Assessment of Non-Indigenous Species (NIS) in the Ports of Hamburg and Kiel

Scientific Report 2017

on behalf of

Bundesamt für Seeschifffahrt und Hydrographie (BSH)
Federal Maritime and Hydrographic Agency

Hamburg

BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

BMVI Expertennetzwerk
Wissen Können Handeln

October 2018

IfAÖ Institut für Angewandte Ökosystemforschung GmbH
Niederlassung Neu Broderstorf, Alte Dorfstraße 11,
18184 Neu Broderstorf
Tel.: +49 38204 618-0

Order Processing

Client: Bundesamt fuer Seeschifffahrt und Hydrographie (BSH)
Federal Maritime and Hydrographic Agency
Bernhard-Nocht-Str. 78
20359 Hamburg
Germany

Contact person: Mariusz Zabrocki (S4181)
Telephone: +49 (0) 40 3190-7481
E-Mail: mariusz.zabrocki@bsh.de

Dr. Katja Broeg (S4105)
Telephone: +49 (0) 40 3190-7415
E-Mail: katja.broeg@bsh.de

Title: **Assessment of Non-indigenous Species (NIS) in the Ports of Hamburg and Kiel**

Project Processing

Project number: P178020

Contractor: IfAÖ Institut für Angewandte Ökosystemforschung GmbH

Postal address: IfAÖ GmbH
Alte Dorfstraße 11
18184 Neu Broderstorf
Germany

Project lead: Dr. Anja Schanz
Telephone: +49 38204 618 49
E-Mail: schanz@ifaoe.de

Authors: Dr. Anja Schanz
Sabine Nestler
Felix Hoffmann (Phytoplankton)

Dr. Claus-Dieter von Duerselen, AquaEcology (Zooplankton)

Date: 30.10.2018

Cover picture: Fouling organisms on a pontoon at the „ThyssenKrupp-Hafen” in the port of Kiel. (Image source: IfAÖ)

Table of Contents

Figures

Tables

1 Summary

In 2017, a non-indigenous species assessment was conducted in the Port of Hamburg and the Port of Kiel. The applied survey methods followed the joint HELCOM/OSPAR guidelines for the contracting parties of OSPAR and HELCOM on the granting of exemptions under the International Convention for the Control and Management of Ships' Ballast Water and Sediment, Regulation A-4. The objective of the survey was 1) to provide a baseline list of non-indigenous species present in the Port of Hamburg and the Port of Kiel, and 2) to evaluate the efficiency and efficacy as well as the practical implementation of the HELCOM/OSPAR port sampling protocol.

In the Port of Hamburg, Neobiota assessments were conducted at four harbor sites: "Petroleumhafen", "Seemannshöft", "Alte Süderelbe" and "Hansahafen". In the Port of Kiel the three harbor sites "Tiessenkai", "Tirpitzhafen" and "Thyssen-Krupp Hafen" were investigated.

At all harbor sites, the assessment of NIS included the sampling of human pathogens, phyto- and zooplankton, benthic infauna, and fouling organisms growing on different hard substrates in ports as well as on introduced settlement plates and mobile epifauna (e.g. crustaceans and fish) by means of baited traps and artificial habitat collectors.

Results of the human pathogen analysis showed that no recorded value, neither for intestinal Enterococci nor for *E. coli* exceeded the threshold values in the ports of Hamburg and Kiel in spring and summer 2017.

In the Port of Hamburg overall, 179 distinct species were found. Of these, 16 NIS were identified, all belonging to the kingdom of Animalia (mainly Crustacea and Mollusca). Most species and NIS (13) were identified at the "Alte Süderelbe" harbor site. The fewest number of species was found at the "Petroleumhafen" with seven NIS. No NIS were identified in phytoplankton. Only one NIS, the bivalve *Dreissena polymorpha,* was detected within the zooplankton samples. All 16 NIS were found within the macrozoobenthos samples. Fourteen of these occurred on artificial hard substrates.

In the Port of Kiel, 205 distinct species were found, of which eleven animal species were identified as non-indigenous (mainly Crustacea and Cnidaria) as well as one species each from the kingdoms Chromista and Plantae. The number of native species and NIS differed only slightly between the three harbor sites. There were no NIS within any of the phyto- and zooplankton samples. Ten NIS were found on artificial hard substrates.

Most of the species accumulation curves did not become asymptotic, which indicates that additional samples could have resulted in the detection of additional species with all methods.

2 Introduction and Objectives

Transport and introductions of non-indigenous (non-native) species (NIS) by shipping are considered as one of the most severe threats to coastal ecosystems worldwide (Carlton & Geller 1993, Wilcove et al.1998, Mack et al 2000, Grosholz 2002). Ocean-going vessels transport NIS in ballast water and as fouling communities attached to their hulls (Carlton 1985, Coutts et al 2003).

In the Federal Ministry of Transport and Digital Infrastructure (BMVI) Network of Experts “Knowledge – Ability – Action”, pathways of introductions and distribution of NIS should be identified and described. Moreover, concepts, methods and decision tools are to be developed in order to prevent introductions of NIS as well as to control the presence of already-occurring NIS. Based on this generated knowledge, early warning concepts for introductions and distributions of NIS by transportation will be developed.

The Federal Maritime and Hydrographic Agency of Germany (BSH) is the responsible authority for measures to prevent introductions of invasive NIS from shipping (Seeaufgabengesetz (SeeAufG) § 1 Abs. 16). The implementation of the Ballast Water Management Convention (BWMC), developed by the International Maritime Organization (www.imo.org), is considered to be a central tool to reduce NIS introduction caused by ballast water in the near future. The BWMC is a convention that stipulates the compliance of discharge standards for ships that are releasing their ballast water. In practice, ships have to install ballast water treatment systems onboard, or may apply for exemption rules when it can be proven that ballast water discharge is of low risk for the recipient port.

In order to grant exemptions from ballast water treatment (BWMC A-4) risk assessments have to be performed. Port surveys are a central part of the risk assessment. In previous years, some port assessments programs have already been conducted by coastal state authorities (e.g. Buschbaum et al. 2012, Rohde et al. 2015, IfAÖ 2017, LUNG 2017). However, the past surveys did not follow all aspects of the Joint HELCOM/OSPAR Guidelines on the granting of exemptions under the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, Regulation A-4, adopted by the HELCOM Ministerial Meeting of 3 October 2013 in Copenhagen and OSPAR Agreement 2013-09. In particular, plankton assessments were not included in former monitoring programs. Since sampling of plankton is an important aspect of the internationally-agreed joint HELCOM/OSPAR harmonized Protocol (JHP), plankton assessments have to be performed in future national port surveys, and may provide important information for possible revisions and/ or adjustments of the JHP.

The aim of the current study was to evaluate the efficiency and efficacy as well as the practical implementation of the port sampling protocol as described in the JHP. The assessment of non-indigenous species in the ports of Hamburg and Kiel in 2017 includes the standardized collection, analysis and documentation of benthos growing on hard substrates, infauna inhabiting soft sediments, mobile macrozoobenthos, including fish, as well as phyto- and zooplankton and human pathogens.

In contrast to former baseline assessments of non-indigenous species that solely focused on benthic habitats, the current study also includes the assessment of plankton in the water column.

In addition, and deviating from methods listed in the JHP, the efficiency and suitability of two different habitat trap types, the “crab condo” and the “oyster crate” for the collection of smaller mobile epifauna such as crustaceans (e.g. amphipods), is tested.

Results and experiences gained during the assessment of NIS in the ports of Hamburg and Kiel serve as a base in order to improve the quality of the port survey protocol described in the JHP.

This report summarizes the methods and results of the port surveys and provides an inventory of species detected in the ports of Hamburg and Kiel. It lists native and introduced non-indigenous and cryptogenic species. Organisms that could not be identified to species level are also listed as species indeterminata.

3 Port Sampling Sites

In 2017, assessments of non-indigenous species were conducted in the port of Hamburg and the port of Kiel (Figure 1).

The number of sampling sites required for an adequate port survey depends on the size and type of port. There is no predetermined number of sites per port indicated in the JHP protocol. However, it is indicated, that three sampling sites per port should be sampled at a minimum.

Sampling methods and stations at individual harbor sites in the ports are listed in Table 1 and Table 2.

Figure 1: Locations of the ports of Kiel and Hamburg (2017) as well as the port of Cuxhaven and the JadeWeserPort in Wilhelmshaven (2018) for the assessment of non-indigenous species.

3.1 Port of Hamburg

The Port of Hamburg is located between the German North Sea and the Baltic Sea and easy to access from the North Sea via the river Elbe. It is located in a distance of approx. 70 nautical miles from the river mouth. Moreover, the port is connected to Scandinavia and the entire Baltic Sea region via the Kiel Canal. Furthermore, the Elbeseitenkanal and the Midland Canal both provide excellent transport connections to inland regions.

The Port of Hamburg is the largest seaport for seagoing vessels in Germany, with approx. 9,000 ship calls per year, almost 300 berths and a total of 43 kilometers of quay. It comprises four state-of-the-art container terminals, three cruise terminals and approx. 50 facilities specialized in handling roll-on roll-off (roro) and breakbulk as well as all types of bulk cargoes. Moreover, it dispatches more than 2,300 freight trains per week (status as of 2017).

In 2016, 138.2 million tons of cargo were transported through the Port of Hamburg, including about 8.9 million standard containers. Hence, the port of Hamburg is the third largest container port in Europe and is listed to be one of the 20 largest container ports worldwide.

In accordance with the size and physical characteristics of the port of Hamburg as wells as logistical feasibility, it was decided to conduct Neobiota assessments at four different harbor sites (Figure 2, Table 1): “Petroleumhafen”, “Seemannshöft”, “Alte Süderelbe” and “Hansahafen” at varying water depths ranging from 2.5 to 11 m.

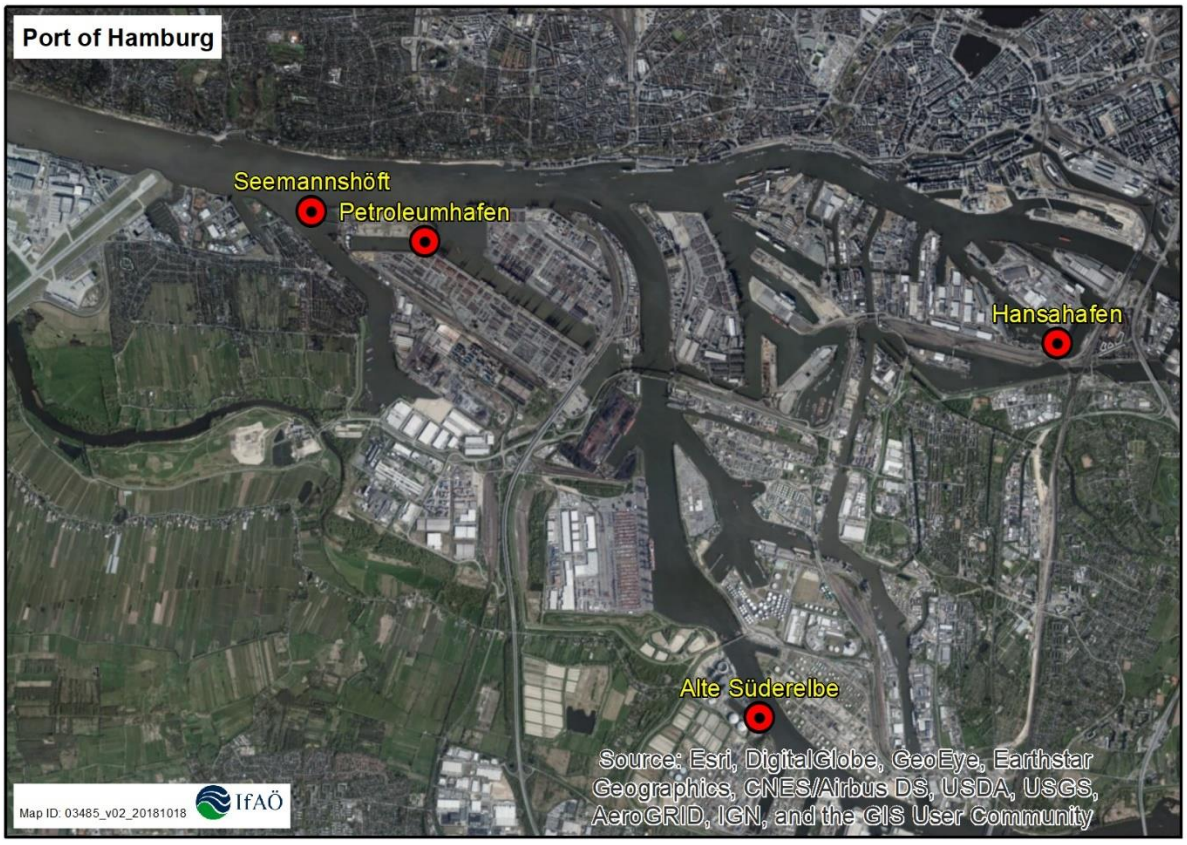

Figure 2: Port of Hamburg: Overview of the four harbor sites for the assessment of Neobiota.

All harbor sites at the Port of Hamburg are strongly influenced by North Sea tides and resulting strong tidal current velocities. However, water masses passing the harbor consists of fresh water with salinity values below 0.5 PSU (Table 7).

Individual harbor sites surveyed in this study are described in the following paragraphs.

Table 1: Harbor sites, methods and type of sampled substrate as well as sample locations, water depths (m) and dates of sampling (incl. deployment and retrieval date of plates and traps) at the Port of Hamburg in 2017.

Harbor site/ Station ID	Position		Water depth	Substrate	Method	Date
	Lat [°N]	Long [°E]	[m]			
Petroleumhafen						
HH_A_1	53.53643	9.90153	2.9	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
					Human pathogens	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_A_2	53.53628	9.89892	1.7	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_A_3	53.53603	9.89587	7.5	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_A_H	53.53655	9.89902	3.0	Wooden jetty	Scratch samples	10.07.2017
HH_A_M	53.53648	9.89987	2.0	Metal pile mooring	Scratch samples	10.07.2017
HH_A_P	53.53640	9.90010	1.7	PVC plates	Settlement plates	10.07.2017-19.10.2017
				Traps	Chinese crab box trap	10.07.2017-12.07.2017
					Gee's minnow trap	10.07.2017-12.07.2017
					Oyster crate	10.07.2017-19.10.2017
					Crab condo	10.07.2017-19.10.2017
Seemannshöft						
HH_B_1	53.53960	9.88065	7.0	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
					Human pathogens	27.04.2017/10.07.2017
				Soft sediment	Grab samples	10.07.2017
HH_B_2	53.53960	9.87920	6.6	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_B_3	53.53943	9.88078	2.0	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	10.07.2017
HH_B_M	53.53948	9.88065	2.0	Metal pile mooring	Scratch samples	10.07.2017
HH_B_S	53.53949	9.88043	2.0	Pontoon (concrete, wood)	Scratch samples	10.07.2017
HH_B_V	53.53949	9.88043	2.0	Pontoon (wood, concrete, tire)	Rapid Assessment	10.07.2017
HH_B_P	53.53955	9.88005	4.0	PVC plates	Settlement plates	10.07.2017-19.10.2017

Harbor site/ Station ID	Position		Water depth	Substrate	Method	Date
	Lat [°N]	Long [°E]	[m]			
				Traps	Chinese crab box trap	10.07.2017-12.07.2017
					Gee's minnow trap	10.07.2017-12.07.2017
					Oyster crate	10.07.2017-19.10.2017
					Crab condo	10.07.2017- lost
Alte Süderelbe						
HH_C_1	53.48637	9.95632	8.0	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
					Human pathogens	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_C_2	53.48625	9.95642	8.0	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_C_3	53.48300	9.96042	14.0	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/10.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_C_H	53.48635	9.95622	14.0	Hard rubber barrier	Scratch samples	11.07.2017
HH_C_S	53.48610	9.95648	14.0	Pontoon (metal)	Scratch samples	11.07.2017
HH_C_V	53.48630	9.95635	14.0	Pontoon (wood, metal)	Rapid Assessment	11.07.2017
HH_C_P	53.48608	9.95645	6.5	PVC plates	Settlement plates	11.07.2017-19.10.2017
				Traps	Chinese crab box trap	10.07.2017-12.07.2017
					Gee's minnow trap	10.07.2017-12.07.2017
					Oyster crate	11.07.2017-19.10.2017
					Crab condo	11.07.2017- lost
Hansahafen						
HH_D_1	53.52472	10.00887	6.5	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/11.07.2017
					Human pathogens	27.04.2017/11.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_D_2	53.52635	10.00688	9.6	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/11.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_D_3	53.52660	10.00397	8.6	Water column	Phytoplankton	27.04.2017/10.07.2017
					Zooplankton	27.04.2017/11.07.2017
				Soft sediment	Grab samples	11.07.2017
HH_D_H	53.52694	10.00659	9.6	Bulkhead	Scratch samples	12.07.2017
HH_D_S	53.52473	10.00907	6.5	Pontoon (concrete, metal)	Scratch samples	12.07.2017
HH_D_V	53.52482	10.00903	6.5	Pontoon (wood, concrete)	Rapid Assessment	12.07.2017
HH_D_P	53.52475	10.00903	3.0	PVC plates	Settlement plates	11.07.2017-19.10.2017
				Traps	Chinese crab box trap	10.07.2017-12.07.2017
					Gee's minnow trap	10.07.2017-12.07.2017
					Oyster crate	11.07.2017-19.10.2017

Harbor site/ Station ID	Position		Water depth	Substrate	Method	Date
	Lat [°N]	Long [°E]	[m]			
					Crab condo	11.07.2017- lost

3.1.1 Petroleumhafen

At “Petroleumhafen”, benthic scratch samples were collected at a wooden jetty and metal pile moorings (Figure 3, Figure 4). Furthermore, scratch samples were taken from stones, partly covering the wooden jetty.

Settlement plates as well as different trap types to collect mobile epifauna were tethered to a pile mooring.

Infauna samples were taken at muddy sediments with varying water depths ranging from 1.7 m to 7.5 m.

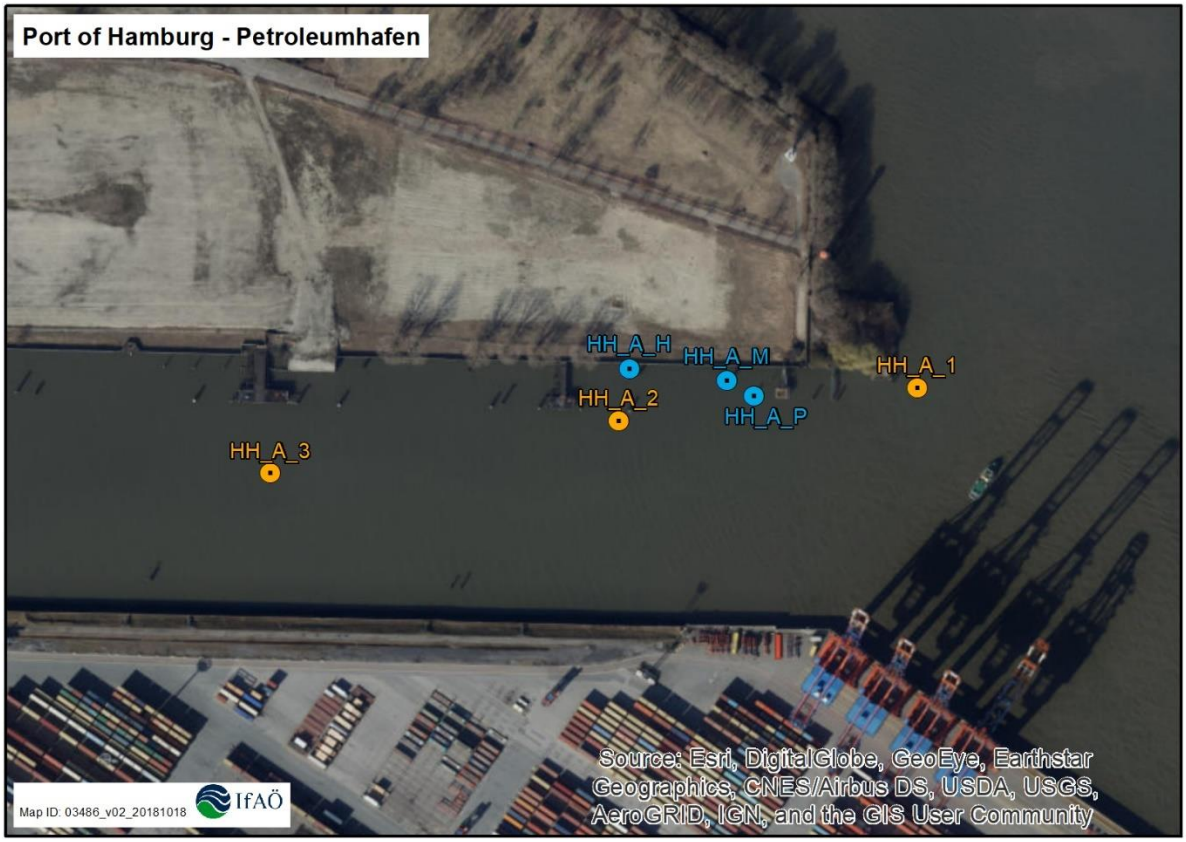

Figure 3: Sampling stations at the ”Petroleumhafen“ harbor site in the Port of Hamburg. **Yellow marks:** plankton and grab samples. **Blue marks:** scratch samples (HH_A_H, HH_A_M) as well as settlement plates and traps (HH_A_P).

Figure 4: Metal pile mooring (*left*) and wooden jetty (*right*) at the “Petroleumhafen“ harbor site in the Port of Hamburg. (Image source: IfAÖ).

3.1.2 Seemannshöft

The “Seemannshöft” harbor site is a pilot station at the entrance to the Port of Hamburg. It is located at the tip of a small land tongue in the Northwest of the Hamburg district Waltershof, between Köhlfleet, a navigable branch of the Elbe River, and the main Elbe River (Figure 5).

Scratch sampling on hard substrates was performed on a wooden and concrete floating pontoon, rubber tires, used as rubbing paunch for both pilot cutters and our harbor boats as well as on a metal pile mooring (Figure 6).

Infauna sampling was conducted in soft sediment at differing water depths between 2.0 m and 7.0 m.

Figure 5: Sampling stations at the ”Seemannshöft“ harbor site in the Port of Hamburg. **Yellow marks:** Plankton and grab samples. **Blue marks:** Scratch samples (HH_B_S, HH_B_M), Rapid Assessment Survey (HH_B_V) as well as settlement plates and traps (HH_B_P).

Figure 6: Metal pile mooring (*left*), pontoon made up of wood and concrete (*left* and *middle*) as well as tire with fouling organisms (*right*) at the ”Seemannshöft“ harbor site in the Port of Hamburg. (Image source: IfAÖ).

3.1.3 Alte Süderelbe

The “Alte Süderelbe” harbor site is considered to be the second largest lake in the city of Hamburg with a length of 6 km and a width of 150 m. The former branch of the Elbe River was cut off from the main river by the construction of a dike after a large storm surge in 1962.

The sampling site was located in close proximity to a warm water sewage disposal of a resident coal-fired power plant (Figure 7). As a consequence, water temperature was distinctly higher at this harbor site in comparison to the other harbor survey sites (Table 7).

Surveyed substrates at the “Alte Süderelbe” mainly comprised wooden and metal parts of a floating pontoon, a hard rubber barrier as well as submerged braided cable (Figure 8).

Water depth of infauna sampling stations varied between 8.0 m and 14.0 m.

Figure 7: Sampling stations at the ”Alte Süderelbe“ harbor site in the Port of Hamburg. **Yellow marks:** plankton and grab samples. **Blue marks:** scratch samples (HH_C_S, HH_C_H), Rapid Assessment Survey (HH_C_V) as well as settlement plates and traps (HH_C_P).

Figure 8: Pontoon composed of wood and metal (*left* and *middle*) as well as hard rubber barrier (*right*) at the ”Alte Süderelbe“ harbor site in the Port of Hamburg. (Image source: IfAÖ).

3.1.4 Hansahafen

The “Hansahafen” harbor site comprises the 530 meter-long O’Swaldkai, situated in the northern portion of the “Hansahafen”, and southerly of the Nordelbe (Figure 9). Among other things, containers, vehicles of every description and in particular tropical fruits are handled at this site. Moreover, the site experiences high local ship traffic.

Scratch sampling took place on bulkheads as well as on wooden, metal and concreate components of a floating pontoon (Figure 10).

Infauna sampling was conducted at water depths between 6.5 m and 9.6 m.

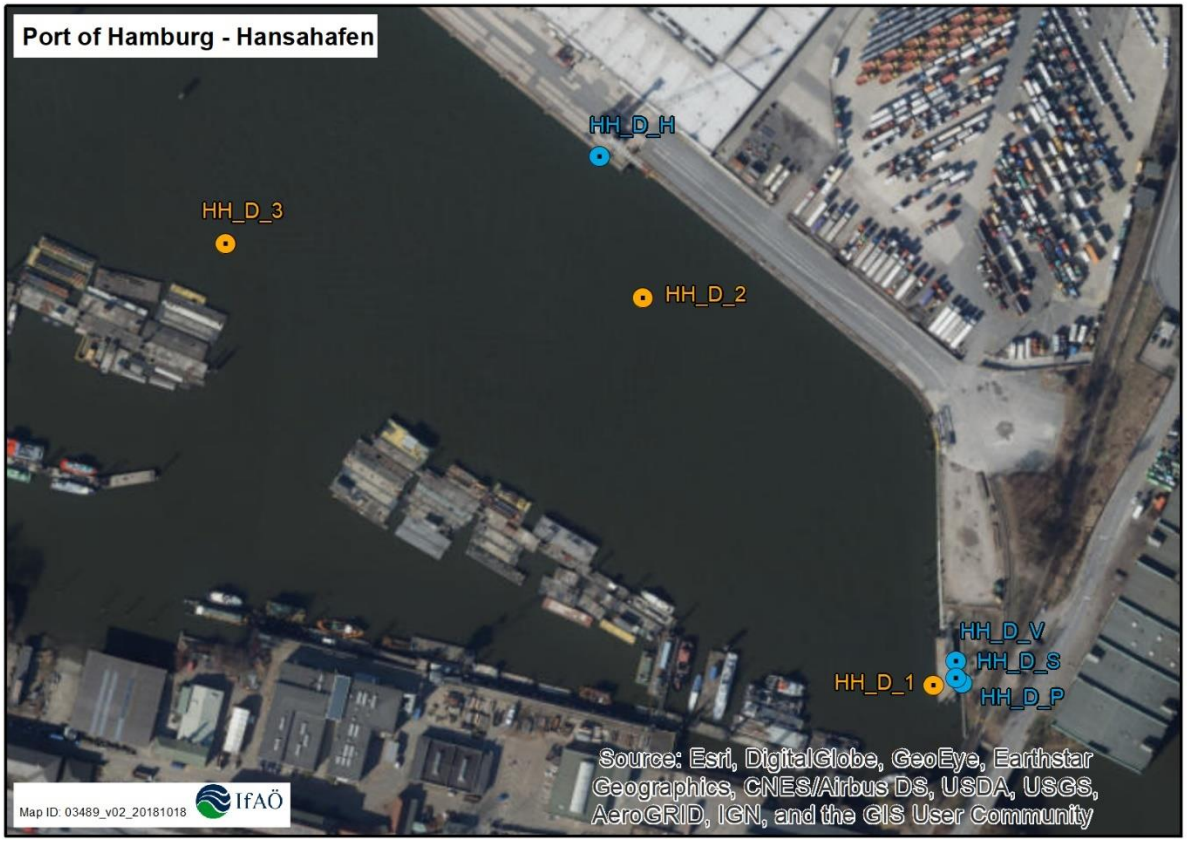

Figure 9: Sampling stations at the ”Hansahafen“ harbor site in the Port of Hamburg. **Yellow marks:** plankton and grab samples. **Blue marks:** scratch samples (HH_D_S, HH_D_H), Rapid Assessment Survey (HH_D_V) as well as settlement plates and traps (HH_D_P).

