COMPLETE

IN-WATER CLEANING (IWC) OF BOATS AND SHIPS IN THE BALTIC SEA REGION - CURRENT PROCEDURES AND FUTURE NEEDS

Workshop Report

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CONTENT

1. EXECUTIVE SUMMARY

This workshop report presents the results of the information compiled and discussions held by the participants who joined the workshop.

There are no specific national regulations with regard to in-water cleaning (IWC) in place. Although in some countries, administrations deny to give permits it is known that ships are cleaned by diving companies with specific working permits.

The results of the workshop show that the subject of the IWC in the Baltic Sea region requires coordinated efforts among the relevant authorities (e.g. Maritime Authorities, Environmental Agencies, Port Authorities, Water Authorities) in the individual countries with the aim of harmonisation at national and later, regional level. This is crucial to ensure consistent conditions for IWC, transparency for stakeholders, and an environmentally sound implementation of IWC.

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2. BACKGROUND

In-water cleaning (IWC) of leisure boats and commercial ships can be an essential part of biofouling management. However, IWC may pose a risk to the environment depending on the nature of biofouling (e.g. microfouling or macrofouling, alien species occurrence), the type of anti-fouling system (AFS) applied (e.g. biocides) and the methods applied for in-water cleaning (IWC) (e.g. high-pressure cleaner with collecting container, brushes, extractors, collection of waste).

With the implementation of the EU Water Framework Directive (EU-WFD), the chemical status of the water bodies must not be deteriorated. The EU Marine Strategy Framework Directive (EU-MSFD) and Invasive Alien Species Regulation (EU-IAS) aim at minimizing non-indigenous or invasive species introduction and spread. Therefore, the procedure of IWC, coming along with a certain environmental risk for the Baltic Sea, should be approved by responsible authorities. In the Baltic Sea Region (BSR), granting of permissions for IWC is in the responsibility of national or even local administrations. National environmental protection agencies (EPAs), municipalities, or port authorities are the competent authorities. At this point, no common understanding of the regulation of IWC and no common basis for the granting of permissions exists. In addition, there is a lack of information on IWC technologies, facilities, and procedures.

There are many activities and developments ongoing globally in the area of biofouling management, e.g. the GloFouling Partnerships Project. However, information is currently scattered in different reviews, reports and other publications.

The IMO Biofouling Guidelines (Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species, Resolution MEPC:207 (62)) and the IMO Guidance for recreational crafts (Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft, MEPC.1/Circ.792) provide practical recommendations for measures that may help to minimize risks of species introduction and spread from biofouling. The guidelines cover also the aspect of IWC and maintenance but there is no concrete recommendation on how environmental risk assessments as basis for permissions of IWC should be performed.

3. OBJECTIVES

The objectives of the workshop were to gather and compile information on legal aspects and regulations of IWC of recreational boats and commercial ships that are already in place in the Baltic Sea countries. Other objectives were exchange of information on practical implementations and good/best practice examples, discussion of knowledge- and/or regulation gaps, and summary of needs of action in order to develop a common understanding for IWC in the BSR.

Administrations, interest organisations of the shipping sector and experts from the BSR were invited to participate and to discuss the issues mentioned above. Representatives of five countries as well as HELCOM followed the invitation by the COMPLETE project (participants list see Annex 1).

Outputs of the Workshop

1) Overview of national regulations of IWC and waste management in the BSR

2) Good practices in the BSR and outside

3) Gaps and needs for action

4. AGENDA OF THE WORKSHOP

At the first day, the workshop focused, after a general introduction to the topic, on the current situation regarding national regulations and legal aspects of IWC in the Baltic Sea countries. Attending participants from Denmark, Finland, Germany, Poland and Sweden discussed and presented information for their respective countries and if available, also for the neighboring countries.

At the second day, actual practices of IWC in the Baltic Sea, good practices, knowledge gaps and discussions about needs for action were discussed.

The detailed agenda is attached in Annex 2.

5. INTRODUCTION

Biofouling means the accumulation of aquatic organisms such as micro-organisms, plants, and animals on surfaces and structures immersed in or exposed to the aquatic environment. Biofouling is an issue of common interest to ship-owners and authorities, as it has an impact on the speed, manoeuvrability, corrosion and fuel consumption (and thereby emissions) of a ship, as well as on introduction and spread of marine invasive species and input of biocides to the marine environment. There are a number of guidelines, conventions, directives and regulations addressing biofouling from different perspectives:

- IMO
    - Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (2011)
    - Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft (2013)
    - International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention, 2008)
- EU
    - Marine Strategy Framework Directive (EU-MSFD)
    - Water Framework Directive (EU-WFD)
    - Invasive Alien Species Regulation (EU-IAS)
    - Biocidal Products Regulation
- HELCOM
    - Baltic Sea Action Plan
- OSPAR
    - North-East Atlantic Environment Strategy

