's deck by a dockside crane and transported to the storage area via motorized equipment such as frontloading tractors. In most cases, ballast tanks are not accessible for conveyors, as they were not designed to address sediment removal as required by the Convention. However, some shipyards have utilized conveyors by cutting access openings in the ship's hull.

If the sediments are to be removed from a ship utilizing either a vacuum or water pressure, pipes may be installed to transport the liquefied sediment into secure containers. In such cases, contractors will need to provide secure, waterproof containers or trucks for transport of this liquid material offsite. While high-pressure washing and vacuum extraction has some benefits in removing sediments from hard-to-reach areas in ballast tanks, handling the extra water and disposing of it in the secure area becomes more problematic.

6

Examples of Best Management Practices (BMPs) for Shipyards with Sediment Reception Facilities

Examples of Best Management Practices (BMPs) for sediment reception facilities are discussed below, and are based on information collected during interviews and site visits to shipyards currently offering this service. The plans are not exhaustive, as little information is available on management practices for removing and disposing of sediments from ballast tanks in line with the Convention. However, this Monograph aims to present some good practices that are presently implemented worldwide.

The following examples provide detailed options for developing and executing BMPs for sediment reception facilities as required in regulation B-1.3 and Guidelines for ballast water management and development of ballast water management plans (G4), and further described in article 5 of the Convention. The tools and approaches outlined below can be implemented as resources allow in accordance with local, national and regional regulations, and through consultation with the Organization.

6.1 EXAMPLE 1: SUGGESTED GUIDANCE FOR DEVELOPING A SEDIMENTS DISPOSAL PLAN

Best sediments management practices for ports and shipyards were developed as part of the Ballast water management system for Adriatic Sea protection (BALMAS) for countries bordering the Adriatic Sea (FMSR 2015). The report evaluated current sediment cleaning services ongoing at the major shipyards bordering the Adriatic Sea. Twenty-four shipyards located in Italy, Slovenia, Croatia, Montenegro and Albania were studied, and data on sediment processing capabilities were collected.

