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Ballast Water Management Systems (BWMS) and their effects on the survival of various microorganisms and how BWMS can stop the spread of invasive species.

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Introduction

Landing is a structural function of ships, in order to adjust their stability, sinking and displacement on the sea water, when they travel without cargo. In the past, ships used to use more conventional means of ballast, such as stones, scrap metal and sandbags, to achieve their balance (Edgar, 2009, pp. 4-5). In contrast, modern ships fill their special tanks, the so-called fore and after peak, with seawater, which are designed to achieve the stability of ships when the ship is traveling unladen. More specifically, ships are filled with seawater after unloading their cargo at the ports of arrival and then begin to discharge the ballast water, so as to reload cargo from other ports (Globallast, 2014).

For many decades, there has been a really serious pollution problem due to the ballast process, as through the ballast seawater, a large number of living organisms are transported from the landing to the port of shipment. Despite the fact that they are really difficult conditions for the living organisms that existed in the ballast tanks, usually a small percentage of them managed to survive and invade their new environment (Braathen, 2011, p. 20). Considering that one cubic meter of seawater contains about 50,000 different microorganisms, each ship needs about 30-50% of its DWT in ballast, so that it can sail unloaded and an additional ten billion. tonnes of ballast are transported annually around the world. However, it is obvious that this process incites the transfer from place to place of billions of organizations, causing problems with great socio-political and economic impact on local communities (Rigby G.R. et-al., 1999, p.189). In fact, this problem is related to other human activities, which burden the marine environment. Intensive fishing activities, in particular trawling, overfishing leading to the extinction of natural predators, as well as wider pollution and pollution of the environment have increased the vulnerability of marine ecosystems, making it easier for Alien Invasion Species (AIS) to invade ballast water. In fact, it is argued that the most important cases of foreign species invasion (AIS) occur along the routes of larger ships, in intensively overfished and contaminated areas (Ahlenius, 2008, p. 12).

The International Maritime Community (IMO) and related environmental organizations are aware of the problem and suggest that shipowners have specific ballast water management facilities to eliminate the AIS phenomenon before they are disposed of. at the sea. To date, however, many studies and tests have been carried out in parallel with the relevant regulations that have been provided, to complete the necessary procedures for the development of the Ballast Water Management System (BWMS) (Ballast Water Management Systems) that will be installed on ships (IMO). , 2004, p. 1), (Glo-ballast, 2014). This paper aims to assess the Ballast Water Management Systems (BWMS) and their effects on the survival of various microorganisms and how BWMS can stop the spread of invasive species.

Chapter 1: Ballast Water Management Systems

The IMO Ballast Water Convention stipulates that ballast management is carried out by exchange, processing, or disposal at special facilities in ports. The basic idea of ballast water management is to remove harmful aquatic and pathogenic organisms by mechanical, physical, chemical or biological methods.

The following important factors must be taken into account when preparing the ballast management plan:

Coastal organisms released into the high seas or mid-ocean generally do not survive and vice versa.

Chemical management can kill organisms in ballast water and thus, chemical dosing in ballast tanks is a candidate method.

Freshwater organisms do not survive in salt water and vice versa.

Ballast water over one hundred days old is in a low risk category, as the lack of light, nutrients and oxygen in ballast tanks generally kill microorganisms.

For ships traveling on short voyages and unable to exchange ballast water, dumping at reception facilities on the shore is another solution.

New methods such as heat management, filtration, disinfection and UV management may be considered.

Ballast water intake should be avoided in the dark or at night as the organisms at the bottom rise to the top.

Ballast water intake should be avoided in shallow water and where the propellers may stir the sediment.

Water intake near wastewater and industrial waste should be avoided.

Water intake from herpes should be avoided where there is an outbreak of phytoplankton and when there is a known outbreak of disease transmitted by ballast water (Carlton, 1985).

1.1 Ballast exchange

Ballast Water Exchange (BWE) ballast received at the port of origin is replaced by ocean water during the voyage. The Ballast Water Exchange Plan (BWEP) is the procedures and advice for safe and efficient ballast water exchange in accordance with applicable requirements. This exchange prevents species from moving, because most of the organisms contained in ocean waters cannot survive in the coastal port environment. There are different conditions in seawater characteristics between coastal and high seas, such as salinity and water temperature, that affect photosynthesis. These differences can make it difficult for organisms to survive in the ship's ballast tank. The exchange of sea ballast must take place in the middle of the ocean or at least 200 nautical miles from the shore and in a location where the water depth is at least 200 meters or more.

Shipowners / operators who have chosen to operate with the BWE as a BWM method must meet the following requirements: 95%, containers using flow or dilution methods must pump three times the volume of each ballast tank; triple volume, documentation and detailed studies confirming this possibility for evaluation must be submitted, as well as annexed to the BWM project (IMO, 1997).

There are three different methods of exchanging sea ballast:

Sequential: In this method the ballast tanks are cleaned from the coastal waters and then exchanged with ocean waters. Margins for stability and resistance to all marine conditions must be provided, as well as stability, longitudinal strength, relaxation, wave-induced ripple vibration and overpressure when selecting the successive method for ballast exchange. / vacuum, stern / bow drawings, propeller sinking and bridge visibility.

Flow method: In this method, water is channeled into the tank and allowed to overflow through the ventilation or special overflow air ducts. The tank volume must be pumped three times to carry out the exchange at 95% efficiency. The flow method does not typically change stability, however, in cases where stability changes, a summary ballast sequence table must be submitted, proving that sufficient strength and stability has been maintained. As the flow method is not suitable for all tanks, they should be evaluated on ships using safe pumping procedures, the size of the overflow component, the graphs and / or tables showing the pumping rates, volumes and time required to exchange marine ballast in each reservoir, pipes and appliances involved in the exchange of marine ballast by the ship's crew; from each other and the installation of additional air ducts, internal overflow pipes (to prevent overflow on the deck) or the connection of pipes between the tanks, where possible.

Dilution method: In this method the tank has two openings, where water is pumped from one opening and at the same time flows out of the other with the same flow, maintaining a constant level in the tank throughout the ballast exchange operation. Ballast, which is approximately three times the capacity of the tank, must be pumped through the tank to achieve 95% efficiency in the elimination of aquatic organisms. With the outflow of water from the bottom of the ballast tanks, the sediments are removed more easily, while the use of ventilation ducts to drain the water above the deck is avoided. If the dilution method is used, the BWMP must indicate the adjustments made to automatically maintain the ballast water level at a constant level, the high and low water level alarms provided when maintaining a constant level in the tank is necessary to operational performance of the ship during ballast exchange duration and arrangements including the provision of a manual shut-off system for any ballast operation pump in the event of a valve malfunction or incorrect control measures. As with all methods, it must be completed and forwarded to the next port where the ballast is discharged (Castro et al., 2013).

Marine ballast exchange systems must comply with the IMO regulations and guidelines set out below:

• The International Convention on the Control and Management of Ship Ballast and Sediments, 2004.

• IMO Resolution MEPC.124 (53), "Guidelines on the exchange of water resources (G6)", adopted on 22 July 2005.

• IMO Resolution MEPC.127 (53), "Guidelines for the Management and Development of the Marine Ballast Exchange Plan (G4)", adopted on 22 July 2005.

• IMO Resolution MEPC.149 (55), "Guidelines on the design and construction standards for a water-ballast exchange system (G11)", adopted on 13 October 2006.

• IMO Resolution MEPC.150 (55), "Design and Construction Guidelines to Facilitate Sediment Control on Ships (G12)", (2006) .

Each ballast exchange method has specific aspects that must be taken into account when choosing the methods to be used in a particular type of ship. The degree to which a ship fits the sequential method, the flow method or the dilution method depends on its design and age. In addition, the loading conditions of the ship for the selected method of sea ballast exchange must be analyzed and calculations performed to prove that the loading conditions meet the applicable requirements (Castro et al., 2013).

The disadvantages of this method are the difficulty in completely removing sediment and residual water from the bottom of the ballast tanks and the organisms that stick to the sides of the tank, as well as the fact that during rough seas it is dangerous for a ship attempting to discharge ballast from ballast tanks. On the other hand, the advantages in the exchange of sea ballast are that the ship is on the way so that not much time is lost during the voyage. Also, no add-ons are required equipment, nor special handling of the process, thus minimizing costs. It can also help control by the Port Authority, because the exchange of ballast in the open ocean can be detected more easily, because the waters have higher levels of salinity than coastal waters (Castro et al., 2013).

1.2 Ballast Management Systems

The implementation of ballast management systems has already begun, as there are many ship managers who want their ships to comply with IMO requirements. There are many technologies involved in ballast management systems. In any case, we must take into account some parameters in order to decide which system is suitable for the ship. Some key factors to consider are the effectiveness of the ballast bodies, how environmentally friendly they are, the safety of the crew, the cost, the ease of installation and operation, and the space available on board. There are many different types of ships that carry sea ballast and therefore there are big differences in the systems. A typical on-board ballast management system uses two or more technologies together to ensure that the ballast management is carried out in accordance with IMO standards (IMO, 2004).

The main types of marine ballast management technologies available on the market are:

• Filtration systems (physical processing)

• Chemical disinfection (oxidizing and non-oxidizing biocides)

• Ultraviolet radiation

• Deoxygenation

• Heating (heat management)

• Acoustic (cavitation)

• Electric pulses

• Magnetic field

1.2.1 Natural Separation / Filtration Systems for ballast management

Natural separation or filtration systems are used to separate marine organisms and suspended solids from ballast using sedimentation or surface filtration systems. Suspended / filtered solids and waste from the filtration process are either discarded in the area from which the ballast is taken or further treated on board prior to disposal. A disadvantage of filtration is that it requires specialized equipment, which has high purchase and installation costs. The cost of filtration increases, the smaller the organisms that need to be removed from the ballast. The following equipment is mainly used for the filtration of the sea ballast (Simpberloff et al., 2013):

Screens / Trays: Screens (fixed or mobile) or trays are used to effectively remove suspended solids from the ballast by automatic washing. They are extremely environmentally friendly, as they do not require the use of toxic chemicals. Screen filtering is effective in removing suspended solids of larger size, but it is not very convenient for removing particles and organisms of smaller size. However, it has been observed that although it is an extremely effective method in removing the majority of suspended solids and organisms from marine ballast, it is not sufficient for management according to IMO standards (IMO, 2004).

Hydrocyclone: A hydrocyclone is an effective equipment for separating suspended solids from aqueous ballast. A high-speed centrifugal force is used to rotate the water to separate the solids. Since the hydrocyclone has no moving part, it is easy to install, operate and maintain on ships. It has been found that since the operation of the hydrocyclone depends to a large extent on the mass and density of the particle, the removal of smaller organisms is not achieved.

Coagulation: As most of the natural filtration methods are not able to remove smaller solid particles, the coagulation method is used before the filtration process to join smaller particles together to increase their size. As the particle size increases, the efficiency increases during the aforementioned filtration processes. One such process involving coagulation of smaller particles into small masses is known as flocculation. Some seawater management systems, using thrombosis and flocculation, use auxiliary powder (eg sand) or coarse filters. This process requires an additional tank and thus extra space on the ships is necessary.

Filters: Natural ballast management systems with filters can also be used to filter small particles. Rubber filters have been found to be more suitable for use on board due to their compact size and lower density compared to conventional granular filtration systems (IMO, 2004).

1.2.2 Chemical Disinfection Systems (Oxidative and non-oxidizing biocides) for ballast management

Biocides (oxidizing and non-oxidizing) are disinfectants that have been tested for the possible removal of bio-invaders from the ballast. Biocides remove marine organisms from ballast. However, it should be noted that biocides are used for disinfection Ballast water must be effective in marine organisms and must also be easily degraded or disposed of to prevent discarded water from becoming toxic to the environment. Based on their functions, biocides are mainly divided into two types, oxidizing and non-oxidizing (USCG, 2017).

Oxidizing biocides: Oxidizing biocides are generally disinfectants such as chlorine, bromine and iodine, used to inactivate organisms in marine ballast. This type of disinfectant acts by destroying the organic structures of microorganisms, such as the cell membrane or nucleic acids. Some of the processes that use oxidizing biocides are chlorination, where chlorine is diluted in water to destroy microorganisms and ozonation, where ozone gas using an ozone generator is channeled to the ballast. Ozone gas decomposes and reacts with other chemicals to kill organisms in the water. Other oxidizing biocides such as chlorine dioxide, peracetic acid and hydrogen peroxide are also used to kill marine organisms (USCG, 2017).

Non-oxidizing biocides: Non-oxidizing biocides are a type of disinfectant that when used interferes with the reproductive, nervous or metabolic functions of organisms. There are many non-oxidizing biocides on the market, however, only a few such as Menadione and Vitamin K are used in the ballast management system because they tend to produce toxic by-products. Many researches are carried out in this field, in order to enable the use of non-oxidizing biological substances in the management of ballast (ABS, 2014).

