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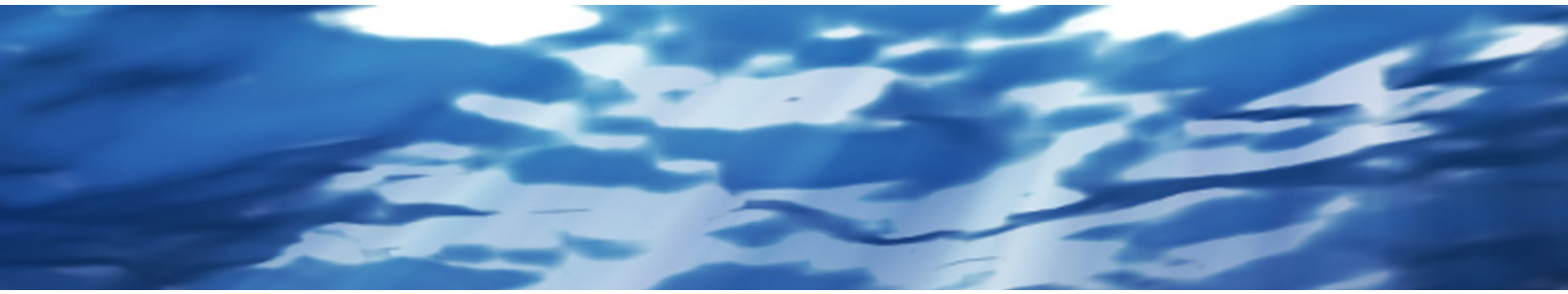
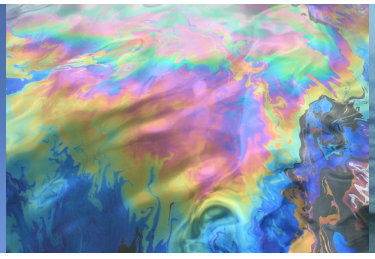


LIGHTHOUSE REPORTS

Use of port State control inspection data from the Paris MoU to assess pressure from shipping on the marine environment

A study of ships operating in the Baltic Sea region



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TRAFIKVERKET

LIGHTHOUSE
SWEDISH MARITIME COMPETENCE CENTRE

INDUSTRY PROGRAMME
SUSTAINABLE SHIPPING

Use of port State control inspection data from the Paris MoU to assess pressure from shipping on the marine environment: A study of ships operating in the Baltic Sea region

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Preface

In this report we analyse the current official control system of ships as a measure to prevent negative effects on the marine environment. We explore the relation between the Port State Control system as implemented by Paris Memorandum of Understanding, and the Marine Strategy Framework Directive, which obligates EU member States to achieve a Good Environmental Status (GES) of their marine waters. In that sense, the report presents a new perspective on the Port State Control statistics that Paris MOU already publish.

This report also aims to serve as a motivator for further analyses and actions to reduce negative impact from shipping on the marine ecosystems, and to coordinate the official measures used by different marine and maritime agencies. Special attention is paid to the Baltic Sea, which like all EU marine waters is embraced by the Marine Strategy Framework Directive. A set of suggestions for further analyses is included in the report conclusions.

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The authors are solely responsible for the content and the conclusions of the report.

The Authors

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Glossary

AFS	International Convention on the Control of Harmful Anti-fouling Systems on Ships / Anti-fouling Systems Convention. Adopted by IMO.
AIS	Automatic Identification System
BWMC	International Convention for the Control and Management of Ships' Ballast Water and Sediments / Ballast Water Management Convention. Adopted by IMO.
EMSA	European Maritime Safety Agency
IMO	International Maritime Organization
IMO-number	Identification number for ships. Mandatory number for passenger ships larger than 100 GT and for other ships larger than 300 GT. IMO-numbers are constant during the lifetime of ships.
Keel date	The formal recognition of the start of a ship's construction
MARPOL	International Convention for the Prevention of Pollution from Ships. Adopted by IMO
MSFD	Marine Strategy Framework Directive, implemented in EU
Paris MoU	Paris Memorandum of Understanding
PSC	Port State Control
PSCO	Port State Control Officer
RO	Recognized Organization. To qualify for the criterion recognized by the Paris MoU the organization must be recognized by one or more Paris MoU Member States.
THETIS	A database hosted by EMSA which informs PSCO which ships are due for an inspection.
UN SDG	United Nations Sustainable Development Goals

Figure 1. Map over the Baltic Sea region. Both HELCOM and IMO define the Baltic Sea as all marine waters from Gulf of Bothnia in the north to Kattegat in the west. In the west the border is defined by a latitude between Denmark and Sweden as indicated by the red line in the map. All nine countries with marine waters in the Baltic Sea except Russia, which is not part of EU, has implemented the Marine Strategy Framework Directive. In this report, AIS-data for ships that visited the Baltic Sea or the Skagerrak in 2018 are analysed. (The map is adjusted from EMODnet).

Summary

In this report we analyse the relation between the Port State Control (PSC) system, as implemented by Paris Memorandum of Understanding (Paris MoU), and the Marine Strategy Framework Directive (MSFD), which obligates EU member States to achieve a Good Environmental Status of their marine waters. The deficiency codes in the Paris MoU PSC THETIS list were reviewed to explore how the codes relate to, i.e. directly or indirectly affect, the marine environment. We further sorted these identified deficiency codes into different, partly overlapping, categories based on their relation to MSFD descriptors. The number of deficiencies in the different categories were thereafter used as indices to infer pressures on the marine environment from different classes of ships. The approach was applied on a PSC inspection data set of ships that operated in the Baltic Sea or Skagerrak in 2018 to investigate if the number of deficiencies in four deficiency categories differed among ship types, ships of different ages and ships from different flag states. We also analysed how deficiencies related to five different MSFD descriptors were distributed among ship classes.

General cargo, container and dry bulk ships had on average more deficiencies per ship than other ship types. The youngest ships had on average fewer deficiencies per ship than older ships and ships from black and grey listed flag states had on average more deficiencies per ship than ships from white listed flag states. Ships registered in Sweden had on average fewer deficiencies per ship than average ships from white-listed flag states. The number of all deficiencies per ship was generally correlated with the number of deficiencies related to the marine environment. Thus, on a general level, the total number of registered deficiencies also reflected the relative environmental performance of different ship classes. However, on a more detailed level, when deficiencies related to specific MSFD descriptors were analysed, some deviances from this general pattern were observed.

The number of ships, as well as the total travelled distance, differed greatly among the different classes of ships. The total pressure on the Baltic marine environment, will, therefore, be larger from the more common middle-aged ships than from older ships, even though older ships on average performed worse than young and middle-aged ships. Similarly, because ships from white listed flag states are much more common, the total number of deficiencies of ships registered in white listed flag states, and hence, the total pressure on the marine environment, is much higher than the total number of deficiencies of, and total pressures from, ships from black and grey listed flag states.

The insight that the total pressure of a class of ships is affected not only by the average performance of the ships in that class, but also by the number of ships and the total travelled distance, does not in any way reduce the need to stop the operation of the worst performing individual ships, and by various means to improve the average performance of ships in the low performing general cargo and dry bulk ship classes. From a marine environment management perspective, it is also important to recognize that also continuous smaller improvements of the performance of the more numerous middle-aged ships and of ships registered in white listed flag states will increase the possibility to achieve Good Environmental Status of the marine environments in Europe.

We conclude that although the Paris MoU scheme for Port State Controls is an important measure to prevent pollution from ships, there is no harmonization between

the work of Paris MoU and the marine environmental management in the EU including the implementation of MSFD. At least eight of the eleven descriptors of the MSFD are influenced by shipping but at least three of them cannot be evaluated by the present scheme for PSC. It is possible, according to our view, to develop the present PSC system to also include control measures that focus on these three descriptors, that is, on the effect on biodiversity, sea-floor integrity and on the production of underwater noise. It is also important to investigate ways to add or modify deficiency codes that would capture the chemical composition of waste streams and remnant chemicals after tank cleanings. An additional development of the PSC system could be to also investigate the behaviour of ships during the period between PSC inspections, e.g. through the use of logged AIS-data. The proposed system development would likely require both new financial resources and competencies.

Sammanfattning

I denna rapport analyserar vi relationen mellan systemet för inspektion av fartyg vid hamnstatskontroller, implementerat av Paris MoU (Paris Memorandum of Understanding), och Havsmiljödirektivet (MSFD), som förpliktar EUs medlemsstater att uppnå en god miljöstatus i sina marina vatten. De 555 olika typerna av anmärkningar, som är beskrivna i Paris MoUs THESTIS, kallas här fortsättningsvis för anmärkningskoder (deficiency codes). Hur anmärkningskoderna relaterar till, det vill säga direkt eller indirekt påverkar, den marina miljön utforskades. Vi sorterade anmärkningskoderna i fyra olika, delvis överlappande, kategorier bland annat baserat på deras relation till Havsmiljödirektivets temaområden (deskriptorer). Antalet anmärkningar i de olika kategorierna användes sedan för att bedöma belastning på den marina miljön från olika typer av fartyg. Inspektionsdata från hamnstatskontroller av fartyg som opererat i Östersjön eller Skagerrak under 2018 specificerades för olika typer av fartyg, fartyg av olika ålder och fartyg från olika flaggstater. Vi analyserade även hur anmärkningar relaterade till havsmiljödirektivets deskriptorer.

Fartygstyperna ”General cargo”, Container och Torrbulk hade i genomsnitt fler anmärkningar per fartyg än andra fartygstyper. Andra jämförelser av genomsnittet anmärkningar per fartyg visade att de yngsta fartygen hade färre anmärkningar än äldre fartyg samt fartyg från svart- och grålistade flaggstater hade fler anmärkningar än fartyg från vitlistade flaggstater. Fartyg registrerade i Sverige visade sig ha färre anmärkningar än fartyg från vitlistade flaggstater. Det totala antalet anmärkningar per fartyg (för alla 555 anmärkningskoder), korrelerade med antalet anmärkningar för koder relaterade till marin miljö. På en generell nivå reflekterade därmed det totala antalet anmärkningar även olika fartygstypers miljöprestanda. Däremot, vid analys på en mer detaljerad nivå finns avvikelser från det generella mönstret när anmärkningar relaterades till specifika deskriptorer.

Antalet fartyg, liksom deras totala avverkade distans, var mycket olika för olika fartygstyper. Det totala trycket på Östersjöns marina miljö, kommer därför att vara större från medelålders fartyg som är vanligare än äldre fartyg, även om äldre fartyg i genomsnitt hade sämre prestanda än unga och medelålders fartyg. Eftersom antalet fartyg från vitlistade flaggstater är mycket större än antalet fartyg från svart- och grålistade flaggstater kommer på motsvarande sätt det totala antalet anmärkningar, och därmed det totala trycket på den marina miljön, vara större från fartyg från vitlistade flaggstater än från fartyg från svart- och grålistade flaggstater.

Insikten om att det totala trycket från en viss typ av fartyg inte endast är påverkad av den genomsnittliga prestandan på fartygen, utan även av antalet fartyg och avverkad distans, minskar inte på något sätt behovet av att stoppa nyttjandet av enskilda fartyg med dålig prestanda, och att med olika medel förbättra prestandan på fartyg i de lågpresterande segmenten, ”General cargo” och Torrbulk. Från ett marint förvaltningsperspektiv är det också viktigt att arbeta kontinuerligt även med mindre förbättringar på medelålders fartyg som är vanligt förekommande och på fartyg från vitlistade flaggstater, vilket ger ökade möjligheter att uppnå god miljöstatus i den marina miljön i Europa.

Sammanfattningsvis noterar vi att även om Paris MoU systemet för hamnstatskontroller är ett viktigt verktyg för att förhindra föroreningar från fartyg, så finns det ingen harmonisering mellan arbetet inom Paris MoU och marin miljöförvaltning inom EU

implementerat i Havsmiljödirektivet. Åtminstone åtta av de elva deskriptorerna i Havsmiljödirektivet är påverkade av sjöfart, men minst tre av dem kan inte utvärderas av nuvarande system för hamnstatskontroller. Det är möjligt, enligt vår mening, att anpassa nuvarande system för hamnstatskontroller och även inkludera kontroller som fokuserar på dessa tre deskriptorer; effekter på biologisk mångfald, havsbottnens integritet och undervattenbuller. Det är också viktigt att undersöka möjligheterna att addera eller modifiera anmärkningskoder så att de kan fånga den kemiska sammansättningen av avfall och utsläpp av restkemikalier från tankrengöringar. En ytterligare utveckling skulle kunna vara att systemet med hamnstatskontroller också analyserar fartygs beteenden under perioden mellan inspektioner, till exempel genom användning av lagrade AIS-data. De föreslagna förändringarna skulle sannolikt kräva nya resurser, samt kompletterande kompetens för att kunna genomföras.

1 Introduction

The Paris MoU scheme for Port State Control (PSC) of ships entering a foreign port is an ambitious collaboration with the goal to eliminate the operation of sub-standard ships through a harmonized inspection system (Paris MoU, 2020), thereby ensuring safe, secure and environmentally friendly maritime shipping (EMSA, 2020). During PSC inspections any deficiencies found are categorized according to a list of defined deficiency codes and all data is collected into the Paris MoU database. Depending on the inspection results in terms of deficiencies and detentions, flag States are sorted on a black-, grey- and white list, where grey and black indicate larger shares of ships that have had detentions. In this study we have identified, and in several alternative ways classified, deficiencies, which have a potential to directly cause pollution or in other ways affect the marine environment. Further, the relation between the identified pollution related deficiencies and the qualitative descriptors in the EU Marine Strategy Framework Directive (MSFD) has been investigated. The MSFD descriptors describe what the marine environment will look like when Good Environmental Status has been achieved. To better understand the relations is important, because previous studies have stressed the need to reduce the discrepancies between environmental regulations of shipping (i.e. IMO conventions) and marine environmental management regulations (i.e. MSFD and other EU directives) (Hassellöv, et al., 2019; Moldanová, et al., 2018).

1.1 Aim

In this study, the main aim was to explore the relation between the Paris MoU scheme for Port State Control and existing environmental frameworks, primarily the MSFD, and to address the following questions:

a) How do PSC deficiency codes of relevance for the marine environment relate to the descriptors in the MSFD?
b) How can these relations and PSC inspection data of ships operating in the Baltic Sea be used to assess environmental pressure from shipping on the marine environment? How is the total number of deficiencies, and the pollution-related deficiencies, varying among ships from:
   - different types
   - different age classes
   - white-, grey- and black-listed flag States
   - Sweden, compared to ships from other flag States, as an indication of competitiveness regarding environmental performance
c) How does total distance travelled affect the distribution of deficiencies within these classes?

1.2 Delimitations

The study focuses on the Baltic Sea area and the Skagerrak, and on the ships that operated in the region anytime during 2018, according to the HELCOM AIS data. Only ships with registered IMO-numbers are included in the analyses. Fishing ships are excluded. Only PSC Inspection data from the latest inspection performed before Dec 31, 2018, is used in the analyses, i.e. one inspection per ship. PSC Inspection data is obtained from the entire Paris MoU area and is not limited to inspections performed by PSC officers in the Baltic region. Regarding environmental management frameworks, the primary focus is on the MSFD descriptors.

2 Background

To set the scene of this study, we argue that it is essential to combine knowledge about regulations aimed to prevent pollution from shipping, and knowledge about marine environmental management. The Port State Control system by the Paris MoU has, since the mid1990s, been incorporated in the EC Councils Directives and in 2009, the port State control Directive (2009/16/EC) entered into force. One year earlier, in 2008, the EU Marine Strategy Framework Directive (MSFD, 2008/56/EC), was adopted aiming at a harmonized management of Europe's marine environment to ensure Good Environmental Status (GES) in 2020. Unfortunately, GES is not yet reached in most of the European coastal environments, which is challenging as the demand of increased utilization of the marine environment, is increasing (OECD, 2016; EC, 2020).

2.1 Regulations of ships via IMO conventions and the Paris MoU

At a global level, the International Maritime Organization, IMO, a specialized agency within the United Nations (UN), has responsibility for the prevention of marine pollution by ships, as well as the safety and security of shipping (IMO, 2020). Since 2015, IMO's work also supports the UN Sustainable Development Goals (SDGs), which is one step in the direction towards closer coupling between environmental regulations of shipping and marine environmental management as described in the SDG number 14 - Life below water.

The foundation of the IMO is a set of international conventions, of which seventeen are agreed as 'relevant instruments' for the Paris MoU. The Paris MoU is an administrative agreement launched in 1982, triggered by the oil spill of the Very Large Crude Carrier (VLCC) Amoco Cadiz outside Brittany (France) in 1978. Today the Paris MoU include 27 member States[1], and covers the waters of the European coastal States and the North Atlantic basin from North America to Europe. Three international IMO conventions are of immediate importance for pollution prevention:

- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, and as further amended by the Protocol of 1997 (MARPOL). MARPOL is the most comprehensive environmental regulatory framework for pollution prevention from ships and it contains six Annexes:
  I. Regulations for the Prevention of Pollution by Oil
  II. Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
  III. Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
  IV. Prevention of Pollution by Sewage from Ships
  V. Prevention of Pollution by Garbage from Ships
  VI. Prevention of Air Pollution from Ships
- International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001 (AFS)

1 The current member States of the Paris MoU are:
Belgium, Bulgaria, Canada, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Norway, Poland, Portugal, Romania, the Russian Federation, Slovenia, Spain, Sweden and the United Kingdom

- International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC)

The Paris MoU has also formed the basis for eight, other regional MoUs[2] established around the globe.

2.1.1 Port State Control Inspections

The system of Port State Control Inspections is one important measure to check ships' compliance to the international conventions. Port State Control Inspections are conducted by Port State Control Officers (PSCO). During a PSC inspection, PSCOs are compiling an inspection report that includes observations about deficiencies that they discover. When sub-standard ships are identified during PSC, measures of varying degrees from registration of deficiencies to detention of the ship are taken by PSC Officers. In the instructions to PSC Officers there are criteria defined on the severity of deficiencies to be considered detainable (Paris MoU, 2020). Provided that the set of criteria are fulfilled, the ship can be detained until the responsible parties (flag State and Recognized Organization, RO) have ensured that the ship complies with all the relevant conventions. In some detention cases that require involvement by a RO, the detention is called RO-related. If a ship has been detained three times during a period of 36 months, or has jumped a detention, or does not call at the agreed repair yard following a detention, the ship may be banned, i.e. refused access to ports in the Paris MoU region. Ships are inspected in foreign ports, implying that e.g. ships exclusively used in domestic traffic are not included in the data.