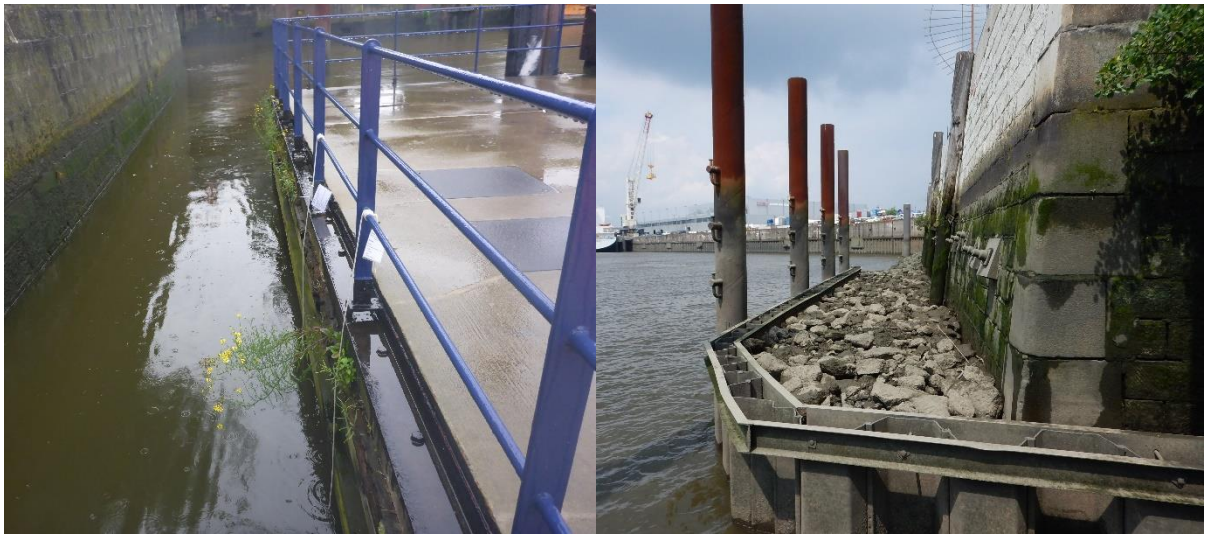

Figure 10: Pontoon made up of wood, concrete and metal (*left*) as well as bulkhead (*right*) at the ”Hansahafen“ harbor site in the Port of Hamburg. (Image source: IfAÖ).

3.2 Port of Kiel

The Port of Kiel is the third largest hub port in Northern Europe. It is the most westerly located European Baltic port, and considered to be one of the most multi-faceted ports in the Baltic Sea. Due to its geographical position, continuous water depth for seagoing vessels and direct connection to the rail and motorway networks, the port is ideal for both passenger transport and cargo handling and has good connections to Scandinavia, Russia and the Baltic states. The Port of Kiel offers customized service at four berths for cruise ships from 140 m to 350 m in length. In 2015, the Port of Kiel experienced 133 calls by 25 different cruise ships with a total tonnage of more than 8.6 million GT.

In accordance with the size and physical characteristics of the Port of Kiel, and taking into account logistical feasibility, NIS assessments were conducted at three harbor sites (Figure 11, Table 2): “Tiessenkai”, “Tirpitzhafen” and “Thyssen-Krupp Hafen” at differing water depths between 1.0 m and 12.0 m. “Tiessenkai” is in direct connection to the Kiel Canal.

The surveyed harbor sites are only slightly affected by tides and exhibit comparable salinities between16 and 17 PSU (Table 19).

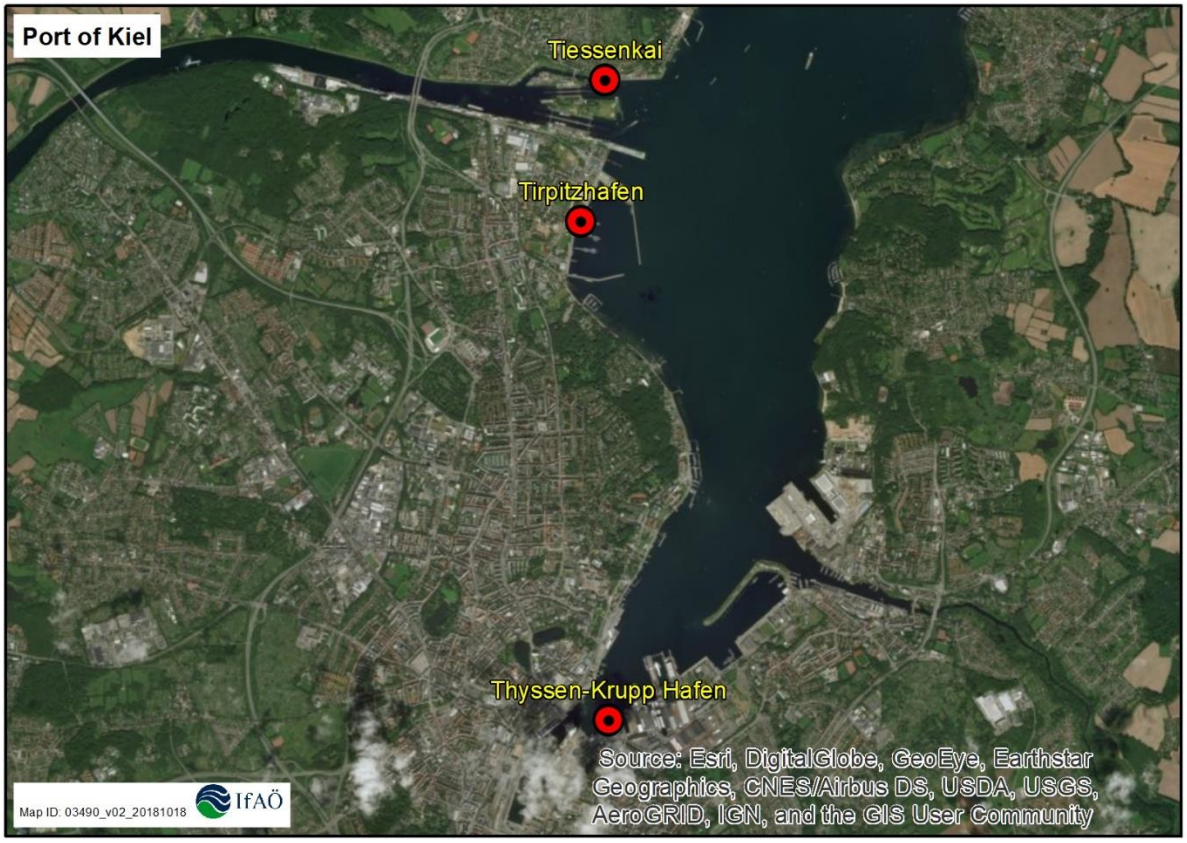

Figure 11: Port of Kiel: overview of the three harbor sites for the assessment of Neobiota.

Table 2: Harbor sites, methods and type of sampled substrate as well as sample locations, water depths (m) and dates of sampling (incl. deployment and retrieval date of plates and traps) at the Port of Kiel in 2017.

Harbor site/ Station ID	Position		Water depth	Substrate	Method	Date
	Lat [°N]	Long [°E]	[m]			
Tiessenkai						
KI_TIK_1	54.36910	10.14570	4.8	Water column	Phytoplankton	26.04.2017/06.07.2017
					Zooplankton	26.04.2017/06.07.2017
					Human pathogens	26.04.2017/06.07.2017
				Soft sediment	Grab samples	06.07.2017
KI_TIK_2	54.36900	10.14638	4.0	Water column	Phytoplankton	26.04.2017/06.07.2017
					Zooplankton	26.04.2017/06.07.2017
				Soft sediment	Grab samples	06.07.2017
KI_TIK_3	54.36890	10.14733	4.0	Water column	Phytoplankton	26.04.2017/06.07.2017
					Zooplankton	26.04.2017/06.07.2017
				Soft sediment	Grab samples	06.07.2017
KI_TIK_H	54.36883	10.14682	4.0	Wooden jetty	Scratch samples	06.07.2017
KI_TIK_S	54.36903	10.14668	1.0	Pontoon	Scratch samples	06.07.2017
KI_TIK_V	54.36883	10.14682	4.0	Rock filling, pile moorings	Rapid Assessment	06.07.2017
KI_TIK_P	54.36880	10.14735	n.a.	PVC plates	Settlement plates	05.07.2017-18.10.2017
				Traps	Chinese crab box trap	05.07.2017-06.07.2017
					Gee's minnow trap	05.07.2017-06.07.2017
					Oyster crate	05.07.2017-18.10.2017
					Crab condo	05.07.2017-18.10.2017
Tirpitzhafen						
KI_TIP_1	54.35558	10.14205	6.0	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
					Human pathogens	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TIP_2	54.35790	10.14310	6.0	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TIP_3	54.36040	10.14720	6.5	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TIP_H	54.35749	10.14270	6.0	Wooden jetty	Scratch samples	05.07.2017
KI_TIP_S	54.35546	10.14190	6.0	Pontoon	Scratch samples	05.07.2017
KI_TIP_V	54.35807	10.14318	6.5	Pontoon, rock filling	Rapid Assessment	05.07.2017
KI_TIP_P	54.35575	10.14207	6.5	PVC plates	Settlement plates	05.07.2017-18.10.2017
				Traps	Chinese crab box trap	05.07.2017-06.07.2017
					Gee's minnow trap	05.07.2017-06.07.2017
					Oyster crate	05.07.2017-18.10.2017
					Crab condo	05.07.2017-18.10.2017

Harbor site/ Station ID	Position		Water depth	Substrate	Method	Date
	Lat [°N]	Long [°E]	[m]			
Thyssen-Krupp Hafen						
KI_TKR_1	54.31793	10.14398	7.5	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TKR_2	54.31883	10.14547	8.0	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TKR_3	54.31983	10.14708	6.0	Water column	Phytoplankton	26.04.2017/05.07.2017
					Zooplankton	26.04.2017/05.07.2017
					Human pathogens	26.04.2017/05.07.2017
				Soft sediment	Grab samples	05.07.2017
KI_TKR_H	54.31955	10.14746	6.0	Wooden jetty	Scratch samples	05.07.2017
KI_TKR_S	54.31914	10.14580	8.0	Pontoon	Scratch samples	05.07.2017
KI_TKR_V	54.31955	10.14746	6.0	Brick wall, concrete	Rapid Assessment	05.07.2017
KI_TKR_P	54.31883	10.14547	9.0	PVC plates	Settlement plates	05.07.2017-18.10.2017
				Traps	Chinese crab box trap	05.07.2017-06.07.2017
					Gee's minnow trap	05.07.2017-06.07.2017
					Oyster crate	05.07.2017-18.10.2017
					Crab condo	05.07.2017-18.10.2017

3.2.1 Tiessenkai

All NIS sampling at the “Tiessenkai” harbor site took place at a public marina in close proximity to the “Tiessenkai”. At “Tiessenkai”, both traditional marine sailboats as well as smaller boats moor during the summer months. Water depth in front of “Tiessenkai” is approx. 4.5 m. Shipping through the Kieler Förde takes place in close proximity. Moreover, harbor tours are conducted from “Tiessenkai” between May and October. “Tiessenkai” is located directly at the gate of the Kiel Canal (North Sea and Baltic canal (NOK).

NIS assessments were conducted at wooden jetties, floating pontoons, a rock filling and pile moorings (Figure 12 and Figure 13). Infauna sampling in soft sediments took place at water depths between 4.0 m and 4.8 m.

Figure 12: Sampling stations at the ”Tiessenkai“ harbor site in the Port of Kiel. **Yellow marks:** Plankton and grab samples. **Blue marks:** Scratch samples (KI_TIK_S, KI_TIK_H), Rapid Assessment Survey (KI_TIK_V) as well as settlement plates and traps (KI_TIK_P).

Figure 13: Rock filling with *Fucus*-cover (left) as well as fouling organisms on a pile mooring at the ”Tiessenkai“ harbor site in the Port of Kiel. (Image source: IfAÖ).

3.2.2 Tirpitzhafen

The “Tirpitzhafen” harbor site is a navy base located in Kiel. It is located close to Kiel Canal and in the Northwest of the Kieler Förde River. It is year-round used as home port for the German marine fleet.

Sampling of NIS inhibiting artificial hard substrates in “Tirpitzhafen” was conducted on wooden jetties, concrete pontoons and a rock filling (Figure 15 and Figure 14).

Infauna samples were collected at water depths between 6.0 m and 6.5 m.

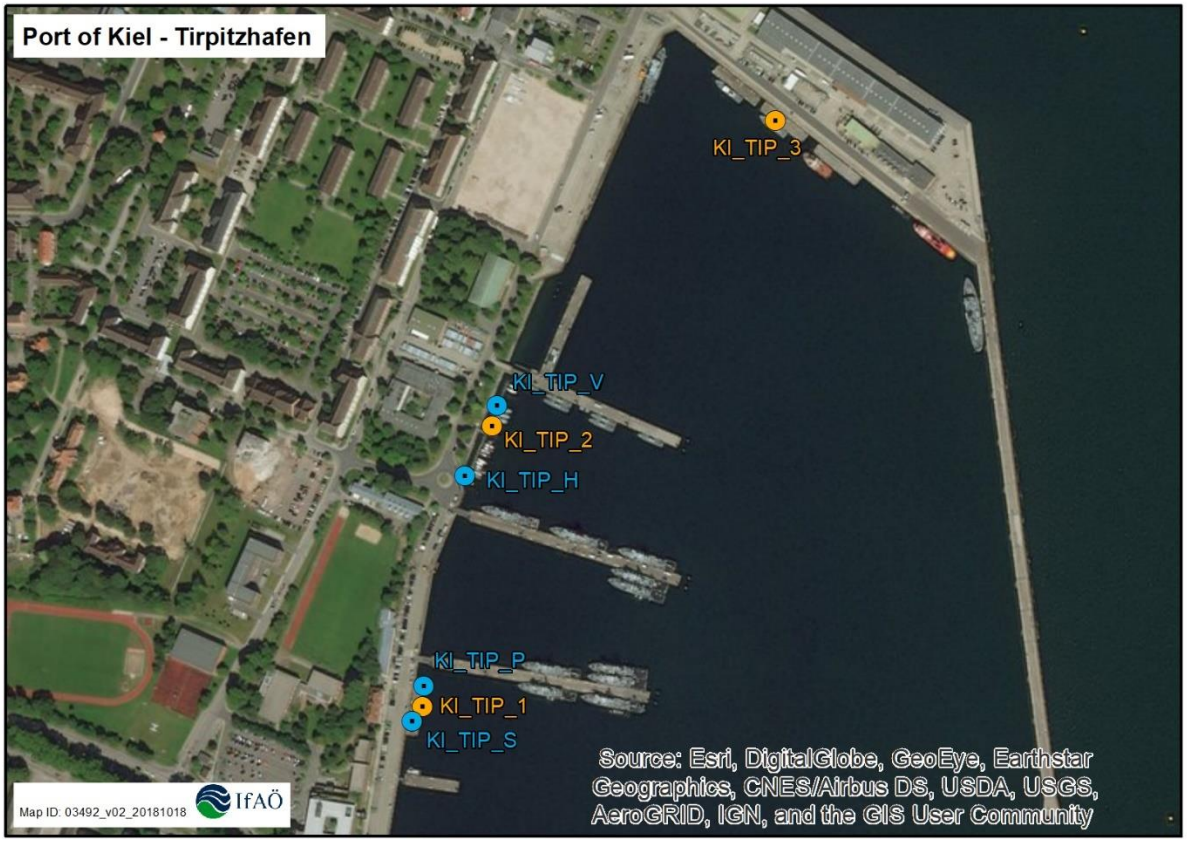

Figure 14: Sampling stations at the ”Tirpitzhafen“ harbor site in the Port of Kiel. **Yellow marks:** Plankton and grab samples. **Blue marks:** Scratch samples (KI_TIP_S, KI_TIP_H), Rapid Assessment Survey (KI_TIP_V) as well as settlement plates and traps (KI_TIP_P).

Figure 15: Wooden jetty (*left*) and pontoon (*right*) with fouling organisms at the ”Tirpitzhafen“harbor site in the Port of Kiel. (Image source: IfAÖ).

3.2.3 Thyssen-Krupp Hafen

The “Thyssen-Krupp Hafen” sampling site is located on the property of ThyssenKrupp Marine Systems at the southern tip of the Kieler Förde. It is positioned in close proximity to both, the ferry terminal of the Kiel-Oslo international ferry as well as the Kiel-Göteborg ferry. International ferry traffic directly passes “Thyssen-Krupp Hafen”.

At “Thyssen-Krupp Hafen” sampling of NIS on artificial hard substrates was performed on wooden jetties and pontoons as well as submerged brick walls (Figure 16, Figure 17).

Infauna in soft sediment was collected at water depths between 6.0 m and 8.0 m.

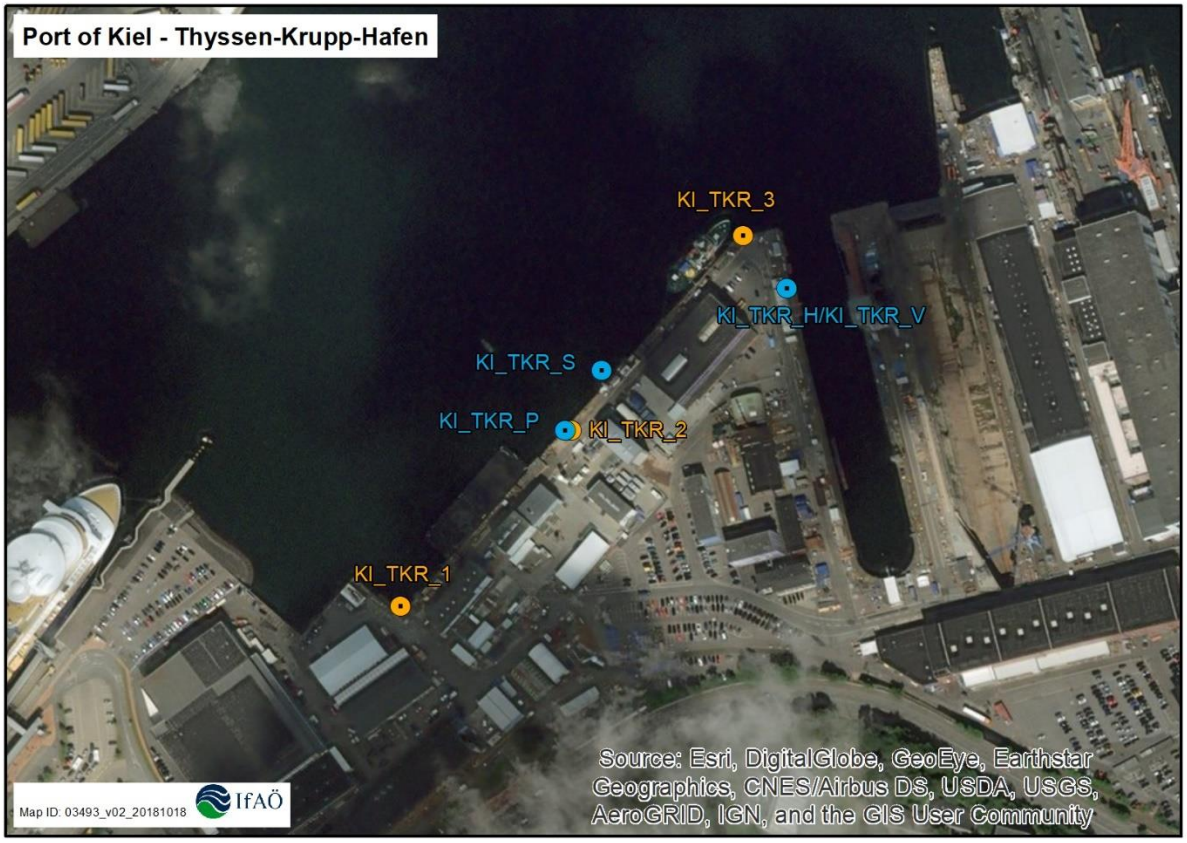

Figure 16: Sampling stations at the ”Thyssen-Krupp Hafen“ harbor site in the Port of Kiel. **Yellow marks:** Plankton and grab samples. **Blue marks:** Scratch samples (KI_TKR_S, KI_TKR_H), Rapid Assessment Survey (KI_TKR_V) as well as settlement plates and traps (KI_TKR_P).

Figure 17: Brick wall (left) and concrete (right) at the ”Thyssen-Krupp Hafen“ harbor site in the Port of Kiel. (Image source: IfAÖ).

4 Assessment Program - Joint HELCOM/ OSPAR Port Survey Protocol (JHP)

In order to investigate the occurrence of NIS in the ports of Hamburg and Kiel in 2017 (Figure 1), NIS were sampled in accordance with the methodology described in the HELCOM-OSPAR Joint Harmonized Procedure on the granting of ballast water management convention (BWMC) exemptions for the comprehensive sampling of NIS in ports (HELCOM 2013) (from now on referred to as the “JHP survey protocol”.

Following the JHP survey protocol,

- ports were briefly characterized and
- environmental site data, such as salinity, water temperature, oxygen content and saturation as well as water transparency were collected.

Sampling of NIS was conducted at predominant and accessible habitats, including hard substrates (e.g. stone fillings, floating pontoons, pile moorings, piers, moles, etc.), soft bottoms (e.g. mud, sand, gravel) and the water column.

The survey included the sampling of:

- human pathogens
- phyto- and zooplankton
- benthic infauna
- fouling organisms growing on different hard substrates in ports as well as on installed settlement plates and
- mobile epifauna (e.g. crustaceans and fish) by means of baited light weight traps

In addition, and deviating from the JHP, smaller epifauna was collected by habitat traps (habitat collectors).

4.1 Hydrological parameters

The hydrological parameters water temperature, salinity and dissolved oxygen (concentration and saturation) were recorded at all harbor sites (Hach Oxyguard Handy Gamma with WTW LF 197 and WTW TA 197 / LF-40) once in spring and once in summer 2017. In addition, water transparency was measured by means of a Secchi disk (30 cm). In the port of Hamburg hydrological parameters were measured at four sites. In the port of Kiel all parameters were collected at three sites. At all harbor sites, hydrological parameters were measured at the three stations with plankton assessment (Hamburg: Figure 3 to Figure 9, Table 1; Kiel: Figure 12 to Figure 16, Table 2), at 0.5 m above the seafloor and at 0.5 m below the water surface.

4.2 Human pathogens assessment

In order to assess the presence of IMO D-2 indicator intestinal enterococci, *Escherichia coli* and *Vibrio cholera*, water sampling followed the guidance described in the EU Bathing Water Directive 2006/7/EC. One water sample (500 ml) each was taken from each harbor sites once in spring and once in summer in 2017. Four harbor sites were sampled in the Port of Hamburg (Table 1) and three sites were assessed in the Port of Kiel (Table 2). Water samples were taken from water depths of approx. 50 cm by means of a Ruttner water sampler. After sampling, the water samples were kept cool and transported to the Landesamt für Gesundheit und Soziales (LAGUS) M-V / Versorgungsamt within 24 h for analysis.

At the LAGUS laboratory, analysis of intestinal enterococci was conducted in accordance with DIN EN ISO 7899-1. *Escherichia coli* was identified according to DIN EN ISO 9308-3, while analysis of *Vibrio cholera* was not performed.

4.3 Plankton assessment

In order to assess phytoplankton and zooplankton species composition and abundance sampling of plankton was performed at all harbor sites once in spring and once in summer 2017, in conjunction with water sampling for human pathogens.

In the port of Hamburg, a total of 8 phytoplankton samples were collected each season: 4 preserved phytoplankton samples from a water sample, and 4 living phytoplankton samples from a plankton net sample. In addition a total of 8 zooplankton samples, 4 preserved zooplankton samples and 4 larger living zooplankton samples, were collected with a plankton net.

In the Port of Kiel, a total of 6 phytoplankton samples, 3 preserved phytoplankton from water samples, and 3 living phytoplankton samples from net samples were collected each season. Moreover, a total of 6 zooplankton samples, 3 preserved zooplankton samples, and 3 larger, living zooplankton samples from plankton net samples were obtained.

4.3.1 Phytoplankton

In order to assess phytoplankton species composition and abundance, one pooled phytoplankton water sample and one concentrated phytoplankton net sample each was collected at all harbor sites, following the HELCOM/OSPAR protocol.

To assess phytoplankton composition and abundances at the individual sites, one pooled water sample with a volume of 250 ml was obtained by collecting water samples from three locations that were located at least 15 m apart from each other (Hamburg: Figure 3 to Figure 9, Table 1; Kiel: Figure 12 to Figure 16, Table 2). At each location, one water sample (0.5 l) was taken at the water surface (1 m depth) and one water sample was taken at 5 m water depth (where feasible) by means of an industrial water sampler according to Ruttner (Figure 18, left).

For qualitative phytoplankton assessments a concentrated vertical samples was taken using a small, hand-held 20 µm plankton net, 250 mm wide and 500 mm deep (Figure 18, right). At each site, a total of three tows were taken (one tow each at the three individual locations) to ensure an adequate sample size. Haul and tow rates during sampling did not exceed 0.25 m/s – 0.30 m/s. Plankton net content was released into clear, colorless iodine-proof bottles with screw caps, preserved in Lugol acid solution (0.25 – 0.5 cm^3/ 100 cm^3 sample), and placed in a cooler for transportation to the IfAÖ laboratory for further analysis. At the laboratory, analysis of phytoplankton samples were conducted by F. Hoffman in accordance with the HELCOM/OSPAR protocol.

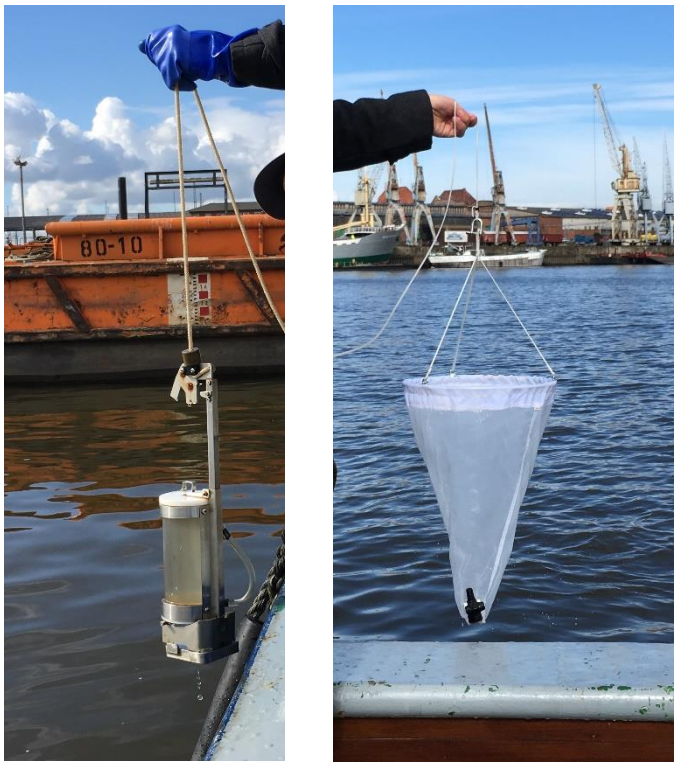

Figure 18: Water sampler according to Ruttner (*left*) and plankton net (*right*).

4.3.2 Zooplankton

To assess zooplankton species composition and abundances, vertical zooplankton samples were collected at each site with a standard 100 µm mesh drop net, 500 wide and 2 m deep.

Vertical “larger” zooplankton including gelatinous species was sampled using a standard 335 µm mesh drop net, 500 mm wide and 2 m deep. At all harbor sites, three tows were conducted with the 100 µm drop net and three tows were performed with the 335 µm drop net respectively (each with one tow at all locations). Location of net tows were at least 15 m apart to ensure an adequate sampling size. The net was stopped 1 m before the bottom, and net tow rate was adjusted to approximately 1 m/s. Net content was released into small storage containers and stored in a cooler. All samples were preserved either in 4 % formalin or 96 % ethanol solution, prior to transportation to the laboratory, as instructed by the analyzing laboratory AquaEcology.

Zooplankton samples were analyzed at the AquaEcology laboratory by Dr. T. Burgmer. Analyses of taxonomic composition and abundances were carried out using a stereo microscope (Olympus SZ40) that has an adjustable magnification factor from 6.7x to 40x. Zooplankton organisms were washed over a 50-µm net collection cup with filtered salt water (adjusted to the salinity of the water body) in order to remove the formalin and then transferred into a sorting solution (mixture of 5 % propane-diol and 0.2 % 1-phenoxy-2-propanol).

Analysis of zooplankton was performed according to the current HELCOM guideline for the monitoring of mesozooplankton (HELCOM 2017). In accordance with this method, sub-samples from the total samples were analyzed until 100 individuals of the three most abundant taxa (except nauplius larvae, Rotifera and Tintinnida) had been counted. This method is suitable for samples with rather small zooplankton organisms in higher abundances and with a fewer total number of taxa. If many taxa are present in almost equal numbers, or only one taxon is predominant, the analysis will become complex and possibly not meet the requirements. In these cases, the analysis of a sample may take up to several days. Since only small volumes will be taken as subsamples, this method cannot identify larger individuals in lower abundances in a statistically-sufficient way.

For that reason, the HELCOM method was combined with a sample preparation using a plankton sample divider. This allowed a stepwise analysis of the divided fractions (1:1). After washing the fixed sample, it was split in subsamples with a plankton sample divider. The maximum dilution level was 256. As a minimum, 500 individuals were recorded per sample. A total of 7 out of 8 samples from the Port of Hamburg met the HELCOM conditions – at least 100 individuals of the 3 most abundant taxa could be analyzed. Most of the categories referred to the various life stages of the calanoid copepod *Eurytemora affinis*. For the 6 samples from the Port of Kiel, the requirements of HELCOM could not be met, since the effort for achieving that goal would have been too high.

In order to achieve representative results for the most frequent taxa and taking into account the composition, sometimes significantly more than 500 individuals per sample were counted. For that reason, further split fractions were analyzed. In this process, taxa which had been counted in sufficient numbers at a higher split level were not further counted. For larger

organisms, at least one-eighth of the total sample was counted, but in most cases the sample was analyzed completely.