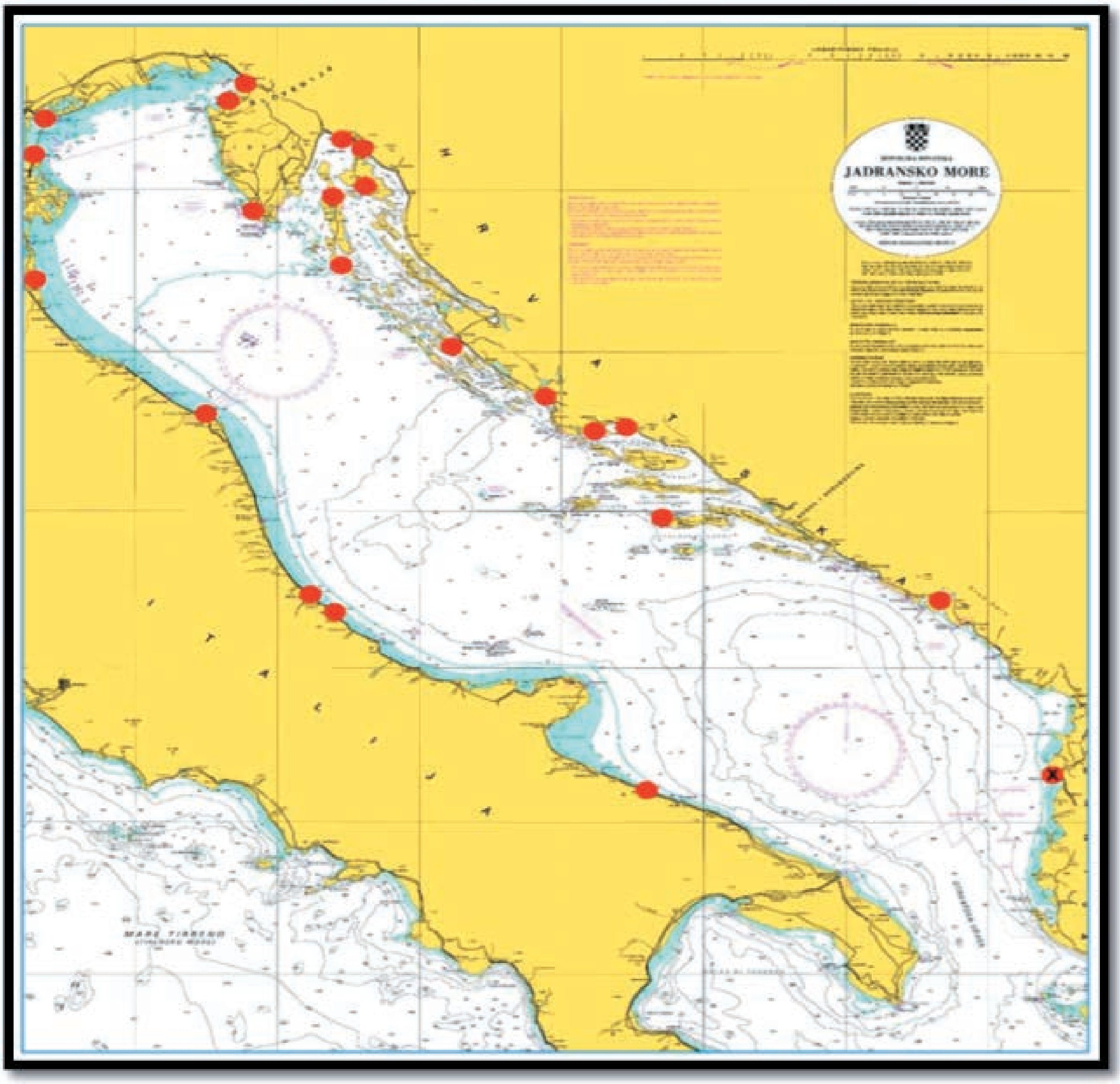


Figure 1.1 Locations of shipyards studied in the BALMAS project.

Figure 1.2 Brodotrogir Shipyard located on the Croatian Adriatic coast. This shipyard was one of the few capable of handling ships requiring ballast tank cleaning and sediments removal services.

Based on information collected from all the shipyards in this study, the following general guidelines for ballast sediments management via reception facilities were created in accordance with provisions of the BWM Convention, namely constructing and operating sediment reception facilities in the region. Their report did not differentiate between “sediment reception facilities” and “sediments disposal facilities”, and the report considers “disposal” to include reception, transfer and final disposal of sediment.

In the context of this Monograph, some language of the BALMAS report has been modified to make those BALMAS guidelines broadly applicable to facilities worldwide.

6.1.1 General Provisions

1. Sediment means any matter settled out of ballast water within ships, including solid residues in ballast tanks and residues of filtered ballast water.
2. Ships shall remove and dispose of sediment in accordance with these provisions, those of the ship’s Ballast Water Management Plan, and those of the coastal states.
3. It is prohibited to discharge sediment into the sea.
4. Sediment sampling shall be carried out before and during the disposal process if required by the authorized persons of the coastal states. The master (i.e. owner, operator, agent or person in charge of the ship) must provide ship access to any authorized person to collect sediment samples, examine documents and make other appropriate inquiries.

6.1.2 Sediment Disposal Options

1. Sediment may be removed from the ship under controlled arrangements in port or in a shipyard.
2. Sediment may be collected manually or by using appropriate and approved equipment.
3. At no time during the sediment removal and disposal process should any sediment or ballast water in the sediment be released into the sea.
4. Any sediment disposal, handling and treatment measures used shall be carried out in such a way as to reduce the risk of: (1) discharging nonindigenous species from the sediment into the sea; and (2) impairing or damaging the environment, human health, property or resources of the disposal area.
5. Each port or shipyard where cleaning or repair of ballast tanks takes place shall ensure appropriate sediment reception facilities and shall follow the Sediment Disposal Plan.

6.1.3 Treatment, Handling and Disposal of Sediments

1. Before any person enters the ballast tank, the tank shall be ventilated, and assessed for oxygen levels and the existence of any toxic or flammable gas.
2. Workers employed to conduct sediment collection, removal and disposal shall be provided with suitable personal protective clothing and equipment including at least the following:
   - protective clothing
   - eye protection
   - rubber gloves
   - rubber boots

Figure 1.3 Inside a ballast tank. Stephan Gollasch, GoConsult.