In the inspection report, each deficiency found is categorized according to a list of 555 deficiency codes called THETIS deficiency codes (EMSA, 2020; Paris MoU, 2017) (Appendix 2). These codes are classified in 18 categories (Table 1), in order to monitor the overall condition of a ship. *Category 14 - Pollution Prevention* relates to the six Annexes of the MARPOL, the AFS and the BWMC and embrace 75 deficiency codes. Although *Category 14* is the only category with an explicit focus on pollution prevention, deficiency codes in other categories may also be of importance for pollution prevention. For example, the *Category 01 – Certificates & Documentation* also list the certificates related to pollution prevention, e.g. *Deficiency code 1119 - International Sewage Pollution Prevention Certificate*, or *1136 - Ballast Water Management Certificate*. Further, some of the codes in the *Category 14 - Pollution Prevention*, may not be of immediate importance for the marine environment, e.g. *14609 - Volatile Organic compounds in tankers*, may rather be of importance for an atmospheric perspective.

2 Asia and the Pacific (Tokyo MoU); Latin America (Acuerdo de Viña del Mar); Caribbean (Caribbean MoU); West and Central Africa (Abuja MoU); the Black Sea region (Black Sea MoU); the Mediterranean (Mediterranean MoU); the Indian Ocean (Indian Ocean MoU); and the Riyadh MoU. The United States Coast Guard maintain the tenth PSC regime.

Table 1. Categories of deficiency codes in the THETIS list

01	Certificates & Documentation	10	Safety of Navigation
02	Structural condition	11	Life saving appliances
03	Water/Weathertight condition	12	Dangerous Goods
04	Emergency Systems	13	Propulsion and auxiliary machinery
05	Radio communication	14	Pollution Prevention
06	Cargo operations incl. equipment	15	ISM
07	Fire safety	16	ISPS
08	Alarms	18	MLC 2006
09	Working and Living Conditions	99	Other

2.1.2 White, Grey and Black list

A basic principle is that the prime responsibility for compliance with the requirements laid down in the international maritime conventions lies with the shipowner/operator. Responsibility for ensuring such compliance remains with the flag State[3]. The performance of each flag State is calculated and a *White, Grey and Black (WGB) list* is presented annually. It contains a full spectrum, from quality flags to flags with a poor performance that are considered high or very high risk. It is based on the total number of inspections and detentions over a 3-year rolling period for flag States with at least 30 inspections in the period. Flag States with less than 30 inspections during the period will not be attributed white, grey or black status on the Paris MoU lists, but in a separate class, *Not listed*.

2.1.3 Ship risk profile

Each ship in the information system will be attributed a ship risk profile (SRP), in accordance with Annex 7 of the Paris MoU text. This SRP will determine the ships priority for inspection, the interval between its inspections and the scope of the inspection. Ships can be *high risk* (HRS), *standard risk* (SRS) or *low risk* (LRS). A ship's risk profile is recalculated daily taking into account changes in the more dynamic parameters such as age, the 36 months inspection history and company performance. Recalculation also occurs after every inspection and when the applicable performance tables for flag States and recognized organizations RO:s are changed[4]. For HRS ships, the period is 5-6 month, for SRS ships 10-12 months, for LRS ships 24-36 months.

2.2 Paris MoU annual statistics 2018

The total number of all types of deficiencies of ships inspected in the Paris MoU-region in 2018 was 43529, of which 7% were in the *Category 14 - Pollution Prevention*, embracing

[3] https://www.parismou.org/about-us/organisation

[4] https://www.parismou.org/inspections-risk/library-faq/ship-risk-profile

deficiency codes related to the six annexes of MARPOL, along with Anti-fouling and Ballast water issues (Paris MoU, 2018) (**Error! Reference source not found.**).

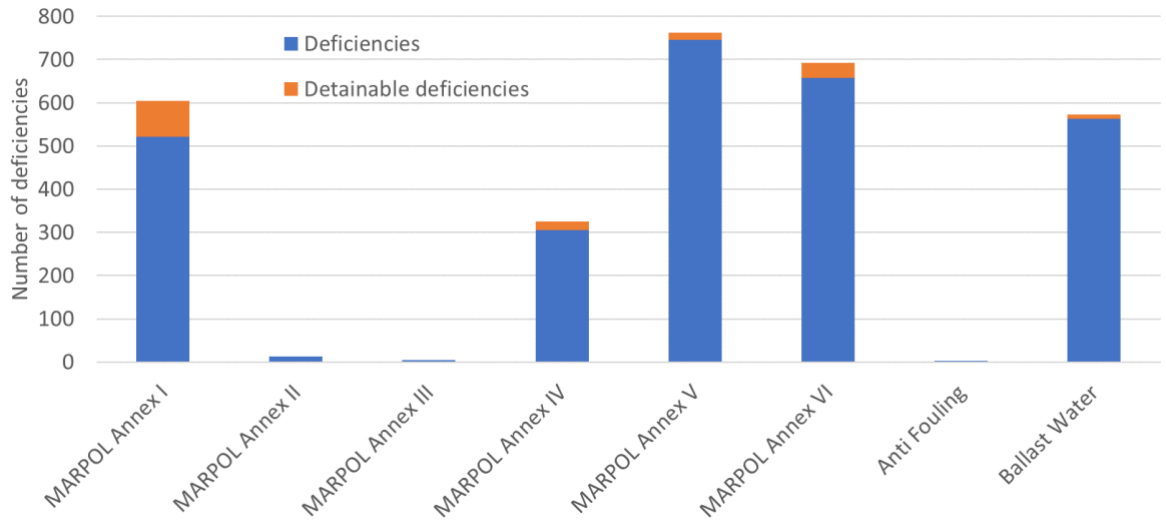

Figure 2. Number of deficiencies in Category 14 - Pollution Prevention *related issues according to the classification in the information system THETIS, from all inspections in the entire Paris MoU region in 2018. In total there were 2973 such deficiencies reported in 2018, of which 166 (5.6%) were detainable deficiencies (Paris MoU, 2018).*

In the statistics from the Paris MoU Annual Reports (Paris MoU, 2016; Paris MoU, 2017; Paris MoU, 2018), it can be concluded that the share of *Category 14 - Pollution Prevention* related deficiencies have accounted for 4.8-5.3%, per year during the period 2014-2017, and 7.3% in 2018 (Table 2). The BWMC entered into force in September 2017. Therefore, no deficiencies relating to BWMC was recorded prior to 2017. The increased share of environmental deficiencies in 2018 versus 2014-2017, can largely be explained by BWMC-related deficiencies.

In 2018, the detention rate (as share of all inspections in the Paris MoU-region) was 3.15% (566 detentions) (Paris MoU, 2018). Out of the 566, there were 97 RO-related detentions (17%).

Table 2. Deficiencies in the THETIS Category 14 - Pollution prevention. *Deficiencies per year and convention, given in total numbers and as percentage of the total number of all deficiencies as reported in the Paris MoU annual reports.*

	2014A		**2015B**		**2016C**		**2017C**		**2018C**	
	Def	Def%	Def	Def%	Def	Def%	Def	Def%	Def	Def%
AFS	17	0.0	10	0.0	13	0.0	7	0.0	3	0.0
MARPOL I	875	1.9	811	1.9	713	1.7	650	1.6	602	1.5
MARPOL II	27	0.1	16	0.0	16	0.0	14	0.0	12	0.0
MARPOL III	4	0.0	5	0.0	4	0.0	10	0.0	5	0.0
MARPOL IV	346	0.7	338	0.8	337	0.8	372	0.9	326	0.8
MARPOL V	598	1.3	610	1.5	551	1.3	470	1.1	762	1.9
MARPOL VI	459	1.0	471	1.1	429	1.0	426	1.0	691	1.7
BWMC	-	-	0	0.0	0	0.0	76	0.2	572	1.4
AFS, BWMC & MARPOL	2326	5.0	2261	5.3	2063	4.8	2025	4.8	2973	7.3

A) Data from Paris MoU Annual Report 2016
B) Data from Paris MoU Annual Report 2017
C) Data from Paris MoU Annual Report 2018

2.3 Marine Environmental Frameworks

Today, several marine environmental frameworks, on global, international, regional and national level exist. There is an ongoing work for harmonization between different initiatives, but even though their common goal is to ensure a healthy marine environment and sustainable use of our seas and oceans, the concrete targets and descriptors used for monitoring may vary. The UN has also appointed the next decade as the United Nations Decade of Ocean Science for Sustainable Development (2021-2030).

2.3.1 UN SDG 14 Life below water

In 2015 United Nations also adopted the 2030 agenda for Sustainability Development, with the 17 Sustainable Development Goals (SDGs). The fourteenth goal, Life Below Water, calls for everyone to conserve and sustainably use the oceans, seas and marine resources for sustainable development. Among the ten targets for the goal are:

- (by 2025) to prevent and significantly reduce marine pollution of all kinds (14.1)
- (by 2020) to sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive ocean (14.2)
- to minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels (14.3).

2.3.2 MSFD

In 2008 the EU member States adopted the Maritime Strategy Framework Directive (MSFD) with the aim to protect the marine environment and to achieve Good Environmental Status (GES) in the EU's marine waters. MSFD includes among other things assessment of status of national marine waters, determination of what GES means for national marine waters and a six-year cyclical process with targets and indicators,

monitoring programmes and development of programme of measures to achieve GES (EC, 2019). There are eleven descriptors used to define GES (Table 3), and several of them are in line with the targets of SDG14. Depending on how the system boundaries are set, e.g. if one includes dredging activities in ports and shipping lanes, shipping affects at least eight of the eleven descriptors.

2.3.3 HELCOM

The nine countries around the Baltic Sea are all members of IMO and of the Helsinki Commission (HELCOM) and are together with the EU, Contracting Parties of the Helsinki Convention, a regional sea convention in the Baltic Sea. The nine countries share a vision to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental cooperation. The countries also cooperate by a number of mutual and national actions. However, only eight of them that are members in EU are bound to implement the MSFD.

2.3.4 Sweden

Sweden is a member in IMO, in EU and in HELCOM. According to the latest Swedish assessment of Swedish marine waters (2018) in line with MSFD, the State of the marine environment around Sweden's coasts does not achieve good environmental status (GES) for nutrients, hazardous substances and non-indigenous species. For all these types of pressures, shipping contributes to the negative situation. In order to achieve GES, the overall pressure on the marine environment needs to be reduced. However, the ships that operate on Swedish territorial waters and within the Swedish Exclusive Economic Zone (EEZ) in the Baltic Sea are from a large number of flag States, and do not necessarily visit the Swedish ports. The international Port State Control system represents one measure to support awareness and to reduce the impacts on the marine environment, also onboard ships that pass Swedish territorial waters and EEZ but are not visiting a Swedish port. Hence, it is important that the PSC reflect the requirements and criteria to reach GES for the marine basins. In addition, it can be argued that it is important that regulations imposed in one country do not cause restrictions on only some of the ship owners active in the area.

Table 3. Qualitative descriptors to describe what the environment will look like when GES has been achieved (EC, 2019). Shipping influences at least eight of the eleven descriptors (Hassellöv, et al., 2019; Moldanová, et al., 2018).

Descriptor		**Affected by shipping**
1.	Biodiversity "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions."	X
2.	Non-indigenous Species "Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems"	X
3.	Commercial Fish and shellfish "Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock."	
4.	Food Webs "All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity"	
5.	Eutrophication "Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters"	X
6.	Sea-floor Integrity "Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected"	X
7.	Hydrographical Conditions "Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems"	X
8.	Contaminants "Contaminants are at a level not giving rise to pollution effects."	X
9.	Contaminants in Seafood "Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards"	
10.	Marine Litter "Properties and quantities of marine litter do not cause harm to the coastal and marine environment"	X
11.	Energy incl. Underwater Noise "Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment"	X

3 Materials and methods

The basis for this study was data from PSC inspections and information on different types of pressures on the marine environment, and their relations to the descriptors in the MSFD. To evaluate the potential use of Paris MoU data to assess environmental pressure from ships from a marine environment perspective, a study was set up for the Baltic Sea and the ships operating there in 2018. To structure the analyses, the deficiency data was sorted in different categories according to pre-defined criteria for the deficiency codes' relation to pressures on the marine environment. Similarly, the ships were sorted in different classes according to pre-defined criteria such as ship type, age and flag state.

3.1 Paris MoU deficiency codes indicating pressure on the marine environment

To, as a first step, identify deficiency codes that indicate a potential pressure on the marine environment, the list of 555 deficiency codes (Appendix 1) from the THETIS database was reviewed (Paris MoU, 2017). For this purpose, PSC inspection data from an initial subsample of 100 ships operating in the Baltic Sea during 2018 was selected for detailed qualitative analyses of the ships' reported deficiencies. The inspection data was requested from the Paris MoU for the period of 2012-2017. The sample was deliberately biased towards ships from grey- and black-listed flag States, which are prone to have many deficiencies per ship (Paris MoU, 2016). The PSC Officers' comments in the inspection protocol were used to review and interpret the practical meaning of each of the deficiency codes. Our interpretations of these PSC Officers' comments were also discussed with two Swedish PSC Officers. In the following analyses the whole data set consisting of deficiency data from PSC inspections of 6573 ships were used.

3.2 Categorisation of Paris MoU deficiency codes and relations to MSFD descriptors

There are many ways to define the relations between the deficiency codes and the potential pressure from ships on the marine environment. In this study three different primary selections are assessed: (1) the *Category 14 - Pollution Prevention* according to the THETIS list, (2) deficiency codes related to the marine environment, from any category on the THETIS list and finally (3) the deficiency codes that can be related to the descriptors in the MSFD.

The deficiency codes may be related to the marine environment to different degrees. For example, a reported deficiency that oil is leaking from the ship into the marine environment, may be worse than a missing International Oil Pollution Prevention certificate. Yet, if there are deficiencies related to the certificate, it could be claimed that such a deficiency imposes an increased risk for a negative effect on the marine environment. To explore the robustness of the analyses in this study, the deficiency codes related to the descriptors in the MSFD were analysed in two different sets. One set included all deficiency codes related to the MSFD descriptors, and another set that only included the deficiency codes indicating an immediate increased pressure on the marine environment, such as documented leakage of oil from the ship in the example above. The complete list of the different selections of deficiency codes is found in Appendix 2.

3.2.1 Category 14 – Pollution Prevention according to the THETIS list

In the Paris MoU THETIS list, *Category 14 – Pollution Prevention* is based on MARPOL, the BWMC and the AFS conventions. Most of the 75 deficiency codes listed in this category are related to the marine environment (some mainly to the atmospheric environment). This selection of deficiency codes was included in this study as it enables comparison with the information given in the annual reports by the Paris MoU, where the statistics are conveniently available for separate Categories in the THETIS list. This selection of deficiency codes is henceforth labelled "*Category 14*".

3.2.2 Deficiency codes related to the marine environment, from any THETIS category

In the THETIS list, there are deficiency codes that are related to the marine environment but not included in *Category 14*. For example, many of the deficiency codes concerning certificates associated with MARPOL's annexes and the BWMC and AFS-conventions are included in *Category 1 – Certificates and Documentation*. On the other hand, there are also deficiency codes in the *Category 14* that are not of immediate relevance for the marine environment. Therefore, the entire list of THETIS 555 deficiency codes (Appendix 1) was reviewed to present an expanded list of deficiency codes related to the marine environment. This category of deficiency codes is labelled "*Marine Pollution*".

3.2.3 Deficiency codes that can be related to the descriptors in the MSFD

The deficiency codes in the "*Marine Pollution*" category were evaluated to identify relations to the descriptors of the MSFD (Table 3) in the light of the framework for environmental impact assessment of shipping activities, developed in the EU BONUS SHEBA project (Hassellöv, et al., 2016). This category of deficiency codes is labelled "*MSFD*". An additional category was created labelled "*MSFD A*", only including the deficiency codes which indicated an immediate increased pressure on the marine environment was also analysed.

3.3 Port State Control Inspection Data Set

Due to the different inspection schemes for ships of different ship risk profiles, a ship may be inspected every third year for low risk ships, or more than once per year for high risk ships. This implies that the annual statistics from Paris MoU does not include annual data on all individual ships operating in the region during a single year. Conversely, the annual inspection statistics will contain data from more than one inspection, especially from ships with a high-risk profile. To assess the potential impact from ships operating in the Baltic Sea during 2018, it is desirable that inspection data from all ships are included. In this study, instead of using annual statistics, the data from each individual ship's latest inspection, prior to December 31, 2018, was selected to produce a data set where each ship's environmental performance was only included once.

3.3.1 Selection of ships through HELCOM AIS data

Based on the analysis of HELCOM AIS data from ships operating in the Baltic Sea or Skagerrak during 2018, a list of IMO-numbers was sent to the Paris MoU and access requested to data from the PSC inspections of these ships for the period 2014-2018. The time period was chosen to include the normal inspection interval for SRS, which can be up to 36 months. To create a data set on the current status of environmental

performance on each ship, data for each ship's latest inspection from the period 2014-2018 were used.

3.3.2 Selection of data from latest PSC inspection

In the year 2018, there were 7839 ships with IMO-number that visited the Baltic Sea including Kattegat and Skagerrak (Figure 1). Of these 7839 ships, 6573 were inspected by PSC-officers at least once between 2014 and 2018 in the Paris MOU area. The 1266 ships not inspected between 2014 and 2018 were either inspected before 2014, after 2018, or were ship types, for example, governmental ships, patrol ships or other domestic or special purpose ships not inspected by PSC-officers.

In this report, the deficiencies detected during the latest inspection of the 6573 ships inspected between 2014 and 2018 were analysed. The latest inspection of most of the ships (78%) was performed in 2017 or 2018, (4% in 2014, 7 % in 2015, 11% in 2016, 22% in 2017 and 56% in 2018). In total, 18223 deficiencies were notified during the latest inspections of the selected 6573 ships. Since only one, the latest, inspection per ship was used in the analysis of the ships in the Baltic Sea, the number of inspections in the data set was also 6573 of which 1017 had no reported deficiencies. The total number of deficiencies detected during all inspections (not only during the latest inspection) of the 6573 ships between 2014 and 2018 was 56010.

3.3.3 Classification of ship types

Ships were classed into seven classes (*Container ships, Dry bulk ships, General cargo ships, Passenger ships, RoRo-ships, Tankers* and other *Miscellaneous ships*) according to type codes provided by Vesselfinder (Appendix 3). RoPax ships (ferries) and cruise ships are included in the class *Passenger ships*. The class *Miscellaneous ships* is very diverse and includes tugs, supply ships and other special purpose ships.