For the 335 µm fraction, the complete sample was analyzed. Smaller organisms such as Rotifera or nauplius larvae being abundant in very low numbers, had not been counted. In contrast, the larger individuals in the 100-µm fraction had always been completely recorded, either in the total sample or in large parts of the sample.

Whenever possible, analyses were carried out down to the species or genus level; alternatively, individuals had been assigned to a higher taxonomic level (see also chapter 5.1.3.2). Copepodid stages of the calanoid copepods were classified in two groups (I-III and IV-V), and with regard to the adults, male and female copepods were distinguished.

The nomenclature used in this report was synchronized with the Register of Marine Species database (WoRMS Editorial Board 2018, Status January, 2018).

4.4 Benthos assessment

4.4.1 Soft sediment

At each harbor site, three infauna samples were collected using an Ekman-Birge grab (Figure 19). All sampling locations were located at least 15 m apart.

At the port of Hamburg a total of 12 infauna samples (4 sites x 3 locations) were collected (Figure 3 to Figure 9, Table 1). In the Port of Kiel, 9 infauna samples (3 sites x 3 locations) were taken (Figure 12 to Figure 16, Table 2).

The infauna grab content was carefully rinsed over a sieve (with 1 mm mesh size) and the sieve content was transferred to sample jars. After sieving, the samples were preserved in 98 % ethanol solution until further processing at the laboratory.

In addition, the associated sediments characteristic of the infauna grabs were visually and olfactory inspected, and the sediment structure and color was recorded in a field protocol.

Infauna sampling was performed once in July 2017 in conjunction with assessment of hard substrates.

Figure 19: Ekman-Birge grab (*left* and *middle*) and sieve residue from a grab sample (*right*).

4.4.2 Hard substrates

4.4.2.1 Rapid Assessment Survey (RAS)

The standardized Rapid Assessment Survey (RAS) of macrozoobenthos and macrophytobenthos in the ports was conducted in accordance with the RAS sampling protocol as described by Gittenberger et al. (2010) and Buschbaum et al. (2012).

At each harbor site, predominant and accessible artificial hard substrates, such as pontoons, metal or wood pile moorings and wooden jetties were visually inspected for benthic organisms, and identified species were documented. Visual inspection at each site was conducted by four scientists over a period of approx. 4 hours once in July 2017.

Organisms in the water column, in particular near artificial structures that were heavily overgrown by epibenthic organisms, were sampled using a landing net with 1 mm mesh size.

When thorough inspections of all habitats and vegetation yielded no additional species for ca. 30 minutes, the survey was considered to be complete.

Smaller organisms or species, that were difficult to identify in the field were transferred into storage containers and preserved with a 98 % ethanol solution for further identification at the laboratory.

4.4.2.2 Scratch samples

Complementary to the visual inspection, scratch samples were taken from two different hard substrate types at each harbor site for species identification in the lab. Epibenthic growth was carefully scraped off the substrates by means of a scraper and organisms were collected in a netting bag attached to the scraper (Figure 20).

Net content was carefully rinsed over a sieve with 1 mm mesh size and transferred into a storage container. All rinsed samples were preserved in a 98 % ethanol solution until further analysis at the laboratory.

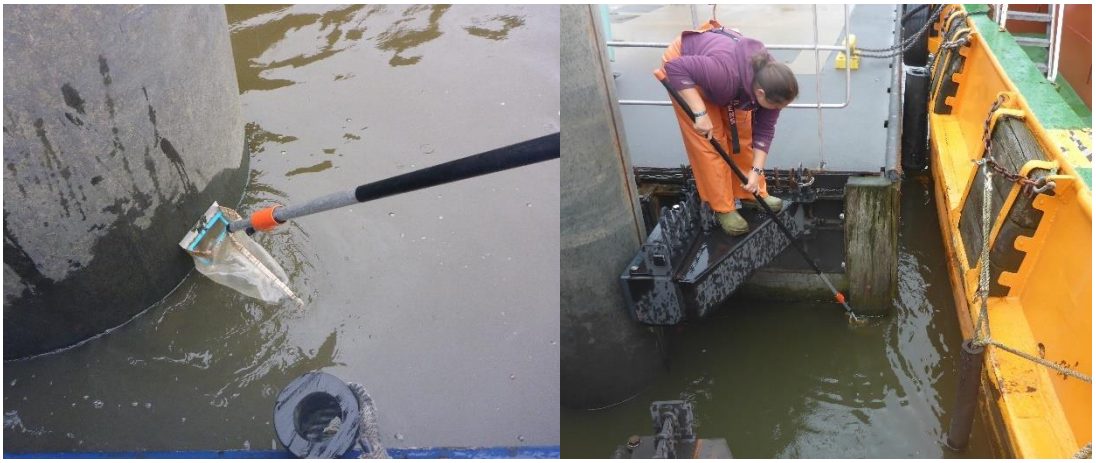

Figure 20: Scraper with fixed netting bag (*left*) and scratch sampling from a pontoon (*right*).

4.4.3 Settlement plates

As an extension of the RAS, one settlement collector, consisting of three settlement plates (sanded grey PVC plates, 15 cm x 15 cm) was deployed at each harbor site for a period of three months from July to October in 2017 (Hamburg: Figure 3 to Figure 9, Table 1; Kiel: Figure 12 to Figure 16, Table 2). Each settlement collector consisted of one plate that was installed 1 m below the water surface, a second plate that was placed 1 m above the bottom, and a third plate deployed in the middle between the surface and the bottom plate (Figure 21).

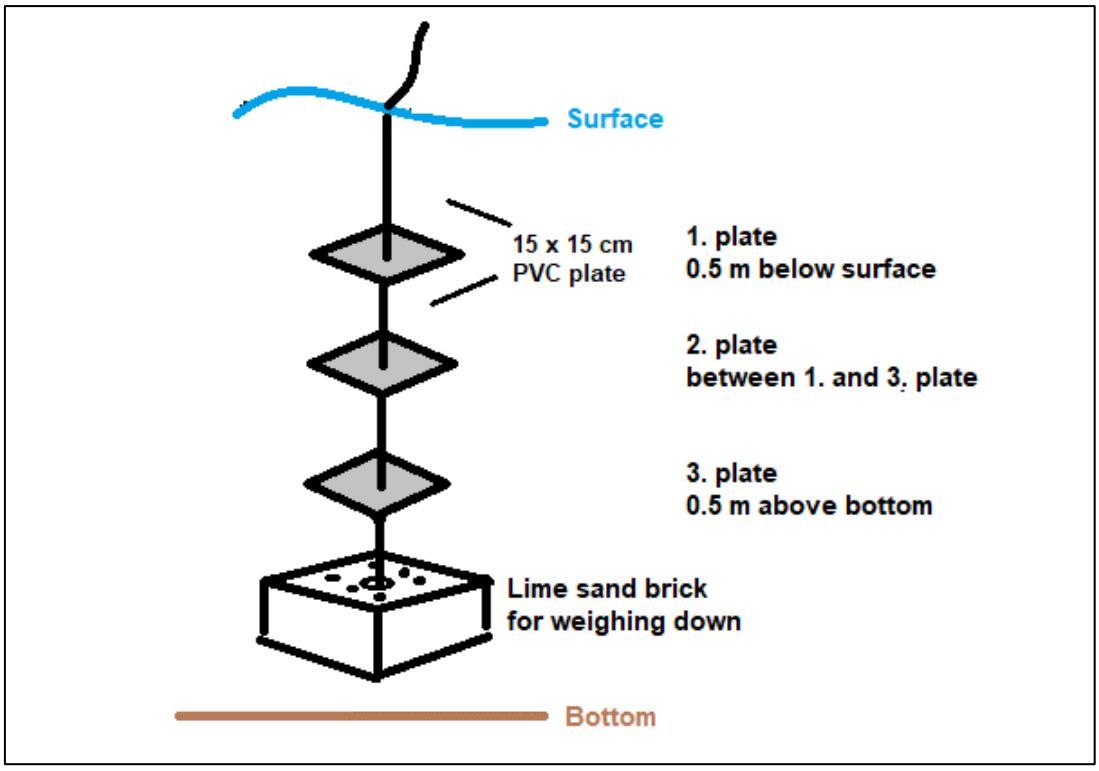

Figure 21: Settlement plate construction.

In the Port of Hamburg a total of 12 settlement plates (4 sites x 1 settlement collector x 3 plates) were deployed. In the Port of Kiel 9 plates (3 sites x 1 settlement collector x 3 plates) were installed.

Water depths of installed settlement plates in the water column differ from water depths as suggested in the HELCOM protocol. However, positions of settlement plates were adjusted to the comparably shallow harbor sites, and allow for comparisons of settlement plates between harbor sites of differing water depths.

When retrieving the plates, they were carefully separated from the connecting rope. Each plate was photographed and all pieces were placed in separated labeled 3 l plastic bags and placed in a cooler. Prior to transport, all plates and pieces were preserved in 70 % ethanol for species identification at the laboratory.

4.4.4 Mobile epifauna (traps)

4.4.4.1 Light weight traps (Chinese crab box trap and Gee's minnow trap)

Mobile epifauna, such as crabs and fish was sampled using two types of baited light weight traps, 1) the Fukui-designed Chinese crab box trap (CT) (63 cm x 42 cm x 20 cm, with 1.3 cm mesh netting (Figure 22, left) and 2) the Gee's minnow trap (GT) (42 cm x 23 c, with 6.4 mm netting and 2.5 cm mouth (Figure 22, right). Traps were baited using frozen fish, cat food and mussels, and tethered to harbor structures such as pilings and docks. To hold the trap in position, a brick attached to the trap served as a weight.

At each harbor site, a total of three traps of each trap type were deployed for up to 48 hours.

After retrieval, the content of traps was directly determined and species identified were listed in a field protocol.

Figure 22: Chinese crab box trap (*left*) and Gee's minnow trap (*right*).

4.4.4.2 Artificial habitat collectors (crab condo and oyster crate)

In addition to light weight traps, the effectiveness and suitability of two different artificial habitat collectors (crates) were tested at all port sites. The "crab condo" and the "oyster crate" have been developed in order to catch mobile epifauna, in particular smaller crustaceans, such as amphipods (Fowler et al. 2013, Hewitt & McDonald, 2013).

The oyster crates (OC) (40 cm x 30 cm x 32.5 cm plastic crate) were filled with dead, autoclaved oyster and mussel shells from the North Frisian Wadden Sea as well as with broken ceramic flowerpots (Figure 23, left). A netting covering the top of the plastic crate prevent the shell and flower pot debris from falling out of the crate during movements and inhibits mobile fauna from fleeing during retrieval.

The crab condos (CC) (25 cm x 15 cm x 15 cm) consisted of PVC tubes, 25 cm long and 5.0 cm in diameter arranged in a 3 x 3 square matrix (Figure 23, middle and right). To prevent specimens from falling out of the trap during retrieval, one end of the PVC matrix was covered by a fine, 1 mm mesh. Moreover, the entire trap was surrounded by a mesh cover (0.5 cm) to provide further habitat and settlement structure. The trap was weighted down with a 2.5 kg dive weight attached to one of the sides to ensure that the condo is deployed horizontally at the targeted harbor locations.

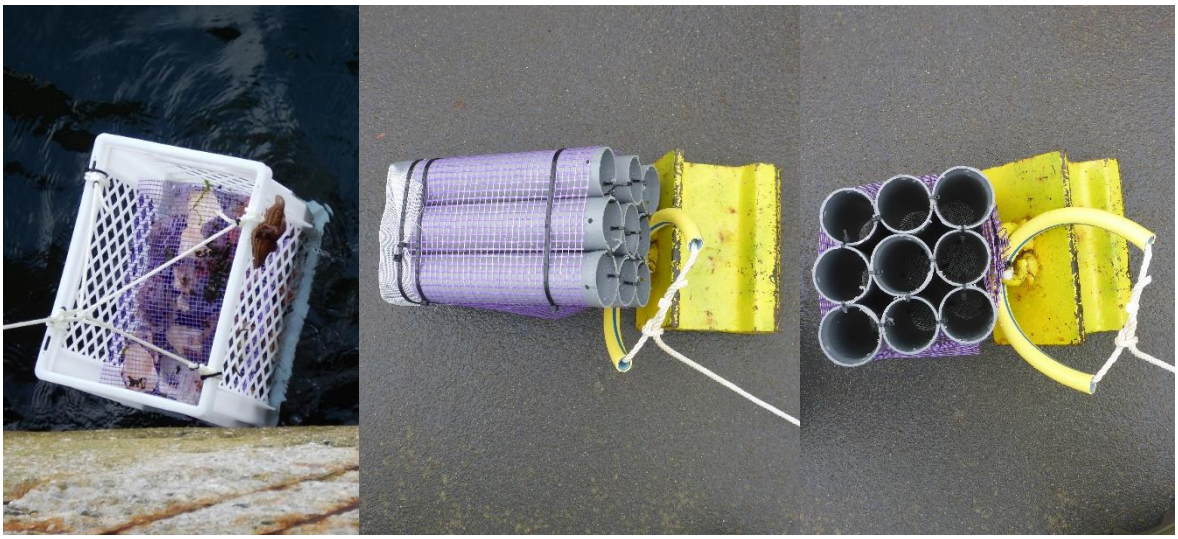

Figure 23: Oyster crate (*left*) and crab condo (*middle* and *right*).

At each harbor site one crab condo and one oyster crate were deployed for ca. three months from July to October 2017 (4 crab condos and 4 oyster crates at the Port of Hamburg, and 3 crab condos and 3 oyster crates at the Port of Kiel).

The traps were randomly attached to the existing harbor structures, such as piles, steel pilings and floating pontoons.

Upon retrieval, all specimens on or inside the habitat collectors were carefully rinsed and collected above a sieve with 1 mm mesh size. Sieve contents were transferred into storage container, and specimens were preserved in 40 % alcohol for identification at the IfAÖ laboratory. In consideration of the high abundances of smaller crustaceans, particularly found in oyster crates, species identification was conducted at the laboratory in order to allow for a precise identification.

4.4.5 Sample processing and analysis

All macrozoobenthos samples were processed at the IFAÖ laboratory. After rinsing and sieving the sample over a sieve (mesh size = 500 µm) with tap water, samples were sorted beneath a stereomicroscope at a magnification of approx. 7x. Species were identified based on available standard literature, current taxonomy publications and conventions as well as unpublished information developed and exchanged at domestic and international workshops. Organisms were determined down to species level, wherever the diagnostic characteristics of individuals have been sufficiently developed.

Proof examples of each taxa were preserved in 70 % ethanol solution and stored in the IfAÖ specimen collection.

4.5 Species accumulation curves

For each group of organisms (phytoplankton, zooplankton and benthos) cumulative curves were calculated with the aim of evaluating whether the number of samples taken represents the species present in the ports investigated. Six models were selected to calculate the accumulation curves based on the respective sampling datasets (Table 3). Accumulation curves were calculated using the Primer 6.0 program. The models for Chao2 and Jacknife 1 and 2 may provide an over-estimation of the number of species, because the analysis includes and corrects for the presence of a relatively high number of rare species. The models for Bootstrap, Michaelis-Menton (MM) and according to Ugland, Gray and Ellingsen (UGE) may provide an under-estimation of the number of species, since the models assume that species abundances within particular communities present are rather equal, in particular when sample numbers are low.

Table 3: Overview of the six models used for the calculation of the accumulation curves.

Model	Note
Chao2	Based on the number of rare species, uses presence/absence data
Jacknife 1	Based on species that only occur in one sample
Jacknife 2	Second order jackknife estimator
Bootstrap	Based on proportion of quadrats containing each species
Michaelis-Menton (MM)	Curve fitted to observe S curve
UGE	Calculated species accumulation curve according to Ugland, Gray & Ellingsen (2003)

5 Results

5.1 Port of Hamburg

Overall, 179 different species were found in the port of Hamburg in 2017. Of these, 16 NIS (equivalent to 9 %) were identified, all of which belonged to the kingdom of Animalia (Figure 24, Figure 25).

Most species (127) and NIS (13) were identified at the “Alte Süderelbe” harbor site. The fewest number of species was found at the “Petroleumhafen” with 79 native species and seven NIS (Figure 26).

Most of the NIS found in the Port of Hamburg belong to the Crustacea and Mollusca (Table 4, Figure 25). NIS belonging to Oligochaeta and Polychaeta were only identified at “Alte Süderelbe” and at “Hansahafen”.

Four non-indigenous Crustacea species as well as the hydroid *Cordylophora caspia* and the bivalve *Dreissena polymorpha* were found at all four investigated harbor sites. Six NIS were identified only at one site (Table 5). Three of these species occurred only at the “Alte Süderelbe” harbor site.

One NIS (*Dreissena polymorpha*) was found within the zooplankton samples. This bivalve species was also found with all benthos sampling methods. All other NIS found in the Port of Hamburg are benthic species (Figure 27). Three species were found with only one of the sampling methods. None of the NIS were identified with all sampling methods (Table 6). However, four species were detected with all four benthos sampling methods (Table 30).

A list of all Taxa and numbers of species per harbor site and sampling method can be found in the Appendix (Table 29 and Table 30).

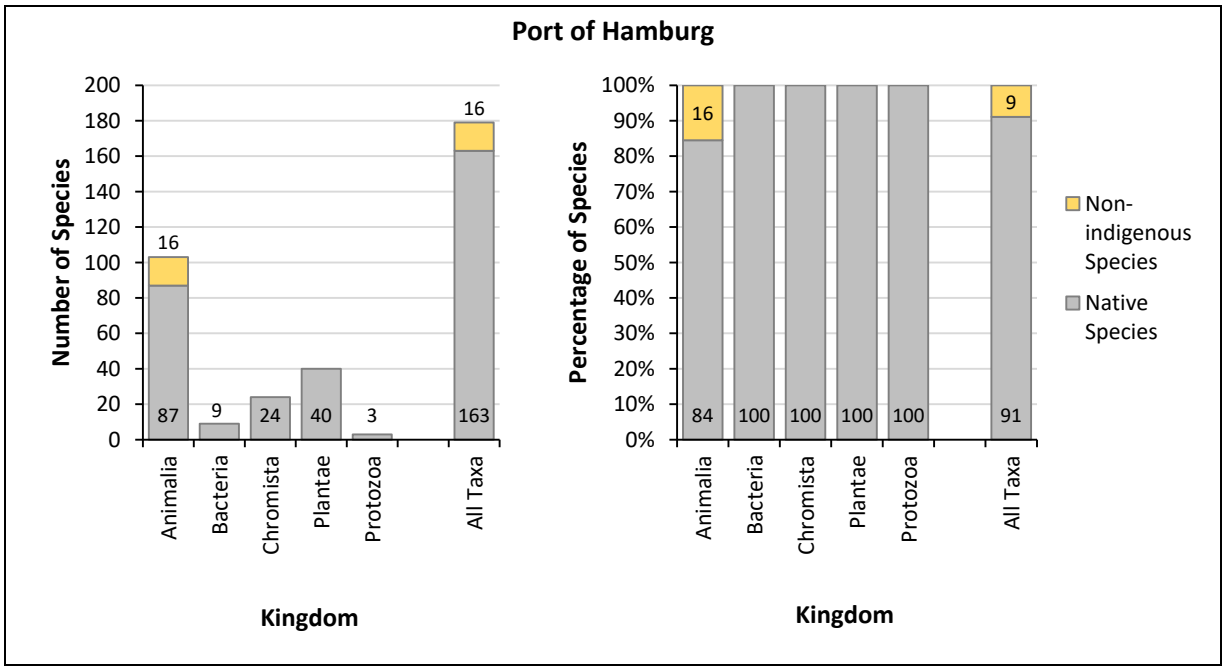

Figure 24: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) of different kingdoms as well as total numbers in the Port of Hamburg in 2017.

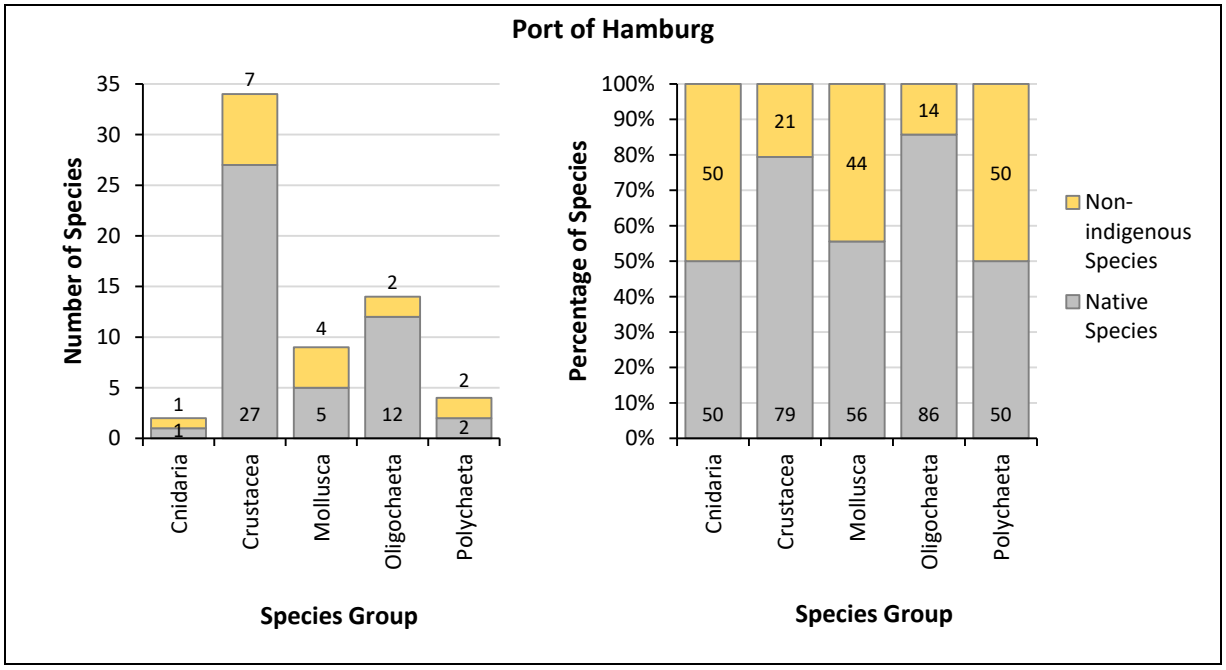

Figure 25: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) of different species groups in the Port of Hamburg in 2017.

Table 4: List of non-indigenous taxa, number of species and percentage of NIS at individual harbor sites in the Port of Hamburg in 2017.

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Animalia				
Cnidaria				
Cordylophora caspia	●	●	●	●
Crustacea				
Chelicorophium curvispinum	●	●	●	●
Chelicorophium robustum	●	●	●	●
Dikerogammarus sp.			●	
Dikerogammarus haemobaphes			●	
Dikerogammarus villosus		●	●	
Eriocheir sinensis	●	●	●	●
Gammarus tigrinus	●	●	●	●
Obesogammarus crassus	●			
Mollusca				
Corbicula fluminea			●	●
Dreissena sp.	●	●	●	●
Dreissena bugensis		●	●	●
Dreissena polymorpha	●	●	●	●
Potamopyrgus antipodarum			●	
Oligochaeta				
Potamothrix sp.			●	
Potamothrix hammoniensis				●
Potamothrix moldaviensis			●	●

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Polychaeta				
Laonome sp. nov.				●
Marenzelleria neglecta			●	
Number of Cnidaria species	1	2	2	2
Number of NIS Cnidaria	**1**	**1**	**1**	**1**
Ratio of NIS Cnidaria/Cnidaria [%]	100	50	50	50
Number of Crustacea species	23	24	25	24
Number of NIS Crustacea	**5**	**5**	**6**	**4**
Ratio of NIS Crustacea/Crustacea [%]	22	21	24	17
Number of Mollusca species	1	3	6	5
Number of NIS Mollusca	**1**	**2**	**4**	**3**
Ratio of NIS Mollusca/Mollusca [%]	100	67	67	60
Number of Oligochaeta species	3	9	11	8
Number of NIS Oligochaeta	**0**	**0**	**1**	**2**
Ratio of NIS Oligochaeta/Oligochaeta [%]	0	0	9	25
Number of Polychaeta species	1	1	2	2
Number of NIS Polychaeta	**0**	**0**	**1**	**1**
Ratio of NIS Polychaeta/Polychaeta [%]	0	0	50	50
Total number of species	86	104	127	111
Total number of NIS	**7**	**8**	**13**	**11**
Ratio of all NIS/All species [%]	8	8	10	10

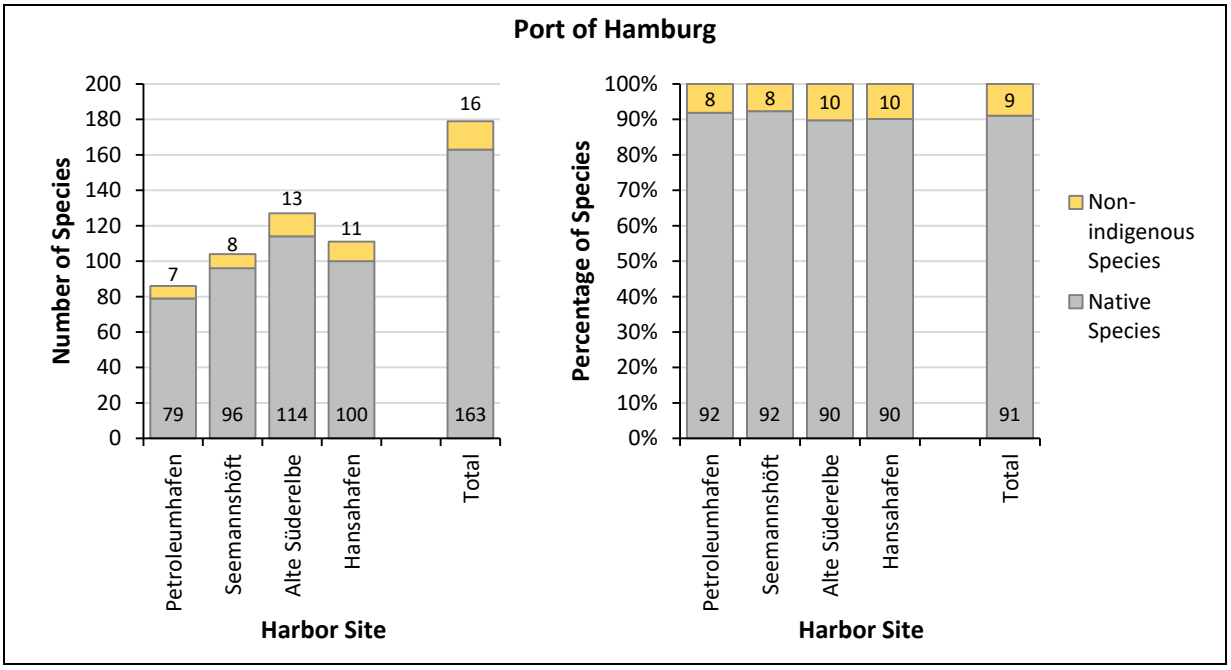

Figure 26: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) at individual harbor sites as well as total numbers in the Port of Hamburg in 2017.

Table 5: Number of NIS in common at individual harbor sites in the Port of Hamburg in 2017 as well as number of NIS at all sites and at only one site.
Bold: Number of NIS per harbor site.

	Petroleumhafen	**Seemannshöft**	**Alte Süderelbe**	**Hansahafen**
Petroleumhafen	**7**	6	6	6
Seemannshöft		**8**	8	7
Alte Süderelbe			**13**	9
Hansahafen				**11**
NIS at all sites	6			
NIS at one site	1	0	3	2

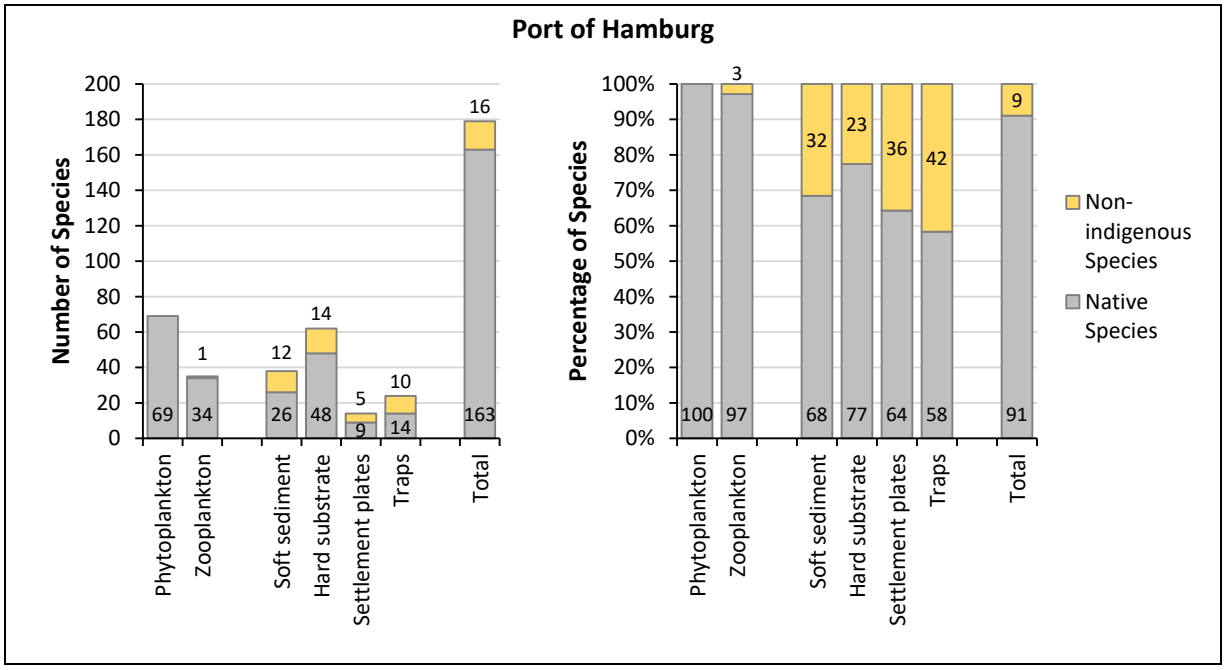

Figure 27: Number of native and non-indigenous species (NIS) found with the different sampling methods as well as total numbers in the Port of Hamburg in 2017.