3. During sediment collection and removal, the ballast tank shall be continuously ventilated and the atmosphere monitored. If deterioration of the tank atmosphere is suspected at any time, each person working in the tank shall be equipped with a personal breathing device.

6.1.4 Sediment Reception Facilities

1. Sediment reception facilities may be temporary or permanent.
2. The sediment reception facility shall provide collection, removal and disposal of sediment in a quantity of at least 2% of the volume of the largest ballast tank on the largest ship to be accommodated.
3. Sediment reception facilities shall provide:
   - a landfill for temporary disposal of sediment
   - a location or methods for safe, environmentally responsible permanent sediment disposal
4. The ship should be informed on:
   - methods of ship-to-shore sediment transfer details
   - information required to provide, in particular the:
     - — approximate quantity of sediment
     - — moisture content, if possible
     - — plan of the ballast tanks

6.2 EXAMPLE 2: SHEDDING LIGHT ON THE ISSUE OF BALLAST SEDIMENTS

In January 2017, Gollasch and David summarized findings from several ballast sediment studies at the 6th IMarEST Ballast Water Technology Conference, London, UK (Ballast tank sediments, Gollasch, S., David, M., IMarEST BWTC, 2017). The authors presented a survey of problems associated with managing ballast sediment based on interviews conducted with tank cleaning professionals, and they proposed general recommendations for the future management of ballast sediment. A summary of their survey work is presented here.

6.2.1 Small Grain Size is a Big Problem

This survey reviewed past studies that investigated grain size distribution of sediment in ballast tanks. For example, Gollasch (1996) surveyed over 70 tanks after five years of active use. He found scattered sediments not only along the tank bottoms, but also on the frames and other support structures. Most of the deposits were silt and clay, which accumulated in layers up to 50 cm deep in some locations. In a second study, Wittling (1999) reported that nearly all the >10 ballast tanks surveyed contained at least 50% fine-grained sediments smaller than 32 µm. Similarly, Radziejewska and colleagues (2006) found that these fine grains comprised roughly 46% of the sediments sampled from ships in Poland. Filtration has been advocated as a management tool for the removal of live organisms from ballast water. However, the 50-µm filters recommended for this use would allow most silt and clay particles to pass through, ultimately reducing the sediment accumulation in tanks by only 10%.

6.2.2 Interviews with Tank Cleaners

Over 20 European ballast tank cleaners were contacted in 2016 and asked to share their experiences dealing with sediment. Interviewees recounted that environmental protection agencies and port authorities were uninformed about current sediments handling procedures. Furthermore, limited preparation was undertaken by the cleaners to deal with sediments after the entry into force of the BWM Convention. Most participants had a better knowledge of sediments dredged from port basins than from ballast tanks, and most dockyards subcontracted their ballast tank cleaning operations. The interviews also revealed some details about the sediments accumulated in tanks. The location and method of ballasting, the type and design of the ballast tanks, and the time since the tanks were last cleaned all influenced the amount of accumulated sediments. On average, ballast tanks accumulate 1-2 cm of sediments annually, comprising about 1% of their total volume. In extreme cases, some mid-sized oceanic ships can accumulate 10-15 tons of sediments after five years of active service. However, layers up to 30 cm have collected in some ships after only two years (Hamer et al. 2002).

6.2.3 Current Tank Cleaning and Sediment Disposal Procedures

In this study, it was found that sediments are routinely removed from ballast tanks by high pressure washing through the drain plugs on the tank bottom. Manual removal using a shovel and bucket is only used in cases where pressure washing is impossible. Removed sediments are not treated, and are disposed of on land per their contamination level in accordance with national legislation. Sediments highly contaminated with heavy metals and other substances are deposited at facilities that ensure they will not pollute local groundwater. Gravity separation is used to separate water from the sediments prior to disposal, and light or uncontaminated sediments are used for landfill or building material.