3.3.4 Classification of ships in age classes

Ships are known to be in service for a long time and ship age has previously been found to influence the performance during PSC inspections. Here, ships were classified in five years bins since keel date; *0-5, 6-10, 11-15, 16-20, 21-25, 25-30,* and *+31 years*.

3.3.5 Classification according to Paris MoU's white-, grey- and black-list

The Paris MoU's white-, grey-, and black- listing of flag States is updated every year on July first and is based on a rolling average of performance during the last three years, for flag States that have had more than 30 inspections during the period. Flag States with fewer inspections than 30, will be labelled as *Not listed*. Sometimes ships also change flag States. This implies that ships' belonging to either class (*white, grey, black* or *not listed*) may change over time. In this study we have used the ships' listing during the first half of 2018 as basis for the classification.

3.3.6 Classification of Swedish ships

To assess the competitiveness of Swedish ships with special respect to environmental performance according to the PSC inspection data, ships registered under *Swedish* flag in 2018 were included in a separate class. As Sweden is a white-listed flag State according to the Paris MoU's listing, this additional class is also included in the *white class*.

3.4 Analyses of deficiencies

Analyses were performed of the total number of deficiencies on the THETIS list, (from the PSC inspection data set sections 3.3.1 and 3.3.2) and of the four categories of deficiency codes related to pressure on the marine environment labelled: *Category 14, Marine Pollution, MSFD* and *MSFD A* (section 3.2). The analyses included number of deficiencies per ship and the total number of deficiencies for all ships within the four defined classes: *Ship Type, Ship Age, White-, grey- black-lis*t, and *Swedish ships*.

Detentions are the strongest indication of a sub-standard ship and indicates a general concern for severe issues identified during PSC. Therefore, analyses of two types of detentions were also included.

3.5 Analyses of influence of distance travelled

When assessing the potential pressure from shipping on the marine environment, beside the characteristics of the ships, it is also important to consider the distances that different ships have travelled in the Baltic Sea. The distance travelled by each ship in the Baltic Sea and the Skagerrak during 2018, has previously been calculated based on HELCOM AIS-data (Hassellöv, et al., 2019). For each class of ship (type, age etc.) the travelled distance was presented.

4 Results and discussion

In this section, we first present the identified qualitative relations between PSC deficiency codes and the descriptors of the MSFD. Then, from section 4.2 and onwards, the analyses of deficiencies for ships operating in the Baltic Sea during 2018 are presented.

4.1 Relation between Paris MoU deficiency codes and MSFD descriptors

We identified 79 deficiency codes (Appendix 2) out of the 555 on the THETIS list (Appendix 1), to be of relevance for the marine environment (the category *Marine pollution*). The 79 deficiency codes were identified in four THETIS categories: *Category 01 - Certificates and Documentation*, *Category 07 - Fire Safety*, *Category 13 – Propulsion and Auxiliary Machinery* and *Category 14 - Pollution Prevention*. Of the deficiency codes in the category *Marine pollution*, 46 (58%) were also included in the *Category 14 - Pollution prevention*. 14 deficiency codes (18 %) were based on MARPOL Annex I.

Of the 75 deficiency codes in the *Category 14*, some of which are not directly related to the marine environment but rather to the atmospheric environment, 21 deficiency codes (28%) were based on MARPOL Annex I. The large number of deficiency codes based on MARPOL Annex I, both in the *Category 14* and the category *Marine Pollution*, is likely a consequence of oil pollution prevention being a major driving force in the development of environmental regulations of international shipping. Oil pollution is related to *MSFD D8 - Contaminants* (Figure 5).

The second largest group of deficiency codes within *Category 14* is based on MARPOL Annex VI – Air Pollution (18 codes out of 75). Despite that the main focus is air pollution, 15 codes are related to the marine environment, primarily through acidification by deposited sulphur oxides (*MSFD D7 – Hydrographical conditions*) and eutrophication through deposited nitrogen oxides (*MSFD D5*) (Figure 5). The *Category 14* selection also consists of deficiency codes based on MARPOL Annex IV – Sewage, and MARPOL Annex V – Garbage, i.e. 4 codes each, all relevant for the marine environment. Deficiency codes based on MARPOL Annex IV – Sewage, are related to both *MSFD D2 – Non-indigenous species*, and *MSFD D5 – Eutrophication*. Deficiency codes based on MARPOL Annex V – Garbage, is primarily related to *MSFD D10 – Marine litter*, but also to *MSFD D5 – Eutrophication*, when it comes to food waste.

The identified deficiency codes in *Category 13 - Propulsion and auxiliary machinery*, that were related to the marine environment, and to *MSFD D8-Contaminants*, were so through their potential indication of oil pollution. The same is valid for the identified codes within *Category 01 - Certificates and Documentation*, and *Category 07 - Fire Safety*.

In the *Marine Pollution* category, 66 of the 79 deficiency codes are related to at least one of the MSFD descriptors; in total 94 relations were identified. However, there are only relations to five of the eleven MSFD descriptors (Figure 5), of which the relations to *MSFD D8 – Contaminants*, are most common (45 relations, 48%), followed by *MSFD D5 – Eutrophication*, (18 relations, 19%), *MSFD D2 – Non-indigenous species*, (15 relations, 16%), *MSFD D7 – Hydrographical integrity* (8 relations 8.5%), and *MSFD D10 – Marine litter*, (8 relations 8.5%).

Previous studies have shown that shipping affects the marine environment with respect to at least eight of the eleven MSFD descriptors (Table 3). This implies that the potential impact on three descriptors (*MSFD D1 – Biodiversity, MSFD D6 – Sea floor integrity*

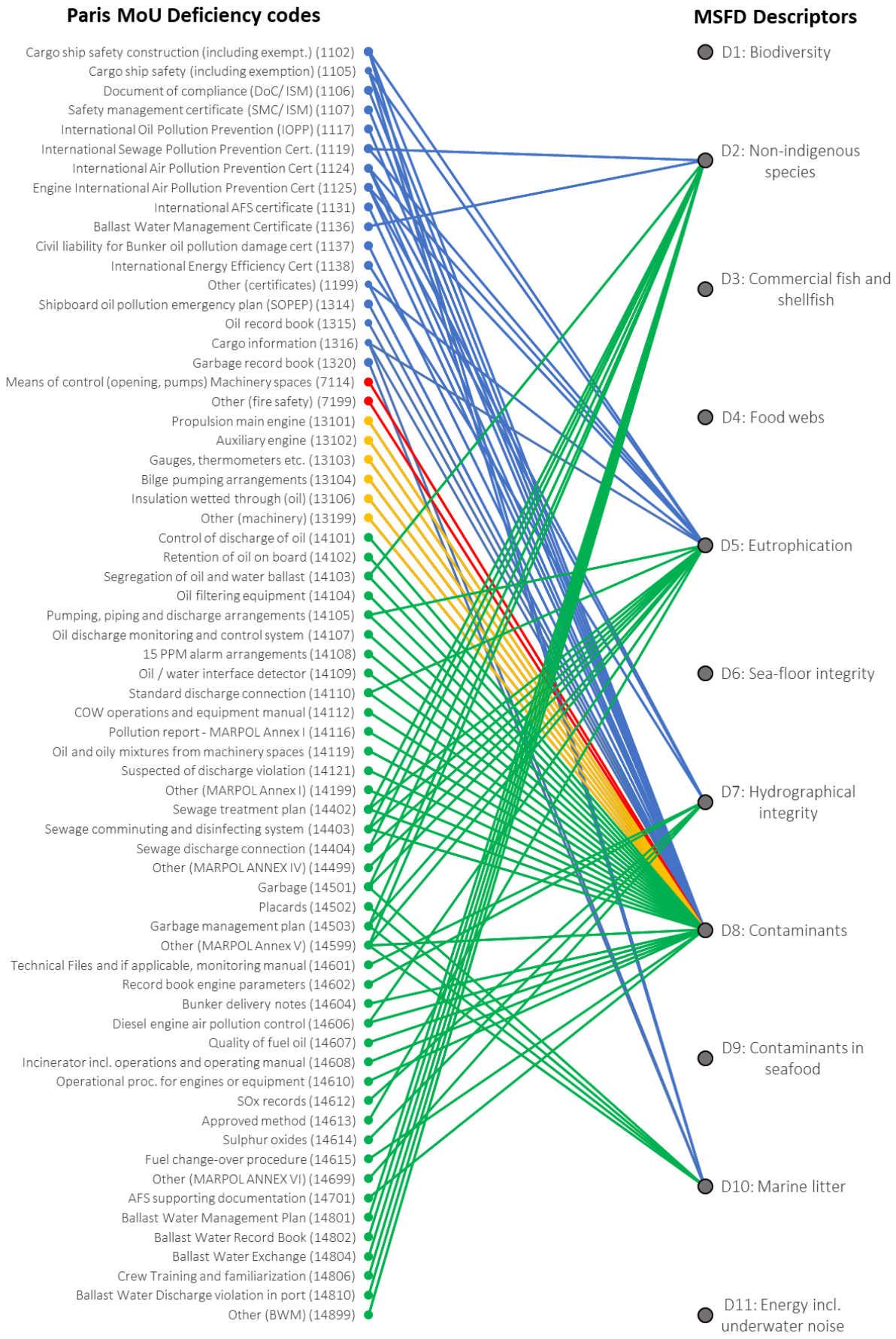

Figure 3. Identified relations between Paris MoU deficiency codes and MSFD descriptors. The colours indicate the Categories in the THETIS list; blue: 01 – Certificates and Documentation, red: 07 - Fire Safety, yellow: 13 - Propulsion and Auxiliary Machinery and green: 14 - Pollution Prevention..

and *MSFD D11 – Energy including underwater noise*) are not captured through the PSC Inspections. This can be explained by the fact that a negative impact, for example, on biodiversity is an effect that cannot be directly assessed through inspection of a ship's structure or equipment in port. However, it would be possible to inspect the ship's behaviour in sensitive or protected sea areas by controlling logged AIS-data, and thereby indirectly inspect the ship's effect on biodiversity. The same argument holds for an impact on sea floor integrity through dredging and wash/erosion of shores. The level of underwater noise from ships is, for example, affected by propeller cavitation, but also by operational measures at sea, such as speed through water. None of the causes are yet captured by PSC inspections.

4.2 Inspection data for ships operating in the Baltic Sea

The four different categories of deficiency codes; *Category 14*, *Marine Pollution*, *MSFD*, and *MSFD A* were used to explore the pressure on the marine environment from ships operating in the Baltic Sea and the Skagerrak during 2018. Because only the latest inspection before December 31, 2018, was analysed, the total number of inspections (6573) equals the number of analysed ships. The total number of deficiencies were 18223 (

Figure 4).

Of the total number of deficiencies, 1374 deficiencies (7.5%) belonged to *Category 14*. The corresponding numbers for the other categories were: *Marine Pollution* 3793 deficiencies (21%), *MSFD* 3371 deficiencies (18%), and *MSFD A* 1696 deficiencies (9.3%). The average number of deficiencies per ship was 2.8 when all deficiencies was considered and 0.2 and 0.6 for *Category 14* and *Marine Pollution*, respectively.

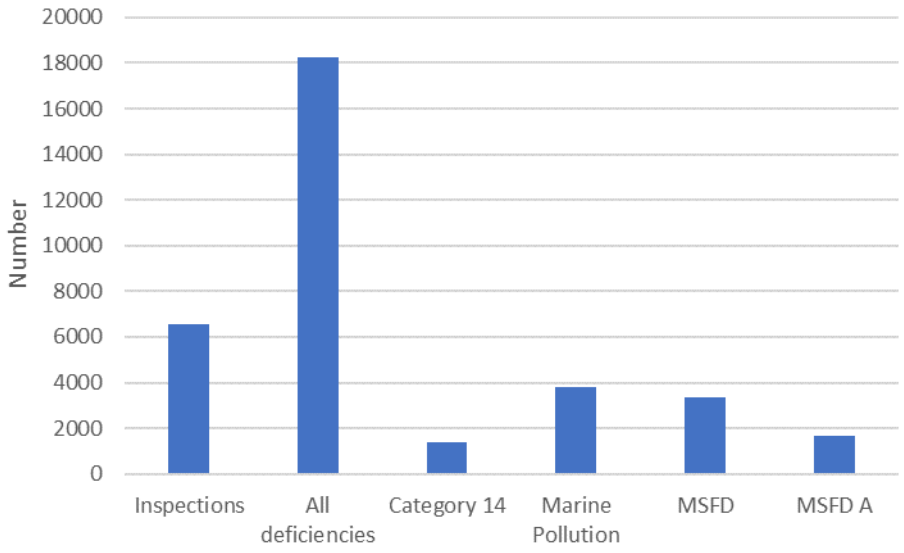

Figure 4. Overview of number of inspections and deficiencies in the four defined categories. For detailed description of the definitions of the categories, see section 3.2.

MSFD and its descriptors are the official tools used in marine environmental management to assess the state of, and pressure on, the marine environment. Therefore, they represent a standard for communication of the status of the marine environment.

All deficiency codes within the *Marine Pollution* category cannot be fitted into the scope of the MSFD descriptors, e.g. codes related to the ship's overall maintenance status.

In our more detailed analysis of deficiencies that were related to the different descriptors of the *MSFD*, some deficiency codes were related to more than one descriptor. Therefore, the sum of the number of deficiencies related to the five different *MSFD* descriptors is higher (4633) than the number of deficiencies related to *MSFD* in the general analysis (3177).

Of the total number of deficiencies related to any of the *MSFD* descriptors (4633), most deficiencies (56%) were related to *MSFD D8 – Contaminants* (Figure 5). The percentage of the deficiencies related to *MSFD D2 – Non-indigenous species*, *MSFD D5 – Eutrophication*, *MSFD D7 – Hydrographical integrity*, and *MSFD D10 – Marine litter*, was lower, i.e. 15%, 15%, 4,3% and 9.5%, respectively.

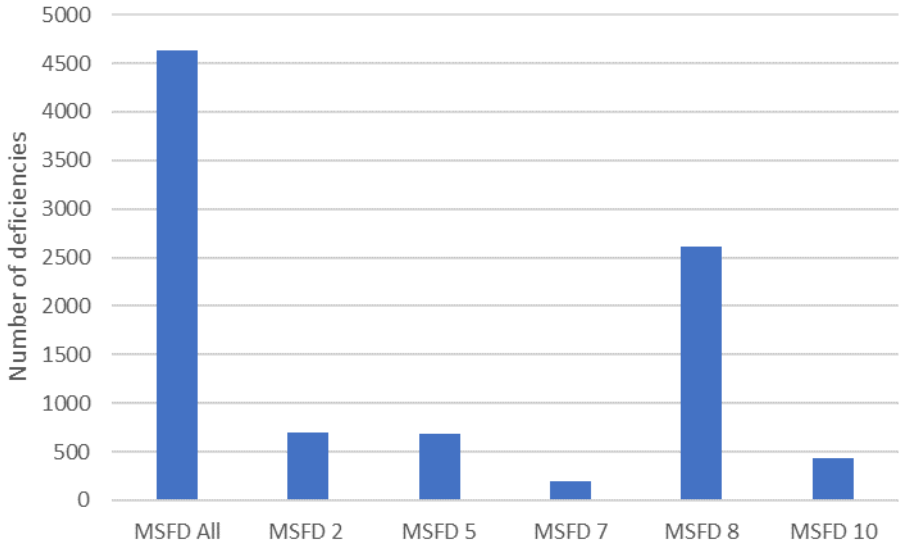

Figure 5. Number of Paris MoU deficiencies related to the Marine Strategy Framework Directive Descriptors. Note that one registered deficiency may be related to more than one MSFD descriptor.

4.2.1 Ship types

Of the analysed 6573 ships the most common ship types were *General Cargo*, *Dry Bulk* and *Tankers* (Table 4, Figure 6). The proportion of ships without any reported deficiencies, was lowest in the class *General Cargo* (4%) and highest in the class *Tanker* (27%), which may be explained by the application of the vetting system where *Tankers* are inspected at a more niched and very high safety standard (Powers, 2008).

Table 4. Number of analysed ships of different types.

Ship type	Number
Container	335
Dry Bulk	1597
General Cargo	1999
Miscellaneous	567
Passenger	221
RoRo	232
Tanker	1622

When analysing all deficiencies, the number of deficiencies per ship was highest for the ship types *General Cargo*, *Container* and *Dry bulk* (Figure 6). The total span was between 2.0 deficiencies per ship for *Tankers* and 3.3 for *General Cargo*, which is 65% more. Analyses of deficiencies in *Category 14* showed that the number of deficiencies per ship ranged between 0.08 and 0.27, being lowest for passenger ships and highest for container ships (Figure 6).

When comparing the number of deficiencies in *Category 14* and the total number of deficiencies for each ship type, the share of the deficiencies related to *Category 14* was approximately 7-8 % for all ship types, except for passenger ships, which had a lower share, 3 %. This is in line with the general annual statistics from the whole Paris MoU region (Table 2).

Regarding deficiencies in category *Marine Pollution*, the number of deficiencies per ship was more than twice as high the number for *Category 14*. This implies that future analyses, if only based on deficiencies included in *Category 14*, most likely will underestimate the potential pressures on the marine environment.

When the number of deficiencies in the *Marine Pollution* and the *MSFD* categories were compared, the deficiencies included in the *MSFD* category were distributed among ship types in a similar way as the deficiencies in the *Marine Pollution* category. The number of deficiencies included in the *MSFD* category was generally only slightly (7-16%) lower (Figure 6). Regarding the *MSFD* related deficiencies, the *General Cargo* and the *Container* ships had both on average 0.62 deficiencies per ship, on average 72% more deficiencies than *Tankers* which had the lowest figure, 0.36.

The in-depth analysis of deficiencies related to the individual *MSFD* descriptors showed that deficiencies related to *MSFD D8 – Contaminants*, dominated for all ship types. *Container* and *General Cargo* ships had the highest number of *MSFD*-related deficiencies per ship (close to 0.5), *Dry Bulk*, *Miscellaneous* and *Passenger ships* had slightly lower number (about 0.4), while *Tankers* had the lowest number (below 0.3) (Figure 7). Analyses were also performed on the deficiencies in the *MSFD A* category, which is defined more narrowly, and only included the deficiencies that indicated an immediate increased pressure on the marine environment. These additional analyses showed that the deficiencies related to the individual descriptors were distributed among ship types in a similar way, with a few minor exceptions, as the deficiencies in the *MSFD* category (Figure 8). The number of deficiencies in the *MSFD A* category was generally about half of the number of deficiencies in the *MSFD* category.