1.2.3 Ultraviolet Radiation Systems for sea ballast management

The ultraviolet ballast management method consists of UV lamps surrounding a chamber through which ballast water is allowed to pass. Mercury lamps produce ultraviolet rays, which act on the DNA of organisms, making them harmless and preventing them from reproducing. This method has been used successfully for the purpose of filtering drinking water and is effective against a wide range of organisms. It requires good propagation of UV radiation in water to be effective, ie it needs clean water and quartz pipes without biopollution and is enhanced in combination with ozone, hydrogen peroxide and titanium dioxide. A disadvantage is that there are molecules in the ballast, which are immune to UV management (ABS, 2014).

1.2.4 Marine ballast management deoxygenation systems

The method of ballast management with deoxygenation involves the cleaning and removal of oxygen from the marine ballast tanks, in order to cause suffocation in the organisms. This is usually done by injecting nitrogen or any other inert gas into the space above the water level in the ballast tanks and typically takes 2-4 days. Thus, this method is usually not suitable for ships that have a short cruising time. Also, due to the reduction of oxygen, the tendency for corrosion of the sheet metal of the tanks can be reduced. If an inert gas generator is already on board, the application of the method requires little extra space. The deoxygenated ballast is placed in specially sealed tanks (ABS, 2014).

1.2.5 Sea Ballast Heat Management Systems

This management involves heating the ballast to reach a temperature that will kill the organisms. A separate heating system can be used to heat the marine ballast in the tanks or the ballast can be used to cool the ship's engine, thus disinfecting the bodies from the heat generated by the engine. However, such a management can take a long time before the organisms become inactive, resulting in increased corrosion in the tanks. Initially seawater is pumped in to flush the ballast tanks. It is then heated and pumped from ballast tanks, where it kills many organisms. After this management the marine ballast is discarded. The main disadvantage of this method is that it requires a special installation with piping to transfer the marine ballast to the system of the ship's engines, where the heat is generated. In some cases, it is necessary to have a filter to retain the dead organisms before the ballast is released. The ballast temperature is affected by the ambient water and so this method may not be efficient in colder waters because more energy will be required to raise the ballast temperature to the most necessary (ABS, 2014).

1.2.6 Acoustic ballast management systems

Ultrasound is used to produce high-energy ultrasound to kill the cells of organisms in the ballast. Such high pressure water cavitation techniques are generally used in conjunction with other systems. Reducing water pressure either by ultrasound or by gas injection leads to the formation of bubbles, which strain the cell membranes of organisms. It is characteristic that it does not create dangerous by-products and is useful as a pre-management (ABS, 2014).

1.2.7 Marine ballast management electrical pulse systems

The electric pulse for ballast management is still under development. In this system, energy is used to kill the organisms in the ballast. Electric pulses can be channeled into the ballast and kill most organisms. The risk to the crew, as well as the cost and size of the equipment required to produce these pulses, is the major drawback to this method of marine ballast management (ABS, 2014).

1.3 Magnetic field systems for marine ballast management

Magnetic forces have been shown to kill certain invertebrates, such as mussels, in laboratory tests. Magnetic field processing uses coagulation technology. The magnetic powder is mixed with the coagulants and added to the ballast. This leads to the formation of magnetic flakes, which include marine organisms. Magnetic disks are used to separate these magnetic clusters from the water (ABS, 2014).

1.4 Selection of Marine Ballast Management System

When choosing a ballast management system, the following factors must be taken into account: the type of ship, the mode of operation of the ship, the maximum and minimum degree of ballast and unloading, the ballast capacity, the required space, its flexibility location of system components, effects of pressure drop, connection to existing systems, if the system is certified safe, power availability, health and safety, impact on tank structure, availability of consumables, spare parts and maintenance support, additional crew workload, crew training, capital costs, operating costs and system availability and delivery time. Particular attention should be paid to hazards and safety factors with the storage and handling of hazardous chemicals used in various chemical processes in the available ballast management systems, such as chlorination, electrochlorination, ozonation, carbon dioxide, carbon dioxide. hydrogen, menadine / vitamin K and perchloric acid. Tips on storing and handling chemicals are contained in IMO Circular, BWM.2 / Circ.20 - Guidelines for Safe Management and Storage chemicals and preparations used for the management of ballast water and for the development of safety procedures for hazards to the ship and crew resulting from the ballast management process. It should also be noted that some processing systems use or produce one or more active substances used in the processing. In addition, some systems require the use of a neutral agent to ensure that all active substance residues used in the management process become safe when the ballast is disposed of (ABS, 2014).

In a newly built ship, the possibilities of installing marine ballast management systems during its design and construction should be determined, while in existing ships, modifications are required to adapt the management systems. The system manufacturer, for his part, must confirm that the system has sufficient capacity to meet the maximum ballast requirements, to inform about the electrical requirements of the system, the types of technology used in the system, the required chemicals and the their consumption rates, health and safety issues regarding the working environment, handling and storage of chemicals, protection systems for normal and emergency operation, training requirements for the operation of the system, work plan for installation, to state the effect that the treated ballast will have on the structure of the ballast tanks, an estimate of the reduction of the ballast / desalination rate of the ship after the installation of the management system and a description of any measures to be taken (ABS, 2014).

Chapter 2: Marine environment and bio-invasions

2.1 Introduction

The vast area covered by the oceans is home to a variety of organisms. Life, as far as we know, first appeared in the sea and so the study of the marine environment explains life in general. Life at sea can provide human prosperity, as it provides us with food, medicine and raw materials, but it can also cause problems for humans with these organisms that cause disease or attack. Marine organisms produce almost half of the oxygen we breathe and affect the earth's climate. For the prudent use of marine resources, the impact of human activities on the marine environment must be mitigated.

Life in the ocean consists of microorganisms, macroalgae, plants, invertebrates, fish, reptiles, birds and mammals. Microorganisms live everywhere in the ocean in great variety. They are very important in many marine environments, as they are, directly or indirectly, food for most marine animals. These include viruses, prokaryotes, single-celled algae, protozoa and fungi. Most seaweed is what is widely known as a macroalgae and plays an important role in many coastal environments, as it converts light energy into organic matter, making it available to other organisms for food. Other organisms may even live on or within the tissues of macroalgae. Flowering plants are land-dwelling plants, but some of them also live in the sea. They are not real marine organisms, as only their roots are covered by water. Many flower plants are found in coastal areas, but they can not survive in their immersion in seawater (Lloyds, 2016).

Invertebrates make up at least 97% of all animal species. This species includes sponges, urticaria, comb-bearers, bilateral-symmetrical worm-shaped animals, mollusks, arthropods, hilly animals, partridges, echinoderms, cordless and cordless. Fish are vertebrate organisms, with complex behaviors related to their adaptation to light, currents, finding food, shelter and avoiding their predators. One of their characteristics is that many of them do not live in a specific area, another that they form herds and migrate, making regular mass movements from one area to another. Sea reptiles, which include, among others, sea turtles and sea snakes, breathe in the air. Sea turtles, although they move slowly on land, are very fast swimmers. Sea snakes, on the other hand, are not very fast swimmers. The metabolic rate of marine reptiles varies with temperature and therefore they do not live in cold areas (Lloyds, 2016).

Seabirds spend a significant part of their lives at sea and feed on marine organisms. They feed on fish, squid, benthic invertebrates, but also some species consume plankton. Penguins, pelicans and gulls with their related species and waterfowl belong to this species. While seals, sea lions, sea horses, sea otters, sea otters, polar bears, sea cows, whales, dolphins and seals are marine mammals. Many of them make seasonal migrations or travel to find food (ABS, 2014).

Each environment has different characteristics, which are challenges and opportunities for the organizations that live there. Organisms are also affected by other organisms, ie the living or vital part of the environment. In this way there is interdependence of the organizations that live in a community. Under favorable conditions, organisms produce far more offspring than they need to replace lost individuals. Thus the population is growing more and more, creating a population "explosion". As more and more people enter the population, they deplete their natural resources, leaving them with insufficient resources to support more people. Organizations have to compete for resources and this is competition between members of the species but also with members of other species. When two species use the same resource and this resource is deficient, they compete as if they were members of the same population. Almost always one of the two species manages to be a little better in the competition and that is what dominates. There is also the prey-prey interaction, as they can use each other as a resource. Still other organisms may feed on plants. With predation, the prey population as a whole is affected, due to the reduction in the number of its individuals (ABS, 2014).

Physical and chemical conditions vary from place to place, resulting in different parts of the ocean hosting very different communities. The most simple discrimination has to do with where they live. Benthic organisms are those that live on or under the seabed and pelagic organisms that live in water levels far from the seabed. Pelagic organisms are distinguished by those that swim weakly or not at all, plankton and animals that can swim quite well, the nycton. The organisms that make up plankton are transported by currents. Planktonic plants and other tiny autotrophic organisms are called phytoplankton, while heterotrophic plankton is called zooplankton. Most ruminants are vertebrates, mainly fish and marine mammals. However, there are some rodent invertebrates, such as squid (ABS, 2014).

Biodiversity, that is, the diversity of life, faces the risk of extinction, as human activities lead species to extinction at a rate unrelated to the extinction of species from natural causes. Humans have an impact by modifying the marine environment, with water quality declining, communities of marine organisms being severely affected and the risks to human health constantly increasing. Deliberate or accidental introduction of non-native species, also known as invasive or exotic species, into areas that are not areas of their natural geographical distribution can have catastrophic consequences, such as reducing the number of native species. Non-native species, in addition to carrying parasites, which can infect native species, are often very strong competitors for food and space. In recent decades there has been an increase in the incidence of non-native species and an important factor is the development of navigation and the transport of organisms through the ballast of ships. It is estimated that approximately 84% of the world's shores have been invaded by non-native species, which in most cases is accidental (Kelly & Magure, 2008).

2.2 Bio-invasion: effects and management

Bio-invaders are a pervasive component of global change. The effects of a bio-invasion can jeopardize biodiversity and natural resources. There are cases where the consequences they may have exceed the initial estimates. In such cases the issue arises on complete elimination of bio-invaders or their reduction with some percentage still existing in the new environment. The effects are mainly on the environment, regardless of how they affect humans. A population that appears in a new environment, intentionally or by human error, is likely to be able to multiply with great frequency, in relation to the number of bio-invaders that first appeared in the area. An attempt is being made to solve this problem through the development of technology and the creation of new regulations of national or international scope for the prevention of bio-invasion. The issue of "xenophobic" management is raised, of course, as views on ecology, the social sciences, resource management, economics and the science of bio-invasion clash over the issue of bio-invasion. However, the measures are taken because the probability of having a negative impact on the ecosystem and / or humans, is greater when we have a bio-invasion of an environment than it happens from local organisms.

It is difficult, in many cases, to assess the effects of the bio-invader. In order for there to be an ecological impact, it is necessary to make any significant change to an ecological process. The same bio-invasion can be characterized differently by separate groups of people depending on the results it brings to each. For some it can bring positive results, while at the same time it can bring negative effects to others. Similar ambiguous results can be created in terms of the ecosystem and the changes they bring to it. Many cases of bio-invasion aimed at conserving a particular species can have negative effects on other species. Similarly, the effects that can be perceived as negative on an ecosystem, people can perceive them as positive in terms of their activities. That is, when assessing an impact of a bio-invasion, it is preferable to consider the full range of ecological, economic and social consequences (Vickerson, 2007).

Another characteristic of bio-invaders is the difficulty in locating their effects. Some effects are obvious, but some extremely important effects are not immediately apparent. For example, 69% of aquatic species imported into six European countries have had some impact on the environment. However, such a percentage, as in similar cases is underestimated, as many impacts are small or in an inaccessible habitat and can be characterized only after intensive study. It is also possible for some bio-invaders to remain harmless for a long time before they spread and acquire the characteristics of an invader (Vickerson, 2007).

There are a number of actions to take to address the effects of bio-invasion. Initially, special attention should be paid to prevention. Once an impact is identified, irreversible changes may have occurred or the measures to be taken may be costly or difficult to implement. Prevention is the main form of management, with the rest of the measures coming when it fails, while it can occur at different stages. For example, the exchange of ballast in the ocean for ships heading to freshwater ports can reduce the concentration of freshwater zooplankton in ship reservoirs by 99% (Vickerson, 2007).

Regardless of the prevention process, some species enter new environments unintentionally. In such a case it is important to recognize the problem in time and take quick steps to address it. Early detection can be improved in innovative ways, such as environmental DNA monitoring. It is possible to bring results with lower financial costs and environmental risk, as opposed to a delayed intervention. As long as the spread of bio-invaders continues unabated, the problem grows and perhaps the only solution is to eradicate them, a process that may pose greater risks, such as the release of other previously suppressed bio-invaders. For this reason it is necessary to carry out substantial research on the ecosystem before launching an effort to eradicate the bio-invader. Such a precaution does not apply to bio-invaders that are detected soon, as they will not have time to develop strong bonds in the new environment. The field of technology for the eradication of bio-invaders has developed to a great extent. This way of dealing with bio-invasion is of particular importance, as it costs less than a third way in terms of long-term management, as well as the eradication of bio-invaders helps endangered species recover. However, continuous monitoring is necessary, as there is a high risk of the bio-invader reappearing and spreading (Vickerson, 2007).