Table 6: Number of NIS in common found with different sampling methods at all harbor sites in the Port of Hamburg in 2017 as well as number of NIS found with all sampling methods and found with only one sampling method.
Bold: Number of NIS per sampling method.

	PP	ZP	SS	HS	SP	TR
Phytoplankton (PP)	**0**	0	0	0	0	0
Zooplankton (ZP)		**1**	1	1	1	1
Soft sediment (SS)			**12**	11	4	7
Hard substrate (HS)				**14**	5	9
Settlement plates (SP)					**5**	5
Traps (TR)						**10**
NIS with all methods	0					
NIS with one method	0	0	1	1	0	1

5.1.1 Hydrological parameters

Hydrological parameters were measured at all four harbor sites in the Port of Hamburg in spring and summer 2017 (Table 7 and Table 8).

The Secchi-depth was at all times and at all measured stations below 1.0 m and salinity was always below 1 PSU.

During spring 2017 water temperature varied mostly between 9 and 11 °C. Only the surface water temperature at the “Alte Süderelbe” harbor site was significantly higher (15.3 °C, HH_C_1). In summer the temperature varied between 20 C° and 22 °C at all four sites.

Oxygen concentrations varied between 8.12 mg/l and 11.91 mg/l in spring and between 5.61 mg/l and 9.35 mg/l in summer. At the “Petroleumhafen” harbor site oxygen saturation was always lower than 80 %. At “Seemannshöft” and “Hansahafen” oxygen saturation was below 80 % during summer 2017. Only at the “Alte Süderelbe” was oxygen saturation always higher than 95 %.

The water column was mostly well mixed and there were no major differences between bottom and surface waters. The only exception was documented at the “Alte Süderelbe”, in particular at HH_C_1.

Table 7: Hydrological parameters at the four harbor sites in the Port of Hamburg in spring 2017.

	Petroleumhafen 27.04.2017			**Seemannshöft 27.04.2017**			**Alte Süderelbe 27.04.2017**			**Hansahafen 27.04.2017**		
	HH_A_1	**HH_A_2**	**HH_A_3**	**HH_B_1**	**HH_B_2**	**HH_B_3**	**HH_C_1**	**HH_C_2**	**HH_C_3**	**HH_D_1**	**HH_D_2**	**HH_D_3**
Water Depth [m]	2.5	2.5	8.5	5.5	3.0	6.5	8.0	12.5	6.0	6.4	11.0	7.0
Secchi-depth [m]	0.4	0.5	0.6	0.6	0.8	0.8	0.4	0.5	0.6	0.6	0.6	0.6
Surface-Salinity [PSU]	0.43	0.43	0.42	0.42	0.42	0.42	0.45	0.41	0.42	0.44	0.43	0.43
Bottom-Salinity [PSU]	0.43	0.43	0.43	0.43	0.43	0.42	0.43	0.42	0.42	0.43	0.43	0.44
Surface-Temperature [C°]	10.2	10.4	10.8	10.0	10.2	10.3	15.3	12.5	10.8	9.5	10.5	9.9
Bottom-Temperatur [C°]	10.3	10.5	10.4	10.3	10.3	10.3	11.9	11.1	10.4	9.8	10.0	9.8
Surface-Oxygen [mg/l]	8.77	8.55	8.12	9.25	9.21	9.07	10.69	11.30	11.74	9.25	8.76	9.31
Bottom-Oxygen [mg/l]	8.66	8.53	8.16	9.38	9.72	9.00	10.92	11.61	11.91	9.43	9.09	9.16
Surface-Oxygen [%]	78.1	76.5	73.7	81.9	82.0	80.9	107.4	105.1	106.6	80.9	78.9	82.5
Bottom-Oxygen [%]	77.3	76.6	73.3	83.7	86.9	80.4	101.7	105.7	106.4	82.9	80.5	80.9

Table 8: Hydrological parameters at the four harbor sites in the Port of Hamburg in summer 2017.

	Petroleumhafen 10.07.2017			Seemannshöft 10.07.2017			Alte Süderelbe 10.07.2017			Hansahafen 11.07.2017		
	HH_A_1	HH_A_2	HH_A_3	HH_B_1	HH_B_2	HH_B_3	HH_C_1	HH_C_2	HH_C_3	HH_D_1	HH_D_2	HH_D_3
Water Depth [m]	2.9	1.7	7.5	7.0	6.6	2.0	14.0	8.0	8.0	6.5	9.6	8.6
Secchi-depth [m]	0.4	0.5	0.4	0.4	0.5	0.6	0.5	0.5	0.4	0.4	0.4	0.4
Surface-Salinity [PSU]	0.50	0.50	0.51	0.49	0.49	0.50	0.46	0.46	0.47	0.48	0.48	0.49
Bottom-Salinity [PSU]	0.50	0.51	0.51	0.49	0.49	0.50	0.46	0.48	0.47	0.49	0.49	0.49
Surface-Temperature [C°]	21.1	21.2	20.9	21.4	21.3	20.9	21.7	22.0	21.5	21.3	21.0	21.4
Bottom-Temperatur [C°]	21.1	20.9	20.2	21.3	21.5	20.8	21.0	21.3	21.3	20.9	20.1	21.4
Surface-Oxygen [mg/l]	6.28	6.34	5.90	6.57	6.58	5.76	9.35	8.70	8.53	5.69	5.68	5.71
Bottom-Oxygen [mg/l]	6.37	5.67	5.84	6.50	6.46	5.76	9.26	8.60	8.84	5.71	5.74	5.61
Surface-Oxygen [%]	70.9	71.6	66.4	74.3	74.7	64.8	106.8	99.8	97.0	64.5	64.5	64.9
Bottom-Oxygen [%]	71.8	63.7	65.3	73.7	73.4	64.7	104.3	98.2	100.2	64.3	64.7	63.7

5.1.2 Human Pathogens

In accordance with the D-2 Ballast Water Performance Standard of the “Ballast water management convention” (IMO, February, 2014) less than 250 colony forming unit (cfu) per 100 ml of *Escherichia coli* and less than 100 cfu per 100 ml intestinal Enterococci should be found in ballast water.

No recorded value, neither for intestinal Enterococci nor for *E. coli* exceeded the threshold values in the Port of Hamburg in spring and summer 2017.

Table 9: Human pathogens at four harbor sites in the Port of Hamburg in spring and summer 2017.

Harbor site	Enterococci cfu/100 ml	*E. coli* cfu/100 ml
Spring 2017		
Petroleumhafen	< 10	76
Seemannshöft	10	158
Alte Süderelbe	< 10	21
Hansahafen	< 10	< 10
Summer 2017		
Petroleumhafen	< 10	< 10
Seemannshöft	< 10	21
Alte Süderelbe	< 10	< 10
Hansahafen	< 10	10

5.1.3 Plankton

5.1.3.1 Phytoplankton

At each of the four harbor sites, phytoplankton samples were taken both in spring and summer (eight samples). Overall, 69 different species were identified. Nearly all phytoplankton species were found exclusively with this monitoring method (Table 30). However, none of these were classified as non-indigenous species (Table 31). The species accumulation curves did not become asymptotic after eight analyzed samples (Figure 28). This indicates that additional samples could have resulted in the detection of additional species.

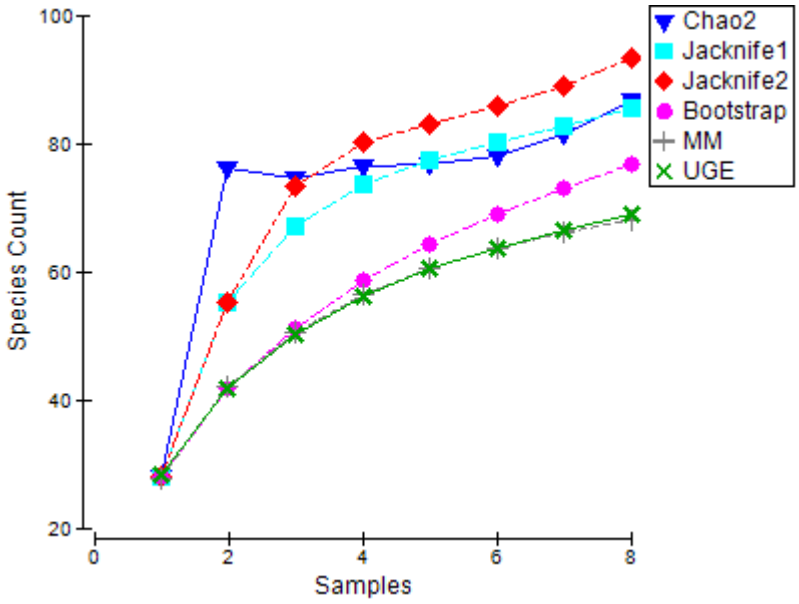

Figure 28: Species accumulation curves based on eight phytoplankton samples in the Port of Hamburg in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.1.3.2 Zooplankton

At each of the four harbor sites, zooplankton samples were taken both in spring and summer (eight samples). Overall, 35 different species were identified, which all belonged to the kingdom of Animalia. Rotifera species were solely found in zooplankton samples. Only the bivalve *Dreissena polymorpha* is described as non-indigenous species and was found at all four investigated harbor sites in the zooplankton samples (Veliger larva) in summer 2017 (Table 32). The species accumulation curves did not become asymptotic after eight analyzed samples (Figure 29). This indicates that additional samples could have resulted in the detection of additional species.

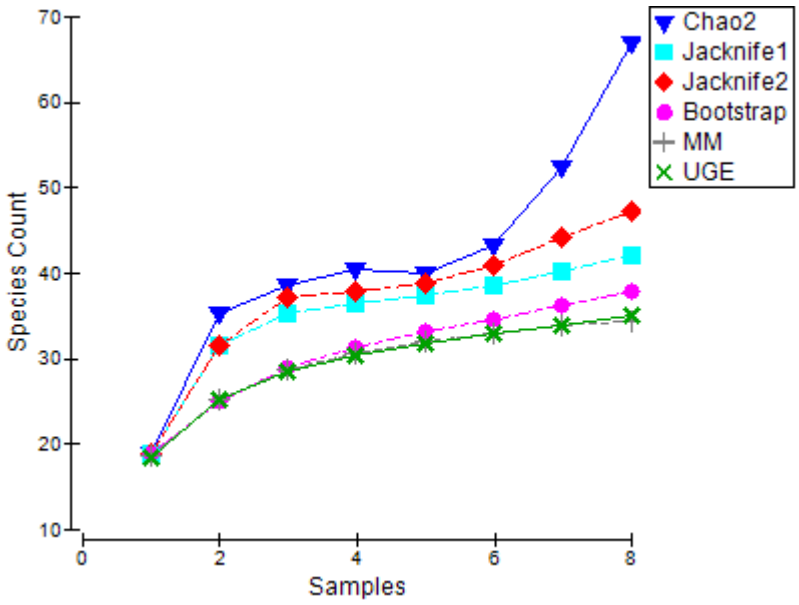

Figure 29: Species accumulation curves based on eight zooplankton samples in the Port of Hamburg in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.1.4 Benthos

Overall, 64 macrozoobenthos samples were taken at all four harbor sites via grab sampling, scratch sampling, Rapid Assessment, settlement plates and traps. A total of 84 different species were identified, of which 16 are classified as NIS (Table 30). Mostly, the species accumulation curves did not become asymptotic after all analyzed samples (Figure 30). This indicates that additional samples could have resulted in the detection of additional species.

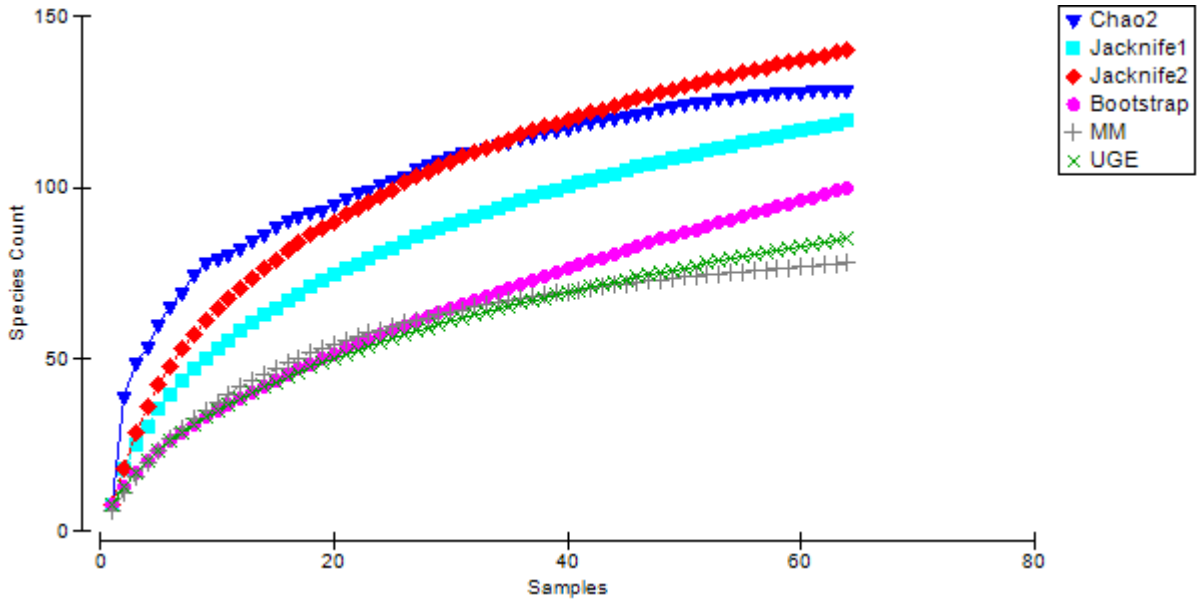

Figure 30: Species accumulation curves based on 64 macrozoobenthos samples (soft bottom samples, scratch samples, RA (visual samples), settlement plates and traps) at the four harbor sites in the Port of Hamburg in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.1.4.1 Soft sediment

The sediments in the Port of Hamburg consisted mainly of muddy sediments (Table 11). Only at the “Alte Süderelbe” harbor site was sandy sediment found.

Within soft bottom samples, 38 taxa were found at the four harbor sites, which all belong to the kingdom of Animalia. Twelve species, mostly crustaceans and molluscans, are classified as NIS. By far most species and NIS were found at the “Alte Süderelbe” harbor site (Table 10). At “Petroleumhafen” only the Oligochaeta-species *Limnodrilus hoffmeisteri* was found in the grab samples.

Table 10: List of all taxa, number of species and percentage of NIS found in soft bottom samples at individual harbor sites in the Port of Hamburg in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Animalia				
Cnidaria				
Cordylophora caspia			●	
Hydra sp.			●	
Collembola				
Collembola indet.				●
Crustacea				
Aoridae gen. sp.		●		
Chelicorophium robustum			●	
Dikerogammarus haemobaphes			●	
Eriocheir sinensis			●	
Gammarus tigrinus			●	●
Jaera (Jaera) albifrons agg.			●	
Insecta				
Chironomus sp.			●	
Chironomus (Microchironomus) sp.				●
Chironomus plumosus-Gruppe			●	
Chironomus riparius-Gruppe			●	
Cladotanytarsus sp.			●	
Dicrotendipes sp.			●	
Nanocladius sp.			●	
Polypedilum (Polypedilum) nubeculosum			●	
Procladius sp.			●	
Tanypus punctipennis			●	●
Tanytarsus sp.			●	
Mollusca				
Corbicula fluminea			●	●
Dreissena bugensis			●	
Dreissena polymorpha			●	
Pisidium sp.			●	
Pisidium casertanum			●	

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Pisidium henslowanum			●	
Potamopyrgus antipodarum			●	
Oligochaeta				
Enchytraeidae gen. sp.			●	
Limnodrilus claparedianus		●	●	●
Limnodrilus hoffmeisteri	●		●	●
Naididae gen. sp.			●	●
Nais bretscheri			●	
Nais elinguis			●	
Potamothrix sp.			●	
Potamothrix moldaviensis			●	●
Psammoryctides albicola			●	
Psammoryctides barbatus			●	●
Quistadrilus multisetosus			●	
Stylaria lacustris			●	
Tubificinae gen. sp.		●	●	●
Polychaeta				
Hypania invalida		●	●	●
Laonome sp. nov.				●
Marenzelleria neglecta			●	
Number of Animalia species	1	3	34	11
Number of NIS Animalia	**0**	**0**	**11**	**4**
Ratio of NIS Animalia/Animalia [%]	0	0	32	36
Number of Bacteria species	0	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0
Number of Chromista species	0	0	0	0
Number of NIS Chromista	**0**	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	0
Number of Plantae species	0	0	0	0
Number of NIS Plantae	**0**	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0	0	0
Number of Protozoa species	0	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0
Total number of species	**1**	**3**	**34**	**11**
Total number of NIS	**0**	**0**	**11**	**4**
Ratio of all NIS/All species [%]	**0**	**0**	**32**	**36**

Table 11: Sediment description of the grab samples in the Port of Hamburg in 2017.

Station	Sediment description
Petroleumhafen	
HH_A_1	muddy sediment, shell of *Dreissena* sp.
HH_A_2	muddy sediment
HH_A_3	muddy sediment
Seemannshöft	
HH_B_1	muddy clay
HH_B_2	muddy clay
HH_B_3	muddy clay
Alte Süderelbe	
HH_C_1	muddy fine sand, shell of *Dreissena* sp.
HH_C_2	sandy sediment, shell of *Corbicula* sp.
HH_C_3	sandy sediment, shell of *Dreissena* sp.
Hansahafen	
HH_D_1	muddy sediment
HH_D_2	muddy sediment
HH_D_3	muddy sediment with parts of fine sand

5.1.4.2 Hard substrates

At the four harbor sites in the Port of Hamburg different hard substrates were investigated via scratch samples and Rapid Assessment (visual observations). Overall 62 species were found. Most species belong to the kingdom of Animalia. However, two Chromista-species and six Plantae-species were also found (Table 12). A total of 4 species (all Animalia) are classified as NIS, of which half are crustacean species. Most species and NIS were found at the “Alte Süderelbe” harbor site and the fewest at “Petroleumhafen”.
Scratch sample results showed, that most species and NIS were found on the pontoon (Figure 31, Table 13).

Table 12: List of all taxa, number of species and percentage of NIS found in scratch samples and with Rapid Assessment (visual observations) at individual harbor sites in the Port of Hamburg in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Animalia				
Bryozoa				
Plumatella repens				●
Chelicerata				
Acari indet.	●			
Cnidaria				
Cordylophora caspia	●	●	●	●
Hydra sp.		●	●	●
Crustacea				
Chelicorophium curvispinum		●	●	●
Chelicorophium robustum	●	●	●	●
Copepoda indet.			●	
Corophium multisetosum	●			
Dikerogammarus sp.			●	
Dikerogammarus haemobaphes			●	
Dikerogammarus villosus		●	●	
Eriocheir sinensis		●	●	●
Gammarus tigrinus	●	●	●	●
Gammarus zaddachi	●			
Obesogammarus crassus	●			
Ostracoda indet.				●
Hirudinea				
Erpobdella octoculata			●	
Erpobdella vilnensis			●	
Piscicolidae gen. sp.			●	
Insecta				
Chironomini gen. sp.			●	●
Chironomus (Lobochironomus) sp.			●	
Cladotanytarsus sp.			●	
Cricotopus (Cricotopus) sp.		●	●	

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Cricotopus (Isocladius) sp.			●	
Cricotopus (Isocladius) intersectus-Gruppe		●	●	●
Dicrotendipes sp.	●		●	
Dolichopodidae gen. sp.				●
Glyptotendipes pallens/glaucus		●		
Limnophyes sp.	●	●	●	
Limoniidae gen. sp.		●		
Nanocladius sp.		●	●	●
Paratanytarsus sp.			●	
Psectrocladius sordidellus/limbatellus	●			
Tanytarsus sp.			●	
Thalassosmittia thalassophila	●			
Tipulidae gen. sp.	●			
Mollusca				
Corbicula fluminea			●	●
Dreissena sp.		●	●	
Dreissena bugensis		●	●	●
Dreissena polymorpha		●	●	●
Potamopyrgus antipodarum			●	
Nematoda				
Nematoda indet.	●		●	●
Oligochaeta				
Chaetogaster sp.		●	●	●
Enchytraeidae gen. sp.	●	●		
Limnodrilus claparedianus			●	●
Limnodrilus hoffmeisteri		●	●	●
Naidinae gen. sp.		●	●	
Nais sp.		●	●	
Nais bretscheri		●	●	
Nais elinguis		●	●	
Nais stolci		●		
Paranais litoralis	●	●		
Potamothrix moldaviensis				●
Psammoryctides albicola				●
Psammoryctides barbatus			●	●
Stylaria lacustris		●	●	●
Tubificinae gen. sp.		●	●	●
Polychaeta				
Hypania invalida			●	
Laonome sp. nov.				●
Protodorvillea kefersteini	●			
Porifera				
Porifera indet.				●
Chromista				
Bacillariophyceae				

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Melosira sp.		●		
Schlauchdiatomeen indet.	●	●		
Tabellaria sp.		●		
Plantae				
Charophyta				
Spirogyra sp.				●
Chlorophyta				
Chlorophyta indet.	●	●	●	
Cladophora sp.		●		
Cladophora glomerata		●	●	●
Stigeoclonium sp.		●		
Ulva sp.			●	
Rhodophyta				
Audouinella sp.		●		
Bangia atropurpurea		●		
Number of Animalia species	16	23	34	25
Number of NIS Animalia	**4**	**8**	**11**	**10**
Ratio of NIS Animalia/Animalia [%]	25	35	32	40
Number of Bacteria species	0	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0
Number of Chromista species	1	2	0	0
Number of NIS Chromista	**0**	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	0
Number of Plantae species	1	4	2	2
Number of NIS Plantae	**0**	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0	0	0
Number of Protozoa species	0	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0
Total number of species	**18**	**29**	**36**	**27**
Total number of NIS	**4**	**8**	**11**	**10**
Ratio of all NIS/All species [%]	**22**	**28**	**31**	**37**

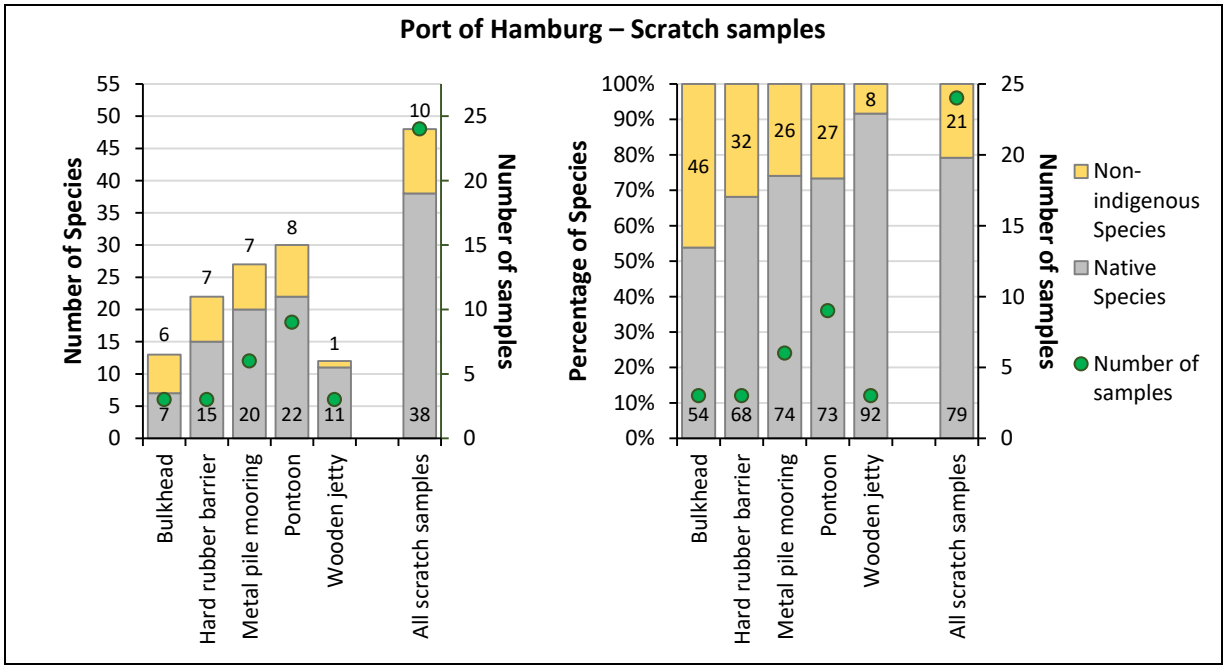

Figure 31: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) as well as total numbers within different kinds of habitats sampled via scratch sampling in the Port of Hamburg in 2017.

Table 13: List of all taxa, number of species and percentage of NIS found within scratch samples from different kinds of habitats in the Port of Hamburg in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Bulkhead	Hard rubber barrier	Metal pile mooring	Pontoon	Wooden jetty
Animalia					
Bryozoa					
Plumatella repens	●			●	
Chelicerata					
Acari indet.			●		
Cnidaria					
Cordylophora caspia	●	●	●	●	●
Hydra sp.	●	●	●	●	
Crustacea					
Chelicorophium curvispinum		●		●	
Chelicorophium robustum	●	●	●	●	
Copepoda indet.		●			
Corophium multisetosum			●		●
Dikerogammarus sp.		●		●	
Dikerogammarus haemobaphes		●			
Dikerogammarus villosus			●	●	
Eriocheir sinensis	●	●	●	●	
Gammarus tigrinus	●	●	●	●	
Gammarus zaddachi					●

Taxon	Bulkhead	Hard rubber barrier	Metal pile mooring	Pontoon	Wooden jetty
Obesogammarus crassus			●		
Ostracoda indet.				●	
Insecta					
Chironomini gen. sp.	●	●		●	
Cricotopus (Cricotopus) sp.		●	●	●	
Cricotopus (Isocladius) sp.				●	
Cricotopus (Isocladius) intersectus-Gruppe		●		●	
Dicrotendipes sp.		●	●	●	
Dolichopodidae gen. sp.				●	
Glyptotendipes pallens/glaucus				●	
Limnophyes sp.		●	●		●
Limoniidae gen. sp.			●		
Nanocladius sp.	●	●	●	●	
Paratanytarsus sp.		●			
Psectrocladius sordidellus/limbatellus					●
Tanytarsus sp.				●	
Thalassosmittia thalassophila			●		●
Tipulidae gen. sp.			●		●
Mollusca					
Dreissena sp.		●	●	●	
Dreissena bugensis	●	●		●	
Dreissena polymorpha	●		●	●	
Nematoda					
Nematoda indet.	●	●			●
Oligochaeta					
Chaetogaster sp.		●		●	
Enchytraeidae gen. sp.			●	●	●
Naidinae gen. sp.		●		●	
Nais sp.			●	●	
Nais bretscheri		●	●	●	
Nais elinguis		●	●	●	
Nais stolci			●		
Paranais litoralis			●		●
Stylaria lacustris	●	●	●	●	
Polychaeta					
Protodorvillea kefersteini			●		
Porifera					
Porifera indet.	●			●	
Chromista					
Bacillariophyceae					
Melosira sp.				●	
Schlauchdiatomeen indet.				●	●
Tabellaria sp.				●	

Taxon	Bulkhead	Hard rubber barrier	Metal pile mooring	Pontoon	Wooden jetty
Plantae					
Charophyta					
Spirogyra sp.				●	
Chlorophyta					
Chlorophyta indet.		●	●	●	●
Cladophora sp.			●		
Cladophora glomerata		●	●	●	
Stigeoclonium sp.				●	
Ulva sp.		●			
Rhodophyta					
Audouinella sp.			●	●	
Bangia atropurpurea			●		
Number of Bryozoa species	1	0	0	1	0
Number of NIS Bryozoa	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Bryozoa/Bryozoa [%]	0	0	0	0	0
Number of Chelicerata species	0	0	1	0	0
Number of NIS Chelicerata	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Chelicerata/Chelicerata [%]	0	0	0	0	0
Number of Cnidaria species	2	2	2	2	1
Number of NIS Cnidaria	**1**	**1**	**1**	**1**	**1**
Ratio of NIS Cnidaria/Cnidaria [%]	50	50	50	50	100
Number of Crustacea species	3	6	6	6	2
Number of NIS Crustacea	**3**	**5**	**5**	**5**	**0**
Ratio of NIS Crustacea/Crustacea [%]	100	83	83	83	0
Number of Insecta species	2	6	7	7	4
Number of NIS Insecta	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Insecta/Insecta [%]	0	0	0	0	0
Number of Mollusca species	2	1	1	2	0
Number of NIS Mollusca	**2**	**1**	**1**	**2**	**0**
Ratio of NIS Mollusca/Mollusca [%]	100	100	100	100	0
Number of Nematoda species	1	1	0	0	1
Number of NIS Nematoda	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Nematoda/Nematoda [%]	0	0	0	0	0
Number of Oligochaeta species	1	4	6	5	2
Number of NIS Oligochaeta	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Oligochaeta/Oligochaeta [%]	0	0	0	0	0
Number of Polychaeta species	0	0	1	0	0

Taxon	Bulkhead	Hard rubber barrier	Metal pile mooring	Pontoon	Wooden jetty
Number of NIS Polychaeta	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Polychaeta/Polychaeta [%]	0	0	0	0	0
Number of Porifera species	1	0	0	1	0
Number of NIS Porifera	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Porifera/Porifera [%]	0	0	0	0	0
Number of Chromista species	0	0	0	2	1
Number of NIS Chromista	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	0	0
Number of Plantae species	0	2	3	4	1
Number of NIS Plantae	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0	0	0	0
Total number of species	13	22	27	30	12
Total number of NIS	**6**	**7**	**7**	**8**	**1**
Ratio of all NIS/All species [%]	46	32	26	27	8
Number of samples	**3**	**3**	**6**	**9**	**3**

5.1.4.3 Settlement plates

At each of the four harbor sites, one settlement plate construction with three plates was installed. Overall, only 14 different species settled on all the plates. However, five of them are classified as NIS. At “Hansahafen”, three NIS were found and at “Petroleumhafen” one NIS was found, but no native species (Table 14). All NIS belong to the kingdom of Animalia.