Because *General Cargo ships*, *Tankers* and *Dry bulk ships* were the most common ship types of the inspected ships, the total number of deficiencies was also highest for these three ship types: *General Cargo ships* (6671 deficiencies), *Dry bulk ships* (4638 deficiencies) and *Tankers* (3239 deficiencies) (Figure 6). The same overall pattern was observed when the total number of deficiencies in *Category 14*, *Marine Pollution*, *MSFD*, and *MSFD A* was analysed. There was also a dominance of deficiencies related to *MSFD D8 – Contaminants*, (Figure 7).

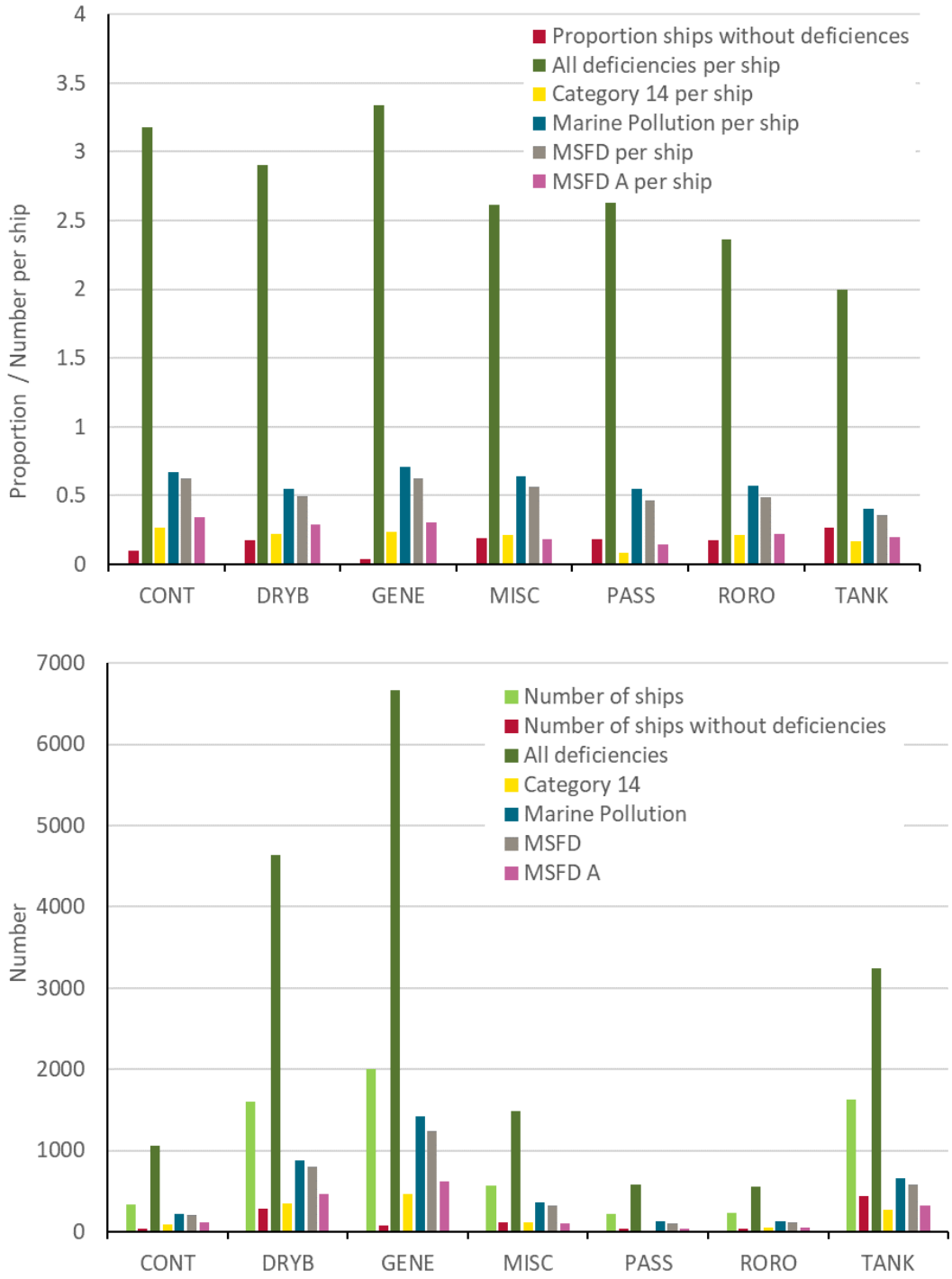

Figure 6. Registered deficiencies at PSC inspections per ship type. Above: Number of deficiencies per ship (i.e. total number of registered deficiencies divided by total number of inspected ships in each ship type class). Below: Total number of registered deficiencies. For details about how deficiencies were grouped into Category 14, Marine Pollution, MSFD, and MSFD A, respectively, see text. For details about definitions of ship types see 3.3.3 Classification of ship types.

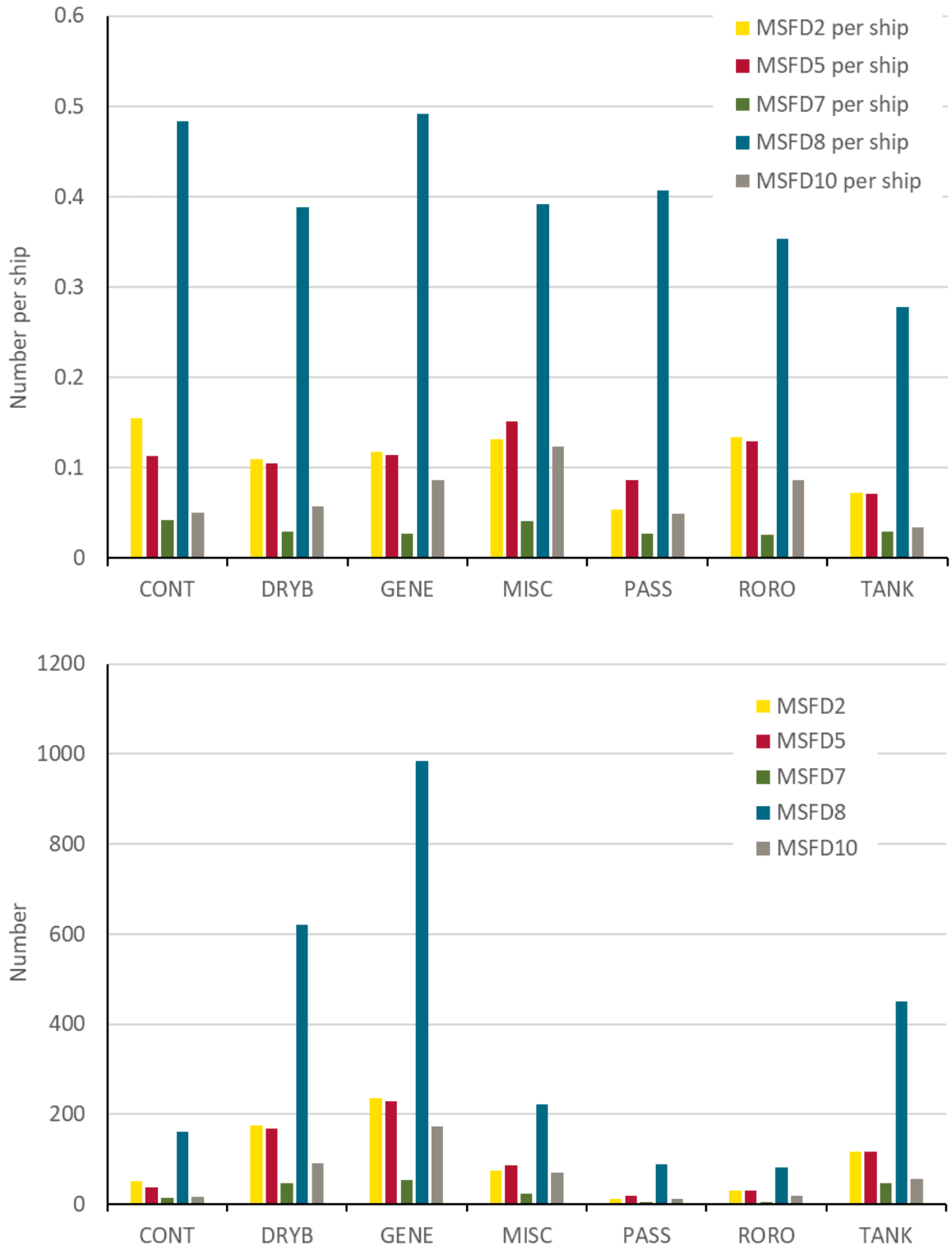

Figure 7. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD-related deficiencies per ship (i.e. total number of MSFD-related deficiencies divided by total number of inspected ships in each ship type category). Below: Total number of MSFD-related deficiencies.

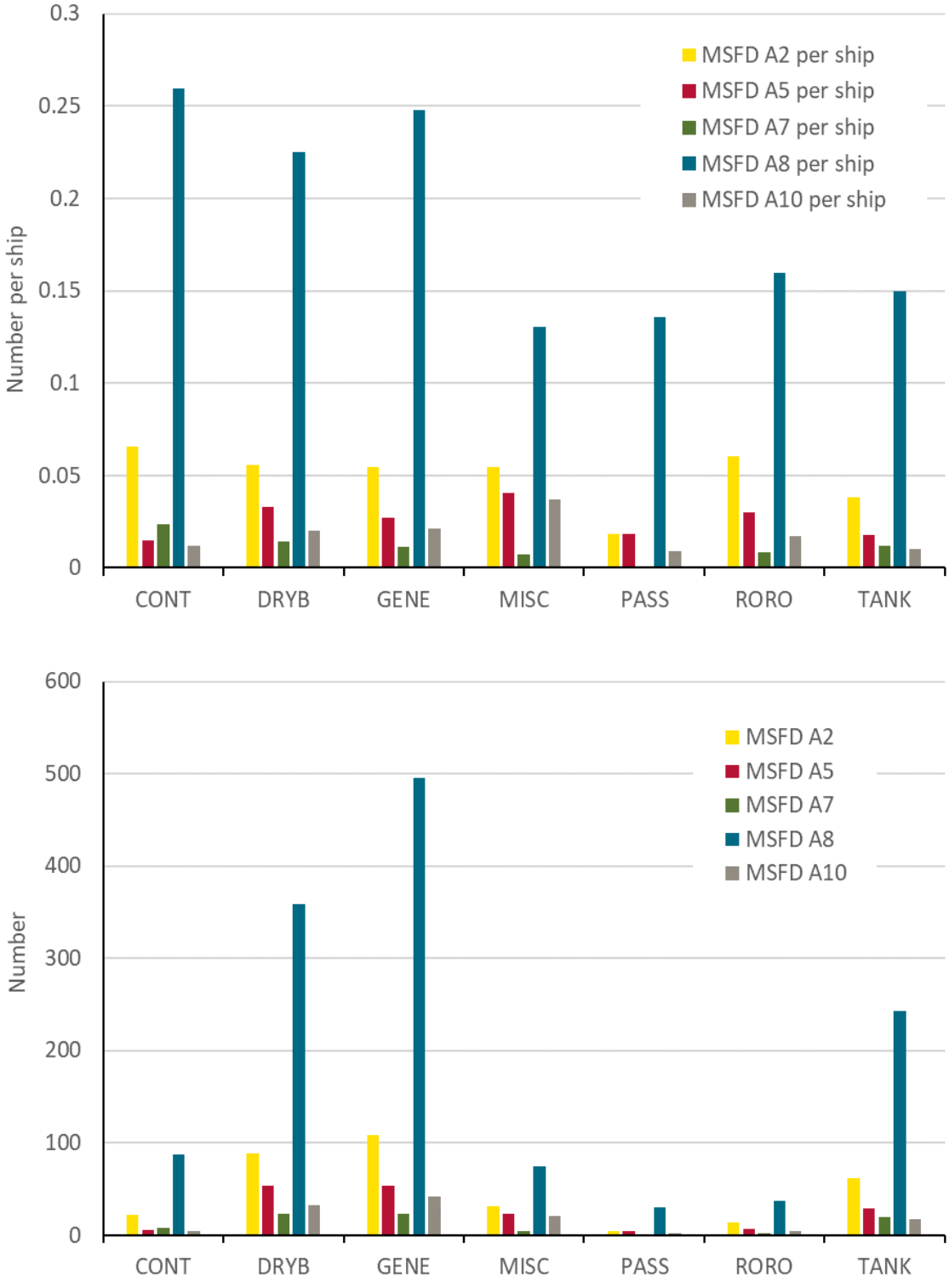

Figure 8. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD A-related deficiencies per ship (i.e. total number of MSFD A-related deficiencies divided by total number of inspected ships in each ship type category). Below: Total number of MSFD A-related deficiencies.

4.2.2 Ship age

Younger ships had less deficiencies per ship than older ships. This overall pattern was valid for all the four different categories of deficiencies analysed, i.e. *Category 14, Marine Pollution, MSFD and MFSD A* (Figures 9 to 11). Younger ships had also the highest proportion of ships without any reported deficiencies. In the youngest age class *0-5yr*, 38% of the ships had no deficiencies when inspected.

The number of ships in each age class is shown in Figure 9 (light green bars). The largest age class, *6-10yr*, consisted of 1881 ships. The number of ships in each age class is declining with increasing age. The oldest age class, *31+yr*, is a larger bin and therefore not entirely comparable with the other age classes.

Because of the large number of ships in the two age classes *6-10* and *11-15 years*, the total number of deficiencies was also registered for ships in these two age classes. The same pattern was valid for all four different categories of deficiencies analysed.

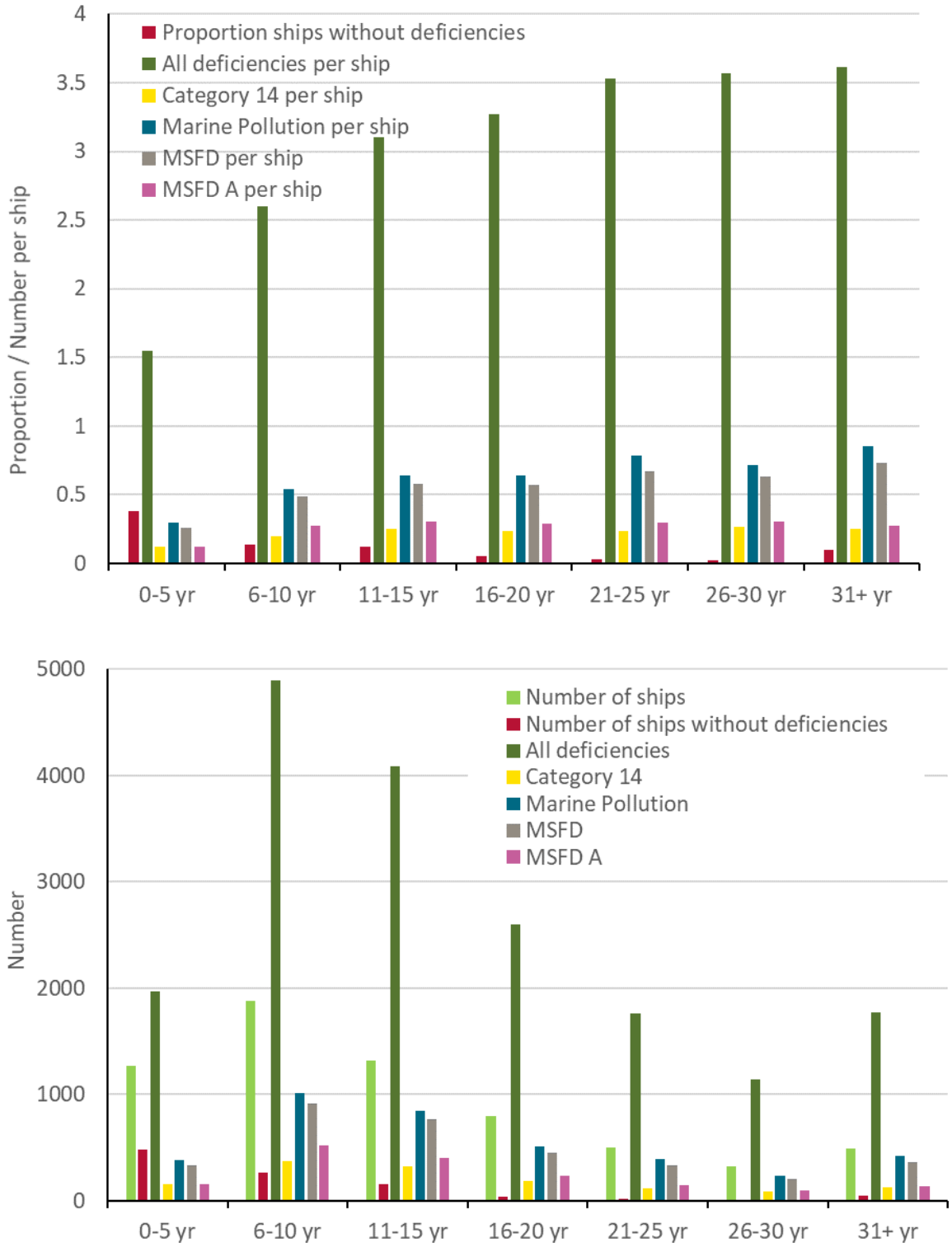

Figure 9. Registered deficiencies at PSC inspections per ship age classes. Above: Number of deficiencies per ship (i.e. total number of registered deficiencies divided by total number of inspected ships in each age class). Below: Total number of registered deficiencies.