When eradication fails or is not proposed as a solution, the long-term management of bio-invaders has been developed with more ambitious goals than a few decades ago. It has been observed that with the help of new technologies, the long-term management of bio-invaders does not pose a risk to the viability of bio-invaders and other organisms in the environment where the bio-invasion has taken place. In order to manage an organism that has invaded and developed over a long period of time in a new environment, the best possible information on the effects of the bio-invasion, the probability of successful recovery of the environment, the management methods and the possible effects must be obtained. to native organisms. It may not be profitable to apply the method due to its high cost and low probability of a successful result. Removing or reducing the population of a bio-invader is not always enough to restore the ecosystem. In these cases it is preferable to keep the bio-invader in the new environment where it was found or to actively restore the ecosystem (Vickerson, 2007).

A key point about bio-invasions and how to deal with them is how society perceives them. This underlines the need to transfer knowledge properly and efficiently. The first step in shaping public opinion is to recognize bio-invasion. When the bio-invasion takes place under water, it is more difficult to perceive than if it took place above ground. The public in this case must be properly and comprehensively informed of the invisible effects. From then on, the frequency of occurrence and reputation of the bio-invader plays an important role, as well as how the public perceives the conservation of local biodiversity and its relationship with global biodiversity. Dealing with a bio-invasion can create a moral dilemma in society. It must be understood that the will and effort to conserve global biodiversity has nothing to do with xenophobic perceptions. The problem is that populations of non-native organisms are more likely to cause ecological damage to the invading environment than local organisms (Vickerson, 2007).

2.3 Cases of ecological disaster

The inadvertent transport of marine organisms through the ballast of ships can pose a great threat to the marine environment. Aquatic invaders can have far-reaching negative effects on the ecosystem they enter. The magnitude of the problem can be described by cases of ecological disaster by country, which could not have happened otherwise than with the transfer of ballast from port to port. Among the hundreds of species that are transferred to ballast water and cause ecological consequences, the IMO lists the 10 most undesirable species as follows (Vickerson, 2007):

1. Cholera (Vibrio cholera)

2. Cladoceran Water Flea (Cercopagis pengoil)

3. Chinese mint crab (Eiocheir sinensis)

4. Toxic algae (red / brown / green tides)

5. Round goby (Neogobius melanostomus)

6. North American comb jelly (Mnemiopsis leidyi)

7. North Pacific seastar (Asterias amurensis)

8. Zebra mussel (Dreissena polymorpha)

9. Asian kelp (Undaria pinnatifida)

10. European green crab (Carcinus maenus)

2.3.1 Cholera (Vibrio cholerae)

There are also effects of seasickness on public health. As early as the 14th century, it was realized that plague epidemics were associated with ship flocks. The marine environment is considered hostile to human-related germs, however, there are cases where germs remain dormant and when found in favorable conditions are converted to infectious agents. Water in many ports around the world is polluted by urban and other wastewater, resulting in the introduction of toxic organisms into new environments through the ballast, which can introduce pathogenic microorganisms and diseases. One such example is the transport of the cholera bacterium Vibrio cholerae, which is responsible for cholera.

The bacterium was transmitted through the ballast to South America, the Gulf of Mexico and other areas. Cholera is caused by the toxogenic strains of the serological groups O1 and O139 of the bacterium V. cholerae, which are often found in marine environments. They are found freely on surfaces such as plants and animal shells, as well as in the intestinal contents of marine animals. Bacterial infection is acquired through the consumption of contaminated water or food (Vickerson, 2007).

Through the ballast there is the possibility of transporting the bacterium from one port to another. In 1992, the carriage of the bacterium from a cargo ship was documented when the same strain was isolated from ballast samples collected from five cargo ships, which started from ports in Latin America and reached the Gulf of Mexico. The cholera had been present in Peru since January 1991 and quickly spread to Latin America and Mexico. Since 1973, 91 sporadic cases of cholera unrelated to the Latin American epidemic have occurred in the United States. Most of these cases were the result of the consumption of shellfish that is endemic to the Gulf of Mexico. Estimates showed that cargo ships carried epidemic cholera.

In October 2010, a cholera epidemic broke out in Haiti. The lack of safe water and sewerage infrastructure, as well as the damage caused by the January 2010 earthquake contributed to its spread. Concerns have been raised that cholera could be transmitted from Haiti to other countries through contamination of coastal waters by ship's ballast water. Ships passing through Haiti are usually cargo ships bound for the United States, other Caribbean islands, and Latin America. During the epidemic, the US Centers for Disease Control and Prevention, the US Food and Drug Administration, and the Haitian Ministry of Health and Population conducted a cholera assessment of freshwater and marine water sources in Haiti. The water collected from the ports of

Port-au-Prince and St. Marc were tested for the presence of V. cholerae and the cholera toxin ctxA. Although V. cholerae was not isolated from seawater samples in ports, the ctxA gene was detected, suggesting that the waters were contaminated with the bacterium (Vickerson, 2007).

The cholera epidemic in Haiti has spread to the Dominican Republic and in some cases to the United States in connection with travel from Haiti, but there is no evidence that these cases are due to ballast transport.

2.3.2 Cladoceran Water Flea (Cercopagis pengoil)

(Cercopagis pengoi), under normal conditions, grows in the Black Sea-Caspian Sea region of North Asia. Its special feature, which makes it stand out from the native zooplankton, is its long tail. It can reach a length of up to 1.27 cm, but about 70% of the total length is its taile.

Their body consists of a head, which is dominated by a large black eye, jaws, four pairs of legs and a pair of branched antennas. The first pair of legs is longer than the others and is used to catch its prey. The other pairs are used to hold the prey as it is consumed. It can be found in freshwater, but also in brackish lakes. They appear in late spring and remain in the water until late autumn. Its lifespan can be from a few days to a week. Unlike other zooplankton that feed mainly on algae, C. pengoi feeds on other zooplankton, which is also the food preferred by young fish. A C. pengoi can eat 20 organisms in a day. While young fish feed on zooplankton, they tend to avoid C. pengoi because of its long tail (Vickerson, 2007).

1992 saw the first outbreaks of C. pengoi in the northeastern part of the Baltic Sea. Especially after 1995, the species expanded its range, forming several permanent populations in various parts of the Baltic. It was first observed in two large baltics of the Baltic, the Gulf of Finland and the Gulf of Riga. The cause of this bio-invasion was thought to be the transport of ballast on the ships. The appearance of C. pengoi in the Gulf of Finland in 1995 was recorded in the eastern basin and was followed by a series of extensions to the open western, northern and southern Baltic. The distribution of C. pengoi in the Baltic shows us the continuous expansion of the species, which is possible due to high reproduction rates (average egg ratio 16.6, maximum egg per female 24). The wide range of optimal Baltic salinity allows C. pengoi to spread for the most part, although water temperature and food availability limit species distribution. The vertical distribution of species in the Baltic is mostly limited to the upper layers of warmer water (Tamara & Panov, 2006).

Zooplankton in the eastern Gulf of Finland was taxonomically diverse and abundant. Eurytemora affinis, Eudiaptomus gracilis, Mesocyclops leuckarti and Thermocyclops oithonoides form the basis for the community, contributing about 50% of the total bio-mass of meso-planopton. By the time the C. pengoi population had reached peak densities, high abundance values of Bosmina longirostris, B. crassicornis, Daphnia cristata and Keratella cochlearis, K. c. baltica, K. quadrata, Synchaeta spp.

Six years after the first record of the appearance of C. pengoi, the species was transported by the ballast of offshore ships, originating from the Baltic and was detected in the Great Lakes of North America. C. pengoi was first reported in the United States in 1998 in Lakes Erie and Ontario, and the following year was found in Lake Michigan. In 1999 it was detected in Finger Lakes, New York and in 2001 it was found in Lake Muskegon near the east shore of Lake Michigan. The parasite first arrived in the United States via the ballast of offshore ships coming from Europe. Due to their tendency to stick to fishing line, they can easily spread to inland waters (EU Commission, 2017).

Despite their small size they have the potential to harm and affect biological communities. Due to its high reproduction rate it can create a very large population in a short time. Scientists are concerned that high populations of C. pengoi will lead to depletion of zooplankton, as it feeds mainly on it. Zooplankton is an important food source for almost all young fish, as well as a major source of some fish throughout their lives. As mentioned, fish do not prefer to feed on C. pengoi because of its tail. So as C. pengoi and native fish compete for zooplankton, it is likely that fish growth and survival will be reduced.

A similar situation applies to Spiny Water Flea (Bythotrephes spp), which is normally found in Europe and North Asia. Through the transport of ballast, it was found in the

Great Lakes of the USA and in inland waters. They also have a tail, a high reproduction rate and feed on zooplankton.

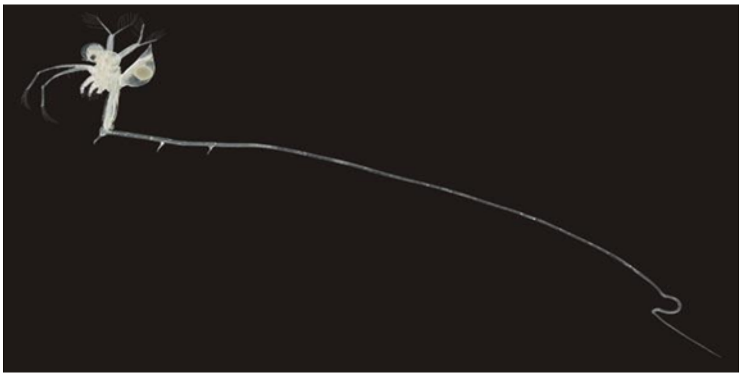

Image 1: Fishhook Waterflea

2.3.3 Chinese mitten crab (Eiocheir sinensis)

Chinese mitten crab (Eiocheir sinensis) grows in Eastern Europe and East Asia. It originates in the temperate and tropical regions between Russia and southern China, including Japan and Taiwan. The central point of their appearance is the Yellow Sea. At a young age it can be found in fresh water and as an adult in brackish water. During their migration period they can be found walking on the ground out of the water. About 90% of his life is spent in freshwater. E. sinensis feeds on algae, trace elements, fish eggs and a wide variety of invertebrates. In its native environment it can live up to 2 years. Their breeding season is in late autumn and winter, in estuarine waters and they can produce between 250,000 and 1,000,000 eggs that hatch in brackish and seawater. In terms of size, it reaches a width of about 8 cm. In an adult E. sinensis the legs are more than twice the width of their shell and their color is grayish green, light brown or dark brown, sometimes with two light spots on the shell. Young E. sinensis are often lighter in color than adults. Its most distinctive feature is the thick hair on its calipers. There is not much information about which organisms feed on E. sinensis, but it is possible that the younger ones are consumed by larger crustaceans, fish, birds, cephalopods and mammals (Sewell, 2016).

Adult crabs are resistant to a wide range of salinity and temperature. Nymphs require higher levels of salinity and are more sensitive to low temperatures.

The first record of E. Sinensis was made in 1935 at the mouth of the river Thames. More recently, it has been detected in Europe and, more specifically, in Finland, Sweden, Poland, Germany, the Czech Republic, Denmark, Belgium, England, France and Russia. It is still found in North America. In the bay of San Francisco, E. sinensis probably appeared intentionally for human consumption. After that, through the ballast has appeared in new locations. It has been observed that in the USA, it has the ability to survive 3 to 5 years, ie longer than in its native environment. It has also been introduced in Europe. It has been detected in the Thames, Medway and Ouse rivers and in several areas between England and Wales, including the Tyne, Tamar and Dee rivers and in Yorkshire. It is possible to transport them by attaching them to the ships, but the main way of transporting them is considered to be the ballast of the ships (Sewell, 2016).

E. sinensis causes many problems when introduced into a new environment. It depletes native species of benthic invertebrates in freshwater and marine ecosystems and crayfish in terms of food and space, as well as may cause population decline of the native species it consumes. It can also cause pebbles used by salmon and trout to spawn during the breeding process. In addition to causing ecological damage, it can also harm human health, as it carries a number of diseases that can affect humans. It is an intermediate host for Paragonimus westermani and can be transmitted to humans when consuming improperly prepared or roasted crabs (Sewell, 2016).

2.3.4 Toxic algae (red / brown / green tides)

Several species of toxic algae have been transferred to new areas in the ballast water of ships. Depending on the species, they can cause enormous losses of marine life through oxygen depletion, toxin release and / or mucus. A toxic algae may consist of a phytoplankton outbreak, a reddish plankton outbreak, or other harmful algae. About 300 species of micro-pain. Almost a quarter of these species are known to produce toxins. The multiplication of germs in sea or brackish waters can cause mass killing of fish and contaminate the marine environment with toxins. Several species of microalgae can produce toxins that damage the gills of fish, resulting in their extensive extinction (McMinn et al., 1997).

There are two groups of organisms according to Harmful Algal Bloom (HAB), those that produce toxins that can contaminate the marine environment or kill fish, and those that produce high biomass, which can cause anoxia and death in marine life. after reaching dense concentrations. There are, however, organisms that can have characteristics of both. The problem of toxic algae has increased in recent decades and is a widespread and serious problem. Typical examples are Aureococcus anophageff erens in the US Great Lakes, the toxic dynasty Gymnodinium catenatum established in southeastern Tasmania in Australia and Alexandrium catenella in the Tau Lagoon in France (McMinn et al., 1997).