6.2.4 Recommendations

Ballast sediments transport large numbers of species and must be managed in addition to ballast water. The following recommendations have been proposed to adequately manage ballast sediments:

1. Shipyards should be prepared to receive sediment from ballast tanks. This preparation should include an estimate of the volumes of sediment expected for disposal, and knowledge of and adherence to the IMO Guidelines for sediment reception facilities (G1).
2. A regional dockyard network should be built to standardize sediment management strategies and avoid competition.
3. Dockyards must ensure that sediments, and water extracted from those sediments, do not enter the ocean, and that all sediment are screened for heavy metal contamination.
4. Uncontaminated sediment may be dried and used for landfill or infrastructure purposes.
5. Awareness campaigns should be conducted to inform all stakeholders (e.g. dockyard workers, ship crews, operators of sediment disposal facilities) of the problems caused by introduced species and the pollution risks associated with pollutants from sediment released into waterways.
6. Sanctions and penalties should be considered when management requirements are not followed.

6.3 EXAMPLE 3: SHIPS' BALLAST TANK CLEANING EXPERIENCE IN THE GREAT LAKES (UNITED STATES)

A site visit was carried out in December 2016 at the Fincantieri Bay Shipbuilding Shipyard in Sturgeons Bay, Wisconsin, United States, to observe current operational practices associated with sediment removal and disposal from ships' ballast tanks. The observer visited the shipyard and met with management personnel to discuss the details of sediments processing and the challenges facing the shipyard.

Figure 3.1 Ships in the Fincantieri Bay Shipyard during the winter season when the Great Lakes are closed to shipping. The shipyard usually accommodates approximately 15 ships for three months, providing all repair and system replacement services.

Figure 3.2 Dry-docking facilities at the Fincantieri Bay Shipyard in Sturgeon Bay, Wisconsin (United States).

Fincantieri Bay Shipbuilding (FBS) has provided ballast sediments removal services to ships transiting the Great Lakes since 2008. Most ships in this area are bulk carriers transporting cement, iron ore or coal. Because they routinely ballast in shallow waters, large quantities of sediments can be taken up and can accumulate in the ballast tanks. Typically, 40 to 120 tons of sediments per ship is removed during the service, which is performed on approximately 1 to 5 ships per year.

6.3.1 Purpose and Timing of Sediments Removal

The sediments removal service at FBS is performed during the winter months (December to February) when the Great Lakes are closed to shipping. The shipyard accommodates 10-12 ships during this time for maintenance and repairs. Sediments removal is routinely performed as requested and is not considered critical to the overall schedule. However, the service is usually performed early in the maintenance process so that necessary inspections and subsequent repairs can be made. Ships require sediment removal for two main reasons:

1. Ballast tanks need to be cleared for structural inspections by licensing and insurance agencies.

   In this case, total sediment removal is not always needed. Selected areas are often targeted for inspection, and small quantities of sediment from those areas can be moved to other ballast tanks on the ship.

2. The volume of sediment becomes excessive and reduces the carrying capacity of the ship.

   A reduction in carrying capacity affects the profitability of the ship, and thus the ship owners can justify the expense of sediment removal and disposal.

6.3.2 Labor and Costs

Sediments removal at FBS is subcontracted out to specialized companies that provide a workforce capable of removing sediments from ships' ballast tanks. All sediments removed from ballast tanks are solid, and no water or slurry removal is practiced. Solid sediments are removed manually by shovel and bucket and placed in lined containers in the shipyard. To reduce the amount of labor and time needed to remove sediments, FBS often uses a horizontal conveyor system installed through an opening cut into the side of the ship. Workers load sediments onto the conveyor, eliminating the need to hand-carry filled containers off the ship. This system was designed by the shipyard and was based on manure management methods practiced on local farms.

After collection, the material is sampled and analysed for selected toxic components by the local municipal government. If the sediments deemed nontoxic by their definition, they are transported to the local landfill to be used as cover material. To date, no toxic components have been detected in sediment collected by FBS. Care is taken during the handling and transfer of the sediment to assure that no sediment material collected from a ship is discharged back to the Great Lakes. Discharge of this material into the water (Great Lakes) is prohibited both by water quality standards, e.g. Federal/State regulations on suspended solids, and Federal regulations governing the introduction of invasive species. There are no regulations in place regarding invasive species that govern the management of the collected sediments that are transported offsite for land disposal.

FBS arranges for sediments removal with the subcontractor, and all incurred costs are billed directly to the ship that requests the service. It is the position of FBS that the sediments removed from a ship remain the responsibility of that ship, and the shipyard is being paid as a contractor to remove and transport the sediments to a designated disposal site.