Fouled vessels create novel, mobile habitats for opportunistic and potentially harmful species. The global commercial fleet consisted of 93 161 vessels in 2017, with estimated total wetted surface area of 570 km2. In 2015, around 11 million recreational vessels were in use in the US and 6 million in Europe. Biofouling is estimated to be responsible for 56-69 % of the established coastal and estuarine non-indigenous species globally (Galil et al., 2019, 2019). Some of the most invasive species are considered to have a “fouling background”. For example, the eradication attempts of the sea squirt Didemnum vexillum in Shakespeare Bay, New Zealand cost NZ$ 650.000 but failed; in Holyhead Harbour, Wales, U.K., the eradication cost £ 350 000 and was originally successful, but the species re-established later (Galil et al., 2019). In addition, invasive species induce maintenance costs to shipping and marine infrastructure, damage to valuable fisheries and aquaculture, as well as increase fuel consumption and thus, emissions of greenhouse gases.

AFS are used to protect ships and boats from biofouling and comprise in most cases biocide-containing components, which are released into the water. A biocide, according to European legislation, has been defined as “a chemical substance (or microorganism) intended to destroy, deter, render harmless, or exert a controlling effect on any harmful organism by chemical or biological means”. The biocidal substances used in AFS have evolved from tar pitch, tar or wax

combined with sulphur or arsenic, and lead with copper nails, to copper and organotin compounds. Tributyltin (TBT), introduced in the 1960s, has been described as the most toxic substance ever deliberately introduced into the marine environment (Frouin-Mouy et al., 2011). Regulations started regionally with small boats and led to the total global ban in 2008 (IMO AFS Convention). The biocides mainly used in current AFS is copper.

IMO MEPC 71 discussed the amendment of Annex 1 of the AFS Convention to include cybutryne. Cybutryne can be associated with adverse effects to the environment, as it is toxic and persistent. It is a priority substance under the EU-WFD, and in Europe, it has already been banned in antifouling products in 2016 under the Biocidal Products Regulation (BPR). At PPR 6 it was agreed to add cybutryne to Annex 1 of the AFS Convention proposing that from 2021 ships will no longer be allowed to apply cybutryne and from 2026 cybutryne shall not be on the hull of the ship or external parts, or it shall be covered with a coating that forms a barrier to cybutryne to prevent its release to the marine environment. With the entry into force of the amendment to Annex 1, all ship-owners have to implement the regulation within the next periodical dry docking.

Recent changes in commercial shipping and leisure boating such as increase in vessel number and size, changes in routes, transit speeds and port stays, as well as anthropogenic coastal modification and disturbance, including climate change have led to increasing problems with biofouling. The management of biofouling should take into account potential harmful effects of AFS on one hand, and the potential risk of introduction of invasive species and other associated negative effects like increased GHG emissions due to fouled ships on the other hand. Risk assessments and decision support considering all aspects are needed for an effective and sustainable management The International Council for the Exploration of the Sea (ICES) recommends developing and evaluating adaptive biofouling management suitable for different vessel types and operation profiles (vessel design, maintenance, performance measures, shipping route, port residence time, etc. (Galil et al., 2019). However, there are still significant gaps which need to be filled (e.g. adequate cleaning techniques, varying national legislations, innovative coatings, etc.)

IWC of commercial ships has become a common practice since shipping has to handle their fouled hulls and niche areas between dry dock intervals. It is known that IWC is also performed on ships and boats with biocide containing AFS, although these systems are not suitable for cleaning, resulting in the damage of the coating and an input of toxins and paint flakes (microplastic) into the marine environment.

6. OUTCOMES

6.1. In-water cleaning: National regulations, current procedures and experiences in the Baltic Sea Region

Participant groups from Denmark, Finland, Germany, Poland and Sweden teamed-up to provide answers to the following questions:

1) *Is there any national regulation in place regarding in-water cleaning (IWC) of commercial ships and leisure boats?*
   a) *With respect to biocides/contaminant release*
   b) *With respect to introduction of non-indigenous/invasive species*
2) *Which administrations are involved or responsible?*
3) *Is there a list of cleaning facilities in your country available?*
4) *What approval process(es) is/are necessary for granting permission of IWC?*
   a) *Type of approval*
   b) *Examples of approval processes*
   c) *Is there any risk assessment performed? What is/should be considered in that context? (Cleaning techniques, type of AFS, amount of biofouling, location where cleaning takes place, origin of the ship, collection and treatment of waste, anything else…)*
   d) *Are there approved/certified cleaning services? What are the requirements for approval?*
5) *In case no regulations are in place: Are there any applications/requests of stakeholders concerning IWC?*
6) *Is it in general allowed to clean ships and boats in-water without any permission?*

It has to be mentioned that response to the questions has been provided on the basis of the knowledge of the WS participants and therefore, information might be non-exhaustive. A summary of national regulations and procedures of the participating countries is shown in table 1 for commercial ships and in table 2 for leisure boats.