There is evidence that some species of algae, although not cyst-forming, can survive ballast passage. Ballast tanks are dark and aerobic environments, so in addition to those that form cysts, phytoplankton species that have alternative diets and / or the ability to survive in the dark have a chance of surviving. A. anophagefferens has both of these characteristics and can survive at least 30 days in the dark. It has had a significant detrimental effect on the benthic communities of Narragansett Bay in Rhode Island, on the shores of Long Island in New York and in New Jersey, due to its reduced light penetration. The distribution of A. anophagefferens seems to be increasing rapidly both inside and outside the US, as it has also been observed in the Saldanha Bay of South Africa (McMinn et al., 1997).

In Tampa Bay, Florida, a study by the Florida Fish and Wildlife Conservation (FWC) and the Wildlife Research Institute (FWRI) is investigating the possibility of non-native harmful algae entering the bay through the ballast. Ships entering the bay are regularly inspected by USCG-owned Foreign Vessel Port State Control. In some of these inspections, staff from the FWC also participate, where they obtain information about the ballast. Researchers collect water, mud and sediment samples from ballast tanks and examine them for potential harmful non-native algae. Species found are classified and tested for toxicity .

G. catenatum first appeared in northern Tasmanian waters in 1985. In a short time, shellfish from the Derwent and Huon estuaries were found to be contaminated with high concentrations of paralytic shellfish venom, Paralytic Shellfish Poisoning (and due to the temperature of the water and the rainfall, over the years, it managed to remain only a secondary component of phytoplankton. G. catenatum is a large dynamostigor, 23 to 41 picometres long and forms chains up to 64 cells long. During its life it produces a brown, spherical, durable and with a tiny bladder surface. They have also been found off the east coast of Tasmania, without, however, detecting any toxicity to shellfish at this site and to sediments from Warrnambool and Lorne, Victoria and the port of Llanco in South Australia (McMinn et al., 1997).

A. catenella is also a PSP-related dinosaur species found in cold coastal areas, mainly in the Pacific Ocean. In addition, an outbreak of reddish plankton of this species has been observed. During its life cycle it also produces a colorless cyst, which can reach up to 56 microns in length. It usually appears with 2, 4 or 8 cell chains. The toxins it produces can affect fish, birds and other mammals. It appeared in Thau Lagoon in France in 1995 and was followed by an outbreak of phytoplankton in 1998. This population, under normal conditions, grows in the temperate climate of Asia. The most likely scenario is that A. catanella enters Thau Lagoon via the ballast of ships coming to the port of Sète, which is in direct contact with the lagoon (Simberloff et al., 2013).

The effects of toxic algae extend to human health, as when a coastal area is contaminated, the conservation of human populations and especially the inhabitants of the area is at stake. Toxins that accumulate in shellfish and fish may sometimes not affect them themselves, however, they can then be transmitted to humans when consuming contaminated seafood and this poses a serious health threat. Unfortunately, detecting contaminated seafood is not easy and it is not easy to determine which seafood is safe to eat. Intensive monitoring of its composition is required to reduce the risk of severe poisoning phytoplankton in harvest areas in combination with biological tests and / or chemical analyzes of seafood (Simberloff et al., 2013) .

2.3.5 Round goby (Neogobius melanostomus)

Neogobius melanostomus grows in the Black, Azov and Caspian Seas. It is a small, soft fish, which as an adult is brown / gray with brown / black spots and can reach up to 17.8 cm in length. It feeds on benthic organisms, mainly crustaceans and mollusks, as well as smaller fish and fish eggs, even their own. They have the ability to feed even in complete darkness and adapt their diet to whatever species is in abundance in the environment they find are standing. It can survive in a wide range of habitats, ranging from fresh to sea water, as it has a wide resistance to salinity and various temperatures. It prefers, however, warmer waters. They are benthic inhabitants in coastal areas and prefer rocky or muddy substrates and macroalgae that provide them with shelter. During the winter they migrate to deep offshore waters. A single N. melanostomus also has the ability to travel long distances (Simberloff et al., 2013).

It has been transported by sea to the Baltic Sea and North America. It is a highly adaptable species, which is spreading rapidly. It competes in food with native fish, as well as feeds on their eggs and young fish. It has the ability to multiply many times per season and survive even in poor water quality. In the US Great Lakes, where N. melanostomus is present, it results in the reduction of native fish populations, since the abundant N. melanostomus feed on them and their eggs. In 1990 it was first detected in North America in the Saint Clair River. It was first recorded in the Great Lakes in 1995 in the area of Duluth Harbor and Lake Superior. It has spread to all major lakes through natural dispersal and merchant shipping. In North America, it has been observed that they mature earlier than usual, which is 2-3 years for females and 3-4 years for males. Also newly formed N. melanostomus in brackish water or lakes tend to be smaller in size and shorter in life. However, their population has declined in recent years, suggesting that they may have reached equilibrium (Simberloff et al., 2013).

In Lake Michigan, N. melanostomus is known to feed, among other things, on the eggs of the bovine osprey and the anchovy (American pelican). With the native variegated cod (Cottus bairdii), there is also competition for food and space. The small N. melanostomus, which is less than 60 mm long and the variegated codfish share a diet of anthropods, as well as the same rocky substrate during the day and for their eating habits at night. As N. melanostomus begins to colonize deeper waters, it may endanger deep-water cattle species. Large N. melanostomus feed on zebra mussels, another species of lake bio-invader that will be discussed below. The lake mussel population may support the growing population of N. melanostomus. Mussels have the ability to accumulate Clostridium botulinum which produces a neurotoxin. Thus there is a possibility of obtaining the neurotoxin from N. melanostomus if it consumes mussels that have the bacterium. The transmission of C. botulinum can be continued if after the round goby is consumed by a bird and in this way the possibility of transmission of the bacterium increases. N. melanostomus, on the other hand, provides an abundant food source for many species, such as the chubby fish, and has been attributed as the reason why the water snake (Nerodia sipedon insularum) of Lake Erie has been removed from the federal endangered species list in 2011 (Simberloff et al., 2013).

The first record of N. melanostomus in the Baltic Sea was made in 1990. In the early years of the bio-invasion there was a low population and limited distribution. It later gradually colonized all the shallow waters in the western part of Gdańsk Bay. Initially the fish lived on stony and rocky substrates, but later they also settled on parts of the sandy bottom and is now the predominant species of fish in most of the shallow waters of the bay. Its population developed especially in the western part of the gulf, in the area where it occupies the native species Gobius niger. In 1994 the fish was detected in almost the entire Polish part of the bay, while the following year it was recorded outside the bay. N. melanostomus is now found in the southern and eastern Baltic Sea, the Gulf of Finland, the Archipelago Sea, the Kattegat and Belt Seas, and southern Sweden. Because it feeds on mussels and arthropods, it competes with flatfish and deep-sea fish. In the Gulf of Gdańsk both of these endemic species have slightly shifted habitat for feeding in deeper waters as a result of its increased density. On the coasts of Lithuania and Latvia, the population of Darius Daynus and Solvita Strake mussels has been found to have declined significantly and N. melanostomus is suspected. N. melanostomus, on the other hand, is a major food species for cod and perch in the Gdańsk Bay and is an important prey for cormorants and coyotes (Simberloff et al., 2013).

2.3.6 North American comb jelly (Mnemiopsis leidyi)

Mnemiopsis leidyi is endemic to the east coast of North and South America. This species prefers coastal saltwater habitats in bays and estuaries. However, it is tolerant of a wide range of salinity and water quality conditions. They are often trapped in brackish waters with low oxygen content and high pollution. It can also be found occasionally in the open ocean at great distances from land. During the period of bad weather the sea will pass into deeper waters, although it generally prefers surface waters. It is bell-shaped with the lower margin of the mouth lobes forming the ring of the bell. The visible internal structures are mainly the gonads and the digestive system. Externally it has eight longitudinal rows or strips of lashes, which divide the body into eight symmetrical shapes and also allow it to move slowly in the water. Although it has an almost translucent colorless body, it often shows a color appearance, as it separates the ambient light into all the colors of the rainbow and the bright fluorescent stripes are visible on the body (Simberloff et al., 2013).

It is a wild carnivore and a large predator of the edible zooplankton, while it can consume up to 10 times its weight per day. In addition, its food includes eggs and larvae of various invertebrates and fish, octopuses, jellyfish and other comb animals. It feeds by constantly pumping water into the body cavity, trapping small prey. He traps large prey by swimming with the pods stretched and then closing them to trap them. If there is food, it will never stop feeding, as it never feels full. Its maximum length generally ranges between 100-120 millimeters, though have been detected larger in the Caspian and Black Seas, areas where M. leidyi has invaded via the ballast.

This species can tolerate a fairly wide range of water temperature, salinity and pollution. If food supply is limited, it has the potential to reduce its natural size and metabolism and therefore reduce its food needs to the point where they can survive for up to three weeks with limited food prevention. In addition, as it self-reproduces, a displaced specimen could start a whole new non-native population. The ballast water of the ships inadvertently introduced M. leidyi into the Black Sea and adjacent seas in 1982. In 1999 it appeared in the Caspian Sea, after being introduced into the ballast water of oil tankers. It was detected in 2006 off the west coast of Sweden and the southern Baltic Sea and in 2007 in the northern part of the Baltic Sea (Simberloff et al., 2013).

M. leidyi is considered to be the most studied genus of comb-bearers, due to its abundance as an endemic species in estuaries in densely populated urban areas of the USA, but also its abundance and rapid growth as a bio-evaporator in the Black Sea. As a bio-invader in the Black Sea, it feeds on zooplankton, which is food for other native fish, but also the eggs and larvae of these fish. There M. leydyi multiplied rapidly, as it did not face any threat from another species. By the mid-1990s, they accounted for 90% of total biomass in the Black Sea and quickly spread to the neighboring Azov Sea. In these seas the population of dolphins has decreased dramatically, as the fish they used for food have become extinct. The rest of the ecosystem has been disrupted, as M. leidyi has even reduced the amount of oxygen in the Black Sea. A similar danger is posed by the Caspian Sea, the Baltic Sea and the longitudinal coast of Norway, where they have entered. The species has a number of natural predators, including fish, jellyfish and other comb-bearers, but natural population control is minimal [56]. In recent years and since the introduction of the comb jelly Beroe ovata, a natural enemy of M. leydyi, which feeds almost exclusively on it, the ecosystem has recovered to some extent (Simberloff et al., 2013).

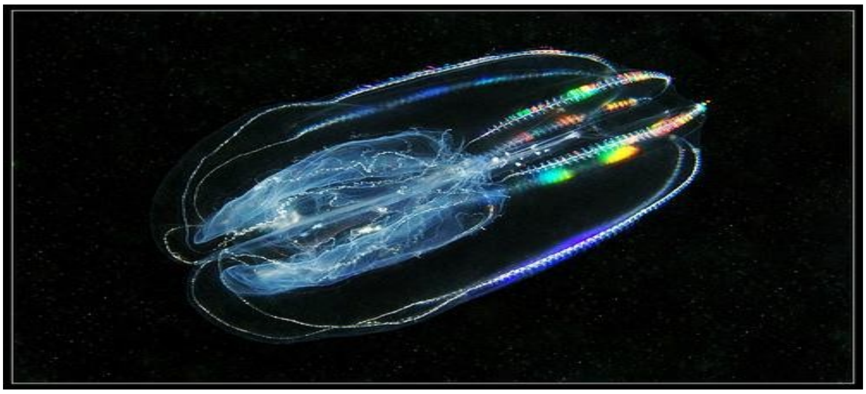

Image 2: North American comb jelly

2.3.7 North Pacific seastar (Asterias amurensis)

Asterias amurensis is native to the North Pacific and surrounding regions of Japan, Russia, northern China, and Korea. It has a yellow color, with red and purple color on its five arms, while it can grow up to 50 cm in diameter. Its special feature is its inverted ends. The lower part is completely yellow and the arms are covered with small, irregular vertebrae, which join at the top where the mouth is in the shape of a fan. It prefers to live in waters with temperatures of 7-10 ° C and is usually found in shallow waters of protected coasts and not on reefs or in areas with high waves. It is, however, capable of withstanding a wide range of temperatures and wide ranges of salinity. It is often found in estuaries and in mud, sand or rocky protected areas of the intermediate zones. It can withstand maximum temperatures up to 25 ° C and minimum 0 ° C. The salinity range for A. amurensis is 18.7-41 ppt and the maximum depth at which they have been found is 220 meters. It feeds on bivalve molluscs, valances, gastropod molluscs, crabs, crustaceans, worms, echinoderms, ascidians, sea urchins and other starfish. It consumes prey, which is usually equal to the length of its arm. The species Solaster paxillatus and the royal crabs have been observed as its predators. It competes in food with the species Uniophora granifera, Coscinasterias muricata and Odobenus rosmarus divergens. It multiplies rapidly, as a female A. amurensis can lay up to 20 million eggs (Simberloff et al., 2013).