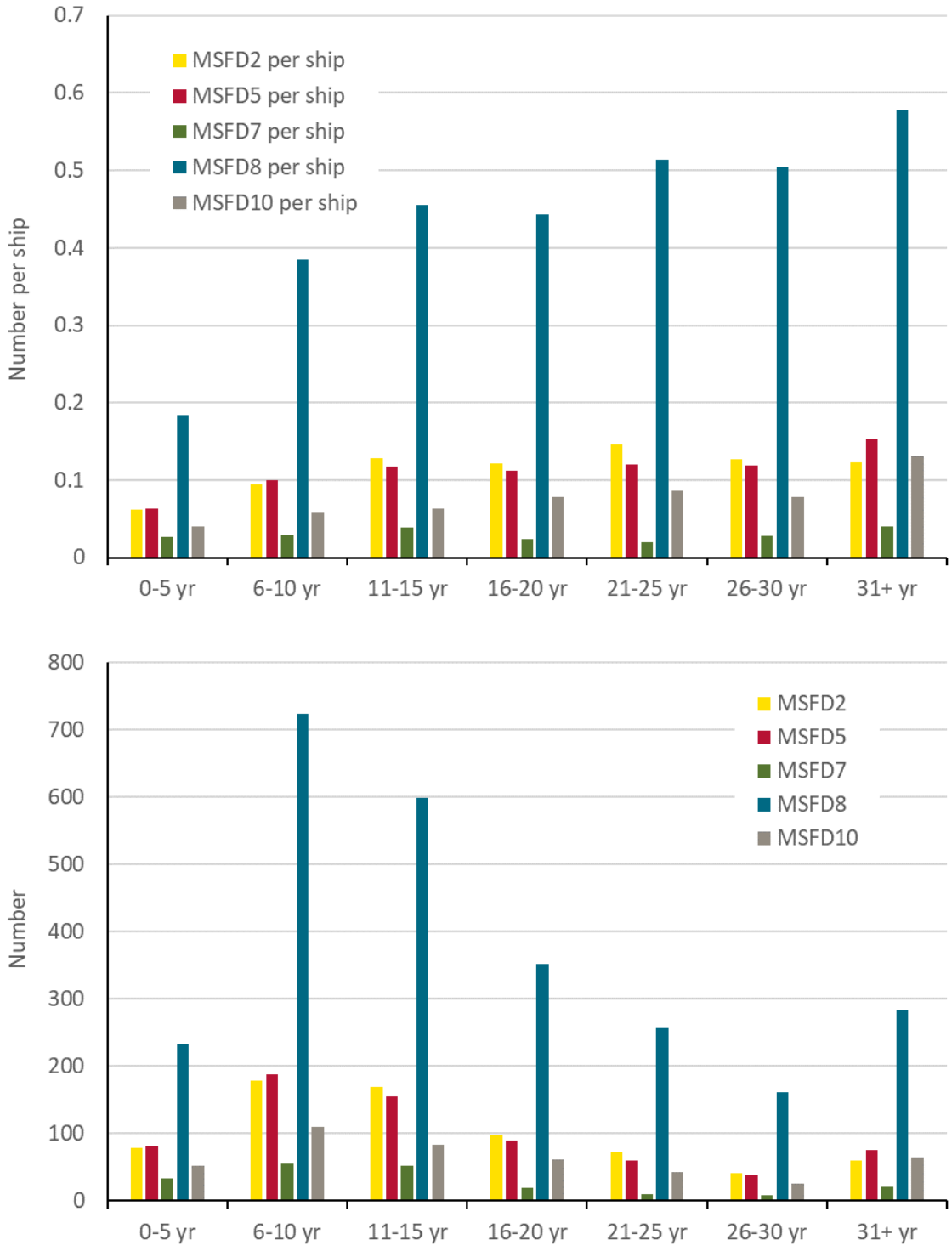

Figure 10. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD-related deficiencies per ship (i.e. total number of MSFD-related deficiencies divided by total number of inspected ships in each ship age class). Below: Total number of MSFD-related deficiencies.

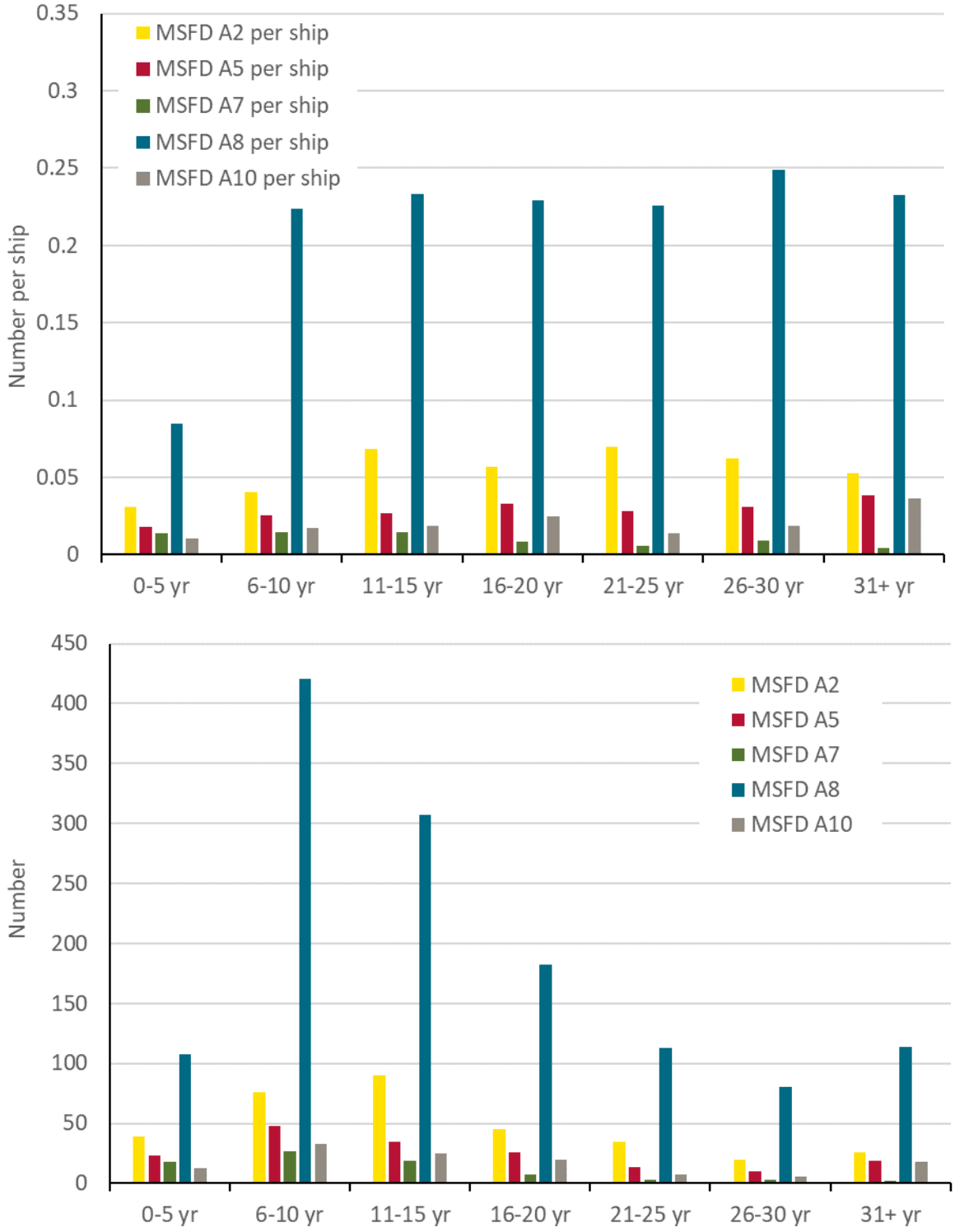

Figure 11. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD A-related deficiencies per ship (i.e. total number of MSFD A-related deficiencies divided by total number of inspected ships in each ship age class). Below: Total number of MSFD A-related deficiencies.

4.2.3 White-, grey-, black-listed flag States and Swedish ships

The system to attribute flag States to white, grey and black lists is intended to raise awareness of sub-standard ships and flag States. In the data from the Baltic Sea, it is

confirmed that ships from flag States on the *black list* have the highest total number of deficiencies per ship (5.6 deficiencies per ship), followed by ships from flag States on the *grey list* (3.3 deficiencies per ship) and finally ships from flag States on the *white list* (2.7 deficiencies per ship) (Figure 12). Ships from flag States with too small fleets are not classed, and their performance was close to ships from flag States on the *grey list* (3.1 deficiencies per ship).

This overall pattern, that ships from flag States on the *black* and *grey lists* had more deficiencies per ship, was, with a few exceptions, valid for all the four different categories of deficiencies analysed, i.e. *Category 14, Marine Pollution, MSFD* and *MFSD A* (Figures 12 to 14). However, because most of the analysed ships were registered in flag States on the *white list*, the total number of the deficiencies were also registered at inspections of ships from flag States on the white list. The same pattern was valid for all the four different categories of deficiencies analysed.

The total number of deficiencies per ship for ships registered in *Sweden* was 1.9, which is lower than the average for the ships from flag States on the *white list* (2.7). In addition, the proportion of ships without any deficiencies was higher for *Swedish ships* (26%) compared to ships on the *white list* (16%). The total number of deficiencies for ships registered in Sweden is low because of the better than average performance (Figure 12), but also because of the small Swedish fleet (Hassellöv, et al., 2019).

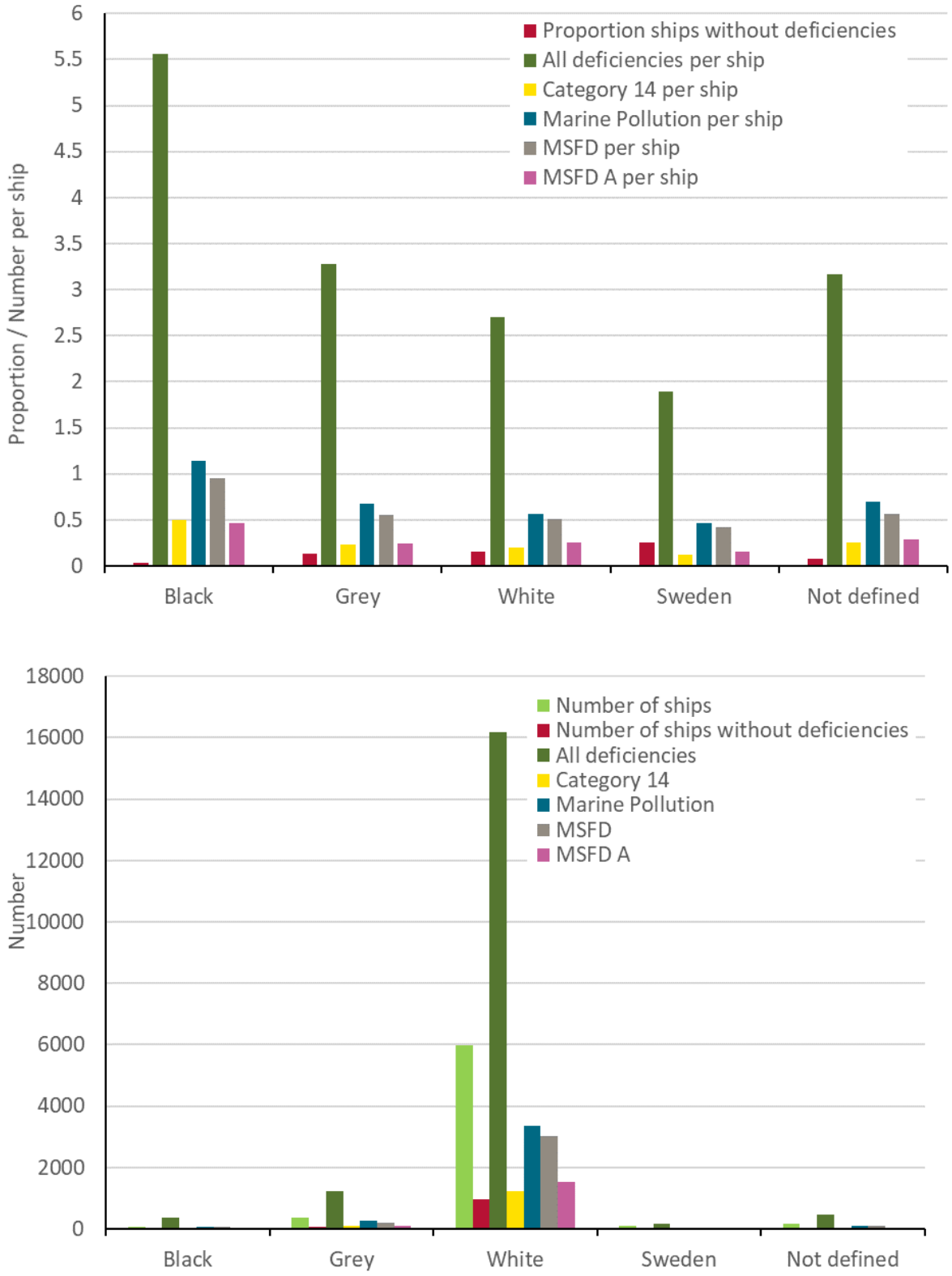

Figure 12. Registered deficiencies at PSC inspections of ships registered in black, grey or white listed flag States, respectively. Above: Number of deficiencies per ship (i.e. total number of registered deficiencies divided by total number of inspected ships in each flag State group). Below: Total number of registered deficiencies. Sweden is a white listed flag State, but data is also presented separately for comparison.

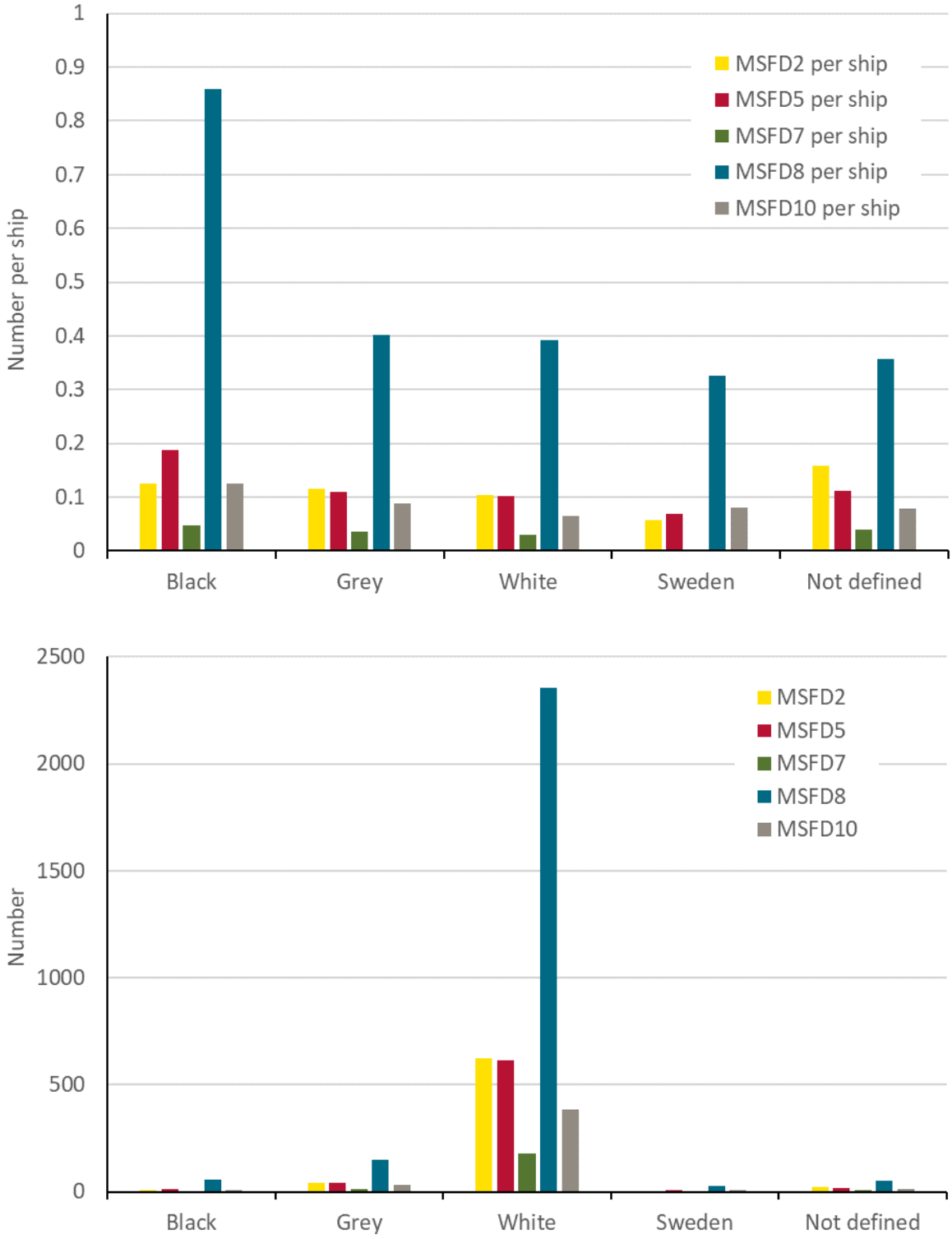

Figure 13. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD-related deficiencies per ship (i.e. total number of MSFD-related deficiencies divided by total number of inspected ships in each flag State group). Below: Total number of MSFD-related deficiencies.

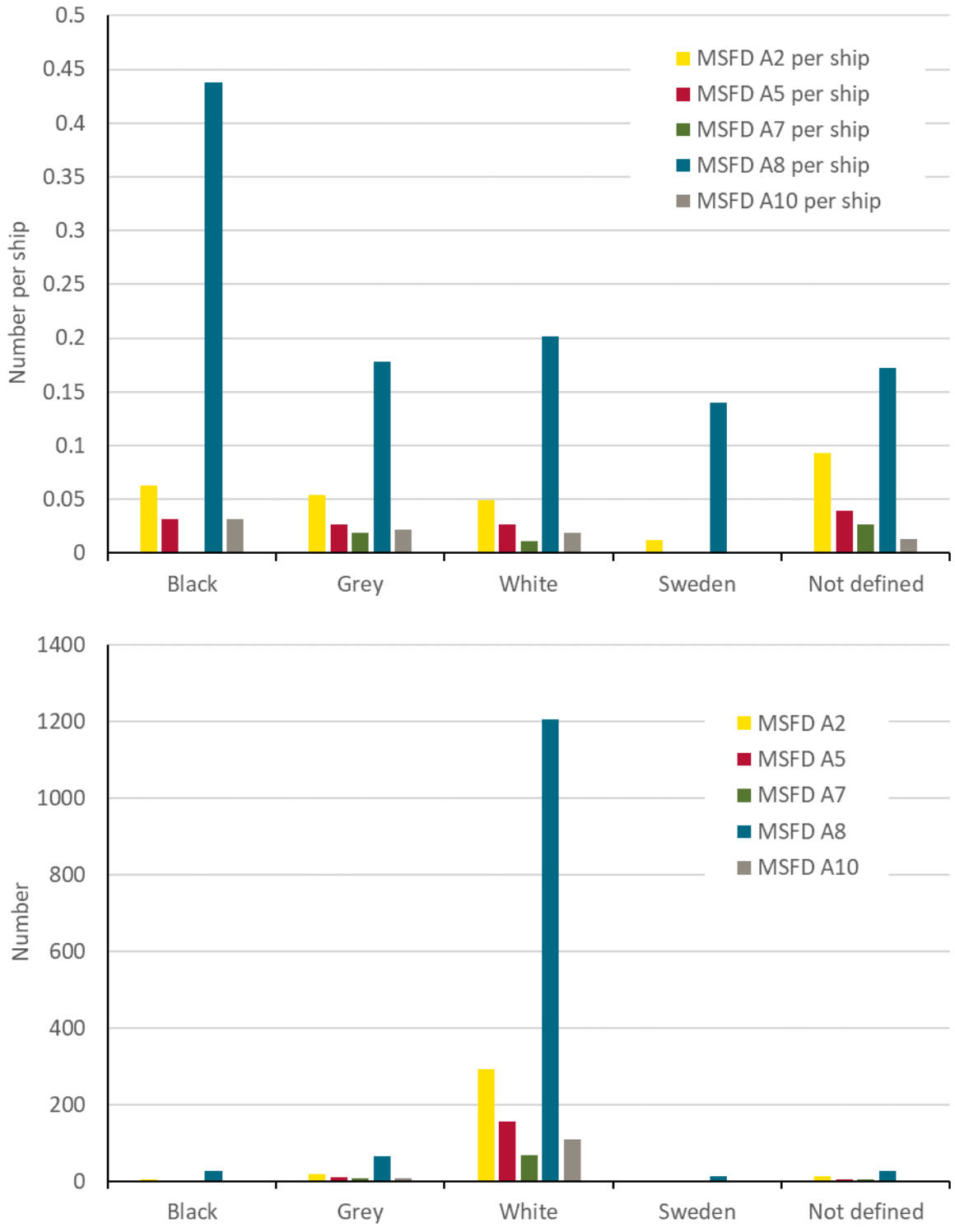

Figure 14. Number of deficiencies which can be related to five of the eleven descriptors of the Marine Strategy Framework Directive. Above: Number of MSFD A-related deficiencies per ship (i.e. total number of MSFD A-related deficiencies divided by total number of inspected ships in each flag State group). Below: Total number of MSFD A-related deficiencies. For details about the relations between registered deficiency codes and MSFD A see 3.2.3. Deficiency codes that can be related to the descriptors in the MSFD.