Denmark

1) There's a procedure for IWC in place, close to the IMO Guidelines, but no national regulation.
2) A port/marina needs to apply for a license for IWC. The license is valid for one year. The procedure for applying for and granting the license is decided by the municipality, and the procedures are not necessarily harmonized between different municipalities. The Danish Maritime Authority is not involved in the process.
3) No.
4) There's a risk assessment procedure in place, including measurement of concentrations of copper and other substances before and after the cleaning.
5) N/A
6) Apparently, there is also cleaning being conducted in the anchorage area without any regulation.

Finland

1) The legislation in Finland is similar to Denmark and Sweden. There's no specific national regulation of IWC either for commercial ships or leisure boats. Individual ports could impose their own regulation, but ports have not used the possibility to set their own regulations regarding IWC (or biofouling management in general) in their environmental permits, even if legislation enables it, similarly to Sweden. Most vessels calling Finnish ports have hard coatings (so-called ice breaker coatings), not biocidal antifouling paints, as in wintertime, sea ice cleans the hull and would also remove the paint. In summer, hulls are cleaned by divers. Vessels visiting Finland only in summer (ice-free period) may have biocidal AFS and they are usually not cleaned. Ships mainly operating in the Baltic Sea (e.g. Viking Line, Finnlines, Tallink, ESL, Bore) do not use any AFS and clean regularly (every 3-4 weeks at least). When cleaning is conducted often, there's not much fouling and the cleaning is easy and fast.
   a) The national biocidal regulation states that the maintenance of recreational craft may not create harmful emissions to the marine environment. Traditionally, boats are cleaned on land, not in water. Authorities want to support the boat owners in shifting from biocidal paints to alternative methods, i.e. cleaning. Therefore, the authorities see that boats with old, hard-surface paint (in good condition) could be cleaned in water, without leakage of copper/zinc to the water. Devices for cleaning leisure boats do not need operating permits. "Seaboost" is developing a non-biocidal coating for leisure boats to be used together with their own cleaning device.
   b) No national regulation.
2) Regional State Administrative Agencies (AVI; issuing the operational environmental permits for ports) and Centres for Economic Development, Transport and the Environment (ELY, supervising these permits) would be responsible if ports would impose their own regulations. The Finnish Transport and Communications Agency (Traficom) as the PSC authority would be responsible for monitoring vessels for AFS Convention.
3) No.
4) Any diving work in a port needs a "work permit" or advance notice for work safety reasons only.
5) IWC industry has requested harmonized regulation for IWC, and hence, Finland proposed to HELCOM Maritime 15-2015 to have a HELCOM recommendation for IWC. However, the proposal received no support.
6) Yes.

Germany

1) IWC generally requires permission. Decisions are legally based on the German Water Act. Central aspect is the avoidance of the input of chemical compounds which would lead to a deterioration of the chemical status of the aquatic environment.

2) It is possible to ask for a cleaning permit from federal states lower water administrations. Some could allow it and some not, as there's no common permission process in place.
3) No.
4) N/A
5) There are requests of stakeholders for IWC.
6) IWC may be taking place outside ports without any permits or knowledge of this.

Sweden

1) There's no national regulation framework.
2) For commercial shipping, the situation is very similar to Denmark. However, the permits are granted on a case-by-case basis and not valid for a full year. Municipal authorities (Miljöförvaltningen) decide on the regulation, which may differ even between adjacent municipalities. The municipalities often ask advice from local environmental agencies. The perspective varies between municipalities: in Malmö and Gothenburg, the hull cleaning companies are seen as responsible for the pollution, whereas in Stockholm, it's the ship-owners. Regarding leisure boats, cleaning facilities were established when it was allowed to clean on biocidal paints, before re-painting, but currently cleaning is only done on non-toxic paints.
3) No.
4) The risk assessment is based on area of traffic, the AFS (permit has only been given for non-toxic coatings), capturing device, and waste treatment procedures. In the ports of Gothenburg and Malmö, no cleaning is allowed if the vessel is in traffic outside the Baltic Sea and the North Sea.

Poland

1) There's no specific national regulation for IWC.
    a) According to the act on environmental pollution from ships, it is forbidden to pollute the water areas and ports.
    b) It is prohibited to introduce alien species. The Ministry of Environment keeps a list of alien plant and animal species, for which maritime transport is the main vector.
2) The ship-owner needs a permission from the harbour officer to clean the hull. However, in practice no permits are given, and cleaning in Poland is only conducted in dry-dock. Even if the cleaning company has certified equipment, due to lack of knowledge and regulation, authority does not give permission for IWC, because responsibility is unclear in case of pollution. If pollution is detected in the Polish economic zone, an investigation will be carried out and penalties will be issued. There are several authorities involved, and different inspectors for cleaning conducted on land.
3) No.

Other BSR countries

Representatives from Estonia, Latvia, Lithuania and Russia were not present during the workshop. Information was gathered by the knowledge of participants present.

Estonia, Latvia and Lithuania

There's IWC taking place in these countries. The situation is largely similar to Finland, i.e. you need to inform the port about any diving operations and pursue a permit for diving operations in the port. There is no particular permit necessary for hull cleaning activities.

Russia

It is known that IWC is taking place and that some companies got permits to carry out diving operations. However, the situation with respect to approval granting processes for IWC activities are not known.