Most of its larvae have been transported via the ballast and it has now entered the southern coast of Australia, being able to move north to Sydney. It was first observed in 1986 in Tasmania and in 1998 in Victoria. Although it prefers the coldest waters, it has adapted to the warm waters of 22 ° C in Australia. As it carries a wide range of prey, as it is capable of feeding on almost anything it can find, it has the potential to cause ecological damage in the area. It has the potential to create large populations in new areas. In the port of Philip, where they were located for the first time, within two years they reached a population of 12 million. In areas where they are an endemic species they are known to go through cycles, where they reach great abundance and then in rapid decline. A. amurensis is considered a serious parasite of native marine organisms. It is one of the main reasons for the decline of the endangered species of spotted handfish (Brachionichthys hirsutus) in Tasmania, as it feeds on fish eggs and skewers, which the fish uses to reproduce. A two-year study of the Australian

Department of Environment and Heritage by the Commonwealth Scientific and Industrial Research Organization (CSIRO) has identified amurensis as one of the ten most potentially harmful domestic species, based on its overall potential impact (Simberloff et al., 2013).

2.3.8 Zebra mussel (Dreissena polymorpha)

More than 185 water invaders have been recorded in the US Great Lakes, disrupting the food chain and polluting the coastal area. Most of these species have been transported to the lake waters from the ballast tanks of seagoing ships and are one of the biggest problems facing the area. Every 28 weeks a new species of invader is observed (Simberloff et al., 2013).

After 1959, whenever the sea route of St. Lawrence, which connects the Great Lakes with the Atlantic Ocean, saw 85 alien species, 54 of which were associated with ballast transport. The rest were transported to the lakes by different procedures, such as the Asian carp that owes its appearance in the lakes by their union with the streets of the Mississippi River basin. An problem that is being tried to be solved by the separation of the waters of the basins, so that the Asian carp cannot enter the waters of the Great Lakes (Simberloff et al., 2013).

The species Dreissena polymorpha (zebra mussel) and Dreissena bugensis (quagga mussel) have been transported to the lakes via the ballast. D. polymorpha gets its name from a striped pattern, which is often seen on its shell and its size can increase up to 5.1 cm. They live an average of 2-5 years and can reproduce from their 2nd year at a rapid rate. Once attached to a surface it remains there in a fixed place. They can detach and detect a new location if environmental conditions change. They thrive in waters rich in nutrients and significant levels of calcium, as these are required for shell production. They prefer slightly alkaline water with temperatures between 20-25˚ C, but can also survive at more extreme prices (Simberloff et al., 2013).

We find them, under normal conditions, in the Caspian and the Black Sea. However, they have been introduced, by chance, to many other areas, such as the Great Lakes, and are very quickly established in the new environment in which they are located. They have colonized most of North American waters, except in areas that have a lot of salt or are too hot for survival. They feed on algae, with the result that there is not enough food for the fish in the lakes and there is a decrease in their population. In addition, they have the ability to filter small organisms and organic particles out of the water at very high prices. It is noteworthy that each mussel can filter one liter of water per day. Within a year (1991-1992) they managed to spread on the Hudson River at fairly high prices. Their biomass turned out to be higher than the combined biomass of all other consumers (fish, zooplankton, zoobenthos, bacteria) of the river. Since there are so many of them, they are able to filter all the fresh water of the river in 2-4 days. Before the invasion, the native mussels filtered the water over a period of 2-3 months. Phytoplankton, zooplankton, bacteria and organic debris, after being filtered by water, are food for zebra mussels. At the same time, however, they form the basis of the aquatic food web and a large percentage of animals depend on them for their survival (Simberloff et al., 2013).

D. polymorpha thrives especially in water pipes because they provide protection and a constant flow of water, and therefore a constant flow of food. Once the mussels are attached to the surface, they multiply at a very fast rate. Their presence has caused indirect ecological changes in the indigenous populations of mussels, the which are threatened with extinction due to lack of food, but also to other fish that live in the open sea. Levels of dissolved oxygen in water have decreased and this can have different effects on different species. Efforts are being made to find out which fish and crabs D. polymorpha may be prone to predation and how this affects their river population.

However, some positive results can be observed from the presence of D. polymorpha. The excessive dose of filtration they carry out, make the water clearer resulting in more light penetrating the roots of the plants. More light allows even more plants to grow, which are a refuge for the fish-seeking organisms (Simberloff et al., 2013).

D. bugensis is a species closely related to D. polymorpha. Although less well known than D. polymorpha, in recent years its growth has overshadowed that of its close relative. They have the ability to thrive off the coast, in deep and muddy waters. Each D. bugensis, which is similar in size to D. polymorpha, has the ability to filter about a quarter of a gallon of water. Lakes Michigan and Huron have covered the bottoms at depths of up to 400 meters. They feed on algae, including diatoms, which are single-celled algae with a cell wall. A key component of their cell wall is silicon dioxide. Until recently, each spring, there was a particular growth of diatoms in the Great Lakes area and the level of silicon dioxide on the lake surface decreased as the diatoms formed their protective shell and then sank to the bottom of the lake taking the dioxide of the lake. with them. Diatoms are commonly used to monitor the ecological status of waters. In this case the fall in silicon levels has been used as an indicator of total algae production in the Great Lakes region. Based on the level of silicon dioxide, algae production in Lakes Michigan and Huron has been found to be about 80% lower in 2008 than it was in the 1980s. This decrease coincided with the appearance of D. bugensis. Mussels filter the algae and thus get the food that other organisms need to survive. An important case is the plight of Diporeia, a tiny creature that was one of the pillars of the Great Lakes food chain, as almost every species of fish in the area relies on Diporeia at some point in its life cycle (Simberloff et al., 2013).

Image 3: Dense agglomeration of zebra mussels

2.3.9 Asian kelp (Undaria pinnatifida)

Undaria pinnatifida is a brown algae found in North Asia, temperate regions of Japan, China and Korea. It can reach a length of 3 meters. It has two distinct stages of life, the macroscopic and the microscopic. The macroscopic stage usually appears from the end of winter to the summer months and the tiny stage appears in the coldest months.

The sporophyte (of the macroscopic stage) has a golden-brown color, with a slightly colored stalk and as they mature, two dense spore leaves develop, one along each end, which bend laterally around the stalk. It grows during the winter and releases spores as summer approaches. These seeds are tiny and scatter, so that they settle and germinate in gametophytes (of the tiny stage), which are very small in size. Temperature, light and depth are important for its development (Simberloff et al., 2013).

It is capable of rapidly colonizing new substrates, even artificial floating structures. They appear in dense, intense population on the benthic coasts, forming a dense dome above the biocosm. Inhabits cold temperate coastal areas and grows best in waters below 12 ° C. They develop in a wide range of wave variations, from protected marinas to the open shores. It extends vertically from a low depth of 18 meters, although it is more common to be at a depth of 1 to 3 meters. It has the ability to receive a wide range of sunlight, but also very low light levels. It is, however, unlikely to invade a high inflow of fresh water. It can grow on any hard surface, including artificial substrates. In natural substrates it lives in rocky reefs, habitats and mainly in soft sediment habitats, clinging to hard surfaces. It can also grow on clams and bivalves, invertebrates and other algae (Simberloff et al., 2013).

It has now been introduced to South Australia, New Zealand, the west coast of the United States, Europe and Argentina, with the release of the species during the shipwreck process. Its population has expanded since the 1970s. In 1994 it was found at the mouth of the river Hamble on the south coast of England. It is believed that this invasion of Britain took place through the circulation of ships from France. The species originally spread to Europe as infectious substance, introduced by oyster spat (Crassostrea gigas). After 1981, an attempt was made to aquaculture it, first in the Mediterranean and then, after 1983, in various locations in Britain on the Atlantic coast. In 2004 it was discovered off the coast and marinas near Plymouth and the south coast of England (Simberloff et al., 2013).

U. pinnatifida can have great ecological effects, as it grows and spreads rapidly, both naturally and by seed dispersal. Invading a new environment displaces natural algae and marine life, as well as altering the habitat, ecosystem and food chain. It can also affect shellfish stocks due to space competition and habitat change. Especially in areas where native algae are absent, U. pinnatifida can greatly alter the structure of ecosystems. Through the ballast, it is possible to transfer various types and stages of the species. It is transferred both as the highly visible sporophyte, but also as the tiny gametophyte. The movement of the larger phase is high risk, but special attention must be paid to the tiny material in the form of spores, gametophytes or immature spores (Simberloff et al., 2013).

2.3.10 European green crab (Carcinus maenus)

Carcinus maenus is native to the European coast of the Atlantic. It has a tolerance for a wide range of salinity, water temperature and habitat type and has been characterized, mainly, as a predatory mollusk. It is a medium-sized crab, which is wider than long. In adults it can grow up to 6 cm in length and 9 cm in width. Its dorsal shell is dark, dark brown to dark green and has small yellow marks. The color of its abdominal surface can change from green to orange and then red. Its special feature is that it has a series of five spines on both sides of its eyes, at the front end of the shell. He has three rounded lobes between his eyes. The last pair of hind legs is relatively flat. It is capable of producing eggs at temperatures up to 26 ° C although larval development is limited to a shorter range. In addition, they are tolerant of oxygen pressures.

Adult C. maenus can tolerate temperatures ranging from 0 to 33 ° C, with the larvae having more limited tolerances. As it grows older, it begins to occupy other substrates, such as mud, sand and rocks. It can also occupy depths of up to 6 meters, while it has been recorded even at 60 meters. It can survive out of the water for several days. It feeds on large and small snails, with a preference for smaller ones. In addition, it consumes soft-shelled molluscs, clams, mussels, young fish and other species, and can withstand up to 3 months without food (Simberloff et al., 2013).

It is now established in South Australia, South Africa, America and Japan. It was introduced to the West Atlantic coast in the early 19th century, between New Jersey and Cape Cod. By the 1960s, it had spread north through Nova Scotia. There have been reports of crab spotting in California since the 1970s. The first documented record was made off the west coast of North America in San Francisco Bay, California in 1989. It was then observed in Oregon in 1997 and British Columbia in 1999. A possible cause for this invasion is ballast transport. It has the ability to survive for many days in ballast tanks, taking into account the long period where it remains a larva (up to 90 days) . They were first found in Canadian waters in 1951 in southwest New Brunswick, and by 1966 they reached south of Halifax. In 1991 they were found on Cape Breton and the rocky lakes of Brad d'Or, in 1994 on the bay of St. Lawrence, in 2004 on the Magdalen Islands and in 2007 in Newfoundland. It is also found on the entire west coast of Vancouver Island. It has been shown to grow faster and reach a larger size on the North American coast of the Pacific than on the North American coast of the Atlantic and in native species (Simberloff et al., 2013).

They can pose a serious threat to the new environment they invade, as they are wild predators that feed on a variety of endemic animals. This species changes the balance between species in ecosystems and affects their diversity. It competes with native crabs for food and disrupts productive habitats for many young species of fish. C. maenus threatens mollusks, crustaceans and fish due to its large population, enormous appetite and intense competition with other species. In some areas it has been reported that because it consumes the predators of the bio-invader Styela, it facilitates its development. Is known to consume at least 158 species and have been widely documented to reduce diversity (Simberloff et al., 2013).

Image 4: European Green Crab

Chapter 3: Legislative Framework combating the bio-invasors and unwanted organisms at sea.

3.1 Introduction

The transfer of organisms to new aquatic environments via ballast, prompted the creation of new regulations in an effort to address one of the most important threats to the planet's oceans. The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, on Agenda 21, called on the IMO and other international bodies to take action to address the problem.

In 1991, the IMO published Guidelines for the Prevention of the Introduction of Unwanted Organisms and Pathogens from Ship's Ballast Waters and Sediments Discharges. 1993. Subsequently, in 1997 it published Guidelines for Control and Management of Ship Ballast to Minimize the Transfer of Harmful Aquatic Organisms and Pathogen (Guidelines for Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogen Resolution A.868).

In February 2004, the IMO adopted the International Convention for the Control and Management of Ship Ballast and Sediment (International Convention for the Control and Management of Ships' Ballast Water- Ballast Water Management - BWM Convention) ballast and reduce the risk of non-native species being imported from the ballast of ships. To supplement the BWM Convention, it has adopted Guidelines contained in the Marine Environmental Protection Committee (MEPC) circulars (IMO, 2004).

In addition to the IMO, other national agencies have introduced regulations, the most important of which is the United States Coast Guard (USCG). The USCG has established regulations as well as guidelines to prevent the introduction and spread of aquatic bio-invaders through the ballast. The final Legislation was published in March 2012 and entered into force in June 2012. As the IMO and USCG introduce a demanding ballast rejection method, a number of technologies have been developed by various vendors to enforce the requirements. These systems must be tested and approved in accordance with the IMO and USCG guidelines respectively (IMO, 2012).

The international legal framework for ocean affairs is based on international law, mainly derived from the United Nations Convention on the Law of the Sea (UNCLOS) (1982). Also published in and other subsequent conditions and non-binding instructions related to ballast management. The measures taken in the European Union mainly concern the BWM Convention and the European Commission has strongly suggested that the Member States approve its implementation. At the same time, there are four regional maritime conventions for Europe, namely the Mediterranean Sea Against Pollution (Barcelona Convention), the Convention on the Protection of the Black Sea against Pollution (Convention on the Protection of the Black Sea Against Pollution - Bucharest Convention), the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) and the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention) of the Maritime Environment of the Northeast Atlantic (Convention for the Protection of the Marine Environment of the North-East Atlantic - OSPAR Convention).