Table 14: List of all taxa, number of species and percentage of NIS found on settlement plates at individual harbor sites in the Port of Hamburg in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Animalia				
Cnidaria				
Cordylophora caspia	●	●	●	●
Hydra sp.			●	
Crustacea				
Chelicorophium curvispinum		●	●	
Chelicorophium robustum		●	●	
Gammarus tigrinus		●	●	●
Insecta				
Cricotopus (Cricotopus) sp.			●	
Dicrotendipes sp.		●	●	
Nanocladius sp.		●	●	
Mollusca				
Dreissena sp.		●	●	●
Dreissena polymorpha		●	●	
Oligochaeta				
Nais elinguis			●	
Stylaria lacustris			●	
Platyhelminthes				
Rhabditophora indet.			●	
Plantae				
Chlorophyta				
Cladophora sp.		●		
Rhodophyta				
Bangia atropurpurea		●		
Number of Animalia species	1	7	12	3
Number of NIS Animalia	**1**	**5**	**5**	**3**
Ratio of NIS Animalia/Animalia [%]	100	71	42	100
Number of Bacteria species	0	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Number of Chromista species	0	0	0	0
Number of NIS Chromista	**0**	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	0
Number of Plantae species	0	2	0	0
Number of NIS Plantae	**0**	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0	0	0
Number of Protozoa species	0	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0
Total number of species	**1**	**9**	**12**	**3**
Total number of NIS	**1**	**5**	**5**	**3**
Ratio of all NIS/All species [%]	**100**	**56**	**42**	**100**

5.1.4.4 Mobile epifauna (Traps)

At all four harbor sites, four different traps were installed to catch mobile epifauna. At the "Seemannshöft", "Alte Süderelbe" and "Hansahafen" sites, the crab condos were lost and could not be recovered.

Within the traps, a total of 24 species were captured, of which ten are described as non-indigenous species. Most species and NIS were found within the traps installed at the "Hansahafen" harbor site.

Most species were trapped within the oyster crates. Only Bryozoa, fish species (Pisces) and the bivalve *Anodonta cygnea* were not found in those traps, but rather in Gee's minnow traps. The fewest species were found in the Chinese crab box trap (*Eriocheir sinensis* and *Gammarus tigrinus*) and these traps were empty in "Seemannshöft" and "Hansahafen".

Non-indigenous species were found in all kinds of traps. However, all of them were found in the oyster crates (Table 15).

Table 15: List of all taxa, number of species and percentage of NIS found in traps that were deployed at individual harbor sites in the Port of Hamburg in 2017. Gee's minnow trap (G) Chinese crab box trap (T), oyster crate (O) and crab condo (C). Crab condo was lost in "Seemannshöft", "Alte Süderelbe" and "Hansahafen". *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

	Petroleum-hafen				Seemanns-höft				Alte Süderelbe				Hansahafen			
Taxon	**G**	**T**	**O**	**C**	**G**	**T**	**O**	**C**	**G**	**T**	**O**	**C**	**G**	**T**	**O**	**C**
Animalia																
Bryozoa																
Plumatella repens													●			
Cnidaria																
Cordylophora caspia			●	●			●				●				●	
Crustacea																
Chelicorophium curvispinum			●				●				●				●	
Chelicorophium robustum			●	●							●				●	
Dikerogammarus villosus											●					
Eriocheir sinensis		●	●	●	●		●		●	●	●				●	
Gammarus tigrinus		●	●	●	●		●			●	●		●			
Gammarus zaddachi			●	●											●	
Ligia oceanica															●	
Palaemon elegans			●				●								●	
Insecta																
Dicrotendipes sp.				●							●				●	
Nanocladius sp.			●	●			●				●				●	
Procladius sp.															●	
Mollusca																
Anodonta cygnea					●											
Corbicula fluminea															●	
Dreissena sp.			●	●												

Taxon	Petroleum-hafen G	T	O	C	Seemanns-höft G	T	O	C	Alte Süderelbe G	T	O	C	Hansahafen G	T	O	C
Dreissena bugensis							●				●				●	
Dreissena polymorpha			●				●				●				●	
Peringia ulvae															●	
Pisidium nitidum															●	
Oligochaeta																
Limnodrilus claparedianus															●	
Limnodrilus hoffmeisteri															●	
Potamothrix hammoniensis															●	
Tubificinae gen. sp.															●	
Pisces																
Blicca bjoerkna					●											
Gymnocephalus cernua	●															
Number of Animalia species	11				10				10				20			
Number of NIS Animalia	**6**				**6**				**8**				**9**			
Ratio of NIS Animalia/Animalia [%]	55				60				80				45			
Number of Bacteria species	0				0				0				0			
Number of NIS Bacteria	**0**				**0**				**0**				**0**			
Ratio of NIS Bacteria/Bacteria [%]	0				0				0				0			
Number of Chromista species	0				0				0				0			
Number of NIS Chromista	**0**				**0**				**0**				**0**			
Ratio of NIS Chromista/Chromista [%]	0				0				0				0			
Number of Plantae species	0				0				0				0			
Number of NIS Plantae	**0**				**0**				**0**				**0**			
Ratio of NIS Plantae/Plantae [%]	0				0				0				0			
Number of Protozoa species	0				0				0				0			
Number of NIS Protozoa	**0**				**0**				**0**				**0**			
Ratio of NIS Protozoa/Protozoa [%]	0				0				0				0			
Total number of species	**11**				**10**				**10**				**20**			
Total number of NIS	**6**				**6**				**8**				**9**			
Ratio of all NIS/All species [%]	**55**				**60**				**80**				**45**			

5.2 Port of Kiel

Overall, 205 different species were found in the Port of Kiel in 2017. Of these, eleven non-indigenous animal species (equivalent to 6 %) were identified as well as one species each from the kingdoms Chromista and Plantae (Figure 32, Figure 33, Table 16).

The number of native species and NIS differed slightly between the three harbor sites. At “Thyssen-Krupp Hafen”, most native species were found (134), but fewest NIS (7). The highest number of NIS (9) and at the same time the lowest number of native species (130) was identified at the “Tirpitzhafen” harbor site (Figure 34).

Most of the NIS found in the Port of Kiel belong to the Crustacea and Cnidaria (Table 16, Figure 33). In addition, one NIS was identified for each of the remaining six species groups. NIS belonging to the Mollusca where not found at any of the investigated sites.

The Crustacea *Amphibalanus improvisus* and *Hemigrapsus takanoi* as well as the brown algae *Fucus edentatus* were found at all three investigated harbor sites. Five NIS were identified only at one site respectively (Figure 34 and Table 17). Three of these species occurred only at the “Tiessenkai” harbor site.

No NIS were found in Phyto- and Zooplankton samples (Figure 35, Table 18). Most NIS were found on hard substrates within scratch samples or via visual observations. Six species were found with only one of the sampling methods. The crustaceans *Hemigrapsus takanoi* and *Sinelobus* sp. nov. were found with all four benthos sampling methods (Table 34).

A list of all taxa and numbers of species per harbor site and sampling method can be found in the Appendix (Table 33 and Table 34).

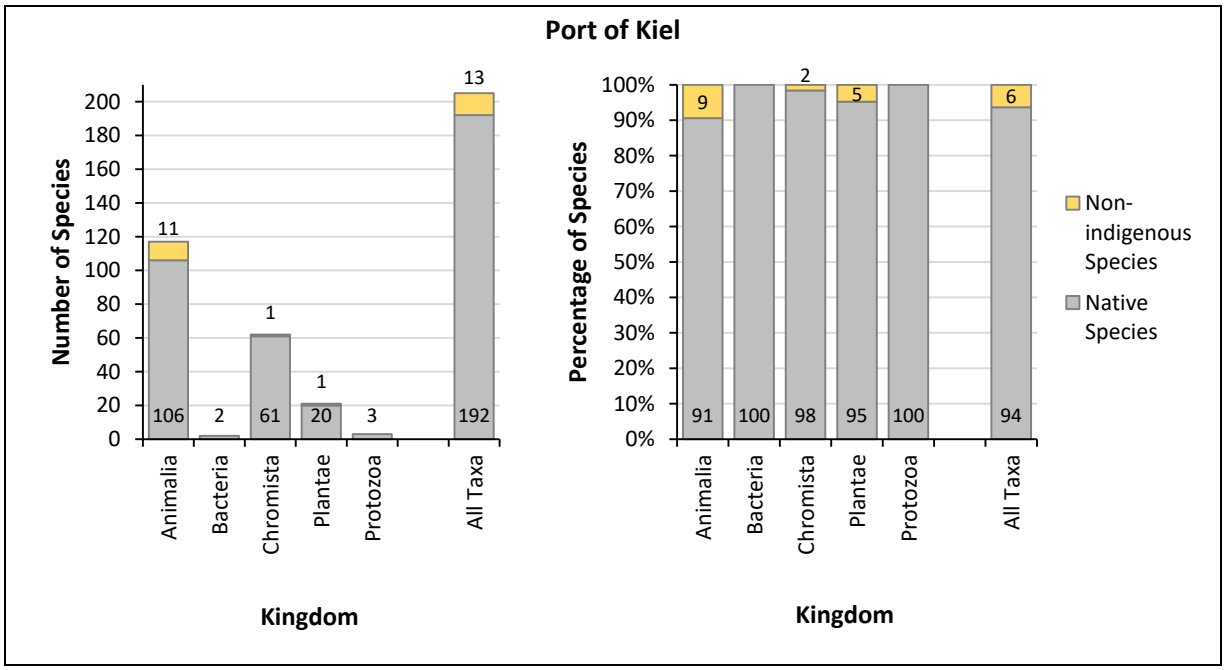

Figure 32: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) of different kingdoms as well as total numbers in the Port of Kiel in 2017.

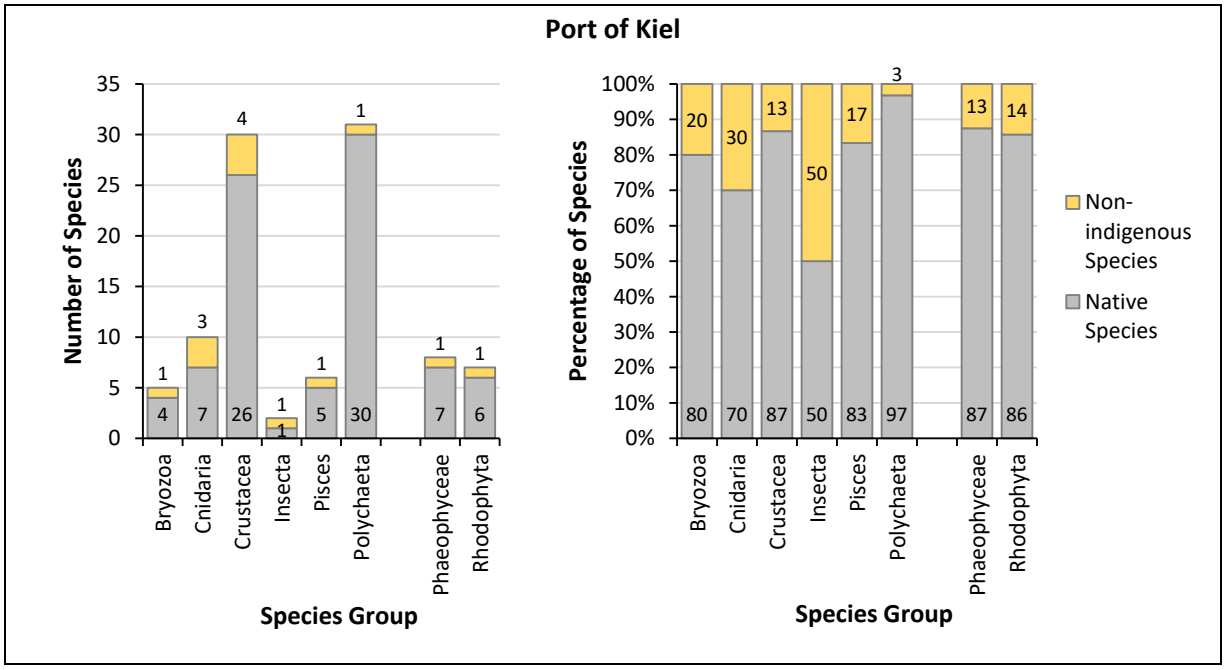

Figure 33: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) of different species groups in the Port of Kiel in 2017.

Table 16: List of non-indigenous taxa, number of species and percentage of NIS at individual harbor sites in the Port of Kiel in 2017.

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Animalia			
Bryozoa			
Amathia gracilis	●	●	
Cnidaria			
Cordylophora caspia		●	●
Garveia franciscana			●
Pachycordyle navis		●	
Crustacea			
Amphibalanus improvisus	●	●	●
Grandidierella japonica		●	●
Hemigrapsus sp.	●		
Hemigrapsus takanoi	●	●	●
Sinelobus sp. nov.	●	●	
Insecta			
Telmatogeton japonicus		●	●
Pisces			
Neogobius melanostomus	●		
Polychaeta			
Marenzelleria viridis	●		

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Chromista			
Phaeophyceae			
Fucus edentatus	●	●	●
Plantae			
Rhodophyta			
Dasya baillouviana	●		
Number of Bryozoa species	4	5	3
Number of NIS Bryozoa	**1**	**1**	**0**
Ratio of NIS Bryozoa/Bryozoa [%]	25	20	0
Number of Cnidaria species	5	9	9
Number of NIS Cnidaria	**0**	**2**	**2**
Ratio of NIS Cnidaria/Cnidaria [%]	0	22	22
Number of Crustacea species	24	23	23
Number of NIS Crustacea	**3**	**4**	**3**
Ratio of NIS Crustacea/Crustacea [%]	13	17	13
Number of Insecta species	1	2	2
Number of NIS Insecta	**0**	**1**	**1**
Ratio of NIS Insecta/Insecta [%]	0	50	50
Number of Pisces species	3	1	3
Number of NIS Pisces	**1**	**0**	**0**
Ratio of NIS Pisces/Pisces [%]	33	0	0
Number of Polychaeta species	19	14	24
Number of NIS Polychaeta	**1**	**0**	**0**
Ratio of NIS Polychaeta/Polychaeta [%]	5	0	0
Number of Phaeophyceae species	8	4	4
Number of NIS Phaeophyceae	**1**	**1**	**1**
Ratio of NIS Phaeophyceae/Phaeophyceae [%]	13	25	25
Number of Rhodophyta species	4	5	4
Number of NIS Rhodophyta	**1**	**0**	**0**
Ratio of NIS Rhodophyta/Rhodophyta [%]	25	0	0
Total number of species	141	139	141
Total number of NIS	**8**	**9**	**7**
Ratio of all NIS/All species [%]	6	6	5

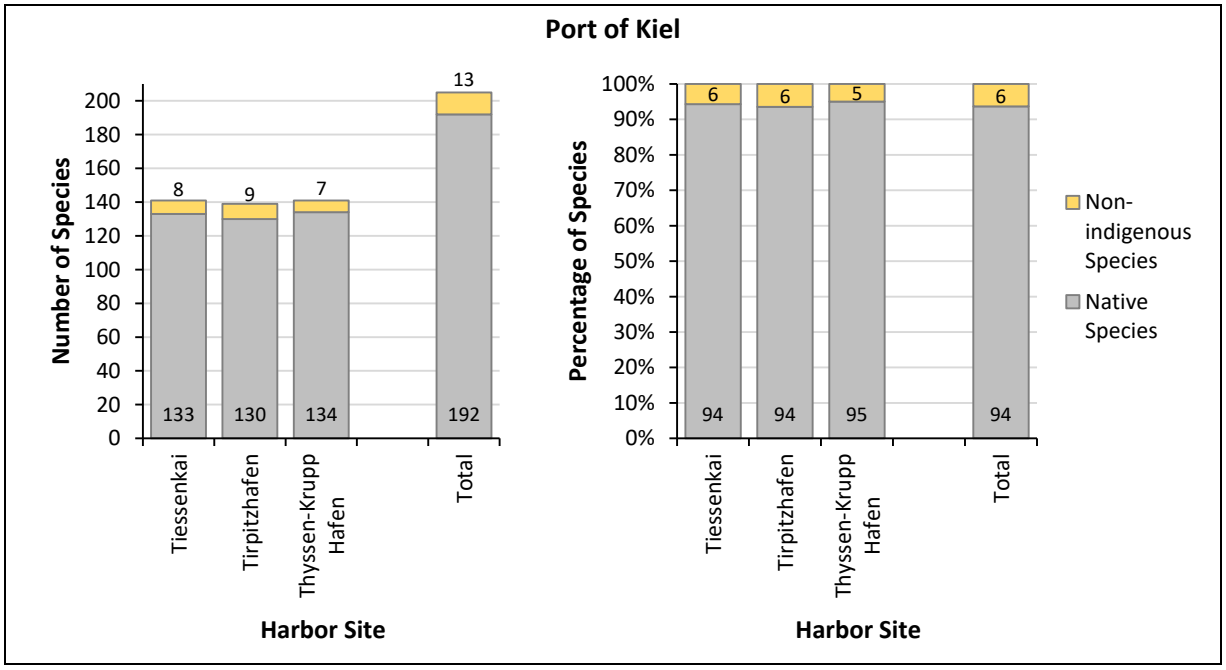

Figure 34: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) at individual harbor sites as well as total numbers in the Port of Kiel in 2017.

Table 17: Number of NIS in common at individual harbor sites in the Port of Kiel in 2017 as well as number of NIS at all sites and at only one site.
Bold: Number of NIS per harbor site.

	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Tiessenkai	**8**	5	3
Tirpitzhafen		**9**	6
Thyssen-Krupp Hafen			**7**
NIS at all sites	3		
NIS at one site	3	1	1

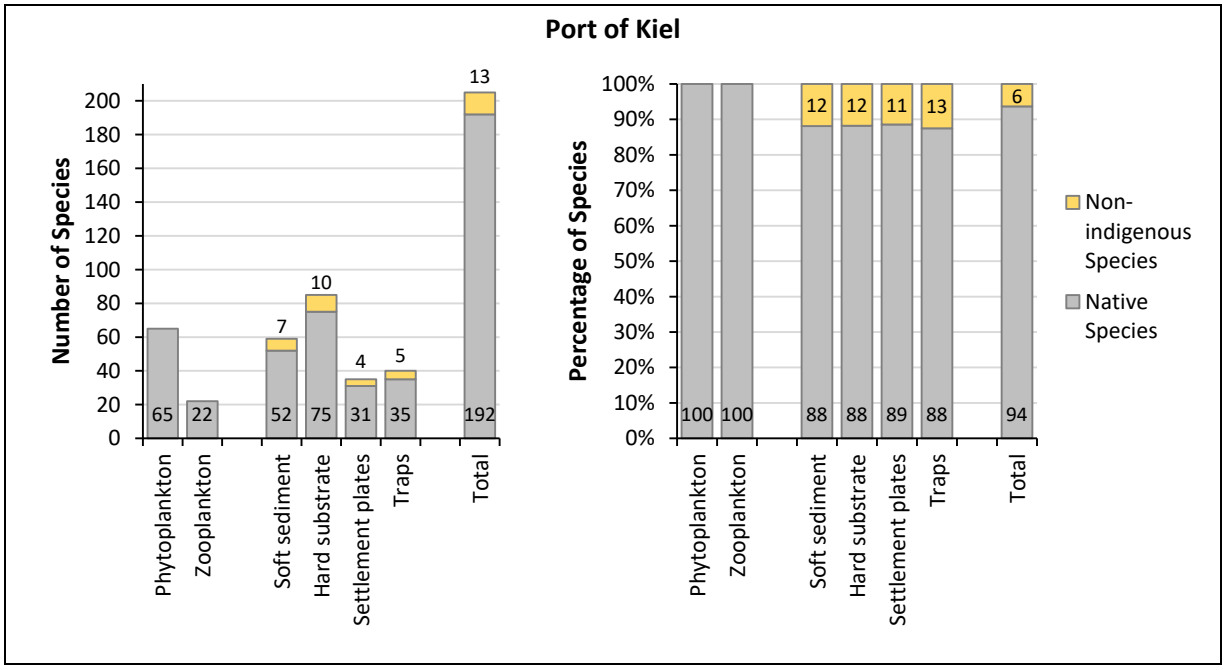

Figure 35: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) found with the different sampling methods as well as total numbers in the Port of Kiel in 2017.

Table 18: Number of NIS in common found with different sampling methods at all harbor sites in the Port of Kiel in 2017 as well as number of NIS found with all sampling methods and found with only one sampling method. *Bold*: Number of NIS per sampling method.

	PP	ZP	SS	HS	SP	TR
Phytoplankton (PP)	**0**	0	0	0	0	0
Zooplankton (ZP)		**0**	0	0	0	0
Soft sediment (SS)			**7**	6	3	2
Hard substrate (HS)				**10**	4	3
Settlement plates (SP)					**4**	3
Traps (TR)						**5**
NIS with all methods	0					
NIS with one method	0	0	1	3	0	2

5.2.1 Hydrological parameters

Hydrological parameters were measured at all three harbor sites in the Port of Kiel in spring and summer 2017 (Table 19 and Table 20).

The Secchi-depth lay between 2.5 m and 5.0 m. Salinity varied mostly between 16 and 17 PSU at the different sampling stations.

During spring 2017 water temperature varied between 7.5 °C and 9.5 °C. In summer the temperature varied between 16 °C and 19 °C at all four sites.

Oxygen concentrations varied between 8.75 mg/l and 9.95 mg/l in spring and between 6.58 mg/l and 9.20 mg/l in summer. At all times and at all measured stations, oxygen saturation was higher than 80 %. Only at “Thyssen-Krupp Hafen” was it lower in the bottom water at Station KI_TKR_2 during summer 2017. At this harbor site, oxygen saturation was significantly lower in the bottom water than in the surface water during summer.

The water column was mostly well mixed.

Table 19: Hydrological parameters at the three harbor sites in the Port of Kiel in spring 2017.

	Tiessenkai 26.04.2017			Tirpitzhafen 26.04.2017			Thyssen-Krupp Hafen 26.04.2017		
	KI_TIK_1	KI_TIK_2	KI_TIK_3	KI_TIP_1	KI_TIP_2	KI_TIP_3	KI_TKR_1	KI_TKR_2	KI_TKR_3
Water Depth [m]	6.0	6.0	5.0	6.5	2.6	6.5	6.8	9.0	12.0
Secchi-depth [m]	3.5	3.5	3.5	2.5	2.6	5.5	4.0	3.5	5.0
Surface-Salinity [PSU]	16.68	16.86	16.73	16.85	16.76	16.90	16.92	16.92	16.33
Bottom-Salinity [PSU]	17.15	17.06	17.07	16.87	16.85	17.10	17.08	17.06	17.05
Surface-Temperature [C°]	9.3	8.3	8.7	9.2	9.4	8.8	7.8	7.8	7.7
Bottom-Temperatur [C°]	8.3	8.4	8.4	8.8	9.0	8.3	7.7	7.8	7.7
Surface-Oxygen [mg/l]	9.49	9.95	9.69	9.90	9.86	9.07	9.62	8.75	9.07
Bottom-Oxygen [mg/l]	9.70	9.76	9.76	8.81	9.93	8.93	8.82	8.76	8.87
Surface-Oxygen [%]	92.4	94.2	92.9	96.0	96.2	87.6	82.5	82.0	86.3
Bottom-Oxygen [%]	92.3	93.0	93.0	84.6	95.9	85.0	82.5	82.2	83.0

Table 20: Hydrological parameters at the three harbor sites in the Port of Kiel in summer 2017.

	Tiessenkai 06.07.2017			Tirpitzhafen 05.07.2017			Thyssen-Krupp Hafen 05.07.2017		
	KI_TIK_1	KI_TIK_2	KI_TIK_3	KI_TIP_1	KI_TIP_2	KI_TIP_3	KI_TKR_1	KI_TKR_2	KI_TKR_3
Water Depth [m]	4.8	4.0	4.0	6.0	6.0	6.5	6.0	8.0	7.5
Secchi-depth [m]	4.0	4.0	3.5	4.0	4.0	4.5	4.0	3.0	3.0
Surface-Salinity [PSU]	16.36	16.38	16.33	16.84	16.48	16.93	16.09	16.20	16.46
Bottom-Salinity [PSU]	16.23	16.20	16.10	16.53	16.78	16.70	16.55	16.71	16.64
Surface-Temperature [C°]	17.8	17.6	18.3	17.2	18.7	17.2	18.5	17.5	16.3
Bottom-Temperatur [C°]	18.5	18.4	18.9	18.4	17.3	17.2	17.2	16.4	16.5
Surface-Oxygen [mg/l]	9.12	9.13	9.20	8.39	8.34	8.65	7.31	7.82	8.28
Bottom-Oxygen [mg/l]	8.67	8.95	9.01	7.92	8.39	8.31	7.02	6.58	7.08
Surface-Oxygen [%]	105.0	104.8	106.5	95.8	98.9	98.8	86.5	90.0	92.3
Bottom-Oxygen [%]	101.7	104.2	104.8	92.4	96.1	94.8	80.2	73.9	80.0

5.2.2 Human pathogens

In accordance with the D-2 Ballast Water Performance Standard of the “Ballast water management convention” (IMO, February, 2014) less than 250 colony forming units (cfu) per 100 ml of *Escherichia coli* and less than 100 cfu per 100 ml intestinal Enterococci should be found in ballast water.

No recorded value, neither for intestinal Enterococci nor for *E. coli* exceeded the threshold values in the Port of Kiel in spring and summer 2017.

Table 21: Human pathogens at three harbor sites in the Port of Kiel in spring and summer 2017.

Harbor site	Enterococci cfu/100 ml	*E. coli* cfu/100 ml
Spring 2017		
Tiessenkai	10	< 10
Tirpitzhafen	< 10	< 10
Thyssen-Krupp Hafen	< 10	< 10
Summer 2017		
Tiessenkai	< 10	< 10
Tirpitzhafen	< 10	< 10
Thyssen-Krupp Hafen	< 10	< 10

5.2.3 Plankton

5.2.3.1 Phytoplankton

At each of the three harbor sites, phytoplankton samples were taken both in spring and summer (six samples). Overall, 65 different species were identified. All species were found exclusively with this monitoring method (Table 34). However, none of these were classified as non-indigenous species (Table 35). The species accumulation curves did not become asymptotic after six analyzed samples (Figure 36). This indicates that additional samples could have resulted in the detection of additional species.