4.2.4 Detentions

The total number of detained ships was 202 out of the total 6573 ship inspected. A ship can have more than one detainable deficiency at the same time. Twenty-five of the detentions were RO-related. The highest percent detentions of inspected ships were found in the ship types General Cargo, Dry Bulk and Container (Figure 15). When considering the total number of ships in each class, it was the ship types General Cargo, Dry Bulk and Tankers that were detained most often (Figure 15).

The percent detentions of inspected ships in the youngest age class (*0-5 yr*) was considerably lower than in the older age classes. The youngest class (*0-5 yrs*) also had the lowest total number of detentions. The larger fleet sizes of ships in the age classes *6-10yr* and *11-15yr*, resulted in as many as 107 detentions (Figure 16).

As the black-, grey- and white-listing of ships is based upon the number of detentions, our data reflect that pattern (Figure 17). On the other hand, if considering the total number of detentions, most detentions were reported from ships on the white list (Figure 17).

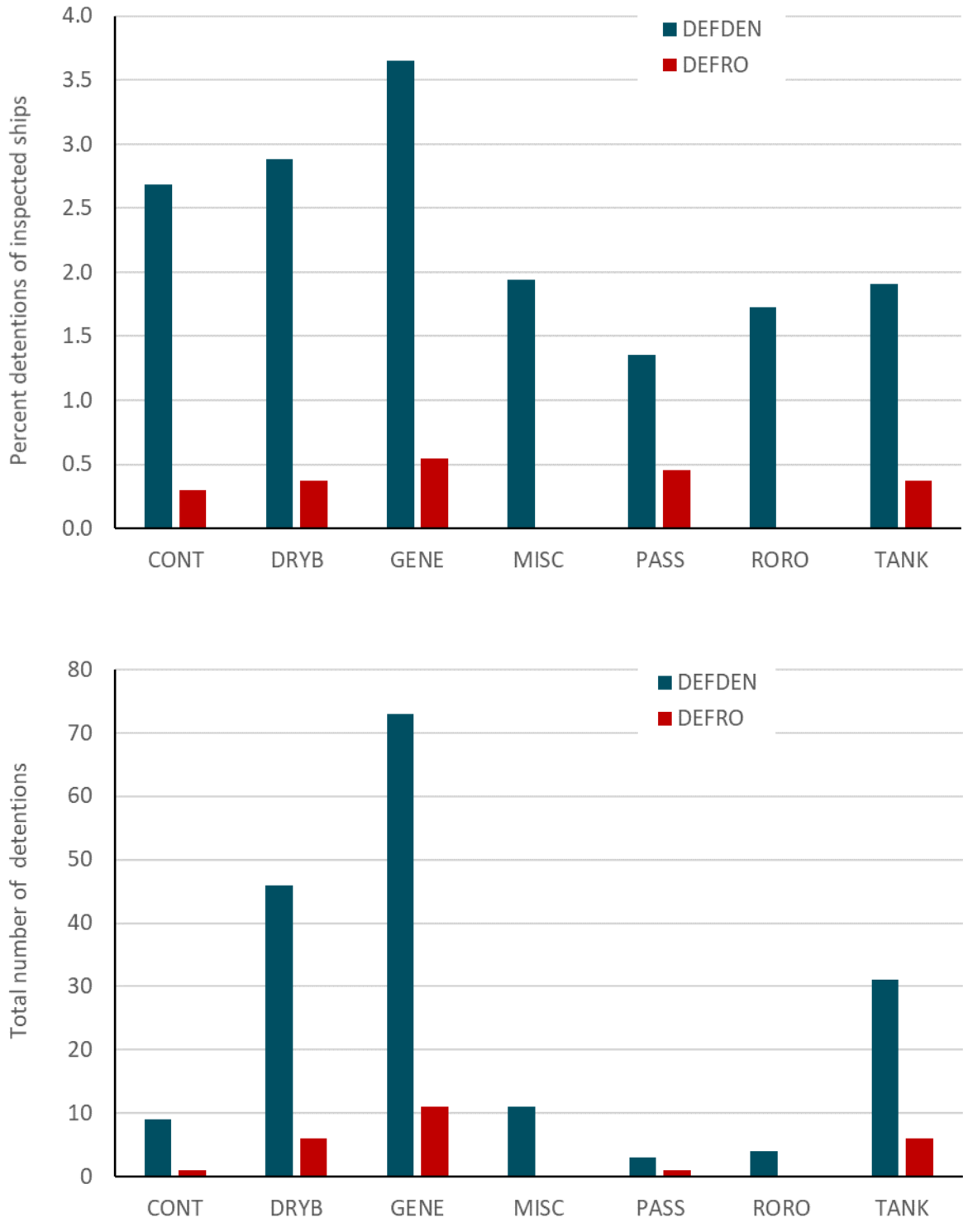

Figure 15. Number of PSC inspections leading to two types of detentions. Detentions that are not RO related are abbreviated DEFDEN, while RO related deficiencies are abbreviated DEFRO. Above: Percent detentions of inspected ships (i.e. total number of detentions divided by total number of inspected ships in each ship type category). Below: Total number of detentions.

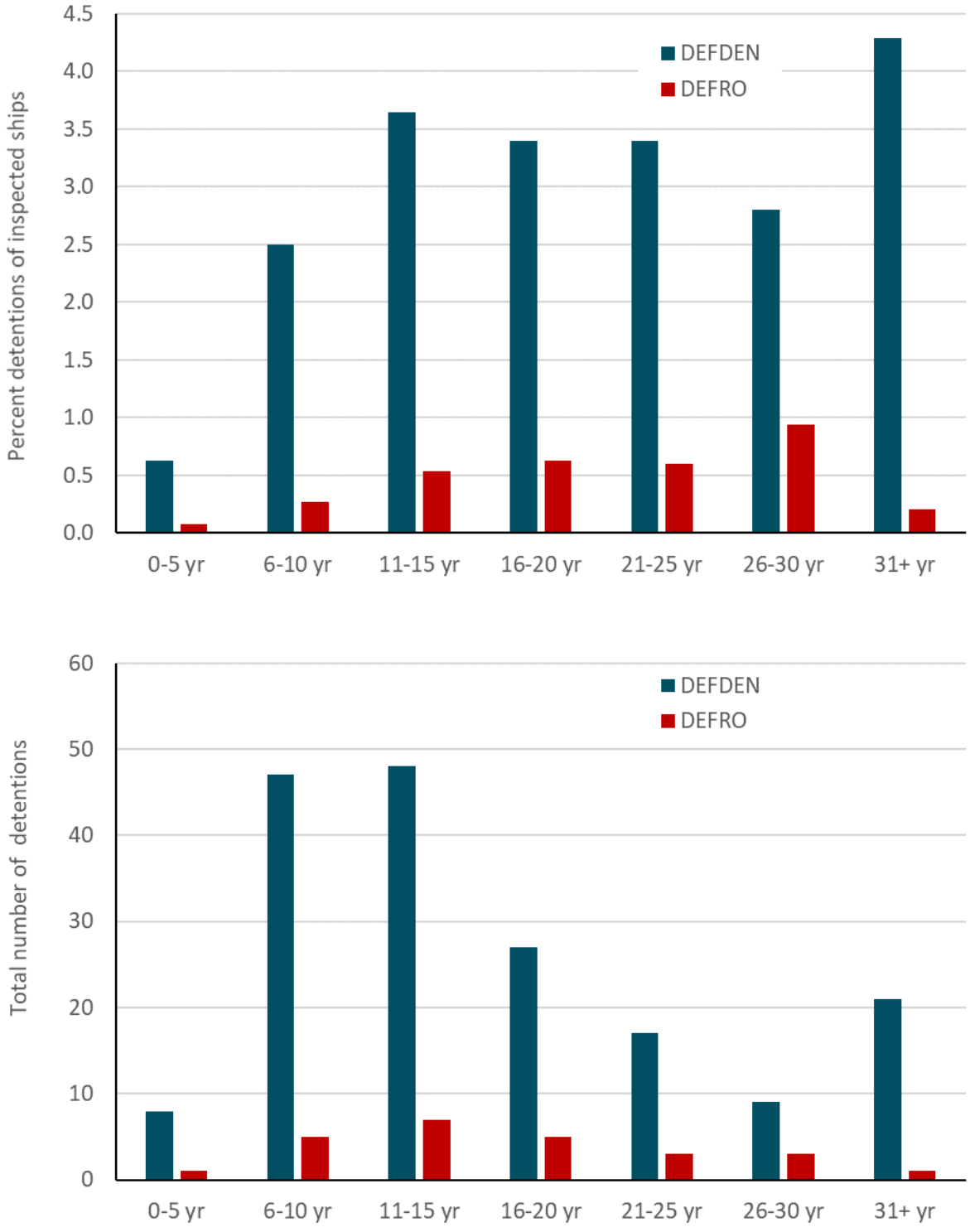

Figure 16. Number of PSC inspections leading to two types of detentions. Detentions that are not RO related are abbreviated DEFDEN, while RO related deficiencies are abbreviated DEFRO. Above: Percent detentions of inspected ships (i.e. total number of detentions divided by total number of inspected ships in each ship age class). Below: Total number of detentions.

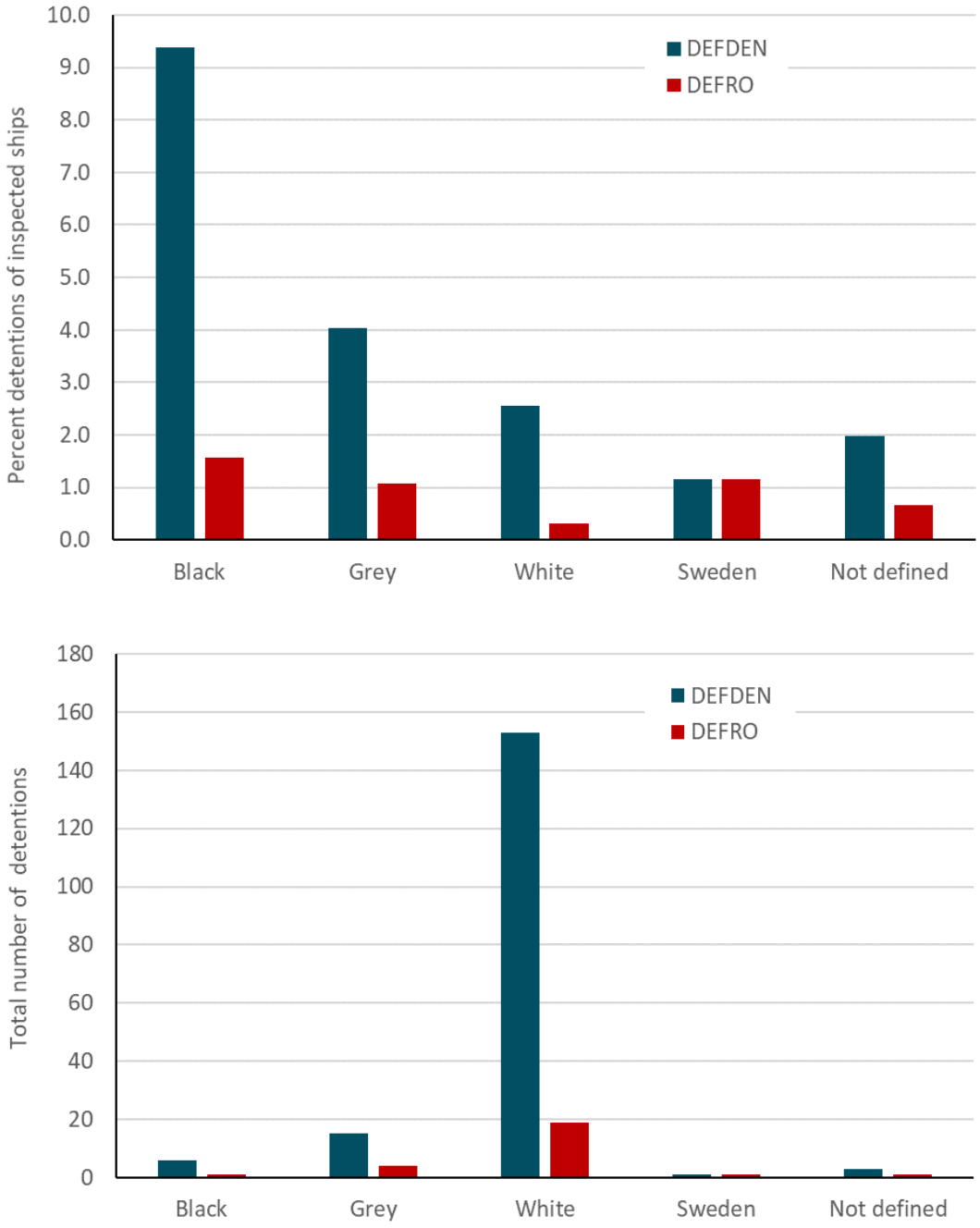

Figure 17. Number of PSC inspections leading to two types of detentions. Detentions that are not RO related are abbreviated DEFDEN, while RO related deficiencies are abbreviated DEFRO. Above: Percent detentions of inspected ships (i.e. total number of detentions divided by total number of inspected ships in flag State group). Below: Total number of detentions.

4.3 Influence of distance travelled

To assess the potential pressure of ships on the marine environment in a specific region it is also important to reflect upon the distance travelled by the ships. The analysis of deficiencies of different ship types showed that *General Cargo ships* had the highest potential pressure on the marine environment (Figure 6, Figure 7 and Figure 8). As *General Cargo ships* also had the longest total travelled distance the pattern is reinforced (Figure 18). On the other hand, *Passenger ships*, which had similar total number of deficiencies as *RoRo ships* (Figure 6), had longer total travelled distance than *RoRo ships*. The total pressure on the marine environment might therefore be higher from *Passenger ships*, (Figure 18). Another example of a reinforced pattern is seen for the ships from flag States in the *white list*. The travelled distance by ships from flag States in the *white list* represent 93% of the total distance travelled by the ships (Figure 18).

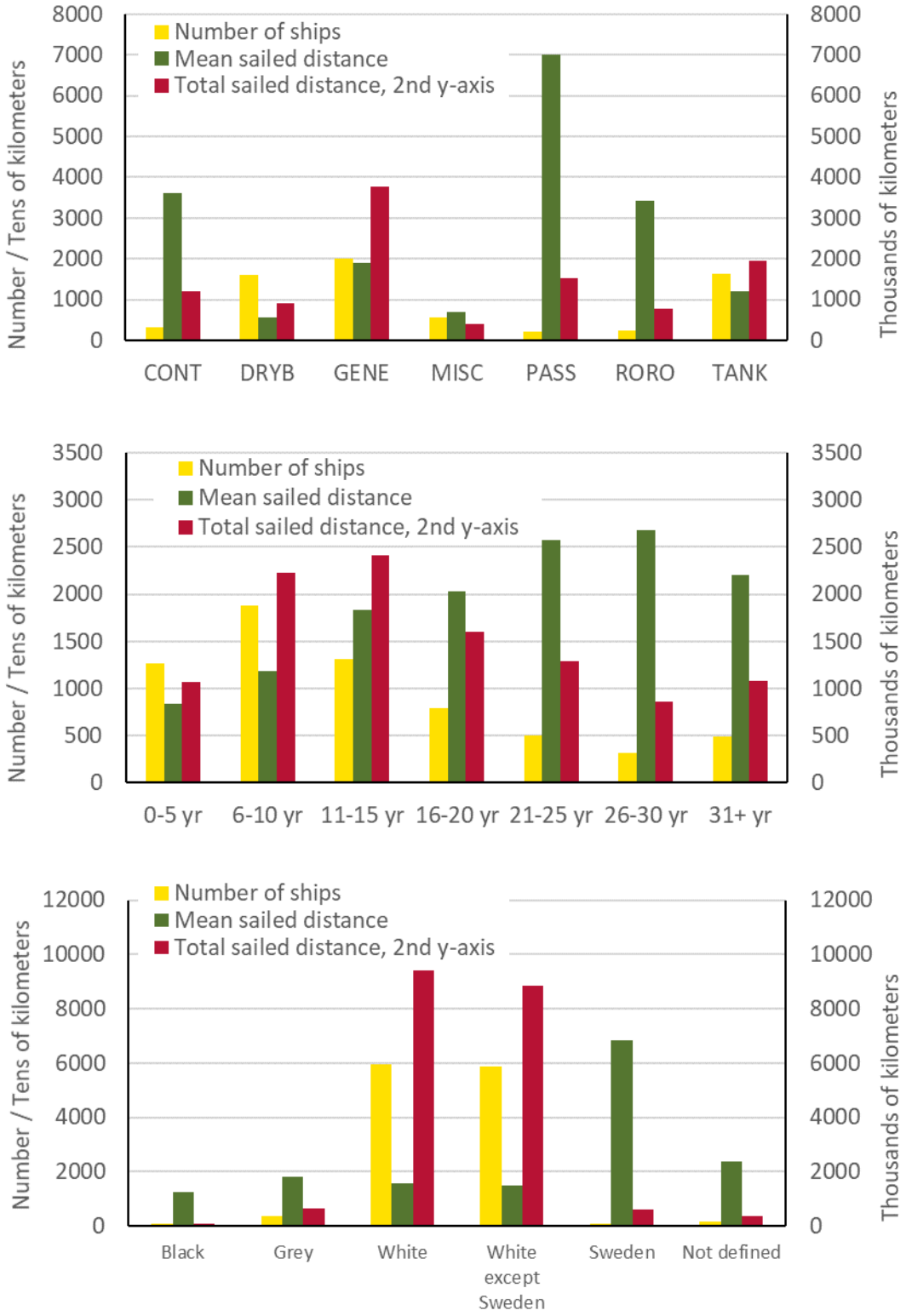

Figure 18. Number of ships, mean operated distance per ship and total operated distance of different ship types, ship age classes, and ships registered in black, grey or white listed flag States, respectively. Only ships with IMO-number which have operated in the Baltic Sea in 2018 and have been inspected by PSC between 2014 and 2018 are included. Thus, the figure is based on the same sample of ships which have been analysed regarding PSC deficiencies. The total operated distance is presented on the secondary y-axis. Sweden is a white listed flag State, but data is also presented separately for comparison.