3.2 Law of the Sea

Under UNCLOS, states have a general obligation to protect and preserve the marine environment, and this obligation includes the prevention of pollution. The convention was the result of extensive cooperation between many states. It includes some provisions on the prevention of biological pollution of the marine environment, but they are general and have a wide scope. Article 196 (1) provides that "States shall take all necessary measures to prevent, reduce and control the pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or not, into a specific part of the marine environment, which may cause significant and harmful changes there " (UNCLOS, 1982).

Pollution is defined by UNCLOS as "The direct or indirect introduction by humans of substances or energy into the marine environment, including estuaries, which are or may be harmful effects, such as damage to living organisms and marine life, dangers for human health, an obstacle to maritime activities, including fisheries and other legitimate uses of the sea, a reduction in the quality of seawater use and a reduction in bridges " (UNCLOS, 1982).

Whether the rejection of ballast and sediments is included in Article 194 or not, a much-discussed issue, the introduction of aliens or new species, is considered in Article 196. This provision sets out the measures necessary for prevention, the reduction and control of the pollution of the marine environment resulting from the intentional or accidental introduction of alien or new species into a particular part of the marine environment, if the introduction of such species may cause significant and harmful changes in it. While ballast rejection is considered part of the normal operation of ships (UNCLOS, 1982).

3.3 Agenda 21

Agenda 21 was adopted during UNCED in 1992 in Rio de Janeiro as a comprehensive action plan for sustainable development. Although non-binding, it has influenced subsequent developments in the legal framework. Chapter 17 deals with the protection of the oceans and all kinds of seas and requires a new and precautionary approach to the management of the seas. States are committed to protecting the marine environment and to reducing and controlling its degradation. This commitment is made in accordance with the policies and resources of each country, but at the same time they are encouraged to work with other countries and to follow the institutional framework of the EU, the IMO or any other relevant body. States should consider adopting appropriate regulations for ballast disposal in order to prevent the spread of non-native species.

3.4 United Nations Convention on Biological Diversity

Along with Agenda 21, the United Nations Convention on Biological Diversity (UNCBD) was signed as part of UNCED's efforts. The Convention was created as a practical tool for implementing the principles of Agenda 21, with the main objective of conserving biodiversity. The purpose of the contract is to conserve biodiversity and aquatic ecosystems. It applies to proceedings under the jurisdiction of a Contracting Party, whether or not the effects of such proceedings are manifest within or outside its national borders. The implementation of the Convention must be in line with the rights and obligations of States under UNCLOS .

The UNCBD does not contain provisions that explicitly regulate the management and control of ballast water, but does include provisions relating to non-native species. In accordance with Article 8, Parties shall prevent the importation of foreign species and the control or eradication of such species if they pose a threat to ecosystems. Non-native species control has been identified as one of the five key operational objectives of marine and coastal biodiversity by the UNCBD Conference of Parties (COP). The Jakarta Mandate, approved by the COP in 1995, has focused on better understanding the causes, routes and effects of alien species and implementing mechanisms to control such routes, including shipping. The COP has also made it clear that it considers the BWM Convention to be a key contribution by the IMO to the effective implementation of the CBD program for the conservation of marine and coastal biodiversity . He has concluded that ballast control and management is a concern, as ballast water has been identified as an important mechanism for transporting aquatic organisms into ecosystems where these organisms could be harmful.

3.5 International Maritime Organization

The IMO is the specialized agency of the United Nations, with responsibility for the safety of shipping and the prevention of marine pollution from ships. The IMO is a specialized agency of the United Nations and is a global authority setting standards for the safety and environmental performance of international shipping. Its main role is to create an institutional framework for the shipping industry, which will be fair and efficient, will be adopted and implemented worldwide. The aim is to create a level playing field so that operators can not tackle their financial problems by compromising on safety and environmental performance. An approach that encourages innovation and efficiency.

Shipping is an international industry and can only operate effectively if the regulations and standards themselves are agreed upon, adopted and implemented on an international basis. IMO measures cover all aspects of international shipping - including ship design, construction, equipment, manning and operation - to ensure that this vital sector remains safe, environmentally sound and energy efficient.

In the late 1980s, Canada and Australia were among the countries with particular problems with invasive alien species and attracted the agency's attention as a motivator for formulating ballast management guidelines. In 1991, the MEPC adopted the International Guidelines for the Prevention of the Introduction of Unwanted Aquatic Organisms and Pathogens from Shipwreck and Sediment Disposal (MEPC resolution (31)). In November 1993, the IMO Assembly adopted Resolution A.774 (18) based on the 1991 Directives, requesting the MEPC and the Maritime Safety Committee (MSC) to review the guidelines for international development applicable and legally binding provisions. It then adopted Resolution A.868 (20) in November 1997 - Guidelines for the Control and Management of Ship Ballast to Minimize the Carriage of Harmful Aquatic Organisms and Pathogens, calling on its Member States to use these new guidelines lines when dealing with the issue of water invaders (Invasive Aquatic Species - IAS) (ABS, 2014).

3.5.1 Guidelines for preventing the introduction of unwanted aquatic organisms and pathogens from marine ballast and sediment discharges

The purpose of the instructions is to be considered as a tool that, if properly implemented, can help minimize the risks associated with ballast discharges, ie the invasion of harmful aquatic species, while protecting the safety of the ship. They are addressed to the IMO Member States and can be applied to all ships, however, the main authority is the port authority of each state. The directives are voluntary and thus the port authorities of each state are encouraged to regulate the regulations for the management of the ballast according to the national legislation. If restrictions apply under the national law of the state, then it should inform the IMO. In addition, any specific requirements applied by Member States in the process of dumping of ballast and sediments must be specified in the detailed information given before the port authority of each State on board the ships before their arrival at port, with sufficient effort by the port authority, for the timely availability of information so that there are no delays. The exchange of information between the administrations, through the IMO, on research, training material and location is also encouraged, as well as on the part of the ships, regarding the immediate information of the port authority in case of non-compliance due to adverse weather conditions. Conditions (ABS, 2014).

The instructions indicate that all ships must be equipped with a Ballast Water Management Plan (BWMP), specifically for each ship, while special attention is paid to the training of the captain and crew, but also the shipyards, shipowners. and classification societies for the design of new ships or the modification of existing ones. They say that the implementation of marine ballast management is at the core of the solution to minimize the invasion of harmful aquatic organisms. The guidelines also suggest some operating procedures as well as some ways of managing the ballast. It is also stated that ballast loading should be avoided in shallow water, in areas that have been declared unsuitable, in the dark or where the propellers may stir sediments and, if possible, the ballast tankers must usually be cleaned at the port or during tanking. In addition, it states that organisms that live near shores generally do not survive when released into the middle of the ocean and that ballast water exchange must therefore take place in deep water. In cases where the ship is to carry out a ballast exchange within 200 nautical miles of the coastal area, a review shall be made. Marine ballast exchange risk assessment advice is given, citing factors such as differences between the ballast uptake zone and the release zone that affect the survival of organisms during transport (ABS, 2014).

Monitoring for compliance with the directives is carried out by the port authority of each state, taking and analyzing samples of marine ballast. This sampling must be carried out without undue delay on board ships and the methods of sampling, searching and monitoring should be the responsibility of each port authority. In areas that are particularly sensitive to the environment, the port authority may require samples of ballast and sediment before being allowed on a ship to dispose of the ballast. If there are harmful aquatic organisms or pathogens in the samples, the port authority may submit the vessel to any contingency plan in force (ABS, 2014).

3.5.2 Marine Ballast Management Contract

Following complex negotiations between the IMO Member States, the International Convention on the Control and Management of BWM Shipwrecked Waters and Sediments was adopted by consensus during a diplomatic conference held at the IMO Headquarters in London on 13 February 2004. The contract requires all ships to implement a ballast management plan. All ships must carry a ballast information log and must carry out ballast management procedures to specific standards. The parties to the BWM Convention have the opportunity to take additional measures, which are subject to the criteria set out in the Convention and the IMO Guidelines. The MEPC, in April 2004, approved a program to develop guidelines and procedures for the uniform implementation of the BWM Convention (ABS, 2014).

The program was further expanded at the MEPC meeting in July 2005 to develop and adopt 14 sets of directives (MEPC.173 (58) - October 2008). The next page lists the instructions briefly (ABS, 2014).

An important supporting role for the successful implementation of the BWM Convention and the adoption of the IMO guidelines is held by the Institute of Marine Engineering, Science & Technology (IMarEST), which works through teams of experts to manage and provides advisory advice to the IMO. Its goal is the exchange of knowledge and guidance on technical issues, through the platform it has created, as well as the information and awareness of its members, which extends to an international network of 20,000 members in more than 120 countries worldwide (ABS, 2014).

Significant efforts have been made to develop appropriate standards for ballast management. These are the ballast exchange standard and the ballast performance standard. Ships performing sea ballast exchange must do so with a volumetric exchange efficiency of 95% of marine ballast and ships using the Ballast Water Management System (BWMS) must meet a performance standard based on agreed unit number volumes. In accordance with Regulation D-3 of the BWM Convention, the ballast management systems used to comply with the Convention must be approved by the administration taking into account the Guidelines for the Approval of the Ballast Management Systems (G8) (ABS, 2014).

A technical team of experts has been set up under the auspices of the Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP) to review proposals submitted for approval of marine management systems using marine management systems. Active Substances. The GESAMP Ballast Water Working Group (BWWG) shall report to the Agency on whether such a proposal poses excessive risks, in accordance with the criteria set out in the process for approving ballast management systems use the Active Substances. The Convention requires a review in order to determine whether there are appropriate technologies to achieve the standard. The MEPC has carried out a number of such revisions and has agreed that appropriate standard-setting technologies are contained in Regulation D-2 of the BWM Convention (ABS, 2014).

3.5.3 Implementation of the Convention for the Management of the Sea Ballast

After many significant obstacles in the ratification of the required instructions for the uniform application of the BWM Convention, as well as for the approval and certification of modern ballast water management technologies, it was decided that the BWM Convention will enter into force on September 8, 2017. The BWM Convention entered into force twelve months after its ratification by 30 states, which represent 35% of all global merchant shipping. Since the entry into force of the BWM Convention, all Ships must manage ballast water on each voyage, either by exchange (standard D-1) or by treating it using an approved marine ballast management system (standard D-2) (ABS, 2014).

The MEPC of the IMO, at its 71st meeting (3-7 July 2017), decided on the date of entry into force of Regulation B-3 of the BWM Convention. Specifically, it found that (USCG, 2017):

"The date of Regulation B-3.10 of the BWM Convention is the International Oil Pollution Prevention Certificate (IOPP) renewal inspection inspection of the ship in accordance with the International Convention on the Prevention of Pollution from the 1973 ships as amended by the Protocol 1978 (MARPOL), Annex I, after the date of entry into force of the BWM Convention ' (USCG, 2017).

A new implementation timetable for compliance with the D-2 standard has also been agreed and is summarized as follows:

A) Ships built before September 8, 2017:

1. at the first renewal inspection for the IOPP certificate after the effective date of the contract if:

.1 this inspection was completed on or after September 8, 2019, or

.2 The IOPP Certificate Renewal Review was completed on September 8, 2014 or later, but before September 8, 2017

2. during the second renewal inspection for the IOPP certificate after the effective date of the contract, if the first renewal after the effective date of the contract is

completed before 8 September 2019, provided that the conditions of paragraph 1.2 above are not met.

B) Ships built on or after September 8, 2017, upon delivery.

C) Vessels not subject to the IOPP Renewal Inspection must carry out a Marine Ballast Management that meets at least the standard described in Regulation D-2 from the date decided by management, but not later than 8 September 2024 (USCG, 2017).

The BWM Convention applies to all vessels, including submarines, vessels, floating platforms, floating storage units (FSUs) and floating production storage and offloading (FPSOs). While not applicable to ships not designed to carry ballast water, ships not operating in international waters, warships, auxiliary ships or other ships owned or operated by the State, ships used only in commercial service, or ships with permanent ballast water in sealed tanks (USCG, 2017).

The IOPP certificate is required in accordance with MARPOL Annex I. All vessels of 400 gross tones and above must have an approved BWMP, Marine Ballast Registry and International Ballast Water Management Certificate. For ships whose Flag has not ratified the BWM Convention, a certificate or declaration may be issued. Ships participating in a management-approved program may use standard technology for up to five years before requiring the installation of an approved management system in accordance with the compliance program. A standard system is a system being tested and evaluated to meet or exceed the requirements of Regulation D-2.