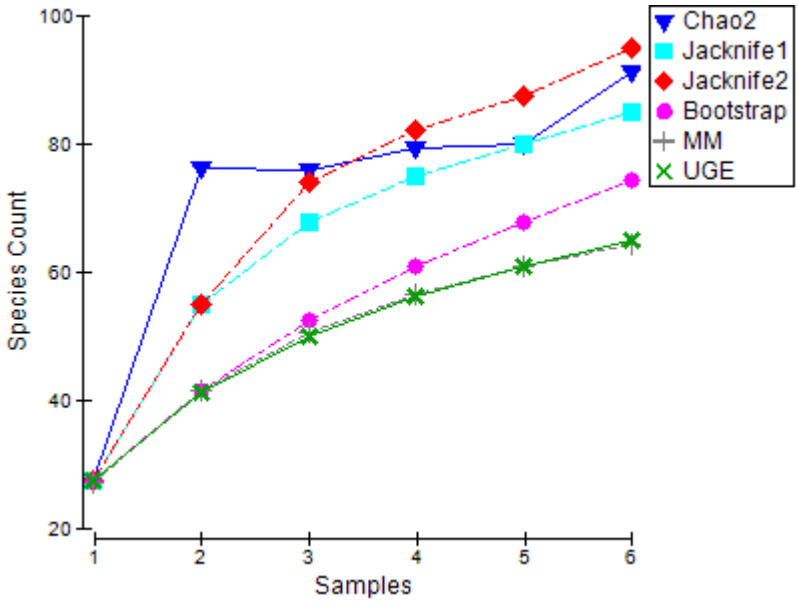

Figure 36: Species accumulation curves based on six phytoplankton samples in the Port of Kiel in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.2.3.2 Zooplankton

At each of the three Kiel harbor sites, zooplankton samples were taken both in spring and summer (six samples). Overall, 22 different species were identified, which all belonged to the kingdom of Animalia. Many of the crustacean species were solely found in zooplankton samples. However, with this method there were no NIS found at any of the sampling sites (Table 36) With one exception, the species accumulation curves did not become asymptotic after six analyzed samples (Figure 37). This indicates that additional samples could have resulted in the detection of additional species.

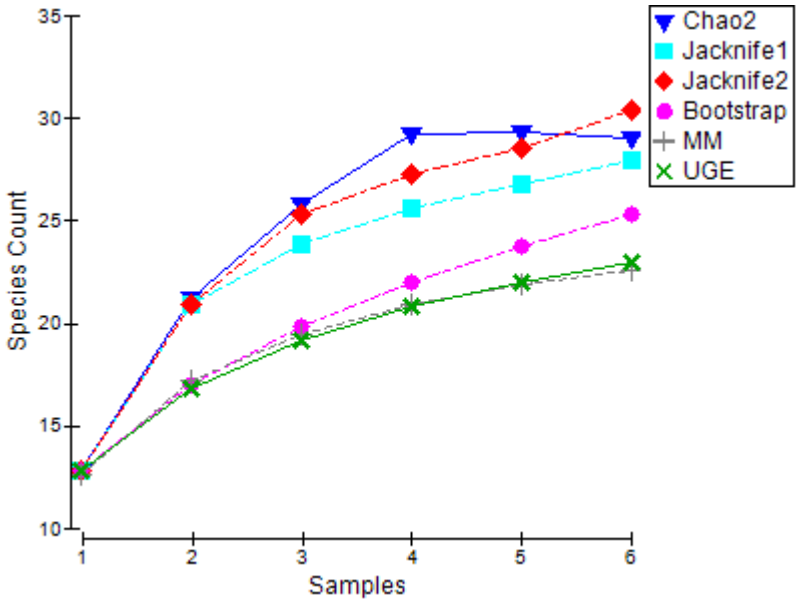

Figure 37: Species accumulation curves based on six zooplankton samples in the Port of Kiel in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.2.4 Benthos

Overall, 51 macrozoobenthos samples were taken at all three harbor sites via grab sampling, scratch sampling, Rapid Assessment, settlement plates and traps. A total of 130 different species were identified, 13 of which are classified as NIS (Table 34). Most of the species accumulation curves did not become asymptotic after all analyzed samples (Figure 38). This indicates that additional samples could have resulted in the detection of additional species.

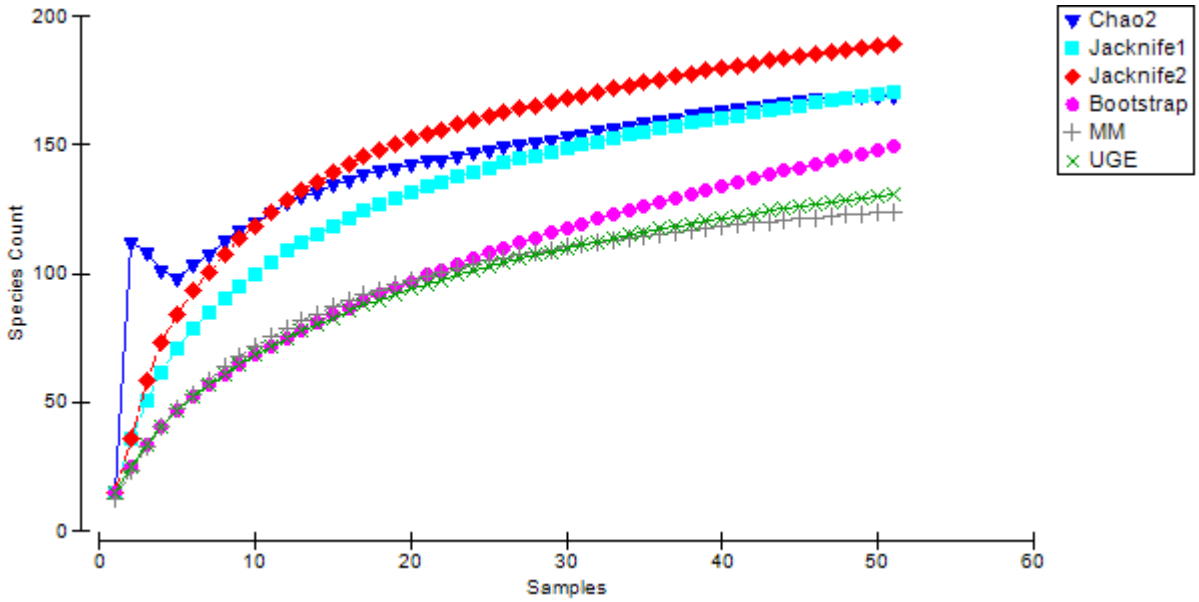

Figure 38: Species accumulation curves based on 51 macrozoobenthos samples (soft bottom samples, scratch samples, RA (visual samples), settlement plates and traps) at the three harbor sites in the Port of Kiel in 2017. The curves for Chao2 and Jacknife 1 and 2 may provide an over-estimation. The curves for Bootstrap, MM and UGE may provide an under-estimation.

5.2.4.1 Soft sediment

The sediments at the “Tirpitzhafen” and “Thyssen-Krupp Hafen” harbor sites consisted mainly of muddy sediments with shell debris. At “Tiessenkai” the sediment was coarser (Table 23).

Within soft bottom samples 40 taxa were found at the four harbor sites. Most of the species belong to the kingdom of Animalia. Seven species are classified as NIS, among them three crustaceans. No molluscan NIS were found. All NIS occurred only at one of the three harbor sites (Table 22). Most species and NIS were found at the “Thyssen-Krupp Hafen” harbor site and the fewest at “Tiessenkai”.

Table 22: List of all taxa, number of species and percentage of NIS found in soft bottom samples at individual harbor sites in the Port of Kiel in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Animalia			
Bryozoa			
Alcyonidioides mytili		●	
Amathia gracilis		●	
Cnidaria			
Clytia hemisphaerica		●	
Garveia franciscana			●
Opercularella lacerata		●	
Sarsia sp.			●
Crustacea			
Amphibalanus improvisus			●
Aoridae gen. sp.	●	●	
Balanus crenatus		●	●
Decapoda indet.		●	
Gammarus sp.			●
Hemigrapsus takanoi		●	
Microdeutopus gryllotalpa		●	
Monocorophium insidiosum	●	●	
Sinelobus sp. nov.	●		
Entoprocta			
Barentsia matsushimana		●	
Insecta			
Halocladius variabilis		●	
Telmatogeton japonicus			●
Mollusca			
Barnea candida		●	
Brachystomia scalaris			●
Cardiidae gen. sp.	●	●	
Corbula gibba			●
Kurtiella bidentata	●		●
Limecola balthica	●		

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Littorina sp.	●		
Musculus subpictus		●	●
Mya sp.	●	●	●
Mytilidae gen. sp.			●
Mytilus edulis		●	●
Parvicardium exiguum		●	
Peringia ulvae	●	●	
Retusa truncatula	●		●
Rissoidae gen. sp.		●	
Scrobicularia plana		●	
Nemertea			
Nemertea indet.			●
Oligochaeta			
Baltidrilus costatus		●	
Paranais sp.		●	●
Paranais litoralis	●	●	
Tubificinae gen. sp.	●	●	
Tubificoides benedii	●	●	●
Polychaeta			
Alitta succinea		●	
Ampharete sp.			●
Arenicola marina	●		
Bylgides sarsi			●
Capitella capitata agg.	●	●	●
Capitellidae gen. sp.	●		
Dipolydora quadrilobata			●
Exogone naidina		●	
Fabricia stellaris			●
Fabriciidae gen. sp.			●
Fabriciola baltica	●		●
Harmothoe imbricata		●	●
Hediste diversicolor	●	●	
Lagis koreni			●
Marenzelleria viridis	●		
Mediomastus fragilis	●	●	●
Microphthalmus sp.			●
Nereididae gen. sp.			●
Nereimyra punctata			●
Pholoe inornata			●
Polydora ciliata			●
Polydora cornuta	●	●	
Pygospio elegans	●	●	●
Scoloplos armiger	●	●	●
Spionidae gen. sp.			●
Streblospio sp.	●		
Streblospio shrubsolii	●		

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Syllidae gen. sp.	●		
Terebellides stroemii agg.			●
Trochochaeta multisetosa			●
Plantae			
Chlorophyta			
Ulva sp.		●	
Number of Animalia species	23	30	34
Number of NIS Animalia	**2**	**2**	**3**
Ratio of NIS Animalia/Animalia [%]	9	7	9
Number of Bacteria species	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]			
Number of Chromista species	0	0	0
Number of NIS Chromista	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]			
Number of Plantae species	0	1	0
Number of NIS Plantae	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]		0	
Number of Protozoa species	0	0	0
Number of NIS Protozoa	0	0	0
Ratio of NIS Protozoa/Protozoa [%]			
Total number of species	**23**	**31**	**34**
Total number of NIS	**2**	**2**	**3**
Ratio of all NIS/All species [%]	**9**	**6**	**9**

Table 23: Sediment description of the grab samples in the Port of Kiel in 2017.

Station	Sediment description
Tiessenkai	
KI_TIK_1	fine sand with parts of coarse sediment and shell
KI_TIK_2	fine sand with parts of coarse sediment and shell
KI_TIK_3	fine sand with parts of coarse sediment and shell
Tirpitzhafen	
KI_TIP_1	muddy sediment with parts of sand and shell
KI_TIP_2	muddy sediment with parts of sand and shell
KI_TIP_3	muddy sediment with parts of sand and shell
Thyssen-Krupp Hafen	
KI_TKR_1	muddy sediment with shell and worm tubes
KI_TKR_2	muddy sediment with shell and worm tubes
KI_TKR_3	muddy sediment with shell and worm tubes

5.2.4.2 Hard substrates

At the three harbor sites in the Port of Kiel, different hard substrates were investigated via scratch samples and Rapid Assessment (visual observations). A total of 85 species were found. Most species belong to the kingdom of Animalia. However, nine Chromista-species and 15 Plantae-species were also found (Table 24). Ten species are classified as NIS among them the brown algae *Fucus edentatus* (found at all three sites) and the red algae *Dasya baillouviana*.
Scratch sample results showed, that slightly more species and NIS were found on the pontoon (47 species and 4 NIS) than on wooden jetty (46 species and 3 NIS; Figure 39, Table 25).

Table 24: List of all taxa, number of species and percentage of NIS found in scratch samples and with Rapid Assessment (visual observations) at individual harbor sites in the Port of Kiel in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Animalia			
Bryozoa			
Alcyonidiidae gen. sp.		●	●
Alcyonidioides mytili	●		
Amathia gracilis	●		
Conopeum seurati		●	
Einhornia crustulenta	●	●	●
Electra pilosa	●	●	●
Chelicerata			
Halacaridae gen. sp.	●	●	●
Cnidaria			
Anthoathecata indet.		●	
Anthozoa indet.	●	●	●
Campanulariidae gen. sp.	●	●	●
Clava multicornis	●	●	●
Clytia hemisphaerica		●	●
Cordylophora caspia		●	●
Garveia franciscana			●
Gonothyraea loveni		●	●
Metridium dianthus	●	●	
Opercularella lacerata	●	●	●
Pachycordyle navis		●	
Sarsia sp.		●	●
Crustacea			
Amphibalanus improvisus	●	●	●
Aoridae gen. sp.		●	●
Balanidae gen. sp.	●		●
Balanus crenatus	●	●	●
Calliopius laeviusculus			●
Carcinus maenas	●	●	●
Gammaridae gen. sp.			●

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Gammarus sp.	●	●	●
Gammarus locusta		●	
Gammarus oceanicus	●	●	●
Gammarus salinus	●	●	●
Gammarus zaddachi	●		
Hemigrapsus sp.	●		
Hemigrapsus takanoi	●		
Idotea balthica			●
Jaera (Jaera) albifrons agg.	●	●	●
Ligia oceanica		●	
Microdeutopus gryllotalpa	●	●	●
Monocorophium insidiosum	●	●	●
Palaemon elegans	●	●	
Praunus inermis	●		
Sinelobus sp. nov.	●	●	
Echinodermata			
Asterias rubens	●	●	●
Insecta			
Halocladius variabilis	●	●	●
Orthocladiinae gen. sp.			●
Telmatogeton japonicus		●	
Mollusca			
Bivalvia indet.		●	
Calliopaea bellula		●	
Elysia viridis	●	●	●
Littorina sp.			●
Littorina littorea	●	●	●
Musculus subpictus		●	
Mya sp.	●		
Mytilidae gen. sp.	●	●	●
Mytilus edulis	●	●	●
Peringia ulvae	●		
Nematoda			
Nematoda indet.	●	●	●
Lineidae gen. sp.			●
Oligochaeta			
Baltidrilus costatus	●		
Enchytraeidae gen. sp.		●	
Pisces			
Gobiidae gen. sp.			●
Mugilidae gen. sp.			●
Platyhelminthes			
Rhabditophora indet.		●	●
Polychaeta			
Alitta succinea	●	●	●
Bylgides sarsi		●	

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Harmothoe imbricata	●	●	●
Neanthes sp.	●		●
Neoamphitrite figulus		●	●
Nereididae gen. sp.		●	
Platynereis dumerilii		●	
Polydora ciliata		●	●
Polydora cornuta	●		
Polynoidae gen. sp.		●	
Scolelepis bonnieri	●		
Porifera			
Chalinidae gen. sp.	●		●
Halichondria (Halichondria) panicea	●		
Tunicata			
Ascidiacea indet.		●	●
Ciona intestinalis	●	●	
Chromista			
Bacillariophyceae			
Schlauchdiatomeen indet.	●	●	●
Phaeophyceae			
Ectocarpales indet.	●	●	●
Ectocarpus siliculosus	●		●
Elachista fucicola	●	●	
Fucus edentatus	●	●	●
Fucus vesiculosus	●	●	●
Petalonia fascia	●		
Pylaiella littoralis	●	●	●
Saccharina latissima	●		
Spongonema tomentosum	●		
Plantae			
Chlorophyta			
Acrosiphonia sp.		●	
Blidingia sp.	●		●
Blidingia marginata	●		
Bryopsis plumosa	●	●	●
Chaetomorpha linum			●
Cladophora sp.	●	●	●
Cladophora sericea		●	
Kornmannia leptoderma	●		
Ulva sp.	●	●	●
Ulva intestinalis		●	
Ulva linza		●	
Ulvales indet.	●		
Rhodophyta			
Acrochaetium sp.		●	

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Aglaothamnion tenuissimum	●	●	
Aglaothamnion/Callithamnion sp.	●	●	●
Callithamnion corymbosum	●	●	●
Ceramium sp.	●	●	●
Dasya baillouviana	●		
Polysiphonia sp.		●	●
Polysiphonia fibrillosa		●	
Porphyra sp.			●
Number of Animalia species	39	43	39
Number of NIS Animalia	**4**	**5**	**3**
Ratio of NIS Animalia/Animalia [%]	10	12	8
Number of Bacteria species	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0
Number of Chromista species	9	5	5
Number of NIS Chromista	**1**	**1**	**1**
Ratio of NIS Chromista/Chromista [%]	11	20	20
Number of Plantae species	9	10	9
Number of NIS Plantae	**1**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	11	0	0
Number of Protozoa species	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0
Total number of species	**57**	**58**	**53**
Total number of NIS	**6**	**6**	**4**
Ratio of all NIS/All species [%]	**11**	**10**	**8**

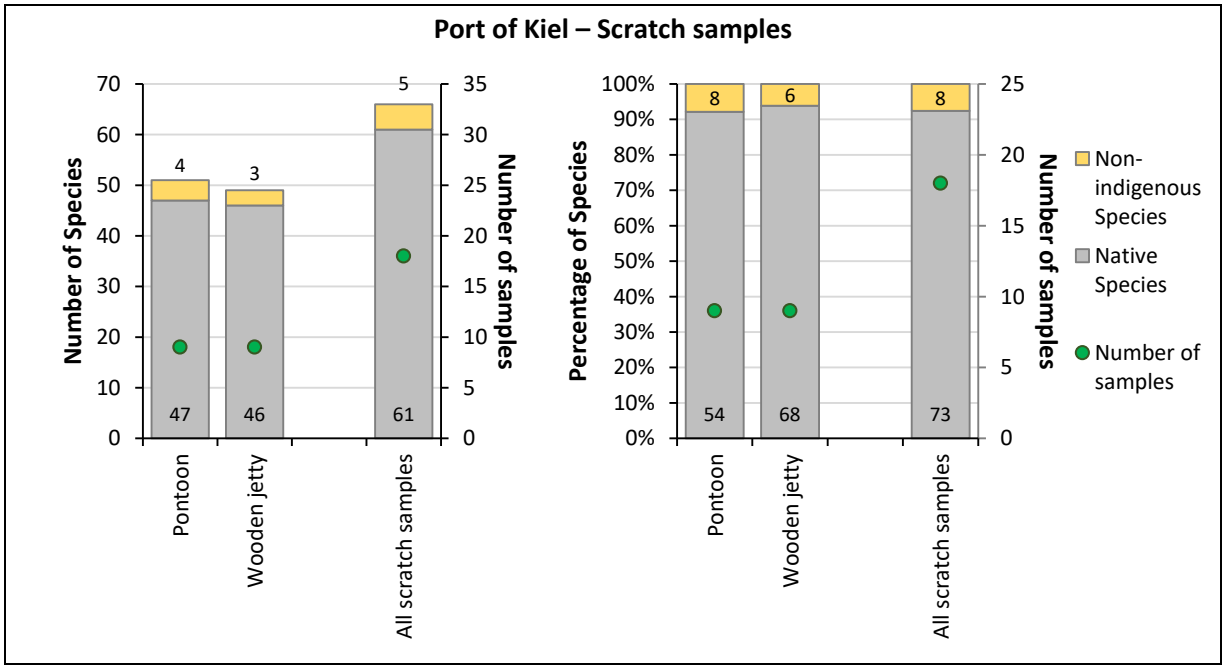

Figure 39: Number (*left*) and percentage (*right*) of native and non-indigenous species (NIS) as well as total numbers within different kinds of habitats sampled via scratch sampling in the Port of Kiel in 2017.

Table 25: List of all taxa, number of species and percentage of NIS found within scratch samples from different kinds of habitats in the Port of Hamburg in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Pontoon	Wooden jetty
Animalia		
Bryozoa		
Alcyonidiidae gen. sp.	●	●
Einhornia crustulenta		●
Electra pilosa	●	●
Chelicerata		
Halacaridae gen. sp.	●	●
Cnidaria		
Anthoathecata indet.	●	
Anthozoa indet.	●	●
Campanulariidae gen. sp.		●
Clava multicornis	●	●
Clytia hemisphaerica	●	●
Cordylophora caspia	●	
Garveia franciscana	●	
Gonothyraea loveni	●	
Opercularella lacerata	●	●
Sarsia sp.	●	●
Crustacea		
Amphibalanus improvisus	●	●

Taxon	Pontoon	Wooden jetty
Aoridae gen. sp.	●	●
Balanidae gen. sp.		●
Balanus crenatus	●	●
Calliopius laeviusculus	●	
Carcinus maenas	●	●
Gammarus sp.	●	●
Gammarus locusta	●	
Gammarus oceanicus	●	●
Gammarus salinus	●	●
Gammarus zaddachi		●
Hemigrapsus takanoi		●
Idotea balthica	●	
Jaera (Jaera) albifrons agg.	●	●
Microdeutopus gryllotalpa	●	●
Monocorophium insidiosum	●	●
Palaemon elegans	●	
Sinelobus sp. nov.	●	●
Echinodermata		
Asterias rubens	●	●
Insecta		
Halocladius variabilis	●	●
Orthocladiinae gen. sp.	●	
Mollusca		
Bivalvia indet.	●	●
Calliopaea bellula	●	
Elysia viridis		●
Littorina littorea	●	●
Mya sp.		●
Mytilidae gen. sp.	●	●
Mytilus edulis	●	●
Peringia ulvae	●	
Nematoda		
Nematoda indet.		●
Oligochaeta		
Baltidrilus costatus	●	
Enchytraeidae gen. sp.	●	
Platyhelminthes		
Rhabditophora indet.	●	●
Polychaeta		
Alitta succinea	●	
Harmothoe imbricata	●	●
Neanthes sp.	●	●
Neoamphitrite figulus	●	
Nereididae gen. sp.	●	
Platynereis dumerilii		●
Polydora ciliata	●	

Taxon	Pontoon	Wooden jetty
Polynoidae gen. sp.	●	
Porifera		
Chalinidae gen. sp.		●
Halichondria (Halichondria) panicea	●	
Tunicata		
Ascidiacea indet.		●
Chromista		
Bacillariophyceae		
Schlauchdiatomeen indet.	●	●
Phaeophyceae		
Ectocarpales indet.	●	●
Ectocarpus siliculosus		●
Elachista fucicola	●	●
Fucus vesiculosus	●	●
Pylaiella littoralis	●	●
Saccharina latissima		●
Spongonema tomentosum	●	
Plantae		
Chlorophyta		
Acrosiphonia sp.		●
Bryopsis plumosa	●	●
Cladophora sericea		●
Kornmannia leptoderma		●
Ulva sp.	●	●
Ulva intestinalis	●	
Ulva linza		●
Rhodophyta		
Acrochaetium sp.	●	●
Aglaothamnion tenuissimum	●	●
Aglaothamnion/Callithamnion sp.	●	●
Callithamnion corymbosum	●	●
Ceramium sp.	●	●
Polysiphonia sp.	●	●
Polysiphonia fibrillosa		●
Number of Bryozoa species	2	3
Number of NIS Bryozoa	**0**	**0**
Ratio of NIS Bryozoa/Bryozoa [%]	0	0
Number of Chelicerata species	1	1
Number of NIS Chelicerata	**0**	**0**
Ratio of NIS Chelicerata/Chelicerata [%]	0	0

Taxon	Pontoon	Wooden jetty
Number of Cnidaria species	8	5
Number of NIS Cnidaria	**2**	**0**
Ratio of NIS Cnidaria/Cnidaria [%]	25	0
Number of Crustacea species	13	11
Number of NIS Crustacea	**2**	**3**
Ratio of NIS Crustacea/Crustacea [%]	15	27
Number of Echinodermata species	1	1
Number of NIS Echinodermata	**0**	**0**
Ratio of NIS Echinodermata/Echinodermata [%]	0	0
Number of Insecta species	1	1
Number of NIS Insecta	**0**	**0**
Ratio of NIS Insecta/Insecta [%]	0	0
Number of Mollusca species	4	4
Number of NIS Mollusca	**0**	**0**
Ratio of NIS Mollusca/Mollusca [%]	0	0
Number of Nematoda species	0	1
Number of NIS Nematoda	**0**	**0**
Ratio of NIS Nematoda/Nematoda [%]	0	0
Number of Oligochaeta species	2	0
Number of NIS Oligochaeta	**0**	**0**
Ratio of NIS Oligochaeta/Oligochaeta [%]	0	0
Number of Platyhelminthes species	1	1
Number of NIS Platyhelminthes	**0**	**0**
Ratio of NIS Platyhelminthes/Platyhelminthes [%]	0	0
Number of Polychaeta species	5	3
Number of NIS Polychaeta	**0**	**0**
Ratio of NIS Polychaeta/Polychaeta [%]	0	0
Number of Porifera species	1	1
Number of NIS Porifera	**0**	**0**
Ratio of NIS Porifera/Porifera [%]	0	0
Number of Tunicata species	0	1
Number of NIS Tunicata	**0**	**0**
Ratio of NIS Tunicata/Tunicata [%]	0	0

Taxon	Pontoon	Wooden jetty
Number of Chromista species	5	6
Number of NIS Chromista	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0
Number of Plantae species	7	10
Number of NIS Plantae	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0
Total number of species	51	49
Total number of NIS	**4**	**3**
Ratio of all NIS/All species [%]	8	6
Number of samples	**9**	**9**

5.2.4.3 Settlement plates

At each of the three harbor sites, one settlement plate construction with three plates was installed. A total 35 different species settled on all the plates. Three crustacean species as well as red algae *Dasya baillouviana* are classified as NIS (Table 26). The non-indigenous barnacle *Amphibalanus improvisus* was found at all three harbor sites.

Table 26: List of all taxa, number of species and percentage of NIS found on settlement plates at individual harbor sites in the Port of Kiel in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Animalia			
Bryozoa			
Alcyonidioides mytili			●
Cnidaria			
Anthozoa indet.			●
Bougainvillia muscus	●	●	●
Campanulariidae gen. sp.	●	●	●
Crustacea			
Amphibalanus improvisus	●	●	●
Balanidae gen. sp.	●		
Gammarus sp.		●	●
Gammarus salinus	●		
Hemigrapsus takanoi		●	
Microdeutopus gryllotalpa	●	●	●
Monocorophium insidiosum			●
Phtisica marina			●
Sinelobus sp. nov.	●		

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Stenothoe monoculoides	●		
Echinodermata			
Asterias rubens	●	●	●
Insecta			
Halocladius variabilis	●	●	
Mollusca			
Brachystomia scalaris	●	●	
Flabellina sp.	●	●	●
Musculus subpictus		●	
Mytilidae gen. sp.	●	●	●
Mytilus edulis	●	●	●
Pusillina sarsii	●	●	
Platyhelminthes			
Polycladida indet.	●	●	●
Polychaeta			
Alitta succinea		●	●
Capitella capitata agg.		●	●
Exogone naidina	●		
Harmothoe sp.			●
Harmothoe impar	●	●	●
Pholoe sp.			●
Platynereis dumerilii	●	●	
Polydora ciliata	●		●
Polydora cornuta	●	●	●
Porifera			
Chalinidae gen. sp.			●
Tunicata			
Ciona intestinalis agg.	●	●	●
Chromista			
Phaeophyceae			
Ectocarpales indet.	●		
Ectocarpus siliculosus	●		
Plantae			
Chlorophyta			
Ulva sp.	●	●	●
Rhodophyta			
Aglaothamnion/Callithamnion sp.	●	●	●
Ceramiales indet.	●		
Ceramium sp.	●	●	●
Dasya baillouviana	●		
Number of Animalia species	20	20	21
Number of NIS Animalia	**2**	**2**	**1**
Ratio of NIS Animalia/Animalia [%]	10	10	5

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Number of Bacteria species	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0
Number of Chromista species	1	0	0
Number of NIS Chromista	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0
Number of Plantae species	4	3	3
Number of NIS Plantae	**1**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	25	0	0
Number of Protozoa species	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0
Total number of species	**25**	**23**	**24**
Total number of NIS	**3**	**2**	**1**
Ratio of all NIS/All species [%]	**12**	**9**	**4**

5.2.4.4 Mobile epifauna (traps)

At each of the three harbor sites, four different traps were installed to catch mobile epifauna.

Within the traps, a total of 40 species were captured, of which five are described as non-indigenous species. Most species and NIS were found within the traps installed at the "Tiessenkai" harbor site (Table 27).

The Chinese crab box trap was empty at "Tiessenkai" and the Gee's minnow traps was empty at "Thyssen-Krupp Hafen". In all other cases only one native species was captured. No NIS were found within these traps.

Most of the species and all NIS were captured with the oyster crates and/or the crab condos. Many species were found with both kinds of traps. However, most of the fish species (Pisces) were captured only within the oyster crates.