Table1: Summary of various aspects concerning IWC of commercial ships in Baltic Sea countries

Commercial ships	**Denmark**	**Finland**	**Germany**	**Poland**	**Sweden**
1. National regulation	No, but a procedure according to the guidelines	No	Water Act	No	No
2. Administrations involved	Ports and municipalities	Regional State Administrative Agencies and Centres for Economic Development, Transport and the Environment	Lower water authorities	Harbor officers	Municipal authorities and local environmental agencies
3. List of cleaning facilities available	Yes	No	No	No	No
4. Approval process for permission	Yearly license requirements; risk assessment procedure	Only for diving work safety	Yes, but practically no issuing of permits so far	Yes, but practically no issuing of permits so far	Case by case, permits only for biocide-free AFS
5. Requests for permits	Yes	Yes, permits for diving work safety	Yes		Yes
6. Cleaning possible without permits	Yes, in the anchorage area	Yes	No	No	Yes

Table2: Summary of aspects regarding IWC of leisure boats in Baltic Sea countries

Leisure boats	**Denmark**	**Finland**	**Germany**	**Poland**	**Sweden**
1. National regulation	No, but a procedure according to IMO Guidance	No	Water Act	No	No
2. Administrations involved	Marinas and municipalities	Regional State Administrative Agencies and Centres for Economic Development, Transport and the Environment	Lower water authorities	Harbor officer	Municipal authorities and local environmental agencies
3. List of cleaning facilities available	Yes	No	No	No	Yes
4. Approval process for permission	Yearly license requirements; risk assessment procedure	Only for diving work safety	Yes, but practically no issuing of the permit so far	Yes, but practically no issuing of permits so far	Case by case, permits only for biocide-free AFS
5. Requests for permits	Yes	Yes, permits for diving work safety	No		Yes
6. Cleaning possible without permits?	Yes, in the anchorage area	Yes	No	No	Yes
7.					

Further issues which have been discussed by the WS participants

Handling of biofouling waste

Handling of biofouling waste from hull cleaning is currently not addressed by the IMO Biofouling Guidelines. In some countries it is considered food waste and may be used e.g. in biogas production, whereas in others it is considered hazardous waste as it may contain e.g. heavy metals and microplastics. In Finland, biofouling waste is not separately regulated, and the cleaning company takes care of the waste in co-operation with waste companies. In UK, the Port of Southampton has given approval to two companies to conduct IWC and handle related waste. Also, in New Zealand, Australia, Dubai and Mauritius, there's a similar process in place. However, in New Zealand, there's regulation regarding the biofouling waste, but no facilities for its disposal.

The role of ports in IWC

The role of ports varies between ship types and countries. Some vessels, e.g. tankers, spend relatively little time in the port and more at anchorage, and are unlikely to conduct cleaning inside the port area. In the Nordic countries, ports operate as companies on commercial terms and may be unwilling to set restrictions to their customers. Ports also strongly compete with each other for calls. In Germany, there are two port bodies: the statutory port authority who gives the permits, and the commercial port operator. In the Netherlands, all ports operate under one authority, whereas in Belgium, the port itself is an authority but still competes commercially with other ports.

Cleaning on biocide containing AFS

For biocidal AFS, a so-called leaching rate is calculated. This rate determines the concentration of the biocide released per period from the AFS. Cleaning on biocidal paint leads to an immediate release of biocides and is considered as an unintended use of the biocide product. However, the risk assessment of the biocide product is conducted only before its introduction to the market and the effect of potential cleaning activities is not included in the process of the the approval of the biocide product. Thus, the risk of IWC should be approved separately with its own risk assessment. For example, in New Zealand, the biocides that come off in cleaning are included in the risk assessment calculation (e.g. in this area we can have x number of cleaning events per year). Quantification of the leakage during cleaning is a clear knowledge gap and is in part being filled within the COMPLETE project in WP 4.3. The amount of leakage depends on the type of cleaning (e.g. water jets or brushes), and the AFS. Also important to know is the impact of cleaning on the effectiveness of the paint: does it reduce its lifetime by 5 days or 5 months? The answer is paint-specific. Cleaning of biocidal AFS is generally not promoted by the WS participants due to the above mentioned environmental impact. As the Baltic Sea has been designated a Particularly Sensitive Sea Area (PSSA) by IMO in 2005, the possibility to prohibit cleaning on biocidal AFS could be considered and discussed e.g. in the HELCOM expert network on hazardous substances.

6.2. In-water cleaning in the Baltic Sea -overview and perspective

Pro-active and re-active hull cleaning in the Baltic Sea is a common practice in commercial shipping. Most cleaning activities are performed re-actively on failing AFS. Pro-active cleaning on non-toxic, durable coatings is performed on ferries. In re-active cleaning, the rate of fouling is checked by underwater surveys or indicated by increased fuel consumption. Proactive cleaning is also called grooming, meaning removing biofilm at an early stage of fouling. The fouling season is very short in the northern Baltic Sea. Ice scratches off both fouling and paint, and hence ice-classified hard coating is used on vessels which sail in ice conditions.