6.3.3 Training

1. Personnel in charge of sediment reception facilities should receive training, including information on international and national provisions of BWM and the principles of the BWM Convention, risks to the environment and human health associated with the sediments disposal process, equipment and processes used for sediments collection and disposal, the ship/port communication interface and local disposal requirements.

2. Personnel employed for sediments disposal shall receive adequate familiarization with safety procedures, human health risks and use of personal protective clothing and equipment.

3. The managing authority of the shipyard should ensure adequate training and familiarization for personnel involved in sediments disposal.

BOX 3
SUMMARY OF FINDINGS

- Shipyards that currently offer ballast tank cleaning services have no experience with procedures to handle the sediments in line with the BWM Convention (invasive species).
- Sediment volumes in ships' ballast tanks are highly variable, but ballast tank cleaning services are not often requested in existing shipyards.
- Most existing shipyards contract out ballast tank services to specialized companies who provide the temporary labor force to remove sediments from ships.
- Most sediment material found in ships' ballast tanks is composed of fine-grain particles (< 35 µm). Therefore, utilizing filtration as a BWM treatment scheme will not preclude sediment accumulation in ballast tanks unless the filters can remove particles less than approx. 35 µm.
- Most routine cleaning of ballast tanks (light sediment build-up) is performed by ships' crews while at sea using some form of hydraulic washing.
- Most heavy ballast sediment removal in shipyards is performed using manual labor, i.e. physically digging out sediments and hauling them off the ship.
- One solution to reduce sediment build-up in ballast tanks for ships that ballast in shallow water areas is to move the water chests higher in the ship.

7

General Guidance for Establishment of Sediment Reception Facilities in accordance with the BWM Convention

7.1 THE BEST MANAGEMENT PRACTICE (BMP) OBJECTIVE

When a ship arrives into either a wet slip, dry dock or marine railway of a sediment reception facility, sediments in the ship's ballast tanks must be removed, securely stored in the shipyard for testing (required by regional, national or local environmental agencies), then transported to the permanent disposal site. Discharge of ballast water sediments into local waters is prohibited. Therefore, some means must be provided to remove sediments from ships and safely dispose of them where transfer of unwanted species from the sediments to the aquatic environment cannot occur.

7.2 BMPS FOR SEDIMENTS DISPOSAL PLANS, FOLLOWING G1 GUIDELINES

1. Each port or shipyard where cleaning or repair of ballast tanks takes place shall ensure appropriate sediment reception facilities and shall develop and follow an approved BMP for operation of the facility.
2. Workers employed to remove sediments from ships' ballast tanks shall undergo training to educate them about the issue of invasive species, and why sediment removal from ballast tanks is an important link in the process of preventing the transport of NIS. This training should take place in conjunction with training about hazardous environments and possible toxic compounds on a ship or in a shipyard.
3. Sediments may be removed from a ship under controlled arrangements in a shipyard designated as a "sediment reception facility" by a Party to the Convention.
4. Sediments may be collected from ballast tanks manually or by using appropriate and approved equipment.
5. Any sediments disposal, handling and treatment measures used shall be carried out in such a way as to reduce the risk of: (1) discharging nonindigenous species from the sediment into the sea; and (2) impairing or damaging the environment, human health, property or resources of the disposal area.
6. At no time during the sediments removal and disposal process should any sediment or ballast water in the sediment be released into the waters near the shipyard directly, or in areas of the shipyard where they could accidentally be transported into the surrounding water.
7. Before any person enters the ballast tank, the tank shall be ventilated, and assessed for oxygen levels and the existence of any toxic or flammable gas.
8. Workers employed to conduct sediment collection, removal and disposal shall be provided with suitable personal protective clothing and equipment including at least the following:
   - protective clothing
   - eye protection
   - rubber gloves
   - rubber boots
9. Shipyards should remove sediments as a "mud" with shovels, if possible, to prevent loss of material into the surface water in the shipyard.

10. Shipyards should provide conveyors to carry the excavated sediments up from the ballast tanks to the dockside facilities. Access holes may need to be cut in the ships' hull for these conveyors.

11. Sediment reception facilities should provide completely sealed storage areas (or containers) to hold the sediment for up to a week to allow time for sampling by regulatory agencies. The areas should be sized to accommodate the volume of sediments expected from a typical ship operating in the region, and should have easy access for mechanized equipment to load the sediments and transport them to the disposal site.