Table 27: List of all taxa, number of species and percentage of NIS found in traps that were deployed at individual harbor sites in the Port of Kiel in 2017. Gee's minnow trap (G) chinese crab box trap (T), oyster crate (O) and crab condo (C). *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

	Tiessenkai				Tirpitzhafen				Thyssen-Krupp Hafen			
Taxon	**G**	**T**	**O**	**C**	**G**	**T**	**O**	**C**	**G**	**T**	**O**	**C**
Animalia												
Crustacea												
Athanas nitescens			●	●				●			●	
Calliopius laeviusculus			●	●								
Carcinus maenas			●	●			●	●		●		
Gammarus oceanicus			●									
Gammarus salinus											●	
Grandidierella japonica							●				●	●
Hemigrapsus takanoi			●	●			●	●			●	●
Microdeutopus gryllotalpa			●	●			●	●			●	●
Monocorophium insidiosum				●			●					
Sinelobus sp. nov.				●								
Echinodermata												
Asterias rubens			●	●	●	●	●	●			●	●
Mollusca												
Elysia viridis							●					
Flabellina sp.								●			●	●
Littorina littorea			●									
Mya truncata												●
Mytilidae gen. sp.			●	●				●				●
Mytilus edulis				●			●				●	●
Nemertea												
Cephalothrix sp.												●
Lineidae gen. sp.			●				●	●			●	●
Pisces												

Taxon	Tiessenkai				Tirpitzhafen				Thyssen-Krupp Hafen			
	G	T	O	C	G	T	O	C	G	T	O	C
Anguilla anguilla											●	
Ctenolabrus rupestris			●									
Gobius niger											●	
Gobiusculus flavescens	●			●			●	●				
Neogobius melanostomus			●									
Platyhelminthes												
Polycladida indet.				●			●	●			●	
Polychaeta												
Alitta succinea			●	●							●	
Capitella capitata agg.			●				●	●			●	●
Harmothoe sp.							●	●				●
Harmothoe imbricata			●	●			●	●			●	
Harmothoe impar			●	●							●	
Pherusa plumosa												●
Phyllodoce sp.			●									●
Platynereis dumerilii				●								
Polydora ciliata				●				●				
Polydora cornuta			●	●			●	●			●	●
Scoloplos armiger							●				●	●
Tunicata												
Ciona intestinalis agg.							●					
Chromista												
Phaeophyceae												
Ectocarpus sp.												●
Plantae												
Chlorophyta												
Ulva sp.				●								
Rhodophyta												
Aglaothamnion/Callithamnion sp.				●			●					●
Ceramium sp.							●					●
Dasya baillouviana				●								
Number of Animalia species	24				19				23			
Number of NIS Animalia	**3**				**2**				**2**			
Ratio of NIS Animalia/Animalia [%]	13				11				9			
Number of Bacteria species	0				0				0			
Number of NIS Bacteria	**0**				**0**				**0**			
Ratio of NIS Bacteria/Bacteria [%]	0				0				0			
Number of Chromista species	0				0				1			
Number of NIS Chromista	**0**				**0**				**0**			
Ratio of NIS Chromista/Chromista [%]	0				0				0			

Taxon	Tiessenkai G	T	O	C	Tirpitzhafen G	T	O	C	Thyssen-Krupp Hafen G	T	O	C
Number of Plantae species	3				2				2			
Number of NIS Plantae	**1**				**0**				**0**			
Ratio of NIS Plantae/Plantae [%]	33				0				0			
Number of Protozoa species	0				0				0			
Number of NIS Protozoa	**0**				**0**				**0**			
Ratio of NIS Protozoa/Protozoa [%]	0				0				0			
Total number of species	**27**				**21**				**26**			
Total number of NIS	**4**				**2**				**2**			
Ratio of all NIS/All species [%]	**15**				**10**				**8**			

6 Discussion and method recommendations

The investigation of several sites in a port requires a great deal of logistical effort, not least due to requesting or obtaining permission to use suitable locations for the experiments as well as the sampling in general.

The following must be taken into account:

1) The choice of methodically meaningful locations and associated stations.
2) The locations and stations must / should be accessible with as little logistical effort as possible.
3) Each location often requires multiple requests / permissions (first to use the locations, facilities, etc., and then later access permission, personnel registration, enabling of access, etc.).
4) The locations should be as "protected" as possible from unintentional loss through heavy water movement, ship traffic or vandalism, etc.

For sampling in tidal waters or port sites exposed to high tides, the time of sampling should always be planned close to the backwater (low water), as strong tidal currents make the use of sampling equipment (e.g. nets and grabs) more difficult.

The spreading of settlement plates in tidal waters requires the highest degree of care, with special attention paid to the deviation of the tidal range from mean low water. The deviations are influenced by the moon phase as well as the prevailing wind direction and strength at the time of the investigation.

In the following sectiopns, observations of individual sampling strategies and parameters are discussed and the difficulties in applying the sampling methods are addressed.

6.1 Infauna sampling (Eckman-Birge)

For the adequate use of a small grab, such as the Ekman-Birge grab, the expected type of substrate should, if possible, be known before sampling.

Reason: without modification, such as the use of additional weights, the grab may be too light and will not penetrate into, or close properly in soil in less cohesive sediments such as fine sand.

6.2 Scratch sampling

In principle, suitable habitats, substrates and locations for scratching must be actively taken into account. Hydrodynamic exposure at the survey sites, such as strong tidal currents and wave movements, seem to have an important impact on epibenthic growth at individual substrate. Sites with too strong water movement due to boat traffic and / or current often exhibit hardly any growth. Strong, continuous water movement likely makes it more difficult for larvae or other organisms to attach.

Besides sheet piling, pontoons, piles, dolphins, etc., floating bodies such as buoys or fenders, which can sometimes be easily pulled out of the water, rotated and the underside scraped off are particularly suitable. This is partly more effective and easier than taking a scratch sample with a long pile scratch. Prerequisite: the objects must be accessible, which is not always the case from the jetty.

In addition to strong tidal current speeds, sedimentation and/ or clogging of substrates with mud is also a problem in some port areas (e.g. Jade-Weser-Port). This has a negative effect on settlement. Furthermore, the extremely limited visibility in these areas hinders sampling.

6.3 Traps

The crab trap was less effective than the small fish trap. This can be due to the trap type as well as the bait used; e.g. Cat food and broken shells, which were available on site (*Dreissena, Corbicula*), were used.

A Gee's minnow trap with broken oyster as bait was hung out in Wilhelmshaven as an experiment. After only 10 minutes, three black-eared gobies were documented. This type of trap is comparatively more expensive.

The construction of the crab condo is quite complicated and time-consuming. The catch quota was very poor. Amphipods have not yet been detected in the crab condo, but a comparatively high number of fish were documented at the Kiel site (predators?).

With respect to the goal to collect small crustaceans, it is advisable to secure the openings of the tubes with a very coarse net to prevent larger predators from wandering in.

For testing purposes, one tube of the cage could be filled with weatherproof cast pellets, net remnants or loose lines, as amphipods prefer to reside in such a system of gaps and spaces.

In contrast, the oyster crate was successfully collecting amphipod species in high abundances.

6.4 Plankton

As a result of the zooplankton assessments in both ports in spring and summer 2017, 59 different taxa had been found. Out of these 59 taxa, 29 had been analyzed down to the species and subspecies level and 8 down to the genus level. The remaining taxa were assigned to higher taxonomic levels.

Analyses of specific groups of the meroplanktonic larvae down to the genus or species level require high preparative efforts. A good example are the nauplius stages of the Cirripedia: In order to ensure an unambiguous identification on the species level, almost all individuals have repeatedly to be turned around with the dissecting needle. In many cases, they even have to be isolated and separately examined under the light microscope with a higher magnification, because certain characteristics cannot be identified with the normal stereo microscope (Ross et al. 2003, Conway 2012). Apart from the shape and construction of the labrum, the size of the individuals as well as the length ratios of the thoracic extensions are decisive characteristics that have to be determined with considerable effort. This holds also for many

other taxonomic groups and subgroups such as the different larval stages of annelida, malacostraca, gastropoda, bivalvia or echinodermata.

Furthermore, some holoplanktonic members of the branchiopods and copepods can only be unambiguously determined on the species level with higher efforts and at higher magnifications of the microscope. Even then, some nauplius stages of the copepods cannot completely be identified on this level.

In order to achieve the goal of identifying all individuals on the species level, enormous efforts will have to be made, often requiring several days for a complete analysis of a sample. And especially for the central issue, the search for non-indigenous species, it will furthermore be necessary to analyze a high number of individuals.

Exemplary analyses of the Kiel samples at higher magnifications have shown that in most cases *Acartia bifilosa* had been the dominant species in spring and summer samples, which had been quantified as genus Acartia only. In July, also individuals of *Acartia tonsa* had been found in small amounts. This is a non-indigenous species that invaded the North Sea in the 1930s and the Baltic Sea in the 1980s. The species is classified as invader of the category 3 (Lackschewitz et al. 2015). Another species occurring in the Baltic Sea is *Acartia longiremis*. This species had not been found in the samples.

The genus Pseudocalanus can also not be analyzed on the species level without additional preparative efforts. In the investigated area of the Baltic Sea, the two species *Pseudocalanus elongatus* and *P. acuspes* can may occur. Both species are similar with regard to their morphological characteristics, but their ecological preferences are different.

In addition to the species *Acartia tonsa* mentioned above, the zebra mussel (*Dreissena polymorpha*) is classified as a non-indigenous species (Lackschewitz et al. 2015). The veliger stage of the zebra mussel had been found in small numbers in all July samples of the port of Hamburg. This species originates from the ponto-Caspian region and invaded the North and Baltic Sea in the 19th century.

6.5 Observations and comments on applied monitoring methods

The following table summarizes observations and lessons learned during the assessment of non-indigenous species (NIS) in the Ports of Hamburg and Kiel in 2017.

Table 28: Observations and "lessons learned" during the assessment of NIS in the harbors of Hamburg and Kiel in 2017.

Parameter/ Method	Implementation		Observation/ Rekommandation
	Pros	Cons	
Plankton & Human Pathogens			
Phytoplankton	Easily to collect		Vertical sampling may be hindered by strong tidal currents. Thus, sampling should be performed during slag water in harbors impacted by tides.
Zooplankton	Easily to collect		Vertical sampling may be hindered by strong tidal currents. Thus, sampling should be performed during slag water in harbors impacted by tides.
Human Pathogens	Easily to collect	Logistics partly challenging	Samples have to be stored cool (on ice) and should be delivered as quickly as possible to the analyzing laboratory.
Rapid Assessment			
Visual inspection of occurring substrates and habitats	Easily to conduct, when performed by experienced taxonomists.	Logistics partly challenging; time consuming in big harbors with several locations incl. different access restrictions and access authorizations	Coordination and permits: Sampling locations and dates have to be carefully chosen, coordinated and harmonized with the responsible harbor masters, agencies and/ or port authorities as a precondition of the successful survey performance. Individual locations often require individual access permissions and are difficult to access without support of the person in charge. Harbors impacted by tides: Comparably small time slots for sampling all parameters and installing settlement plates and traps in harbors that are impacted by tides often require an enormous logistic effort in the provision of sufficient experienced personal and/or

Parameter/ Method	Implementation		Observation/ Rekommandation
	Pros	Cons	
			time. Usually, the assessment of all monitoring parameters required one day each at individual harbor site, performed by four to five scientists.
Infauna (Ekman-Birge grab)	Moderately to conduct	Some problems, depending on substrate type and tidal currents	Successful sampling by means of the small grab is dependent on the type of substrate, since the weight of the grab may be too light to penetrate or close in soil in less cohesive sediments such as e.g. fine sand. Strong tidal currents may hinder the application of the grab because of the light weight.
Epibenthos (sratch sampling)	Easily to conduct		All suitable substrates should be sampled in consideration of different exposure to water movement (sheltered versus exposed habitats) caused by e.g. tidal currents, boat wakes, wind induced waves, etc.).
Fouling organisms (settlement plates)	Easily to install, successful in species collection	Problems in areas exposed to strong water movements (tidal currents and waves) as well as strong siltation	Location for installation of settlement plates have to be carefully chosen in order to prevent damage or loss of plates. Aspects that have to be considered when choosing an adequate installation site for the successful retrieval of plates are: -installation site should be protected for the general public in order to prevent movement or damage of plates -cordage or rope for plate installation should be protected from shaving or rubbing (e.g. by plastic tube) to prevent breaking.

Parameter/ Method	Implementation		Observation/ Rekommandation
	Pros	Cons	
Mobile Epifauna			
Light weight traps (Chinese crab box trap and Gee's minnow trap)	Easy deployment and handling	Sampling success only in certain cases / fishing quota	Sampling success is generally very low. In order to improve sampling success of traps the character of bait should be carefully chosen. E.g. rotten fish might be more successful/ attracting than fresh/ or initially frozen fish. An additional bright light that can be deployed in the traps may further attract organisms at night. Time span of trap deployment may have to be increased in order to increase sampling success. In contrast, an increase in trap deployment time may increase the costs of personnel, as an additional visit for trap retrieval might become necessary.
Oyster crate	Very effective habitat trap for small crustaceans	Slightly unwieldy; heavy, during trap retrieval/lifting out of water.	Traps may become heavier by the time of retrieval due to siltation during deployment. Trap emptying is comparably time consuming because of small shell debris and broken ceramic flowerpot parts that are carefully rinsed in order to detect all organisms inhabiting the trap habitat. Both, retrieval as well as emptying of traps may be conducted by two persons to facilitate and accelerate work process.
Crab condo	Easy deployment	Time consuming in trap construction. Bad sampling/ fishing quota for small crustaceans.	Construction of the crab condo is comparably time consuming and complicated. Traps were partly effective in catching fish that were inhabiting tubes. Plastic tubes did not attract crabs or amphipods. Diameter of tubes seem to be too big for amphipod attraction. A filling of netting or hairballs or similar

Parameter/ Method	Implementation		Observation/ Rekommandation
	Pros	Cons	
			may be more effective in attracting small crustaceans, such as amphipods.

7 Acknowledgements

We would like to thank the following port authorities and companies for access to their facilities and assistance during the survey as well as for port information: Hamburg Port Authority (Portfolio Asset Management, Claas Biermann; Fahrzeug- und Gerätebetrieb, Markus Karp), Thyssenkrupp Marine Systems GmbH (Fire Brigade/Yard Security Services, Renke Gosch & Carolin Ehrlich); Wasserstraßen- und Schifffahrtsamt Kiel-Holtenau (Petra Rinner), Marinestützpunktkommando Kiel, Hafenkapitän (Rüdiger Wippich).

We are grateful to the following colleagues for strong field assistance in trapping and sorting of organisms as well as the performed taxonomy during this survey: Felix Hoffmann, Dr. Anna Dietrich, Lisa Schüler, Sonja Graf, Stefanie Breyer and Frank Gloede.

8 Literature

Buschbaum, C., Lackschewitz, D. & Reise, K. (2012). Nonnative macrobenthos in the Wadden Sea ecosystem. Ocean & Coastal Management 68: 89-101.

Cariton, J.T. & Geller, J.B. (1993). Ecological roulette: The global transport of nonindigenous marine organisms. Science 261 (5117): 78-82.

Carlton, J.T. (1985). Transoceanic and interoceanic dispersal of coastal marine organisms: the biology of ballast water. Oceanography and Marine Biology: An Annual Review 23: 313-371.

Conway, D. V. P. (2012). Marine zooplankton of southern Britain. Part 2: Arachnida, Pycnogonida, Cladocera, Facetotecta, Cirripedia and Copepoda (ed. A.W.G. John). Occasional Publications. Marine Biological Association of the United Kingdom, No 26 Plymouth, United Kingdom 163 pp.

Coutts, A.D.M., Moore, K.M. & Hewitt, C.L. (2003). Ships' sea-chests: an overlooked transfer mechanism for non-indigenous marine species? Marine Pollution Bulletin 46 (11): 1510-1513.

Fowler, A.E., Forsström, T., von Numers, M. & Vesakoski, O. (2013). The North American mud crab *Rhithropanopeus harrisii* (Gould, 1841) in newly colonized Northern Baltic Sea: distribution and ecology. Aquatic Invasions 8 (1): 89-96.

Gittenberger, A., Rensing, M., Stegenga, H. & Hoeksma, B. (2010). Native and non-native species of hard substrata in the Dutch Wadden Sea. Nederlandse Faunistische Mededelingen 33: 21-75.

Grosholz, E. (2002). Ecological and evolutionary consequences of coastal invasions. Trends in Ecology & Evolution 17 (1): 22-27.

HELCOM (2013a). Joint Harmonised Procedure for the Contracting Parties of HELCOM and OSPAR on the granting of exemptions under International Convention for the Control and Management of Ships' Ballast Water and Sediments, Regulation A-4, 51 S.

HELCOM (2013b). Joint HELCOM/OSPAR Guidelines on the granting of exemptions under the International Convention for the Control and Management of Ships' Ballast Water and Sediments, Regulation A-4. 2013 HELCOM Ministerial Declaration.

HELCOM (2017). Manual for marine monitoring in the COMBINE programme of HELCOM. http://www.helcom.fi/action-areas/monitoring-and-assessment/manuals-and-guidelines/combine-manual.

Hewitt, M.J. & McDonald, J.I. (2013). The efficacy of crab condos in capturing small crab species and their use in invasive marine species monitoring. Management of Biological Invasions 4 (2): 149-153.

IfAÖ (2017). Neobiota-Erfassung an ‚Hot Spots' der Neubesiedlung in niedersächsischen Küstengewässern - Forschungsbericht 2016. Auftraggeber: Nationalparkverwaltung Niedersächsisches Wattenmeer, 64 S.

Lackschewitz, D., Reise, K., Buschbaum, C., Karez, R. (2015). Neobiota in deutschen Küstengewässern - Eingeschleppte und kryptogene Tier- und Pflanzenarten an der deutschen Nord- und Ostseeküste, 2014. LLUR SH - Gewässer D 25, Landesamt für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein, 216 pp.

LUNG (Hrsg) (2017). Pilotstudie zur Erfassung und Bewertung von nicht- einheimischen Arten (Neobiota) nach den Vorgaben der Meeresstrategie-Rahmenrichtlinie und der HELCOM in Küstengewässern Mecklenburg-Vorpommerns. BIOCONSULT Schuchardt & Scholle GbR Bremen. Auftraggeber: Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern (LUNG), Güstrow, 63 S.

Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M. & Bazzaz, F.A. (2000). Biotic invasions: causes, epidemiology, global consequences and control. Ecological Applications 10 (3): 689-710.

Rohde, S., Markert, A., Schupp, P. & Wehrmann, A. (2015). Neobiota-Basislinie in niedersächsischen Küstengewässern. Bericht erstellt im Auftrag des NLWKN und NLPV, 80 S.

Ross, P. M., M. T. Burrows, S. J. Hawkins, A. J. Southward, & K. P. Ryan (2003). A Key for the Identification of the Nauplii of Common Barnacles of the British Isles, with Emphasis on Chthamalus. Journal of Cruastacean Biology, 23(2): 328–340.

Ugland, K.I., Gray J.S. & K.E. Ellingsen (2003). The species-accumulation curve and estimation of species richness. Journal of Animal Ecology, 72, 888-897).

Wilcove, D.S., Rothstein, D., Dubow, J., Phillips, A. & Losos, E. (1998). Quantifying threats to imperiled species in the United States. BioScience 48 (8): 607-615.

WoRMS Editorial Board (2018). World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Accessed 2018-01-10. doi:10.14284/170

9 Appendix

9.1 Port of Hamburg

Table 29: List of all taxa, number of species and percentage of NIS at individual harbor sites in the Port of Hamburg in 2017. *Yellow* highlighted: Non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Animalia				
Bryozoa				
Plumatella repens				●
Chelicerata				
Acari indet.	●			
Cnidaria				
Cordylophora caspia	●	●	●	●
Hydra sp.		●	●	●
Hydrozoa indet.	●	●	●	
Collembola				
Collembola indet.				●
Crustacea				
Alona quadrangularis	●	●	●	●
Aoridae gen. sp.		●		
Bosmina (Bosmina) longirostris	●	●	●	●
Bosmina (Eubosmina) coregoni	●	●	●	●
Ceriodaphnia sp.	●	●	●	●
Chelicorophium curvispinum	●	●	●	●
Chelicorophium robustum	●	●	●	●
Chydorus sphaericus	●	●	●	●
Copepoda indet.	●	●	●	●
Corophium multisetosum	●			
Crangonidae gen. sp.	●			
Cyclopidae gen. sp.	●	●	●	●
Daphnia sp.	●	●	●	●
Daphnia cucullata	●	●	●	●
Diaphanosoma brachyurum	●	●	●	●
Diaptomidae gen. sp.		●	●	●
Dikerogammarus sp.			●	
Dikerogammarus haemobaphes			●	
Dikerogammarus villosus		●	●	
Disparalona rostrata		●	●	
Eriocheir sinensis	●	●	●	●
Eurytemora affinis	●	●	●	●
Eurytemora velox			●	
Gammaridea indet.		●	●	●
Gammarus tigrinus	●	●	●	●
Gammarus zaddachi	●			●
Harpacticoida indet.	●	●		●
Ilyocryptus sordidus	●	●	●	●

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Jaera (Jaera) albifrons agg.			●	
Leptodora kindtii	●	●	●	●
Leydigia acanthocercoides		●	●	●
Ligia oceanica				●
Macrothrix laticornis	●	●	●	●
Neomysis integer	●			
Obesogammarus crassus	●			
Ostracoda indet.			●	●
Palaemon elegans	●	●		●
Hirudinea				
Erpobdella octoculata			●	
Erpobdella vilnensis			●	
Piscicolidae gen. sp.			●	
Insecta				
Chironomidae gen. sp.		●	●	●
Chironomini gen. sp.			●	●
Chironomus sp.			●	
Chironomus (Lobochironomus) sp.			●	
Chironomus (Microchironomus) sp.				●
Chironomus plumosus-Gruppe			●	
Chironomus riparius-Gruppe			●	
Cladotanytarsus sp.			●	
Cricotopus (Cricotopus) sp.		●	●	
Cricotopus (Isocladius) sp.			●	
Cricotopus (Isocladius) intersectus-Gruppe		●	●	●
Dicrotendipes sp.	●	●	●	●
Dolichopodidae gen. sp.				●
Glyptotendipes pallens/glaucus		●		
Limnophyes sp.	●	●	●	
Limoniidae gen. sp.		●		
Nanocladius sp.	●	●	●	●
Paratanytarsus sp.			●	
Polypedilum (Polypedilum) nubeculosum			●	
Procladius sp.			●	●
Psectrocladius sordidellus/limbatellus	●			
Tanypus punctipennis			●	●
Tanytarsus sp.			●	
Thalassosmittia thalassophila	●			
Tipulidae gen. sp.	●			
Mollusca				
Anodonta cygnea		●		
Corbicula fluminea			●	●
Dreissena sp.	●	●	●	●
Dreissena bugensis		●	●	●
Dreissena polymorpha	●	●	●	●
Peringia ulvae				●

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Pisidium sp.			●	
Pisidium casertanum			●	
Pisidium henslowanum			●	
Pisidium nitidum				●
Potamopyrgus antipodarum			●	
Nematoda				
Nematoda indet.	●		●	●
Oligochaeta				
Chaetogaster sp.		●	●	●
Enchytraeidae gen. sp.	●	●	●	
Limnodrilus claparedianus		●	●	●
Limnodrilus hoffmeisteri	●	●	●	●
Naididae gen. sp.			●	●
Naidinae gen. sp.		●	●	
Nais sp.		●	●	
Nais bretscheri		●	●	
Nais elinguis		●	●	
Nais stolci		●		
Oligochaeta indet.	●	●	●	●
Paranais litoralis	●	●		
Potamothrix sp.			●	
Potamothrix hammoniensis				●
Potamothrix moldaviensis			●	●
Psammoryctides albicola			●	●
Psammoryctides barbatus			●	●
Quistadrilus multisetosus			●	
Stylaria lacustris		●	●	●
Tubificinae gen. sp.		●	●	●
Pisces				
Blicca bjoerkna		●		
Gymnocephalus cernua	●			
Pisces indet.		●		
Platyhelminthes				
Rhabditophora indet.		●	●	
Polychaeta				
Hypania invalida		●	●	●
Laonome sp. nov.				●
Marenzelleria neglecta			●	
Protodorvillea kefersteini	●			
Porifera				
Porifera indet.				●
Rotifera				
Asplanchna sp.	●	●	●	●
Brachionus calyciflorus calyciflorus	●	●	●	●
Brachionus leydigii	●	●	●	●
Brachionus pala	●	●	●	●

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Brachionus quadridentatus	●	●	●	●
Brachionus urceolaris	●	●	●	●
Kellicottia bostoniensis	●			
Keratella quadrata	●	●	●	●
Bacteria				
Cyanobacteria				
Aphanizomenon sp.	●	●	●	●
Chroococcales indet.		●		
Chroococcus sp.			●	
Cuspidothrix issatschenkoi			●	●
Cyanobacteria indet. (Filament)		●	●	●
Dolichospermum spiroides	●		●	
Lemmermanniella sp.			●	
Merismopedia tenuissima			●	
Microcystis sp.	●	●		●
Microcystis aeruginosa			●	
Oscillatoria limosa			●	
Pseudanabaena sp.		●	●	●
Chromista				
Bacillariophyceae				
Actinocyclus normanii	●	●	●	●
Actinoptychus senarius				●
Asterionella formosa	●	●	●	●
Aulacoseira ambigua	●	●	●	●
Aulacoseira granulata	●	●	●	●
Coscinodiscus radiatus		●		●
Cyclotella sp.	●	●	●	●
Diatoma tenuis			●	
Fragilaria crotonensis	●	●	●	●
Melosira sp.		●	●	●
Nitzschia acicularis	●	●	●	
Paralia sulcata	●	●	●	●
Pennales indet.		●		
Schlauchdiatomeen indet.	●	●		
Surirella sp.			●	●
Synedra sp.		●	●	●
Tabellaria sp.		●		
Thalassiosira sp.			●	
Chrysophyceae				
Dinobryon divergens			●	●
Synura sp.			●	
Cryptophyta				
Plagioselmis sp.		●	●	●
Rhodomonas sp.		●		

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Dictyochophyceae				
Dictyocha speculum				●
Dinophyceae				
Ceratium furcoides		●		●
Peridiniales indet.	●			
Peridinium sp.		●	●	●
Plantae				
Charophyta				
Closterium sp.	●			
Closterium acutum		●	●	●
Spirogyra sp.				●
Staurastrum sp.	●		●	●
Chlorophyta				
Actinastrum hantzschii	●	●	●	●
Acutodesmus acuminatus	●	●	●	●
Acutodesmus obliquus		●	●	●
Binuclearia lauterbornii				●
Carteria sp.				●
Chlamydomonas sp.	●	●	●	●
Chlorophyta indet.	●	●	●	
Cladophora sp.		●		
Cladophora glomerata		●	●	●
Coelastrum astroideum	●	●	●	●
Crucigeniella irregularis	●		●	●
Desmodesmus armatus	●	●	●	
Desmodesmus communis	●	●	●	●
Desmodesmus denticulatus	●		●	●
Desmodesmus opoliensis	●	●	●	●
Dictyospaerium sp.	●			●
Lemmermannia komarekii			●	
Micractinium pusillum	●		●	●
Micractinium quadrisetum	●	●	●	●
Monactinus simplex		●	●	●
Monoraphidium arcuatum	●	●	●	●
Monoraphidium contortum	●	●	●	●
Monoraphidium convolutum			●	●
Oocystis sp.		●	●	●
Pediastrum boryanum var. boryanum	●	●	●	●
Pediastrum duplex	●	●	●	●
Pseudopediastrum boryanum		●		
Selenastrum gracile	●		●	●
Sphaerocystis schroeteri	●	●		
Stauridium tetras	●	●		
Stigeoclonium sp.		●		
Tetraëdron caudatum	●	●	●	●

Taxon	Petroleum-hafen	Seemanns-höft	Alte Süderelbe	Hansa-hafen
Tetraëdron minimum		●		
Tetrastrum staurogeniaeforme	●	●	●	●
Treubaria sp.	●	●	●	●
Ulva sp.			●	
Willea crucifera	●			
Rhodophyta				
Audouinella sp.		●		
Bangia atropurpurea		●		
Protozoa				
Discomitochondria indet.	●	●	●	●
Euglena sp.	●	●		●
Phacus sp.	●			
Number of Animalia species	46	55	72	59
Number of NIS Animalia	**7**	**8**	**13**	**11**
Ratio of NIS Animalia/Animalia [%]	15	15	18	19
Number of Bacteria species	3	3	9	4
Number of NIS Bacteria	**0**	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0
Number of Chromista species	9	17	17	17
Number of NIS Chromista	**0**	**0**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	0
Number of Plantae species	25	27	28	29
Number of NIS Plantae	**0**	**0**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	0	0	0	0
Number of Protozoa species	3	2	1	2
Number of NIS Protozoa	**0**	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0
Total number of species	**86**	**104**	**127**	**111**
Total number of NIS	**7**	**8**	**13**	**11**
Ratio of all NIS/All species [%]	**8**	**8**	**10**	**10**

Table 30: List of all taxa, number of species and percentage of NIS found with the different sampling methods at all harbor sites in the Port of Hamburg in 2017. PP = phytoplankton; ZP = zooplankton; SS = soft sediment; HS = hard substrate (scratch samples and Rapid Assessment); SP = settlement plates; TR = traps. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Port of Hamburg	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Animalia						
Bryozoa						
Plumatella repens				●		●
Chelicerata						
Acari indet.				●		
Cnidaria						
Cordylophora caspia			●	●	●	●
Hydra sp.			●	●	●	
Hydrozoa indet.		●				
Collembola						
Collembola indet.			●			
Crustacea						
Alona quadrangularis		●				
Aoridae gen. sp.			●			
Bosmina (Bosmina) longirostris		●				
Bosmina (Eubosmina) coregoni		●				
Ceriodaphnia sp.		●				
Chelicorophium curvispinum				●	●	●
Chelicorophium robustum			●	●	●	●
Chydorus sphaericus		●				
Copepoda indet.		●		●		
Corophium multisetosum				●		
Crangonidae gen. sp.		●				
Cyclopidae gen. sp.		●				
Daphnia sp.		●				
Daphnia cucullata		●				
Diaphanosoma brachyurum		●				
Diaptomidae gen. sp.		●				
Dikerogammarus sp.				●		
Dikerogammarus haemobaphes			●	●		
Dikerogammarus villosus				●		●
Disparalona rostrata		●				
Eriocheir sinensis			●	●		●
Eurytemora affinis		●				
Eurytemora velox		●				
Gammaridea indet.		●				
Gammarus tigrinus			●	●	●	●
Gammarus zaddachi				●		●
Harpacticoida indet.		●				
Ilyocryptus sordidus		●				