Most AFS need the vessel moving often and fast enough for the AFS to be working efficiently. To be able to select the suitable AFS, the operational profile of the vessel (speed, days at sea, days at harbour, surface speed) needs to be known. However, operation rarely stays the same for 5 years, i.e. until the next dry docking. Operational profile might change and thus, AFS loses its performance and effectivity. Under these circumstances, the hull needs to be cleaned.

Unfortunately, most AFS are not designed for IWC. Cleaning on self-polishing copolymer (SPCs) or controlled depletion polymers (CDPs) removes upper paint layers, leading to spontaneous release of biocides and other paint compounds, e.g. microplastics. Biocidal AFS typically contain a matrix or polymeric binder (20-30 %), core biocides (15-40 %), co- or booster biocides (4-5 %), erosion additives like zinc oxide (5-15 %), pigments (3-4 %), plasticizers (2-5 %), catalysts (0.5-2 %) and solvents (15-20 %). Cleaning can be considered as unintended use of the AFS and is inconsistent with the conditions within the risk assessment conducted according to MAMPEC, the chemical fate model to predict environmental concentrations of antifoulants in harbours and estuaries. In the US, cleaning on antifouling paints is allowed if it doesn't result in visible plumes in the water. If a visible plume is detected, the cleaning should be stopped, but this is not monitored. Some macrofouling communities may be very difficult to be removed, and hence some cleaning companies may use sharp blades in addition to brushes and water jets which leads to even higher input and damage of AFS.

There are several alternatives for biocide containing AFS. Regarding silicon coatings, the challenge is to develop a coating soft enough to reduce the rate of attachment of organisms but hard enough to endure service life of 5 years. Some companies claim they provide hard coatings that need to be applied only once in a ship's lifetime. However, these are still in a testing phase, as more than 100 test batches are needed before entering the market. The advantage of non-biocidal hard coatings is that there are no conflicts with any regulation around the world, e.g. of ports or application at dock as long as they are free from biofouling. For some ports e.g. in New Zealand, Australia and California, the ship needs to declare what kind of AFS they have before entering the ports.

Fouling does not occur equally all around the hull, which means that different antifouling techniques need to be used on plain surfaces of the hull and in niche areas such as e.g. sea chest, bow thruster and stabilizers. An underwater survey is always conducted before IWC commences. Niches are often not accessible for cleaning. Diving companies have proposed to mark and log the size of all securing bolts, count and log all drain holes, including their size, and providing access

points into thruster gratings, allowing divers to access the tunnel. Ship engineers should be involved in addressing these issues through ship design.

IWC of leisure boats is becoming more and more popular as well as economically feasible in Sweden, with approx. 30 cleaning stations of two service providers. Boat owners can book the cleaning via an app, and the cleaning only takes between 10 and 15 minutes. The typical cost for cleaning a 10 m boat with no heavy fouling is approx. EUR 20. There should be a system for collecting the waste at each station. Some cleaning stations for leisure boats are also present in southern Finland. A hard coating on a leisure boat may be used for 5-6 years instead of yearly repainting with biocidal paint.

In Finland, Germany and northern Sweden, boats are taken out of the water every winter and the cleaning is mainly done in the marinas on land.

7. WHAT ARE THE GAPS AND NEEDS FOR ACTION?

Discussion between authorities is needed for harmonization of regulation, permission and practices of IWC in the BSR. The issues to be discussed include:

- environmental risk assessment as basis for granting permissions for IWC;
- different cleaning approaches (pro-active vs. re-active);
- cleaning on antifouling paints vs. on non-toxic durable coatings;
- used tools and cleaning devices (rotating brushes, hydro jets);
- collection of removed fouling;
- filtration/flocculation of particles, organisms and dissolved substances.

Several actors (BIMCO, NACE, IMarEST, DNVGL, and ports) have developed or are in the process of developing their own standards for biofouling management, including IWC, and there's clear need for exchange of knowledge and experience, discussion, and finally harmonization.

The WS participants were invited to give their perspectives on knowledge gaps and needs for action. In discussion groups the following set of guiding questions has been addressed:

1) *Do you think that there is a need for regulation of biofouling management?*
2) *Where are the knowledge gaps? (e.g. methods, technologies, risk estimation, regulation process, practical implementation, demand, costs)*
3) *Do you think regional harmonization should be approached?*
4) *What are the needs for action? From the authority's, the cleaning company's, the ship/boat owner's perspective? (e.g. authority: suggestions for stakeholders based on good practice in the BSR, development of risk assessment tool/decision support tool, shared database on cleaning technologies/companies…)*

Outcome of the discussion group on commercial shipping

Examples form countries like Australia and New Zealand showed that regulation could enhance the implementation of effective and sustainable biofouling management. Especially the need for cleaning of niche areas must be regulated as this is not an economic issue for the ship-owners. With regard to biofouling management, the IMO is the body for regulations with regard to ships in international waters (e.g. the IMO Ballast Water Management Convention), but not regarding national responsibilities, e.g. ports and marinas. Moreover, IMO does not regulate anything as such, but they bring up conventions, which countries might ratify and implement. Regarding biofouling management, the IMO Guidelines are not sufficient as such. Ship-owners mainly follow the Guidelines when it's mandatory to do so, e.g. in Australia. For the implementation of the Biofouling Guidelines, harmonization at the Baltic Sea Region level should be approached. For that purpose, defined standard procedures and instructions ("do it like this and collect the material as well as you can") and respective technology are basic requirements for a successful implementation.