All vessels over 400 gross tones are subject to inspection and certification, while vessels below 400 gross tones will be subject to national research and certification depending on the status of each state. The research and certification system under the BWM Convention is similar to that of all other IMO conventions. Upon completion of the initial investigation, an International Maritime Ballast Management Certificate will be issued for a ship whose Flag has ratified the BWM Convention. For other vessels, a Certificate of Conformity for Sea Ballast Management will be issued. Both the Certificates and the Declaration are valid for five years, with the performance of annual inspection, interim inspection and renewal inspection. The IMO's Guidelines for Inspections (Interim Survey Guidelines, included in the circular, BWM.2 / Circ.7), have been incorporated into the IMO's Harmonized System of Survey and Certification Guidelines, Resolution A.997 (25)) when the BWM Convention entered into force (USCG, 2017).

Exemption may be granted to a ship or ship on a voyage or voyage between designated ports or locations or to a ship operating exclusively between designated ports or locations. An example of a ship that could qualify for this exemption could be a merchant ship moving exclusively between one or more ports. The exemption granted shall be valid for a maximum period of up to five years with an interim inspection and provided that the ship does not mix ballast water or sediment, except between ports or places specified in the exemption. However, exceptions can be revoked at any time by the issuing administrations. To be exempt, a risk assessment must be carried out in accordance with MEPC Resolution.162 (56) - Risk Assessment Guidelines under Regulation A-4 of the BWM Convention (USCG, 2017).

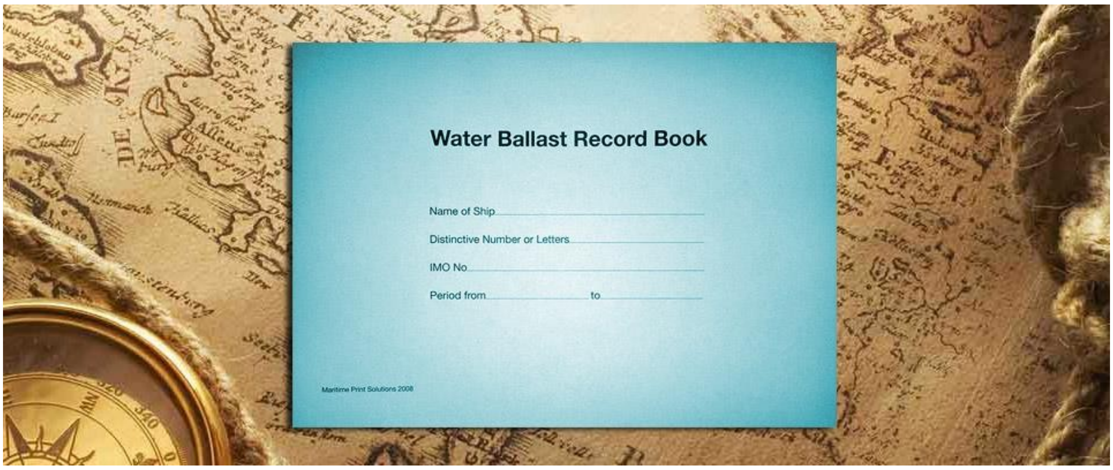

Image 5: Water Ballast Record Book

3.5.4 GLOBALLAST

A joint effort of the IMO, the United Nations Development Program (UNDP), the governments of the Member States and the shipping industry is the Global Ballast Water Management (Globallast, 2010) program.), with the aim of assisting less industrialized countries in managing ballast. Six key developing regions of the world were identified and then measures were taken to reduce the transport of harmful organisms from the ship's ballast by implementing the IMO ballast management guidelines and preparing for the implementation of the BWM Convention. The measures included, for example, "Education and Awareness Programs". The project was completed in 2004, but was seen as such a success that it was followed by a Globallast partnership, the "Building Partnerships to Support Developing Countries to Reduce Harmful Aquatic Harm Transmission" program. The aim of the new partnership was to reduce the risk of bio-invasion by ballast and prepare them for the implementation of the BWM Convention. The GloBallast partnerships would initially expire in October 2012, however, the project executive committee decided to extend the project until June 2017 (Globallast, 2010).

3.6 US Coast Guard Regulations

All ships arriving in US ports planning to dump marine ballast must exchange or treat ballast and manage sediment. U.S. law requires the Ballast Water Management System (BWTS) to be approved by the USCG. The revised USCG ballast management regulations entered into force on June 21, 2012. The regulations require compliance with the management standard at the first scheduled tanking after January 1, 2016 for existing vessels and for the delivery of new vessels. However, as there are currently not enough BWTS to hold a USCG type-approval certificate, shipowners can apply for an extension. Ships can be extended for 5 years, using an Alternative Management System (AMS), which is usually. an IMO approved system that has received AMS approval from the USCG (2017). Another regulatory compliance option is the use of drinking water (from the US public water system). In such cases the ballast tanks must be cleaned and the sediments removed in advance.

The USCG regulation exempts certain ships from its application. The following vessels are exempt from ballast management requirements, reporting requirements and record keeping (USCG, 2017):

crude oil tankers engaged in offshore trade, and vessels operating exclusively within a "Captain of the Port" zone (COTP).

Also, the following ships are exempted only from the requirements of the management of the sea ballast:

- seagoing vessels operating in more than one COTP zone, not operating outside the exclusive economic zone (EEZ) and less than or equal to 1,600 gross tons or less than or equal to 3,000 gross tons (International Convention for the Measurement of Ship Capacity) , 1969).

- non - seagoing ships

- vessels receiving and discharging ballast in only one COTP zone (USCG, 2017).

3.7 Update of the Marine Ballast Management Expansion Scheme (BWM) according to USCG

Shipowners / operators are required to comply with U.S. ballast regulations as provided for in Title 33 of the Code of Federal Regulations (CFR), Part 151, Sections 151.1510 or 151.2025. On the date of compliance with the regulation, the use of one of the approved sea ballast management methods is required. One of the approved methods is the installation and operation of a BWMS-type sea ballast management system approved by the USA (USCG, 2017).

33 CFR 151.2036 allows the Coast Guard to grant an extension of a ship's compliance date to a shipowner / pilot who has documented that, despite efforts, it is not possible to comply with one of the approved ballast management methods. If an approved type system for a ship is not available and compliance with other approved marine ballast management methods is not possible, the shipowner / pilot may apply for an extension of the ship's compliance date. If the options provided by the USCG are not practically available despite the effort, shipowners can request an extension to the implementation schedule. The availability of an AMS does not preclude the shipowner from receiving an extension. USCG regulations provide the process for applying for these extensions when they can be documented. The length of the compliance date extension, when granted, will be based on the availability of USCG-approved systems. Shipowners should anticipate that this will usually not be in line with the planned tanking (USCG, 2017).

For ships that must meet a compliance date before 31 December 2018, applications will be evaluated as follows (USCG, 2017):

1) Extension requests, which do not provide a justification for why compliance with one of the BWM methods in 33 CFR 151.1510 or 151.2025 is not possible from the current compliance date, will be removed (USCG, 2017).

2) Shipowners and pilots who have identified a USCG-approved type BWMS available for a ship but do not have enough time to install it before the ship's compliance date should provide strategy, including a detailed installation plan, for how the ship will comply with the installation of a BWMS type approved by the USCG before the end of the expansion. Extensions granted on this basis should not exceed 18 months (USCG, 2017).

3) Shipowners and pilots who have determined that a USCG-approved BWMS is not available for a ship should provide a strategy, including a timetable, for how the ship will comply before the end of the expansion . Extensions granted on this basis should not exceed 30 months (USCG, 2017).

For vessels that have a compliance date of January 1, 2019 through December 31, 2020, the USCG will begin processing these requests 18 months prior to the ship's compliance date. These requests could be affected by changes in the market or the availability of approved systems. Shipowners and operators are encouraged to submit additional information in support of their extension request (USCG, 2017).

For ships that have a compliance date of 1 January 2021 or later, no extensions are provided. Shipowners and operators must plan to meet the current compliance date.

For AMS, ships that have AMS installed do not qualify for expansion because the ship already complies with the regulations. The AMS can be used for a period of five years after the date of compliance. Once the systems are approved, a ship will no longer be able to install AMS instead of the approved systems. Therefore, if a ship has not passed the compliance date and the installation of an AMS is considered a compliance method, the shipowner or pilot should evaluate whether a USCG-approved type BWMS is available. If a system is found to be unavailable, AMS may be installed prior to the ship's compliance date and may be used for up to five years after that date (USCG, 2017).

Existing compliance date extensions are valid until the date specified in the letter and can be transferred to a new shipowner / pilot for the remainder of the time period. Upon completion of the letter, a ship must apply one of the approved ballast management methods specified in 33 CFR 151.1510 or 151.2025.

For extension requests, shipowners and pilots must apply for an extension 12-16 months before the compliance date. Applications submitted less than 12 months before the ship's compliance date are at stake. The USCG is now requesting that the application be considered, that additional information be requested from the applicant, and that it decide whether to grant or deny the application. If the extension request is not accepted, this allows the shipowner or operator sufficient time to prepare and install a BWMS or to evaluate compliance options using another approved ballast management method prior to the compliance date.

For additional extensions, if the USCG grants an extension for a ship, the shipowner / pilot will have to plan the work to ensure that the ship complies with the extended date. While the release of additional extensions should not be expected (USCG, 2017).

Image 6: Marine ballast processing unit.

3.8 European Union regulations and steps in tackling the issue.

Regarding the EU involvement in the management of the ballast, a number of measures have been taken, mainly with a view to the adoption and implementation of the BWM Convention. According to the European Commission, "invasive alien species are animals and plants that are introduced accidentally or intentionally into a natural environment where they are not normally found, with serious negative consequences for their new environment". EU Regulation 1143/2014 on invasive alien species (Regulation (EU) No 1143/2014 of the European Parliament and of the Council on the prevention and management of the importation and spread of invasive alien species) entered into force on 1 January 2015. The Regulation "seeks to address the problem of invasive alien species in a comprehensive manner, in order to protect natural biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impact that these items"(European Commission, 2017).

In addition, the regulation stipulates that "a large proportion of invasive alien species is inadvertently imported into the Union. Therefore, more efficient management of unintentional import routes is vital. Action in this area should be gradual, given the relatively limited experience in this area. Actions should include voluntary measures, such as those proposed by the International Maritime Organization's Guidelines for the Control and Management of Ship Pollution and mandatory measures. The action should build on the experience gained in the Union and in the Member States in the management of certain routes, including measures established by the International Convention on the Control and Management of Shipwrecks and Sediments adopted in 2004. Therefore, the Commission should take all appropriate measures to encourage Member States to ratify this Convention " (Klasse & Locke, 2007).

The Berne Convention for the Conservation of European Wildlife and Natural Habitats was adopted in 1979. The Convention has a modern approach to environmental protection based on precaution and cooperation. The parties to the contract are called upon to "strictly control the importation of foreign goods". Ballast water is not mentioned in the text of the convention, but has been included as an issue to be considered with regard to invasive species in subsequent discussions. In 1992 the expert group of the Bern Convention on Alien Species was set up and in 2003 the

European strategy on invasive alien species was adopted. The Berne Convention Committee has advised its Member States to implement the IMO's technical guidelines for ballast management in order to minimize the unintentional transport of foreign species. Prior to the entry into force of the BWM, the Committee also advised Member States to take urgent steps to adopt the BWM Convention (European Commission, 2017).

The directives of the European Parliament and the Council of the EU, which affect the management and control of the ballast, are the Maritime Strategy Framework Directive, which states that the marine environment is a valuable heritage that must be protected and preserved by the community and that the aim of these efforts should be to provide clean, healthy and productive oceans and seas with preserved biodiversity. According to the Directive, the European Community must limit its impact on marine waters, regardless of the consequences of that impact. The directive for marine equipment aims to improve maritime safety and prevent marine pollution, through the uniform application of relevant international legislation, on equipment to be placed on ships for which issue safety certificates to or for the benefit of Member States in accordance with international conventions, as well as to ensure the free movement of such equipment within the community (European Commission, 2017).

In addition, the Biocidal Products Directive is the main legislation governing the sale and use of chemicals on the common market and in the territory of the Member States. If a product contains the substances covered by the Directive, it must be approved in accordance with it in order to be marketed and used in the territory of the Member States. The Port State Inspection Directive, which is linked to the Paris Memorandum of Understanding (MOU), aims, inter alia, to establish common criteria for port State control and harmonization of inspection and detention procedures, drawing on the expertise and experience of the Paris MOU(European Commission, 2017).

The Port Waste Collection Directive is primarily intended to ensure the reception of ship waste facilities, ie all waste falling within the scope of MARPOL 73/78. Member States must ensure that the availability of port reception facilities is sufficient to meet the needs of ships . The Habitats Directive also aims to help ensure biodiversity through the conservation of natural habitats and of wild fauna and flora in Europe. According to the directive, countries must ensure that deliberate imports are regulated so that natural habitats are not harmed.

The United Nations Environment Program (UNEP) launched the Regional Maritime Program in 1974 to address the degradation of the world's oceans and coastal areas through the sustainable management and use of marine and coastal areas. environment. There are four regional maritime conventions for Europe. These are the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention), under which the Contracting Parties shall take all measures in accordance with international law for the prevention, suppression and control of pollution in its territory. Mediterranean, caused by discharges from ships. The Parties shall also ensure the effective implementation of the rules generally recognized internationally regarding the control of this type of pollution. It is recognized that shipping, due to ballast water, sediments and hull pollution, is the main source of pollution in the Mediterranean region. The Contracting Parties are required to enact national legislation to control the importation of marine species, and recommend the development of a regional program to strengthen the capacity of Mediterranean countries to reduce the transport of aquatic organisms through the ballast waters of ships and reservoirs (European Commission, 2017).