12. Sediment *disposal* sites should be located as far from the coast (or a river) as possible, to minimize the possibility of introducing unwanted species back into surface waters.

13. No surrogate or reliable analysis currently exists to test sediments for the broad spectrum of possible invasive species. Therefore, sediment testing will likely focus on toxicity, as required by most landfills.

14. Sediment reception facilities should develop a regional or national agreement defining the responsibilities and liabilities associated with each stakeholder listed in the Sediment Disposal Plan. The ship will have responsibility for the sediments, and the reception facility (shipyard) will simply provide a service to remove the sediments and arrange for transport to a disposal site. The shipyard will not have any liability for the material (unless there is leakage in the yard), but the disposal site will need some sort of liability agreement with the ship to accept responsibility for the sediments. Such agreements could be created in consultation with the Organization.

15. Shipyards associated with sediment reception facilities should provide (and market) retrofit services to relocate sea chests higher in ships that operate in shallow or highly turbid waters. Moving ballast intakes higher in a ship has been shown to be an effective adjustment to limit sediment build-up in ballast tanks.

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Annex

Template for Creating a Sediment Reception Facility

A comprehensive, workable, and sustainable plan for creation and operation of sediment reception facilities is required by the BWM Convention. The following is a template of steps to follow when addressing the general requirements for sediment reception facilities (see G1 Guidelines), including suggestions drawn from findings in this Monograph.

1. Sediment reception facilities should be designed and located within existing shipyards. However, if such enterprises are not available, then sediment reception facilities could be established within existing ports. Most ballast tank sediments cleaning services do not require that ships be placed in dry-dock. Therefore, expensive infrastructure does not need to be created for this service.

2. Any sediment reception facility should be designed based on the expected ship types that will be utilizing the facility and the requirements the ships would have for ballast tank cleaning.

3. The following details concerning the operation of the planned sediment reception facility should be determined and made available to any ships that could utilize this service:

   3.1 The amount of dockage available for ships requiring ballast tank cleaning services, and the anticipated length of time a ship would be required to be in the facility.

   3.2 The maximum amount of sediments (volume or weight) that the facility could handle at any one time.

   3.3 The types of sediments removal processes that are available at the facility, and any expectations of ships crew while in the facility.

   3.4 The procedure for requesting ballast tank sediments removal services, and the anticipated wait-list time for the services to be rendered.

   3.5 An accurate listing of all applicable fees associated with this service.

4. A determination of all regional, national and local legislation and regulations that will affect the design, construction, and operation of the facility will need to be determined during the planning phase, including:

   4.1 The equipment (if any) that will be installed to offload sediment from the ships.

   4.2 Waterway access to the facilities, including approaches, turning basins and interaction with other ships.

   4.3 Collection, handling and storage, and transport of the sediments to the permanent disposal site.

   4.4 Sampling, testing and analysis of the sediments to determine if there are any quality limitations associated with their permanent disposal.

   4.5 The effect on the environment due to construction and operation of such a facility.

   4.6 Health and safety issues associated with operation of such a facility.

   4.7 Training requirements for facility staff, employees, and contracted temporary workforces.

4.8 A formal environmental impact assessment of the facility to estimate overall environmental benefits and costs.

5. A detailed plan should be drafted addressing disposal, handling, and treatment measures that will be applied to collected sediments to avoid unwanted side effects that could create damage to the local and regional environment, human health or regional resources.

6. All personnel associated with the sediment reception facility should receive adequate training about possible risks to human health associated with processing sediments from ships' ballast tanks. All personnel should receive suitable protective clothing and equipment to prevent any possible contamination from processed sediments.

6.1 Personnel training should utilize prepared educational materials. These training materials should describe the purpose and principles of the BWM Convention and clearly describe all risks associated with the handling of sediments from ships' ballast tanks. The training should provide a sufficient understanding of the types of ships utilizing the facilities and any operational constraints associated with removing sediments from ballast tanks. The training should also fully describe local controls on the disposal of sediments, and laws and regulations in place to prevent discharge of this material into the environment.

6.2 Personnel training should be formally organized by the manager of the sediment reception facility, and be delivered by qualified professionals.

More Information?

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