In the BSR, some ports just deny all IWC due to lack of knowledge. Moreover, port authorities are not always able to control everything due to lack of competent personnel. The knowledge gaps are related to capture systems, filtering, waste treatment and disposal, type of coating which might be cleaned without negative impact on the paint itself and the environment, performance of hard non-biocidal coatings, and the use of new systems to prevent fouling (e.g. ultrasonic), especially for niche areas.

Regional harmonization should be approached. However, the same standards may not work everywhere. Even in the Baltic Sea, environmental conditions, which are essential for the type and amount of biofouling which can develop, vary considerably. Therefore, regulation/risk assessment should focus on the most important basic requirements and have to leave enough room for locally tailored implementation. In that context, certification of technology, methods, and cleaning providers could be considered.

Awareness needs to be raised on various aspects of biofouling management including the fact that biocidal coatings do not work under specific circumstances like slow steaming and long resting periods. In these cases, cleaned might be necessary even though the AFS are not developed to be cleaned. Thus, other AFS might be better for both, the environment and, in terms of costs, for the ship-owner. Cost-effectiveness analyses are needed to support ship-owners in choosing the best available technology considering all aspects mentioned above. Therefore, surveys and assessments of available technologies and practices are needed. There's a class approval for companies doing underwater survey before cleaning, and a similar approval could be required after cleaning, as the ship-owners want to see images / videos after cleaning. If a global biofouling convention would be developed, enforcement would be necessary. In general, the commitment of all parties is of utmost importance: ship-owners, different authorities, ports, cleaning companies, AFS manufacturers, shipyards, and ship designers.

Outcome of the discussion group on leisure boating

Implementation of effective and sustainable biofouling management could be improved by introduction of rules, procedures and pragmatic advice regarding best practice. A common harmonized interpretation and implementation of the IMO Biofouling Guidance is needed, taking into account that conditions vary a lot within the HELCOM/OSPAR regions. There could be certificates for both, sustainable cleaning and coatings. Attention should also be paid to waste management. There are big differences in the awareness level between the countries in the region. Package and instruction leaflets of AFS should show the areas where they can be used without overdosing of the containing biocides. In addition, areas where copper concentration is already high could be marked to avoid additional copper in case of low fouling pressure (e.g. freshwater, low salinity waters). This information is available from the results of the BONUS CHANGE project and will also be included in the COMPLETE Best Practice Guide. The HELCOM recommendation on AFS should be followed. The BSR might serve as a demonstration area for innovation with respect to the implementation of the IMO Biofouling Guidance especially concerning the use of alternative coatings without biocides and certified cleaning facilities.

The TBT regulation started first with the smallest boats. The same could be accomplished locally or regionally (through HELCOM) with other biocidal paints without major economic impact. Shipping should be regulated internationally but boating can be regulated locally/regionally. But it has to be considered that biofouling management others than use of biocides has to be implemented in order to avoid fouling.

The removed fouling needs to be captured, but this is in practice not always the case, especially for leisure boats. For example, a mobile cleaning system with rotating brushes for small motorboats does not allow collection of material. Before any filtering can be conducted, there must be the ability to collect the removed material. The size of the fouling organisms varies between ca. 8 µm (spores of algae) and 200 µm (barnacles). New Zealand has set a limit of 12.5 µm filtration. DG Diving, operating in the Baltic Sea also on commercial ships has the ability to filter down to 8 µm by several filtration sequences.

8. TOWARDS HARMONIZED STANDARDS FOR IN-WATER CLEANING

The Baltic and International Maritime Council (BIMCO) currently develops an IWC standard for commercial shipping. There is a need for alternative solutions such as hull cleaning to increase the efficiency, reduce GHG emissions, and avoid species introductions in shipping. Solutions include cleaning either during dry-docking or in-water, innovation in the form of new paint types or alternative AFS, and better design of ships, especially niche areas. Dry-docking is very costly compared to IWC. However, some ports are prohibiting IWC under their jurisdiction due to the release of biofouling and anti-fouling paint biocides and coatings and associated risks of accumulation of harmful substances and invasive non-native species. An IWC standard is needed because biofouling management cannot work without IWC. The perspective of BIMCO is that the standard needs to be globally applicable, a cleaning company should only be approved once, and demands should be the similar everywhere. The focus should be on better co-operation between paint manufacturers, cleaning companies and ship-owners to improve fuel consumption, reduce pollution and GHG emissions, and reduce the risk of spreading invasive non-native species.