5 Conclusions and recommendations

Today the assessment of ships' environmental performance in the PSC inspections is not in a format that it can be directly used to assess the contribution of shipping activity to degradation of the environmental status of the marine environment according to the MSFD. In this report we have reviewed the deficiency codes in the Paris MoU PSC THETIS list to explore how the codes relate to, i.e. directly or indirectly affect, the marine environment. We further sorted these identified deficiency codes into different, partly overlapping, categories based on their relation to MSFD descriptors. The number of deficiencies in the different categories were thereafter used as indices to infer pressures on the marine environment from different classes of ships. The approach was applied on a PSC inspection data set of ships that operated in the Baltic Sea or Skagerrak in 2018 to investigate if the number of deficiencies in four deficiency categories differed among ship types, ships of different ages and ships from different flag states. We also analysed how deficiencies related to five different MSFD descriptors were distributed among ship classes.

One of the four analysed categories of deficiency codes, labelled *Category 14*, is defined by Paris MoU and has an explicit focus on pollution prevention. However, *Category 14* does not, for example, include deficiencies of certificates related to pollution prevention. We therefore created the alternative wider category labelled *Marine Pollution*, which, according to our view, in a more comprehensive way combine deficiency codes that are related to the marine environment. We recommend that future analyses of the pressure of ships' deficiencies on the marine environment should not only be based on deficiencies in *Category 14* as such analyses most likely will underestimate pressure. We also suggest future analyses, in line with the work to identify detainable deficiencies, that can estimate the relative environmental risks associated with e.g. deficiencies related to certificates and documents and malfunctioning equipment, respectively.

Our analyses of PSC inspection data of ships that operated in the Baltic Sea or Skagerrak in 2018 showed that certain classes of ships were performing worse or better than other classes. *General cargo*, *Container* and *Dry bulk ships* had on average more deficiencies per ship than other ship types. The youngest ships (*0-5yrs*) had on average fewer deficiencies per ship than older ships and ships from black and grey listed flag states had on average more deficiencies per ship than ships from white listed flag states. Ships registered in Sweden had on average fewer deficiencies per ship than average ships from white-listed flag states.

In general, the number of all deficiencies per ship was correlated with the number of deficiencies related to the marine environment. Thus, on a general level, the total number of registered deficiencies also reflected the relative environmental performance of different ship classes. However, on a more detailed level, when deficiencies related to specific MSFD descriptors were analysed, some deviances from this general pattern were observed. In future, new regulations, or stricter implementations of current regulations, may also change the correlation observed. Further detailed analyses of the effects of detected deficiencies on the marine environment, as expressed by the MSFD descriptors, are therefore recommended.

It is important to note that the number of ships, as well as the total travelled distance, differed greatly among the different classes of ships that operated in the Baltic Sea. The

total pressure on the Baltic marine environment, i.e. not the average pressure from individual ships, will therefore be larger from the more common middle-aged ships between *6 and 15 years* of age than from older ships, even though older ships on average perform worse than young and middle-aged ships. Similarly, because ships from *white listed* flag states are much more common, the total number of deficiencies of ships registered in *white listed* flag states, and hence, the total pressure on the marine environment, is much higher compared to the total number of deficiencies of, and total pressures from, ships from *black* and *grey listed* flag States.

The insight that the total pressure of a class of ships is affected not only by the average performance of the ships in that class, but also by the number of ships and the total travelled distance, does not in any way reduce the need to stop the operation of the worst performing individual ships, and by various means to improve the average performance of ships in the low performing general cargo and dry bulk ship classes. However, from a marine environment management perspective it is important to recognize that even smaller continuous improvements of the performance of the more numerous middle aged ships and of ships registered in white listed flag States will increase the possibility to achieve Good Environmental Status of the marine environments in the Baltic Sea and other European waters.

We conclude that although the Paris MoU scheme for Port State Controls is an important measure to prevent pollution from ships, there is no harmonization between the work of Paris MoU and the marine environmental management in the EU including the implementation of MSFD. At least eight of the eleven descriptors of the MSFD are influenced by shipping but at least three of them cannot be evaluated by the present scheme for PSC. It is possible, according to our view, to develop the present PSC system to also include control measures that focus on these three descriptors, that is, on the effect on biodiversity, sea-floor integrity (for example beach erosion) and on the production of underwater noise. It is also important to investigate ways to add or modify deficiency codes that would also capture the chemical composition of waste streams and remnant chemicals after tank cleanings. An additional development of the PSC system could be to also investigate the behaviour of ships during the period between PSC inspections, e.g. through the use of logged AIS-data. The proposed system development would likely require both new financial resources and competencies.

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Appendix 1

	Paris MoU on Port State Control List of Paris MoU Deficiency codes1
THETIS Code	Defective item
01 - Certificates & Documentation	
011 - Certificates & Documentation - Ship Certificate	
1101	Cargo ship safety equipment (including exemption)
1102	Cargo ship safety construction (including exempt.)
1103	Passenger ship safety (including exemption)
1104	Cargo ship safety radio (including exemption)
1105	Cargo ship safety (including exemption)
1106	Document of compliance (DoC/ ISM)
1107	Safety management certificate (SMC/ ISM)
1108	Load lines (including Exemption)
1109	Decision-support system for masters on pass. ships
1110	Authorization for grain carriage
1111	Liquefied gases in bulk (CoF/GC Code)
1112	Liquefied gases in bulk (ICoF/IGC Code)
1113	Minimum safe manning document
1114	Dangerous chemicals in bulk (CoF/BCH Code)
1115	Dangerous chemicals in bulk (ICoF/IBC Code)
1116	Operational limitations for passenger ships
1117	International Oil Pollution Prevention (IOPP)
1118	Pollution prevention by noxious liquid sub in bulk
1119	International Sewage Pollution Prevention Cert.
1120	Statement of Compliance CAS
1121	Interim Statement of Compliance CAS
1122	International ship security certificate
1123	Continuous synopsis record
1124	International Air Pollution Prevention Cert
1125	Engine International Air Pollution Prevention Cert
1126	Document of compliance dangerous goods
1127	Special purpose ship safety
1128	High speed craft safety and permit to operate
1129	Mobile offshore drilling unit safety
1130	INF certificate of fitness
1131	International AFS certificate *)
1132	Tonnage certificate
1133	Civil liability for oil pollution damage cert.
1134	Polar ship certificate
1135	Document for carriage of dangerous goods
1136	Ballast Water Management Certificate
1137	Civil liability for Bunker oil pollution damage cert
1138	International Energy Efficiency Cert
1139	Maritime Labour Certificate
1140	Declaration of Maritime Labour Compliance (Part I and II)
1199	Other (certificates)

012 - Certificates & Documentation - Crew Certificate	
1201	Certificates for master and officers
1202	Certificate for rating for watchkeeping
1203	Certificates for radio personnel
1204	Certificate for personnel on tankers
1205	Certificate for personnel on fast rescue boats
1206	Certificate for advanced fire-fighting
1209	Manning specified by the minimum safe manning doc
1210	Certificate for medical first aid
1211	Cert for personnel on survival craft & rescue boat
1212	Certificate for medical care
1213	Evidence of basic training
1214	Endorsement by flagState
1215	Application for Endorsement by flagState
1216	Certificate for personnel on ships subject to the IGF Code
1217	Ship Security Officer certificate
1218	Medical certificate
1219	Training and qualification MLC - Personnel safety training
1220	Seafarer' employment agreement SEA
1221	Record of employment
1222	Doc evidence for personnel on passenger ships
1223	Security awareness training
1224	Certificate for rating able seafarer deck/engine and electro-technical
013 - Certificates and Documentation – Document	
1302	SAR co-operation plan for pass.ships on fixed trade
1303	Unattended machinery spaces (UMS) evidence
1304	Declaration of AFS compliance
1305	Log-books/compulsory entries
1306	Shipboard working arrangements
1307	Maximum hours of work or the minimum hours of rest
1308	Records of seafarers' daily hours of work or rest
1309	Fire control plan – all
1310	Signs, indications
1311	Survey report file
1312	Thickness measurement report
1313	Booklet for bulk cargo loading/unloading/stowage
1314	Shipboard oil pollution emergency plan (SOPEP)
1315	Oil record book
1316	Cargo information
1317	Cargo record book
1318	P & A manual
1319	Shipboard mar. poll. Emergency plan (MPEP) for NLS
1320	Garbage record book
1322	Conformance Test Report
1323	Fire safety operational booklet
1324	Material safety data sheets

1325	ACM Statement of compliance (including exemption)
1326	Stability Information Booklet
1327	Energy Efficiency Design Index File
1328	Ship Energy Efficiency Management plan
1329	Report of inspection on MLC, 2006
1330	Procedure for complaint under MLC, 2006
1331	Collective bargaining agreement
1332	AIS test report
1333	Ship specific plans for the recovery of persons from the water
1334	STS Operation Plan and Records of STS Operations
1335	Polar Water Operational Manual
1336	Certificate or documentary evidence of financial security for repatriation
1337	Certificate or documentary evidence of financial security relating to shipowners liability
1338	LNG Bunker Delivery Note
1339	Copy of IGF Code or national legislation
02 - Structural condition	
2101	Closing devices/watertight doors
2102	Damage control plan
2103	Stability/strenght/loading information and instruments
2104	Information on the A/A-max ratio (Roro/pass.only)
2105	Steering gear
2106	Hull damage impairing seaworthiness
2107	Ballast, fuel and other tanks
2108	Electric equipment in general
2109	Permanent means of access
2110	Beams, frames, floors-op.damage
2111	Beams, frames, floors-corrosion
2112	Hull - corrosion
2113	Hull - cracking
2114	Bulkhead –corrosion
2115	Bulkheads - operational damage
2116	Bulkheads – cracking
2117	Decks – corrosion
2118	Decks – cracking
2119	Enhanced survey programme (ESP)
2120	Marking of IMO number
2121	Cargo area segregation
2122	Openings to cargo area, doors, …, scuttles
2123	Wheelhouse door, -window
2124	Cargo pump room
2125	Spaces in cargo areas
2126	Cargo tank vent system
2127	Safe access to tanker bows
2128	Bulk carriers additional safety measures
2129	Bulkhead strength
2130	Triangle mark
2132	Water level detectors on single hold cargo ships
2133	Asbestos containing materials
2134	Loading/Ballast condition (Tanker)
2199	Other (Structural condition)
03 - Water/Weathertight condition	
3101	Overloading
3102	Freeboard marks
3103	Railing, gangway, walkway and means for safe passage
3104	Cargo and other hatchways
3105	Covers (hatchway-, portable-, tarpaulins, etc.)
3106	Windows, side scuttles and deadlights
3107	Doors
3108	Ventilators, air pipes, casings
3109	Machinery space openings
3110	Manholes / flush scuttles
3111	Cargo ports and other similar openings
3112	Scuppers, inlets and discharges
3113	Bulwarks and freeing ports
3114	Stowage incl. uprights, lashing, etc (timber)
3199	Other (load lines)
04 - Emergency Systems	
4101	Public address system
4102	Emergency fire pump and its pipes
4103	Emergency lighting, batteries and switches
4104	Low level lighting in corridors
4105	Location of emergency installations
4106	Emergency steering position communications/ compass reading
4107	Emergency towing arrangements and procedures
4108	Muster list
4109	Fire drills
4110	Abandon ship drills
4111	Damage control plan
4112	Shipboard Marine Pollution emergency operations
4113	Water level indicator
4114	Emergency source of power - Emergency generator
4115	Safe areas
4116	Means of communication between safety centre and other control stations
4117	Functionality of Safety Systems
4118	Enclosed space entry and rescue drills
4119	IGF Code Drills and Emergency Exercises
05 - Radio communication	
5101	Distress messages: obligations and procedures
5102	Functional requirements
5103	Main installation
5104	MF radio installation
5105	MF/HF radio installation
5106	INMARSAT ship earth station
5107	Maintenance / duplication of equipment
5108	Performance standards for radio equipment
5109	VHF radio installation

5110	Facilities for reception of marine safety information
5111	Satellite EPIRB 406MHz / 1.6 GHz
5112	VHF EPIRB
5113	SART/AIS-SART
5114	Reserve source of energy
5115	Radio log (diary)
5116	Operation/maintenance
5118	Operation of GMDSS equipment
5199	Other (radio communication)
06 - Cargo operations including equipment	
6101	Cargo securing manual
6102	Grain
6103	Other cargo - timber -deck/construction
6104	Lashing material
6105	Atmosphere testing instruments
6106	Cargo transfer - Tankers
6107	Cargo operation
6108	Cargo density declaration
6199	Other (cargo)
07 - Fire safety	
7101	Fire prevention structural integrity
7102	Inert gas system
7103	Division – decks, bulkheads and penetrations
7104	Main vertical zone
7105	Fire doors/openings in fire-resisting divisions
7106	Fire detection
7108	Ready availability of fire fighting equipment
7109	Fixed fire extinguishing installation
7110	Fire fighting equipment and appliances
7111	Personal equipment
7112	Emergency escape breathing Device and disposition
7113	Fire pumps and its pipes
7114	Means of control (opening, pumps) Machinery spaces
7115	Fire-dampers
7116	Ventilation
7117	Jacketed high pressure lines and oil leakage alarm
7118	International shore-connection
7120	Means of escape
7121	Crew alarm
7122	Fire control plan
7123	Operation of Fire protection systems
7124	Maintenance of Fire protection systems
7125	Evaluation of crew performance (fire drills)
7199	Other (fire safety)
08 – Alarms	
8101	General alarm
8102	Emergency signal
8103	Fire alarm
8104	Steering-gear alarm
8105	Engineer's alarm
8106	Inert gas alarm
8107	Machinery controls alarm
8108	UMS-alarms
8109	Boiler-alarm
8110	Closing watertight doors alarm
8199	Other (alarms)
09 - Working and Living Conditions	
091 - Working and Living Conditions - Living conditions	
9101	Minimum age
9102	Dirty, parasites
9103	Ventilation (Accommodation)
9104	Heating
9105	Noise
9106	Sanitary facilities
9107	Drainage
9108	Lighting (Accommodation)
9109	Pipes, wires (insulation)
9110	Electrical devices
9111	Sickbay
9112	Medical equipment
9113	Access/structure
9114	Sleeping room
9115	No direct openings into sleeping rooms cargo/mach.
9116	Furnishings
9117	Berth dimensions, etc.
9118	Clear head
9119	Messroom (location)
9120	Oil skin locker
9121	Laundry
9122	Record of inspection (Accommodation)
9124	Galley, handlingroom (maintenance)
9127	Cleanliness
9128	Provisions quantity
9129	Provisions quality
9130	Water, pipes, tanks
9131	Cold room
9132	Cold room temperature
9133	Cold room cleanliness
9134	Food personal hygiene
9135	Food temperature
9136	Food segregation
9137	Record of inspection
9198	Other (crew and accommodation)
9199	Other (food)
092 - Working and Living Conditions - Working Conditions	

9201	Ventilation (Working spaces)
9202	Heating
9203	Lighting (Working spaces)
9204	Safe means of access
9205	Safe means of access shore – ship
9206	Safe means of access deck - hold/tank, etc.
9207	Obstruction/slipping, etc.
9208	Protection machinery
9209	Electrical
9210	Machinery
9211	Steam pipes and pressure pipes
9212	Danger areas
9213	Gas instruments
9214	Emergency cleaning devices
9216	Personal equipment
9217	Warning notices
9218	Protection machines/parts
9219	Pipes, wires (insulation)
9220	Structural features (ship)
9221	Entry dangerous spaces
9223	Gangway, accommodation-ladder
9224	Stowage of cargo
9225	Loading and unloading equipment
9226	Holds and tanks safety
9227	Ropes and wires
9228	Anchoring devices
9229	Winches and capstans
9230	Adequate lighting - mooring arrangements
9232	Cleanliness of engine room
9233	Guards / fencing around dangerous machinery parts
9234	Night working for seafarer under the age of 18
9235	Fitness for duty – work and rest hours
9236	Legal documentation on work and rest hours
9237	Fitness for duty – intoxication
9297	Other (working space ILO)
9298	Other (accident prevention)
9299	Other (mooring)
10 - Safety of Navigation	
10101	Pilot ladders and hoist/pilot transfer arrangements
10102	Type approval equipment
10103	Radar
10104	Gyro compass
10105	Magnetic compass
10106	Compass correction log
10107	Automatic radar plotting aid (ARPA)
10109	Lights, shapes, sound-signals
10110	Signalling lamp
10111	Charts
10112	Electronic charts (ECDIS)
10113	Automatic Identification System (AIS)
10114	Voyage Data Recorder (VDR) / Simplified Voyage Data Recorder (S-VDR)
10115	GNSS receiver/terrestrial radio navigation system
10116	Nautical publications
10117	Echo sounder
10118	Speed and distance indicator
10119	Rudder angle indicator
10120	Revolution counter
10121	Variable pitch indicator
10122	Rate-of-turn indicator
10123	International code of signals- SOLAS
10124	Life-saving signals
10125	Use of the automatic pilot
10126	Records of drills and steering gear tests
10127	Voyage or passage plan
10128	Navigation bridge visibility
10129	Navigation records
10132	Communication - SOLAS Chapter V
10133	Bridge operation
10134	HSC operation
10135	Monitoring of voyage or passage plan
10136	Establishment of working language on board
10137	Long-Range Identification and Tracking system (LRIT)
10138	Bridge Navigational Watch Alarm System (BNWAS)
10199	Other (navigation)
11 - Life saving appliances	
11101	Lifeboats
11102	Lifeboat inventory
11103	Stowage and provision of lifeboats
11104	Rescue boats
11105	Rescue boat inventory
11106	Fast rescue boats
11107	Stowage of rescue boats
11108	Inflatable liferafts
11109	Rigid liferafts
11110	Stowage of liferafts
11111	Marine evacuation system
11112	Launching arrangements for survival craft
11113	Launching arrangements for rescue boats
11114	Helicopter landing and pick-up area
11115	Means of rescue
11116	Distress flares
11117	Lifebuoys incl. provision and disposition
11118	Lifejackets incl. provision and disposition
11119	Immersion suits
11120	Anti-exposure suits
11121	Thermal Protective Aids
11122	Radio life-saving appliances
11123	Emergency equipment for 2-way comm.