The Convention on the Protection of the Black Sea against Pollution (Bucharest Convention) requires its parties to take all necessary measures to prevent, reduce and control pollution. Ballast water is not mentioned in the convention, but regardless of this, the Black Sea Commission for the Protection of Pollution from Pollution has given high priority to promoting cooperation in the Black Sea region, in accordance with the principles and recommendations of the BWM Convention. Furthermore, the Convention on the Protection of the Marine Environment of the Baltic Sea Region (Helsinki Convention), although there is no reference to ballast water, promotes the adoption and implementation of the BWM Convention with the aim of ecologically restoring the Baltic Sea region and maintaining ecological balance .

The Parties to the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) shall take the necessary measures to prevent and eliminate pollution and to protect the maritime area from the adverse effects of human activities, including: conserve marine ecosystems. There is no reference to marine ballast management, but AIS has been identified as threatening biodiversity and marine ecosystems. The OSPAR Commission together with the Helsinki Commission (HELCOM) took measures to manage the ballast, promoting a voluntary model of ballast water exchange .

3.9 Regulations of Sweden

The Swedish Marine Ballast Act (Barlastvattenlag) was issued in November 2009 to amend the provisions of the BWM Convention, in accordance with Swedish law. It is largely designed to be very similar to the Convention and applies to Swedish and foreign vessels traveling within the Swedish Maritime Territory or EEZ with the same exceptions listed in Article 3 of the BWM Convention. According to the provisions of the law, ballast water must be treated either on board with an approved management system, or exchanged, or deposited in a receiving facility, or managed by any other approved method before being discharged from the vessel. The Swedish Government shall designate the authority responsible for approving the management systems and methods, decide on the requirements for the provision of sediment collection facilities for the cleaning and repair of ballast tanks, shall require a BWMP and a Marine Ballast Logbook and may decide on certificates and inspections of Swedish ships, and penalties for violations are set. Entered into force at the same time as the BWMC (Näringsdepartementet, 2009).

3.10 Initiatives of India

According to the IMO BWM Convention, studies are carried out with the help of biological research in ports, which aim to create databases and identify suitable locations for ballast dumping in emergencies. This research extends to 8 major ports in India. The National Institute of Oceanography (NIO) has been designated by the Indian Ministry of Shipping as a leading form of research and development to assist the ministry in addressing ballast management issues.

The Institute initially completed basic port surveys, conducted a risk assessment and identified ballast dump sites for the ports of Mumbai, Jawaharlal Nehru, Mormugao and Visakhapatnam, under the auspices of Globallast and the Government of India initiative. . Through this program, NIO has also developed a user-friendly and valid electronic platform for recording the history of the ballast of ships. This platform is a key prerequisite for performing a ballast risk analysis. These efforts are then planned to be extended to the other 8 major ports (Mangalore, Cochin, Chennai, Haldia, Kandla, Tuticorin, Paradeep and Kolkata) of the country, through a memorandum of understanding between NIO and the Directorate General of Shipping. - DGS) (Emerton & Tessema, 2001).

Image 7: Ship in the process of abatement

Chapter 4 : Alternative ballast management procedures

4.1 Introduction

Since the late 1990s, various concepts have emerged that have allowed ships to operate without the need to discharge or discharge sewage or sewage for their ballast needs. Since the adoption of the BWM Convention in 2004, interest in these alternatives to conventional BWMs has grown as they offer ways to avoid or significantly reduce operational issues, exchange costs and reservoir sediment management costs or address separated ballast waters to meet the relevant D-1 or D-2 rejection standards of the Convention. These alternatives include NoBallast Ships, using new forms of ship hull, or more simply installing or upgrading a freshwater production system on board.

4.2 Ship without ballast (Free-Ballast Ship)

It's a promising design for deterring environmental organisms and ending all demands for expensive sterilization equipment, such as expensive filters, ultraviolet radiation, chemical biocides and other technologies. Such a technological step requires a complete overhaul of ship design that will lead to new design constraints that derogate from existing IMO conventions. The effects on propulsion, structural strength, stability and damage stability will be significant.

This innovative design has many advantages over conventional designs (based on Type C cargo tanks and using ballast), combining environmentally friendly features with increased efficiency as well as projected lower construction and operating costs. Creating vessels with the ballast alternative means that they are no longer subject to ballast water management regulations. Removing pumps, piping and valves connected to ballast tanks could reduce maintenance costs, free up the electricity usually required during flushing to make ballast water management plants redundant, making it more economical. compliance with IMO rules. In addition to the cost of regulatory benefits, ballast-free vessels could have an extended service life without the threat of corrosion caused by sediment accumulation in ballast tanks. Eliminating this goal would also reduce inspection and cleaning times, making life easier for crew members (Globallast, 2011).

Some key features of landlocked ships are:

o Ballast beams: Ship ballast tanks are replaced by longitudinal ballast structural beams consisting of a central tank, two intermediate tanks and two side tanks surrounding the cargo hold below the ballast stream and connected to an intake manifold and an intake manifold. at the bow and stern respectively. These ballast logs are swirled to reduce the ship's buoyancy.

o Frame shape: The V-shaped hull minimizes resistance and optimizes propeller conditions in fully loaded and unloaded conditions, reducing the weighted sum of the wetted surface.

o Computational Liquidity (CFD) tools: Computational fluidity (CFD) compares the syrup resistance of the new design with that of a more traditional design and helps maximize pressure fields in the bow and stern area.

o Propulsion: Twin screws and optimum diameter propellers allow the tractor to be low immersed in the unloading condition and ensure high energy efficiency through an overlapping propeller assembly. Propulsion power is estimated based on resistance and propeller analyzes.

Cut and heel: Longitudinal bulkheads provide torque balance around the longitudinal centerline for all separation alternatives and prevent large decorative surfaces from appearing during load work.

o Load separation

The ultimate goal is to increase the ship's draft, the vertical distance between the water line and the bottom of the hull, and to prevent its large rise from the water when it unloads the heavy cargo. One idea was to widen the beams and use unique frame designs to displace water from the center of the boat in an effort to increase stability (Globallast, 2011).

In the early 2000s, Delft University of Technology proposed a "Monomaran" design that would implement a catamaran-like vessel in transport containers.

For over a decade, scientists at the University of Michigan have been exploring continuous flow methods for ship stability. Instead of ballast tanks, ships could be equipped with a variable buoyancy system that includes a network of logs running from the bow to the stern, below the waterline, reducing the potential retrieval of contaminated water along the ocean. The water passing through these canals would reduce the ship's buoyancy, instead of burdening it. During full load condition or any condition where ballast is not necessary, the outer ballast trunks will be separated using valves in each of the bulkhead bulkheads. This is necessary to provide the vessel with adequate failure survival in accordance with current IMO requirements (Globallast, 2011).

Of course, many boats face dimensional limitations. Typically, a ballastless tanker will have to increase in width to carry the same load as a conventional boat because generally the minimum draft required for its voyage and length is limited. This is at least a more expensive ship, if not incompatible with the size restrictions. Along with the lack of regulatory pressure, strong conservatism in the shipping industry is also a factor that hinders land-based shipping. Pilots may be concerned about being the first to introduce a new type of vessel, so there is a possibility that it may not be navigable. Thus, several solutions have been introduced that minimize ballast evacuation, without completely neutralizing the tanks. An example is the storm valve designs, which feature a V design and some temporary ballast tanks that can be lifted to increase draft during bad weather. Another option is to clean the water externally (ie at the doors) before adding it to ballast tanks (Globallast, 2011).

The prospect of ballast-free navigation in a liquefied natural gas (LNG) space is currently being investigated. The overall move towards ballast shipping will face challenges. Port and docks will need to be updated to include a higher difference between loaded and unloaded conditions than conventional carriers and designs will require a high level of precision to make appropriate adjustments to the management. Despite concerns in the past, the advantages of building a ship without ballast far outweigh the disadvantages.

4.3 Freshwater production on board

Another alternative flow management technique would be to produce large quantities of fresh drinking water on board. This could be achieved through the installation of fresh water evaporators independent of the existing ones for the production of drinking water to meet the needs of the ship's crew. Unused exhaust gases could be used in this process to provide the required energy. An advantage of this process then is that the fresh water produced could be sold to ports where there is a shortage of water in the ballast infrastructure to meet their needs, and thus the ship could increase its annual income. Untapped water can be discharged at no environmental cost. In current technology, the brine from the distiller is discharged directly into the sea. But if this brine, which is already heat-treated, could be discharged into the ballast water reservoirs the salinity in the reservoirs will increase and the destruction of marine organisms will occur to some extent.

Although from a technical and mainly economic point of view, methods such as the two mentioned above are not easy to implement as many factors need to be taken into account, they clearly constitute a long-term profitable investment for shipowners or shipowners (Globallast, 2011).

Conclusion

Shipping is the most economical means of transportation and transports over 90% of the goods worldwide. Every year, about 3-5 billion are transported for the service of maritime transport. tons of ballast internationally each year. It can be a key factor for the stability of a ship especially when it is unloaded, but it is also a vehicle for significant economic and ecological impacts on the environment and humans. In recent years, efforts have been made for green shipping, with the shipping industry looking for alternative processes to treat ballast or to make existing ones more environmentally sustainable and economically viable for shipowners. In this way, new ships will be able to help reduce global pollution. Bio-invaders significantly affect the biodiversity of the marine ecosystem they enter, the natural resources and services it provides, as well as humans. Quantifying the effects of a bio-invasion at both ecological and economic levels is difficult to achieve, as many effects take a long time to be perceived. The main action of the competent organizations and authorities should be the correct and effective information of the citizen. Because the sooner he understands the problem and the impact it has, the sooner he will be able to intervene to deal with it. Therefore, greater emphasis should be placed on prevention in order to identify potential vectors and routes of entry of bio-invaders, as well as to detect intrusions as early as possible, so that there is the possibility of a rapid response, which leads to a possibility of their eradication. . In case of bio-invasion, it must be detected and treated in a timely manner. It is imperative that systematic research be carried out in order to improve existing processing methods, to develop new ones and to make the combined methods work effectively.

Installing one or more on-board management systems is a time-consuming and expensive process for shipowners with strict compliance deadlines. Following the implementation of the Convention, all ships had to have ballast water management systems on board. Due to the lack of experience but also the existence of many different processing methods, each with its own limitations and advantages, shipowners are reluctant to adopt a processing system. The cost of capital, maintenance and installation are very important factors that need to be thoroughly considered before making a decision. Also the age of the ship, its type, its functional specifications play a decisive role in the choice of processing system. Understandably, a ballast management system that is optimal for one ship is unlikely to be the best solution for another of a different type and capacity. After the IMO deadlines, all vessels must implement a management system, in accordance with the management standards of the D-2 regulation. Applying to new ships seems to be easier than retrofitting older ships. This is because in new ships the possibilities of installing marine ballast management systems are determined during their design and construction, while in existing ships modifications are required to adapt the management systems. So for existing ships that are unable to install a wastewater management system as required by BWM convention regulations, they should rely on ground installations at ports. This in turn creates problems in the ports themselves since the lack of space in them is known. So there is a need to make serious investments both financially and in finding space. Apart from this, there is also the issue of the time burden required for the proper conduct of the waste water exchange. Additional investment is required to train ship crews in the proper handling of systems in order to comply effectively with compliance rules.

A basic condition of shipowners is compliance with the BWM Convention, which requires compliance with certain regulations and obligations at national and local level, and the existence of a Ballast Management Plan (BWMP) defined by the flag state. By signing the BWM Convention, States agree to compliance dates set by the International Maritime Organization or the US Coast Guard respectively. Failure to do so will result in severe penalties, so as to discourage any violations. Of course, the design, the inspection, the implementation as well as the sanctions imposed by the states differ. The problem of marine bio-invasion, however It is limited by borders, on the contrary it is spreading rapidly. The processing standards proposed by the US Coast Guard differ from those adopted by the IMO through the BWM Convention. This results in nations deciding unilaterally on the application and observance of the rules, confusing shipowners who are called upon to make decisions on a case-by-case basis.

Some innovations in ship design and engineering present good potential for improvement in the practicality, cost-effectiveness and safety of ships. Ballast functions and can offer an alternative to existing contractual practices, while of course meeting the ballast rejection standards required by the BWM Convention.

A modern solution is the NoBallast Ship, according to which the ship will be able to travel without the need to collect ballast water in tanks, but to pass in a continuous flow along the entire length of the ship. In order to promote the development of new and cost-effective ballast management systems, it will be important for shipowners, ship designers, national administrations, MEPCs and bio-invasive biologists to work together to revise regulations and guidelines. BWM, where appropriate, propose amendments or additions to facilitate the testing, evaluation and approval of innovative systems that meet the objectives of the Convention, with the aim of ensuring environmental safety and reducing operational issues and exchange costs.

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