BIMCO co-operates with ship-owners, hull cleaners, ports and paint manufacturers. The standard should ensure good quality cleaning, fulfilling a set of specifications providing that the environmental impact of the process is controlled, the coating performance is not impaired, and the cleaning process is planned, safe and effective. BIMCO will develop guidelines to plan and document the IWC. In addition, ship documentation on coating history, including dry-docking schedule and paint jobs, a logbook for inspections, pictures/videos on the specification and verification of result will be addressed. The standard will include a description of how and what to measure before and after cleaning, guidance on hull performance and service life of coatings, including procedures for the use of systems, guidance on handling of collected materials and

seawater discharge, its collection, filtering and/or treatment and handling, as well as an approval process of cleaning suppliers, including efficacy testing of the systems.

There are some significant challenges: How to determine threshold values that can be accepted globally? Niche areas are very hard to clean, and innovation may be needed. In addition, more states are planning national legislation.

9. EXAMPLES OF GOOD PRACTICE OF BIOFOULING MANAGEMENT

The shipping company Wallenius Wilhelmsen sailing mainly in the North Atlantic, implemented a sophisticated Biofouling Management Policy (BMP). Wallenius Wilhelmsen is working together with AFS manufacturers, aiming at the application of hard coatings without biocides in combination with cleaning for their fleet.

The ship-specific Biofouling Management Plan (BFMP), according to IMO Guidelines, is kept on board each vessel. Underwater inspections are carried out in minimum 3 times per year, and these include niches areas and vertical inspections. The inspections are documented with a report and video. Fouling intensity of each vessel is scored by using the "Fouling Factor Scale". If there's evidence of biofouling, the hull is cleaned in the first available port, followed by frequent monitoring and automatic addition to early docking scheme in order to renew the coating, in case cleaning damages the performance of the coating. There's also regular propeller polishing with minimum intervals of 6 months. Niche areas are inspected at least 3 times per year. These include rudder, rudderstock and hinge, propeller and shaft, rope guards, sea chest(s), bilge keel, stern/bow thruster, bulbous bow, chine lines, echo sounders and velocity probes, cathodic protection anodes, sea inlet pipes and overboard discharge outlets. If fouling is detected in any of these niches, they are cleaned.

They have a preferred provider of cleaning services which has a very high cleaning standard and captures 97 % of the removed material. It also utilise flocculation in order to capture parts of the dissolved copper and zinc. Time needed for cleaning is 10-11 hours per ship, costs are very high.

There were also other examples for best management practices for IWC presented at the meeting.

The cornerstones of good management are i) a pro-active strategy, ii) selection of the suitable coating, iii) application of suitable cleaning tools, and iv) proper capture, filtration and deposition of the removed material.

Biofouling management aims at the reduction of skin/hull friction, reduction of gaseous emissions by fuel savings, reduction of the input of microplastics and harmful substances, and prevention of introduction and spread of fouling organisms. When conducting cleaning before leaving, the ship will sail with a smooth hull, and no organisms will be transported. However, this approach is quite

expensive. The approach of “Grooming” means early cleaning at a biofilm stage. But even in that stage, invasive species can be present. Performance systems should be used to monitor the skin friction, and regular in-water surveys should be conducted, at least before each transcontinental cruise.

Regarding selection of the suitable coating, hard, durable non-toxic coatings & pure fibreglass enforced epoxies need to be cleaned very often. With epoxy-silicone hybrids, the cleaning interval is significantly longer. Cleaning tool options include soft rotating brushes, hydro jetting and rubber lips. The biofilm and debris should be captured, with a separate collection and filtration unit on a barge or at berth.

The volume of water to be filtrated is huge. The possibility to combine the filtration with the ballast water management system of the vessel was discussed. Effluent concentrations of biocides and amount of living organisms must not exceed (quality) standards. Some cleaning companies can fulfil the requirements when the coating is suitable for cleaning and cleaning is conducted at an early stage. In the EU, copper concentration thresholds have been set only for the sediment and not for water. Copper is not an indicator in the EU-MSFD and hence there’s no monitoring of copper implemented. In the US, the allowed limits vary between ports. A worldwide threshold is probably not possible to agree on.

To provide the workshop participants with information on the current techniques applied for IWC, a cleaning company presented practical examples of their hull cleaning services. The company is focused on underwater maintenance, repair and inspection activities for the shipping industry. They operate portable hull cleaning devices. A 200 m vessel takes ca. 6 hours to clean with one diver at a time. Their cleaning capacity is ca. 600 m2 / hour. The hull cleaning device includes a collecting feature and is equipped with a water filtration system. The machine is capable to clean both, flat and curved areas. There are a variety of tailor-made brushes for different coatings, to efficiently clean the underwater hull without damaging the paint surface (approved by paint manufacturers). The machine collects the cleaning waste, guiding it to filtration. The equipment meets the environmental requirements of the Swedish authorities (in Malmö and Gothenburg) and is following the IMO Guidelines.

What would be good/best practice in the Baltic Sea Region?