11124	Embarkation arrangement survival craft
11125	Embarkation arrangements rescue boats
11126	Means of recovery of life saving appliances
11127	Buoyant apparatus
11128	Line-throwing appliance
11129	Operational readiness of lifesaving appliances
11130	Evaluation, testing and approval
11131	On board training and instructions
11132	Maintenance and inspections
11133	Personal and group survival equipment
11134	Operation of Life Saving Appliances
11135	Maintenance of Life Saving Appliances
11199	Other (life saving)
12 - Dangerous Goods	
12101	Stowage/segregation/packaging of dangerous goods
12102	Dangerous liquid chemicals in bulk
12103	Liquefied gases in bulk
12104	Dangerous goods code
12105	Temperature control
12106	Instrumentation
12107	Fire protection cargo deck area
12108	Personal protection
12109	Special requirements
12110	Tank entry
12112	Dangerous goods or harmful substances in pack. Form
12199	Other (tankers)
13 - Propulsion and auxiliary machinery	
13101	Propulsion main engine
13102	Auxiliary engine
13103	Gauges, thermometers etc.
13104	Bilge pumping arrangements
13105	UMS-ship
13106	Insulation wetted through (oil)
13107	Maintenance procedures for all gas related installations
13108	Operation of machinery
13199	Other (machinery)
14 - Pollution Prevention	
141 - Pollution Prevention - MARPOL Annex I	
14101	Control of discharge of oil
14102	Retention of oil on board
14103	Segregation of oil and water ballast
14104	Oil filtering equipment
14105	Pumping, piping and discharge arrangements
14106	Pump room bottom protection
14107	Oil discharge monitoring and control system
14108	15 PPM alarm arrangements
14109	Oil / water interface detector
14110	Standard discharge connection
14111	SBT, CBT, COW
14112	COW operations and equipment manual
14113	Double hull construction
14114	Hydrostatically balanced loading
14115	Condition Assessment Scheme
14116	Pollution report - MARPOL Annex I
14117	Ship type designation
14119	Oil and oily mixtures from machinery spaces
14120	Loading, unloading & cleaning procedures cargo spaces of tankers
14121	Suspected of discharge violation
14199	Other (MARPOL Annex I)
142 - Pollution Prevention - MARPOL Annex II	
14201	Efficient stripping
14202	Residue discharge systems
14203	Tank washing equipment
14204	Prohibited discharge of NLS slops
14205	Cargo heating systems - cat. Y substances
14206	Ventilation procedures / equipment
14207	Pollution report - MARPOL Annex II
14208	Ship type designation
14299	Other (MARPOL Annex II)
143 - Pollution Prevention - MARPOL Annex III	
14301	Packaging
14302	Marking and labelling
14303	Documentation (MARPOL Annex III)
14304	Stowage
14399	Other (MARPOL - Annex III)
144 - Pollution Prevention - MARPOL Annex IV	
14402	Sewage treatment plan
14403	Sewage comminuting and disinfecting system
14404	Sewage discharge connection
14499	Other (MARPOL Annex IV)
145 - Pollution Prevention - MARPOL Annex V	
14501	Garbage
14502	Placards
14503	Garbage management plan
14599	Other (MARPOL Annex V)
146 - Pollution Prevention - MARPOL Annex VI	
14601	Technical Files and if applicable, monitoring manual
14602	Record book engine parameters
14603	Approved doc exhaust gas cleaning system
14604	Bunker delivery notes
14605	Type approval certificate of incinerator
14606	Diesel engine air pollution control

14607	Quality of fuel oil
14608	Incinerator incl. operations and operating manual
14609	Volatile Organic compounds in tankers
14610	Operational proc. for engines or equipment
14611	Ozone depleting substances
14612	SOx records
14613	Approved method
14614	Sulphur oxides
14615	Fuel change-over procedure
14616	Alternative arrangements
14617	Sulphur content of fuel used
14699	Other (MARPOL ANNEX VI)
147 - Pollution Prevention - Anti Fouling	
14701	AFS supporting documentation
14702	Logbook entries referring AFS
14703	Paint condition
14799	Other (AFS)
148 - Pollution Prevention – Ballast Water	
14801	Ballast Water Management Plan
14802	Ballast Water Record Book
14803	Construction dates applicable for BWM
14804	Ballast Water Exchange
14805	Sediment removal and disposal
14806	Crew Training and familiarization
14809	Conditions for exemptions
14810	Ballast Water Discharge violation in port
14811	Ballast Water Management System
14899	Other (BWM)
15 – ISM	
15150	ISM
16 - ISPS	
16101	Security related defects
16102	Ship security alert system
16103	Ship security plan
16104	Ship security officer
16105	Access control to ship
16106	Security drills
16199	Other (maritime security)
18 - MLC, 2006	
181 - Minimum requirements to work on a ship	
18101	Minimum age
18102	Night working
18103	Medical fitness
18104	Recruitment and placement service
18199	Other (Minimum requirements

182 - Conditions of employment	
18201	Fitness for duty - work and rest hours
18202	Legal documentation on work and rest hours
18203	Wages
18204	Calculation and payment
18205	Measures to ensure transmission to seafarer's family
18299	Other (Conditions of employment)
183 - Accommodation, recreational facilities, food and catering	
18301	Noise, vibration and other ambient factors
18302	Sanitary Facilities
18303	Drainage
18304	Lighting (Accommodation)
18305	Hospital accommodation (Sickbay)
18306	Sleeping room, additional spaces
18307	Direct openings into sleeping rooms cargo/mach.
18308	Furnishings
18309	Berth dimensions, etc.
18310	Minimum headroom
18311	Mess room and recreational facilities
18312	Galley, handlingroom (maintenance)
18313	Cleanliness
18314	Provisions quantity
18315	Provisions quality and nutritional value
18316	Water, pipes, tanks
18317	Food personal hygiene
18318	Food temperature
18319	Food segregation
18320	Record of inspection (food and catering)
18321	Heating, air conditioning and ventilation
18322	Insulation
18323	Office
18324	Cold room, cold room cleanliness, cold room temperature
18325	Training and qualification of ship's cook
18326	Laundry, Adequate Locker
18327	Ventilation (Working spaces)
18328	Record of inspection
18399	Other (Accommodation, recreational facilities…)
184 - Health protection, medical care, social security	
18401	Medical Equipment, medical chest, medical guide
18402	Access to on shore medical doctor or dentist
18403	Standard medical report form
18404	Medical doctor or person in charge of medical care
18405	Medical advice by radio or satellite
18406	Medical care onboard or ashore free of charge
18407	Lighting (Working spaces)
18408	Electrical
18409	Dangerous areas

18410	Gas instruments
18411	Emergency cleaning devices
18412	Personal equipment
18413	Warning notices
18414	Protection machines/parts
18415	Entry dangerous spaces
18416	Ropes and wires
18417	Anchoring devices
18418	Winches & capstans
18419	Adequate lighting - mooring arrangements
18420	Cleanliness of engine room
18421	Guards - fencing around dangerous machinery parts
18422	Asbestos fibres
18423	Preventative information
18424	Steam pipes, pressure pipes, wires (insulation)
18425	Access / structural features (ship)
18426	Exposure to harmful levels of ambient factors
18427	Ship's occupational safety and health policies and programmes
18428	On board programme for the prevention of occupational injuries and diseases
18429	Procedure for inspection, reporting and correcting unsafe conditions and for investigating and reporting on-board occupational accidents
18430	Ship's safety committee
18431	Investigation after accident
18432	Risk evaluation, training and instruction to seafarers
18499	Other (Health protection, medical care…)
99 – Other	
99101	Other safety in general
99102	Other (SOLAS operational)
99103	Other (MARPOL operational)

1 Paris MoU assumes no liability or responsibility for any errors or omissions.

Reference: (Paris MoU, 2017)

Appendix 2

List of deficiency codes selected due to relation to potential pressure on the marine environment "Marine Pollution"

		MSFD Descriptors					MSFD A
		2	5	7	8	10	
01 - Certificates & Documentation							
1102	Cargo ship safety construction (including exempt.)		5		8	10	
1105	Cargo ship safety (including exemption)		5		8	10	
1106	Document of compliance (DoC/ ISM)				8		
1107	Safety management certificate (SMC/ ISM)				8		
1117	International Oil Pollution Prevention (IOPP)				8		
1119	International Sewage Pollution Prevention Cert.	2	5				
1122	International ship security certificate						
1123	Continuous synopsis record						
1124	International Air Pollution Prevention Cert		5	7	8		
1125	Engine International Air Pollution Prevention Cert		5	7	8		
1131	International AFS certificate *)				8		
1136	Ballast Water Management Certificate	2					
1137	Civil liability for Bunker oil pollution damage cert				8		
1138	International Energy Efficiency Cert			7			
1199	Other (certificates)		5		8		
1305	Log-books/compulsory entries						
1311	Survey report file						
1314	Shipboard oil pollution emergency plan (SOPEP)				8		
1315	Oil record book				8		
1316	Cargo information		5		8	10	
1320	Garbage record book					10	
1328	Ship Energy Efficiency Management plan						
07 - Fire safety							
7114	Means of control (opening, pumps) Machinery spaces				8		
7117	Jacketed high pressure lines and oil leakage alarm						
7199	Other (fire safety)				8		
13 - Propulsion and auxiliary machinery							
13101	Propulsion main engine				8		X
13102	Auxiliary engine				8		X
13103	Gauges, thermometers etc.				8		X
13104	Bilge pumping arrangements				8		X
13105	UMS-ship						
13106	Insulation wetted through (oil)				8		X
13108	Operation of machinery				8		
13199	Other (machinery)				8		X
14 - Pollution Prevention							
14101	Control of discharge of oil				8		X
14102	Retention of oil on board				8		X
14103	Segregation of oil and water ballast	2			8		X
14104	Oil filtering equipment				8		X
14105	Pumping, piping and discharge arrangements		5		8		X
14107	Oil discharge monitoring and control system				8		X
14108	15 PPM alarm arrangements				8		X

14109	Oil / water interface detector				8		X
14110	Standard discharge connection		5		8		X
14112	COW operations and equipment manual				8		
14116	Pollution report - MARPOL Annex I				8		X
14119	Oil and oily mixtures from machinery spaces				8		X
14121	Suspected of discharge violation				8		X
14199	Other (MARPOL Annex I)				8		X
14301	Packaging						
14302	Marking and labelling						
14402	Sewage treatment plan	2	5		8		
14403	Sewage comminuting and disinfecting system	2	5		8		X
14404	Sewage discharge connection	2	5				X
14499	Other (MARPOL ANNEX IV)		5				X
14501	Garbage	2	5			10	X
14502	Placards					10	X
14503	Garbage management plan	2	5			10	
14599	Other (MARPOL Annex V)	2	5		8	10	X
14601	Technical Files and if applicable, monitoring manual			7			
14602	Record book engine parameters			7			
14604	Bunker delivery notes				8		
14605	Type approval certificate of incinerator						
14606	Diesel engine air pollution control		5		8		X
14607	Quality of fuel oil				8		X
14608	Incinerator incl. operations and operating manual				8		X
14610	Operational proc. for engines or equipment				8		X
14611	Ozone depleting substances						
14612	SOx records			7			X
14613	Approved method		5				
14614	Sulphur oxides			7			X
14615	Fuel change-over procedure				8		X
14617	Sulphur content of fuel used						
14699	Other (MARPOL ANNEX VI)			7			X
14701	AFS supporting documentation				8		
14801	Ballast Water Management Plan	2					
14802	Ballast Water Record Book	2					X
14804	Ballast Water Exchange	2					X
14806	Crew Training and familiarization	2					X
14810	Ballast Water Discharge violation in port	2					X
14899	Other (BWM)	2					

Additional deficiency codes of potential relevance for the marine environment

01 - Certificates & Documentation	1114	Dangerous chemicals in bulk (CoF/BCH Code)
	1115	Dangerous chemicals in bulk (ICoF/IBC Code)
	1126	Document of compliance dangerous goods
	1317	Cargo record book
02 - Structural condition	2107	Ballast, fuel and other tanks
04 - Emergency Systems	4112	Shipboard Marine Pollution emergency operations
12 - Dangerous Goods	12101	Stowage/segregation/packaging of dangerous goods
	12102	Dangerous liquid chemicals in bulk
	12103	Liquefied gases in bulk
	12104	Dangerous goods code
	12105	Temperature control
	12106	Instrumentation
	12107	Fire protection cargo deck area
	12108	Personal protection
	12109	Special requirements
	12110	Tank entry
	12112	Dangerous goods or harmful substances in pack. Form
	12199	Other (tankers)
14 - Pollution Prevention	14106	Pump room bottom protection
	14111	SBT, CBT, COW
	14112	COW operations and equipment manual
	14113	Double hull construction
	14114	Hydrostatically balanced loading
	14115	Condition Assessment Scheme
	14117	Ship type designation
	14120	Loading, unloading & cleaning procedures cargo spaces of tankers
	14201	Efficient stripping
	14202	Residue discharge systems
	14203	Tank washing equipment
	14204	Prohibited discharge of NLS slops
	14205	Cargo heating systems - cat. Y substances
	14206	Ventilation procedures / equipment
	14207	Pollution report - MARPOL Annex II
	14208	Ship type designation
	14299	Other (MARPOL Annex II)
	14302	Marking and labelling
	14303	Documentation (MARPOL Annex III)
	14304	Stowage
	14399	Other (MARPOL - Annex III)
	14603	Approved doc exhaust gas cleaning system
	14609	Volatile Organic compounds in tankers
	14616	Alternative arrangements
	14702	Logbook entries referring AFS
	14703	Paint condition
	14799	Other (AFS)
	14804	Ballast Water Exchange
	14806	Crew Training and familiarization
	14809	Conditions for exemptions
	14811	Ballast Water Management System

Appendix 3

Classification of ship types.

Vesselfinder type names	**This report**
Container Ship	CONT
Container Ship (Fully Cellular with	CONT
Aggregates Carrier	DRYB
Bulk Carrier	DRYB
Cement Carrier	DRYB
Limestone Carrier	DRYB
Ore/Oil Carrier	DRYB
Self Discharging Bulk Carrier	DRYB
Wood Chips Carrier	DRYB
Fishing Ship	FISH
Trawler	FISH
Deck Cargo Ship	GENE
General Cargo	GENE
General Cargo Ship	GENE
Heavy Load Carrier	GENE
Livestock Carrier	GENE
Nuclear Fuel Carrier	GENE
Palletised Cargo Ship	GENE
Passenger/General Cargo Ship	GENE
Refrigerated Cargo Ship	GENE
"FSO (Floating	MISC
"Restaurant Ship	MISC
Bunkering Tanker	MISC
Buoy/Lighthouse Ship	MISC
Cable Layer	MISC
Crane Ship	MISC
Crew Boat	MISC
Dredger	MISC
Drilling Ship	MISC
Exhibition Ship	MISC
Fire Fighting Ship	MISC
Fish Carrier	MISC
Fishing Support Ship	MISC
Hopper Dredger	MISC
Icebreaker	MISC
Landing Craft	MISC
Motor Hopper	MISC
Non Propelled Barge	MISC
Offshore Support Ship	MISC
Offshore Tug/Supply Ship	MISC
Patrol Ship	MISC
Pilot Ship	MISC
Pipe Burying Ship	MISC
Pipe Layer	MISC
Platform	MISC
Pollution Control Ship	MISC

Pontoon	MISC
Pusher Tug	MISC
Research Ship	MISC
Operating Ship	MISC
Salvage Ship	MISC
Search & Rescue Ship	MISC
Standby Safety Ship	MISC
Supply Tender	MISC
Training Ship	MISC
Tug	MISC
Utility Ship	MISC
Waste Disposal Ship	MISC
Well Stimulation Ship	MISC
Whale Catcher	MISC
Work/Repair Ship	MISC
Yacht	MISC
Passenger (Cruise) Ship	PASS
Passenger Ship	PASS
Passenger/Landing Craft	PASS
Passenger/Ro-Ro Cargo	PASS
Passenger/Ro-Ro Cargo Ship	PASS
Ro-Ro Cargo Ship	RORO
Vehicles Carrier	RORO
Asphalt/Bitumen Tanker	TANK
Chemical Tanker	TANK
Chemical/Oil Products Tanker	TANK
CO2 Tanker	TANK
Crude Oil Tanker	TANK
Edible Oil Tanker	TANK
Liquefied Gas	TANK
LNG Tanker	TANK
LPG Tanker	TANK
Molasses Tanker	TANK
Oil Products Tanker	TANK
Water Tanker	TANK
Vegetable Oil Tanker	TANK

Lighthouse samlar industri, samhälle, akademi och institut i triple helix-samverkan för att stärka Sveriges maritima konkurrenskraft genom forskning, utveckling och innovation. Som en del i arbetet för en hållbar maritim sektor initierar och koordinerar Lighthouse relevant forskning och innovation som utgår från industrin och samhällets behov.

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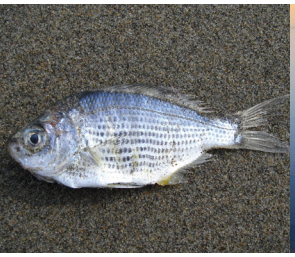

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