In order to get closer to the definition of “best practice” for biofouling management in the Baltic Sea, the discussion groups were posed the following questions:

1) *Which AFS/coatings can be recommended for in-water cleaning in the BSR?*
2) *Which minimum requirements for cleaning technologies must be fulfilled?*
3) *What about incentives for e.g. proactive cleaning?*
4) *What should be included in a risk assessment (type of coating/AFS, operational profile, cleaning technology/techniques available, biofouling level, cleaning location (harbour, marina, off the coast), ship/boat type, collection and treatment of waste…)*

Outcome of the discussion group on commercial shipping

1) Durable (hard) non-biocide coatings (epoxy-silicon hybrids, silicon chemically bound), Silicon coatings (soft, rubber-like). They are not suitable for drifting ice conditions of the northern Baltic Sea, as the coating will be destroyed.
2) The most important requirements are capture of the removed biofouling and filtration. There are a lot of different substances in antifouling coatings that may not be biocides, but still should not be discharged in the water. The choice of the cleaning technique should be appropriate for the coating type and fouling level.
3) There may no other incentives besides fuel savings required. Additional suggestions by the participants were: A “green supply chain” especially for consumer goods could also consider biofouling management. In this model, cargo owners pay more for transports but can charge a higher price for their goods. Sensitive areas could only be visited by clean-hulled vessels and certain AFS. This applies mainly to cruise ships, and perhaps is not relevant / feasible in the Baltic Sea.
4) The factors listed in the question should be included. Each vessel should have a certified biofouling management plan, which separates the hull and niche areas. Marine Growth Prevention (MGPS) methods for the niches should be included. The risk assessment should also include safety regulation of the diving work, e.g. no propeller or sonar activity or discharges when divers are active, and take into account the requirements of the International Ship and Port Facility Security Code (ISPS).

Outcome of the discussion on leisure boating

1) Only hard coatings should be recommended for cleaning. If the coating is soft, only soft cleaning should be applied.
2) The cleaning should be safe for environment and cost-efficient. Capture should be done with sufficient capture rate as well as waste management. There should be certificates for the cleaning technology. The cleaning of boats could operate similarly as a car wash, where all the water is treated and not put directly back to the sea. This would require infrastructure and facilities.
3) Boat owners should demand cleaning facilities in the marinas, which would be an incentive for the marina owner to provide cleaning services.
4) The cleaning technology / company should be certified. If no cleaning is conducted on biocidal paint, no risk assessment will be required concerning contaminants.

10. FUTURE NEEDS AND SUGGESTIONS

The workshop ended with drafting some take-home messages. A consensus was reached on the need for regional harmonization of IWC. For that purpose, standards are required: for commercial shipping, harmonisation should be international (through IMO) or interregional (i.e. HELCOM-OSPAR), whereas for leisure boating, a regional approach could be feasible. A holistic assessment, taking into account invasive species, biocides, GHG emissions, waste management and economic aspects, should be conducted. Currently, there are significant knowledge gaps regarding the effectivity of capture systems and filtration, waste management, the performance of coatings enduring cleaning, and new antifouling technologies, which need to be filled. Moreover, the existing regulations and standards need to be surveyed and utilized as basis, certificates for cleaning and coatings need to be developed, and awareness needs to be raised, leading into commitment of different stakeholders.

The outcomes of the workshop will be an essential part of the biofouling management roadmap for the Baltic Sea Region to be developed within the COMPLETE project. The roadmap will be oriented on the content of the IMO Biofouling Guidelines. Aim is to give feedback to IMO regarding the Guideline within its evaluation period. COMPLETE will keep its stakeholders informed and involved.

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Annex 1

Participants list

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Annex 2

Workshop agenda

Monday, 27 May 2019, 12:00 – 17:00

12:30 – 13:30	Welcome by BSH (Katrin Ewert)
	About the COMPLETE project (Miina Karjalainen, KMRA)
	Workshop agenda and objectives (Annika Krutwa, BSH)
	Round of introductions
13:30 – 13:50	"Biofouling in the spotlight" (Katja Broeg, BSH)
13:50 – 15:00	Breakout session: national regulations, current procedures and experiences in the Baltic Sea Region
15:00 – 15:30	Coffee break
15:30 – 17:00	National presentations Baltic Sea countries: results from the breakout session

Tuesday, 28 May 2019, 9:15 – 17:00

9:15 – 9:45	"In-water hull cleaning in the Baltic Sea" (Burkard Watermann, LimnoMar)
9:45 – 10:30	Working phase I: What are the gaps and needs for action?
10:30 – 11:00	Coffee break
11:00 – 12:00	Summary working phase I: results and discussion
12:00 – 13:00	Lunch break
13:00 – 13:30	Examples of good practice (Annika Krutwa & Burkard Watermann)
13:30 – 14:45	Working phase II: What would be good/best practice in the BSR?
	AFS
	Cleaning technologies
	Incentives
	Risk assessment
14:45 – 15:15	Coffee break
15:15 – 16:15	Summary working phase II: results and discussion
16:15 – 17:00	Concluding session: Future needs and suggestions
17:00	Closing remarks