Port of Hamburg	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Jaera (Jaera) albifrons agg.			●			
Leptodora kindtii		●				
Leydigia acanthocercoides		●				
Ligia oceanica						●
Macrothrix laticornis		●				
Neomysis integer		●				
Obesogammarus crassus				●		
Ostracoda indet.		●		●		
Palaemon elegans						●
Hirudinea						
Erpobdella octoculata				●		
Erpobdella vilnensis				●		
Piscicolidae gen. sp.				●		
Insecta						
Chironomidae gen. sp.		●				
Chironomini gen. sp.				●		
Chironomus sp.			●			
Chironomus (Lobochironomus) sp.				●		
Chironomus (Microchironomus) sp.			●			
Chironomus plumosus-Gruppe			●			
Chironomus riparius-Gruppe			●			
Cladotanytarsus sp.			●	●		
Cricotopus (Cricotopus) sp.				●	●	
Cricotopus (Isocladius) sp.				●		
Cricotopus (Isocladius) intersectus-Gruppe				●		
Dicrotendipes sp.			●	●	●	●
Dolichopodidae gen. sp.				●		
Glyptotendipes pallens/glaucus				●		
Limnophyes sp.				●		
Limoniidae gen. sp.				●		
Nanocladius sp.			●	●	●	●
Paratanytarsus sp.				●		
Polypedilum (Polypedilum) nubeculosum			●			
Procladius sp.			●			●
Psectrocladius sordidellus/limbatellus				●		
Tanypus punctipennis			●			
Tanytarsus sp.			●	●		
Thalassosmittia thalassophila				●		
Tipulidae gen. sp.				●		
Mollusca						
Anodonta cygnea						●
Corbicula fluminea			●	●		●
Dreissena sp.				●	●	●
Dreissena bugensis			●	●		●
Dreissena polymorpha		●	●	●	●	●

Port of Hamburg	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Peringia ulvae						●
Pisidium sp.			●			
Pisidium casertanum			●			
Pisidium henslowanum			●			
Pisidium nitidum						●
Potamopyrgus antipodarum			●	●		
Nematoda						
Nematoda indet.				●		
Oligochaeta						
Chaetogaster sp.				●		
Enchytraeidae gen. sp.			●	●		
Limnodrilus claparedianus			●	●		●
Limnodrilus hoffmeisteri			●	●		●
Naididae gen. sp.			●			
Naidinae gen. sp.				●		
Nais sp.				●		
Nais bretscheri			●	●		
Nais elinguis			●	●	●	
Nais stolci				●		
Oligochaeta indet.		●				
Paranais litoralis				●		
Potamothrix sp.			●			
Potamothrix hammoniensis						●
Potamothrix moldaviensis			●	●		
Psammoryctides albicola			●	●		
Psammoryctides barbatus			●	●		
Quistadrilus multisetosus			●			
Stylaria lacustris		●	●	●	●	
Tubificinae gen. sp.			●	●		●
Pisces						
Blicca bjoerkna						●
Gymnocephalus cernua						●
Pisces indet.		●				
Platyhelminthes						
Rhabditophora indet.		●			●	
Polychaeta						
Hypania invalida			●	●		
Laonome sp. nov.			●	●		
Marenzelleria neglecta			●			
Protodorvillea kefersteini				●		
Porifera						
Porifera indet.				●		
Rotifera						
Asplanchna sp.		●				
Brachionus calyciflorus calyciflorus		●				

Port of Hamburg	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Brachionus leydigii		●				
Brachionus pala		●				
Brachionus quadridentatus		●				
Brachionus urceolaris		●				
Kellicottia bostoniensis		●				
Keratella quadrata		●				
Bacteria						
Cyanobacteria						
Aphanizomenon sp.	●					
Chroococcales indet.	●					
Chroococcus sp.	●					
Cuspidothrix issatschenkoi	●					
Cyanobacteria indet. (Filament)	●					
Dolichospermum spiroides	●					
Lemmermanniella sp.	●					
Merismopedia tenuissima	●					
Microcystis sp.	●					
Microcystis aeruginosa	●					
Oscillatoria limosa	●					
Pseudanabaena sp.	●					
Chromista						
Bacillariophyceae						
Actinocyclus normanii	●					
Actinoptychus senarius	●					
Asterionella formosa	●					
Aulacoseira ambigua	●					
Aulacoseira granulata	●					
Coscinodiscus radiatus	●					
Cyclotella sp.	●					
Diatoma tenuis	●					
Fragilaria crotonensis	●					
Melosira sp.	●			●		
Nitzschia acicularis	●					
Paralia sulcata	●					
Pennales indet.	●					
Schlauchdiatomeen indet.				●		
Surirella sp.	●					
Synedra sp.	●					
Tabellaria sp.				●		
Thalassiosira sp.	●					
Chrysophyceae						
Dinobryon divergens	●					
Synura sp.	●					

Port of Hamburg	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Cryptophyta						
Plagioselmis sp.	●					
Rhodomonas sp.	●					
Dictyochophyceae						
Dictyocha speculum	●					
Dinophyceae						
Ceratium furcoides	●					
Peridiniales indet.	●					
Peridinium sp.	●					
Plantae						
Charophyta						
Closterium sp.	●					
Closterium acutum	●					
Spirogyra sp.				●		
Staurastrum sp.	●					
Chlorophyta						
Actinastrum hantzschii	●					
Acutodesmus acuminatus	●					
Acutodesmus obliquus	●					
Binuclearia lauterbornii	●					
Carteria sp.	●					
Chlamydomonas sp.	●					
Chlorophyta indet.				●		
Cladophora sp.				●	●	
Cladophora glomerata				●		
Coelastrum astroideum	●					
Crucigeniella irregularis	●					
Desmodesmus armatus	●					
Desmodesmus communis	●					
Desmodesmus denticulatus	●					
Desmodesmus opoliensis	●					
Dictyospaerium sp.	●					
Lemmermannia komarekii	●					
Micractinium pusillum	●					
Micractinium quadrisetum	●					
Monactinus simplex	●					
Monoraphidium arcuatum	●					
Monoraphidium contortum	●					
Monoraphidium convolutum	●					
Oocystis sp.	●					
Pediastrum boryanum var. *boryanum*	●					
Pediastrum duplex	●					
Pseudopediastrum boryanum	●					
Selenastrum gracile	●					

Port of Hamburg	Plankton		Benthos			
Taxon	**PP**	**ZP**	**SS**	**HS**	**SP**	**TR**
Sphaerocystis schroeteri	●					
Stauridium tetras	●					
Stigeoclonium sp.				●		
Tetraëdron caudatum	●					
Tetraëdron minimum	●					
Tetrastrum staurogeniaeforme	●					
Treubaria sp.	●					
Ulva sp.				●		
Willea crucifera	●					
Rhodophyta						
Audouinella sp.				●		
Bangia atropurpurea				●	●	
Protozoa						
Discomitochondria indet.	●					
Euglena sp.	●					
Phacus sp.	●					
Number of Animalia species	0	35	38	54	12	24
Number of NIS Animalia	0	1	12	14	5	10
Ratio of NIS Animalia/Animalia [%]	0	3	32	26	42	42
Number of Bacteria species	9	0	0	0	0	0
Number of NIS Bacteria	0	0	0	0	0	0
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0	0	0
Number of Chromista species	23	0	0	2	0	0
Number of NIS Chromista	0	0	0	0	0	0
Ratio of NIS Chromista/Chromista [%]	0	0	0	0	0	0
Number of Plantae species	34	0	0	6	2	0
Number of NIS Plantae	0	0	0	0	0	0
Ratio of NIS Plantae/Plantae [%]	0	0	0	0	0	0
Number of Protozoa species	3	0	0	0	0	0
Number of NIS Protozoa	0	0	0	0	0	0
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0	0	0
Total number of species	**69**	**35**	**38**	**62**	**14**	**24**
Total number of NIS	**0**	**1**	**12**	**14**	**5**	**10**
Ratio of all NIS/All species [%]	**0**	**3**	**32**	**23**	**36**	**42**

Table 31: List of all phytoplankton taxa, number of species and percentage of NIS at individual harbor sites in the Port of Hamburg in 2017. SP: spring; SU: summer. Higher taxa were not counted if associated species were identified as well.

Port of Hamburg	Petroleum-hafen		Seemanns-höft		Alte Süderelbe		Hansa-hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Bacteria								
Cyanobacteria								
Aphanizomenon sp.		●		●		●		●
Chroococcales indet.				●				
Chroococcus sp.						●		
Cuspidothrix issatschenkoi						●		●
Cyanobacteria indet. (Filament)			●		●		●	
Dolichospermum spiroides		●				●		
Lemmermanniella sp.						●		
Merismopedia tenuissima						●		
Microcystis sp.		●		●				●
Microcystis aeruginosa						●		
Oscillatoria limosa					●			
Pseudanabaena sp.			●		●		●	
Chromista								
Bacillariophyceae								
Actinocyclus normanii	●	●	●	●	●		●	●
Actinoptychus senarius							●	
Asterionella formosa	●		●		●		●	
Aulacoseira ambigua	●		●		●		●	
Aulacoseira granulata		●		●	●	●	●	●
Coscinodiscus radiatus			●				●	
Cyclotella sp.	●	●	●	●	●	●	●	●
Diatoma tenuis					●			
Fragilaria crotonensis		●		●	●	●	●	●
Melosira sp.			●		●		●	
Nitzschia acicularis	●		●	●	●			
Paralia sulcata		●	●	●		●	●	●
Pennales indet.				●				
Surirella sp.					●		●	
Synedra sp.				●	●	●	●	●
Thalassiosira sp.					●			
Chrysophyceae								
Dinobryon divergens					●		●	
Synura sp.					●			
Cryptophyta								
Plagioselmis sp.			●		●		●	
Rhodomonas sp.			●					
Dictyochophyceae								
Dictyocha speculum							●	
Dinophyceae								

Port of Hamburg	Petroleum-hafen		Seemanns-höft		Alte Süderelbe		Hansa-hafen	
Taxon	SP	SU	SP	SU	SP	SU	SP	SU
Ceratium furcoides				●				●
Peridiniales indet.		●						
Peridinium sp.				●		●		●
Plantae								
Charophyta								
Closterium sp.		●						
Closterium acutum			●		●		●	
Staurastrum sp.	●	●			●		●	
Chlorophyta								
Actinastrum hantzschii		●	●	●	●	●	●	●
Acutodesmus acuminatus	●	●	●	●	●	●	●	●
Acutodesmus obliquus				●		●	●	●
Binuclearia lauterbornii							●	
Carteria sp.							●	
Chlamydomonas sp.	●		●		●		●	
Coelastrum astroideum		●		●	●	●		●
Crucigeniella irregularis		●				●	●	
Desmodesmus armatus		●		●		●		
Desmodesmus communis		●		●	●	●	●	
Desmodesmus denticulatus		●				●		●
Desmodesmus opoliensis	●	●	●	●	●	●	●	●
Dictyospaerium sp.		●					●	
Lemmermannia komarekii						●		
Micractinium pusillum		●			●		●	
Micractinium quadrisetum		●		●		●		●
Monactinus simplex				●		●		●
Monoraphidium arcuatum	●		●		●		●	
Monoraphidium contortum	●	●	●	●	●	●	●	●
Monoraphidium convolutum					●		●	
Oocystis sp.				●		●		●
Pediastrum boryanum var. *boryanum*	●	●		●	●	●	●	●
Pediastrum duplex		●	●	●		●	●	●
Pseudopediastrum boryanum				●				
Selenastrum gracile		●				●	●	
Sphaerocystis schroeteri	●		●					
Stauridium tetras		●		●				
Tetraëdron caudatum		●	●			●	●	●
Tetraëdron minimum				●				
Tetrastrum staurogeniaeforme	●		●		●		●	●
Treubaria sp.		●		●		●		●
Willea crucifera		●						
Protozoa								
Discomitochondria indet.	●	●	●	●	●	●	●	●

Port of Hamburg	Petroleum-hafen		Seemanns-höft		Alte Süderelbe		Hansa-hafen	
Taxon	SP	SU	SP	SU	SP	SU	SP	SU
Euglena sp.	●		●				●	
Phacus sp.	●							
Number of Animalia species	0		0		0		0	
Number of NIS Animalia	**0**		**0**		**0**		**0**	
Ratio of NIS Animalia/Animalia [%]	0		0		0		0	
Number of Bacteria species	3		3		9		4	
Number of NIS Bacteria	**0**		**0**		**0**		**0**	
Ratio of NIS Bacteria/Bacteria [%]	0		0		0		0	
Number of Chromista species	9		16		17		17	
Number of NIS Chromista	**0**		**0**		**0**		**0**	
Ratio of NIS Chromista/Chromista [%]	0		0		0		0	
Number of Plantae species	25		23		26		27	
Number of NIS Plantae	**0**		**0**		**0**		**0**	
Ratio of NIS Plantae/Plantae [%]	0		0		0		0	
Number of Protozoa species	3		2		1		2	
Number of NIS Protozoa	**0**		**0**		**0**		**0**	
Ratio of NIS Protozoa/Protozoa [%]	0		0		0		0	
Total number of species	**40**		**44**		**53**		**50**	
Total number of NIS	**0**		**0**		**0**		**0**	
Ratio of all NIS/All species [%]	**0**		**0**		**0**		**0**	

Table 32: List of all zooplankton taxa, number of species and percentage of NIS at individual harbor sites in the Port of Hamburg in 2017. SP: spring; SU: summer. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Port of Hamburg	Petroleum-hafen		Seemanns-höft		Alte Süderelbe		Hansa-hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Animalia								
Cnidaria								
Hydrozoa indet.		●	●	●	●	●		
Crustacea								
Alona quadrangularis	●	●		●		●	●	●
Bosmina (Bosmina) longirostris	●	●	●	●	●	●	●	●
Bosmina (Eubosmina) coregoni		●		●		●		●
Ceriodaphnia sp.		●		●		●		●
Chydorus sphaericus	●		●	●	●		●	●
Copepoda indet.	●	●	●	●	●	●	●	●
Crangonidae gen. sp.		●						
Cyclopidae gen. sp.	●	●	●	●	●	●	●	●
Daphnia sp.		●	●	●	●	●	●	●
Daphnia cucullata		●		●		●		●
Diaphanosoma brachyurum		●		●		●		●
Diaptomidae gen. sp.				●		●		●
Disparalona rostrata				●		●		
Eurytemora affinis	●	●	●	●	●	●	●	●
Eurytemora velox						●		
Gammaridea indet.				●	●	●		●
Harpacticoida indet.	●	●	●	●				●
Ilyocryptus sordidus	●	●		●		●		●
Leptodora kindtii		●		●		●		●
Leydigia acanthocercoides				●		●		●
Macrothrix laticornis	●	●		●	●	●		●
Neomysis integer		●						
Ostracoda indet.						●		
Insecta								
Chironomidae gen. sp.				●		●		●
Mollusca								
Dreissena polymorpha		●		●		●		●
Oligochaeta								
Oligochaeta indet.	●	●		●	●	●	●	●
Stylaria lacustris				●				
Pisces								
Pisces indet.			●					
Platyhelminthes								
Rhabditophora indet.			●					
Rotifera								
Asplanchna sp.	●	●	●	●	●	●	●	●
Brachionus calyciflorus		●	●	●	●	●	●	●

Port of Hamburg	Petroleum-hafen		Seemanns-höft		Alte Süderelbe		Hansa-hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Brachionus leydigii	●	●	●		●		●	
Brachionus pala	●	●	●	●	●		●	
Brachionus quadridentatus		●		●		●		●
Brachionus urceolaris		●	●	●	●	●	●	●
Kellicottia bostoniensis	●							
Keratella quadrata	●		●	●	●	●	●	●
Number of Animalia species	26		30		29		26	
Number of NIS Animalia	**1**		**1**		**1**		**1**	
Ratio of NIS Animalia/Animalia [%]	4		3		3		4	
Number of Bacteria species	0		0		0		0	
Number of NIS Bacteria	**0**		**0**		**0**		**0**	
Ratio of NIS Bacteria/Bacteria [%]	0		0		0		0	
Number of Chromista species	0		0		0		0	
Number of NIS Chromista	**0**		**0**		**0**		**0**	
Ratio of NIS Chromista/Chromista [%]	0		0		0		0	
Number of Plantae species	0		0		0		0	
Number of NIS Plantae	**0**		**0**		**0**		**0**	
Ratio of NIS Plantae/Plantae [%]	0		0		0		0	
Number of Protozoa species	0		0		0		0	
Number of NIS Protozoa	**0**		**0**		**0**		**0**	
Ratio of NIS Protozoa/Protozoa [%]	0		0		0		0	
Total number of species	**26**		**30**		**29**		**26**	
Total number of NIS	**1**		**1**		**1**		**1**	
Ratio of all NIS/All species [%]	**4**		**3**		**3**		**4**	

9.2 Port of Kiel

Table 33: List of all taxa, number of species and percentage of NIS at individual harbor sites in the Port of Kiel in 2017. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Animalia			
Bryozoa			
Alcyonidiidae gen. sp.		●	●
Alcyonidioides mytili	●	●	●
Amathia gracilis	●	●	
Conopeum seurati		●	
Einhornia crustulenta	●	●	●
Electra pilosa	●	●	●
Chelicerata			
Acari indet.			●
Halacaridae gen. sp.	●	●	●
Cnidaria			
Anthoathecata indet.		●	
Anthozoa indet.	●	●	●
Bougainvillia muscus	●	●	●
Campanulariidae gen. sp.	●	●	●
Clava multicornis	●	●	●
Clytia hemisphaerica		●	●
Cordylophora caspia		●	●
Garveia franciscana			●
Gonothyraea loveni		●	●
Hydrozoa indet.	●	●	●
Metridium dianthus	●	●	
Opercularella lacerata	●	●	●
Pachycordyle navis		●	
Sarsia sp.		●	●
Crustacea			
Acartia sp.	●	●	●
Amphibalanus improvisus	●	●	●
Aoridae gen. sp.	●	●	●
Athanas nitescens	●	●	●
Balanidae gen. sp.	●		●
Balanus crenatus	●	●	●
Calliopius laeviusculus	●		●
Carcinus maenas	●	●	●
Centropages hamatus	●	●	●
Copepoda indet.	●	●	●
Corophiida indet.			●
Decapoda indet.		●	
Evadne nordmanni	●	●	●
Gammaridae gen. sp.			●
Gammaridea indet.			●

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Gammarus sp.	●	●	●
Gammarus locusta		●	
Gammarus oceanicus	●	●	●
Gammarus salinus	●	●	●
Gammarus zaddachi	●		
Grandidierella japonica		●	●
Harpacticoida indet.	●	●	●
Hemigrapsus sp.	●		
Hemigrapsus takanoi	●	●	●
Idotea balthica			●
Isopoda indet.	●		
Jaera (Jaera) albifrons agg.	●	●	●
Ligia oceanica		●	
Microdeutopus gryllotalpa	●	●	●
Monocorophium insidiosum	●	●	●
Oithona similis	●	●	●
Palaemon elegans	●	●	
Phtisica marina			●
Podon/Pleopis sp.	●	●	●
Praunus inermis	●		
Pseudocalanus sp.	●	●	●
Sessilia indet.	●	●	●
Sinelobus sp. nov.	●	●	
Stenothoe monoculoides	●		
Temora longicornis	●	●	●
Temora longicornis/Centropages hamatus	●	●	●
Echinodermata			
Asterias rubens	●	●	●
Entoprocta			
Barentsia matsushimana		●	
Insecta			
Halocladius variabilis	●	●	●
Orthocladiinae gen. sp.			●
Telmatogeton japonicus		●	●
Mollusca			
Barnea candida		●	
Bivalvia indet.	●	●	●
Brachystomia scalaris	●	●	●
Calliopaea bellula		●	
Cardiidae gen. sp.	●	●	
Corbula gibba			●
Elysia viridis	●	●	●
Flabellina sp.	●	●	●
Gastropoda indet.	●	●	●
Kurtiella bidentata	●		●
Limecola balthica	●		

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Littorina sp.	●		●
Littorina littorea	●	●	●
Musculus subpictus		●	●
Mya sp.	●	●	●
Mya truncata			●
Mytilidae gen. sp.	●	●	●
Mytilus edulis	●	●	●
Parvicardium exiguum		●	
Peringia ulvae	●	●	
Pusillina sarsii	●	●	
Retusa truncatula	●		●
Rissoidae gen. sp.		●	
Scrobicularia plana		●	
Nematoda			
Nematoda indet.	●	●	●
Nemertea			
Cephalothrix sp.			●
Lineidae gen. sp.	●	●	●
Nemertea indet.			●
Oligochaeta			
Baltidrilus costatus	●	●	
Enchytraeidae gen. sp.		●	
Paranais sp.		●	●
Paranais litoralis	●	●	
Tubificinae gen. sp.	●	●	
Tubificoides benedii	●	●	●
Pisces			
Anguilla anguilla			●
Ctenolabrus rupestris	●		
Gobiidae gen. sp.			●
Gobius niger			●
Gobiusculus flavescens	●	●	
Mugilidae gen. sp.			●
Neogobius melanostomus	●		
Platyhelminthes			
Polycladida indet.	●	●	●
Rhabditophora indet.		●	●
Polychaeta			
Alitta succinea	●	●	●
Ampharete sp.			●
Arenicola marina	●		
Bylgides sarsi		●	●
Capitella capitata agg.	●	●	●
Capitellidae gen. sp.	●		
Dipolydora quadrilobata			●
Exogone naidina	●	●	

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Fabricia stellaris			●
Fabriciidae gen. sp.			●
Fabriciola baltica	●		●
Harmothoe sp.	●	●	●
Harmothoe imbricata	●	●	●
Harmothoe impar	●	●	●
Hediste diversicolor	●	●	
Lagis koreni			●
Marenzelleria viridis	●		
Mediomastus fragilis	●	●	●
Microphthalmus sp.			●
Neanthes sp.	●		●
Neoamphitrite figulus		●	●
Nereididae gen. sp.		●	●
Nereimyra punctata			●
Pherusa plumosa			●
Pholoe sp.			●
Pholoe inornata			●
Phyllodoce sp.	●		●
Platynereis dumerilii	●	●	
Polychaeta indet.			●
Polydora ciliata	●	●	●
Polydora cornuta	●	●	●
Polynoidae gen. sp.		●	
Pygospio elegans	●	●	●
Scolelepis bonnieri	●		
Scoloplos armiger	●	●	●
Spionidae gen. sp.	●	●	●
Streblospio sp.	●		
Streblospio shrubsolii	●		
Syllidae gen. sp.	●		
Terebellides stroemii agg.			●
Trochochaeta multisetosa			●
Porifera			
Chalinidae gen. sp.	●		●
Halichondria (Halichondria) panicea	●		
Tunicata			
Ascidiacea indet.		●	●
Ascidiidae gen. sp.			●
Ciona intestinalis agg.	●	●	●
Ciona intestinalis s. str.	●	●	
Oikopleura (Vexillaria) dioica	●	●	●
Bacteria			
Cyanobacteria			
Cyanobacteria indet. (Filament)	●	●	

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Spirulina major		●	●
Spirulina subsalsa		●	
Chromista			
Bacillariophyceae			
Achnanthes sp.		●	
Actinoptychus senarius			●
Amphiprora sp.		●	
Amphora sp.			●
Asterionella formosa			●
Bacillaria paxillifera			●
Centrales indet.	●		
Chaetoceros sp.	●	●	●
Chaetoceros lorenzianus	●	●	●
Chaetoceros subtilis	●	●	●
Coscinodiscus sp.	●		
Coscinodiscus granii	●	●	●
Coscinodiscus radiatus	●	●	●
Cyclotella sp.	●	●	●
Cylindrotheca closterium	●	●	●
Dactyliosolen fragilissimus	●	●	●
Diatoma tenuis		●	
Diploneis sp.			●
Ditylum brightwellii	●	●	●
Guinardia delicatula	●	●	
Guinardia flaccida	●		
Leptocylindrus minimus	●	●	●
Licmophora sp.	●	●	●
Melosira moniliformis		●	●
Melosira nummuloides		●	●
Nitzschia sp.			●
Odontella aurita		●	
Paralia sulcata			●
Pennales indet.	●	●	●
Proboscia alata	●	●	●
Pseudo-nitzschia sp.			●
Pseudosolenia calcar-avis	●	●	
Rhizosolenia hebetata f. *semispina*	●	●	●
Rhizosolenia setigera	●	●	
Rhizosolenia setigera f. *pungens*	●	●	
Schlauchdiatomeen indet.	●	●	●
Skeletonema marinoi	●	●	●
Thalassionema nitzschioides	●	●	●
Thalassiosira sp.	●		●
Thalassiosira eccentrica	●	●	
Ciliophora			

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Mesodinium rubrum	●	●	
Cryptophyta			
Hemiselmis sp.	●	●	●
Katablepharis sp.	●		
Leucocryptos marina	●	●	
Plagioselmis sp.	●	●	●
Teleaulax sp.	●	●	●
Teleaulax acuta	●	●	●
Telonema sp.	●		
Dictyochophyceae			
Apedinella radians			●
Dictyocha speculum	●	●	●
Pseudopedinella sp.		●	
Dinophyceae			
Ceratium fusus	●	●	●
Ceratium tripos	●	●	
Dinophyceae indet.	●	●	●
Dinophysis norvegica	●	●	●
Heterocapsa triquetra	●		
Prorocentrum cordatum	●		
Prorocentrum micans			●
Protoperidinium pellucidum	●	●	●
Haptophyta			
Chrysochromulina sp.	●	●	
Phaeophyceae			
Ectocarpales indet.	●	●	●
Ectocarpus sp.			●
Ectocarpus siliculosus	●		●
Elachista fucicola	●	●	
Fucus edentatus	●	●	●
Fucus vesiculosus	●	●	●
Petalonia fascia	●		
Pylaiella littoralis	●	●	●
Saccharina latissima	●		
Spongonema tomentosum	●		
Plantae			
Chlorophyta			
Acrosiphonia sp.		●	
Binuclearia lauterbornii	●		
Blidingia sp.	●		●
Blidingia marginata	●		
Bryopsis plumosa	●	●	●
Chaetomorpha linum			●
Cladophora sp.	●	●	●
Cladophora sericea		●	

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Desmodesmus communis		●	
Kornmannia leptoderma	●		
Oocystis sp.	●	●	
Pachysphaera sp.	●		●
Pseudopediastrum boryanum		●	●
Pyramimonas sp.	●	●	●
Ulva sp.	●	●	●
Ulva intestinalis		●	
Ulva linza		●	
Ulvales indet.	●		
Rhodophyta			
Acrochaetium sp.		●	
Aglaothamnion tenuissimum	●	●	
Aglaothamnion/Callithamnion sp.	●	●	●
Callithamnion corymbosum	●	●	●
Ceramiales indet.	●		
Ceramium sp.	●	●	●
Dasya baillouviana	●		
Polysiphonia sp.		●	●
Polysiphonia fibrillosa		●	
Porphyra sp.			●
Protozoa			
Discomitochondria indet.	●	●	●
Ebria tripartita	●	●	●
Eutreptiella sp.			●
Number of Animalia species	80	79	86
Number of NIS Animalia	**6**	**8**	**6**
Ratio of NIS Animalia/Animalia [%]	8	10	7
Number of Bacteria species	1	2	1
Number of NIS Bacteria	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0
Number of Chromista species	45	42	39
Number of NIS Chromista	**1**	**1**	**1**
Ratio of NIS Chromista/Chromista [%]	2	2	3
Number of Plantae species	13	14	12
Number of NIS Plantae	**1**	**0**	**0**
Ratio of NIS Plantae/Plantae [%]	8	0	0
Number of Protozoa species	2	2	3
Number of NIS Protozoa	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0

Taxon	Tiessenkai	Tirpitzhafen	Thyssen-Krupp Hafen
Total number of species	**141**	**139**	**141**
Total number of NIS	**8**	**9**	**7**
Ratio of all NIS/All species [%]	**6**	**6**	**5**

Table 34: List of all taxa, number of species and percentage of NIS found with the different sampling methods at all harbor sites in the Port of Kiel in 2017. PP = phytoplankton; ZP = zooplankton; SS = soft sediment; HS = hard substrate (scratch samples and Rapid Assessment); SP = settlement plates; TR = traps. *Yellow* highlighted: non-indigenous species (NIS). Higher taxa were not counted if associated species were identified as well.

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Animalia						
Bryozoa						
Alcyonidiidae gen. sp.				●		
Alcyonidioides mytili			●	●	●	
Amathia gracilis			●	●		
Conopeum seurati				●		
Einhornia crustulenta				●		
Electra pilosa				●		
Chelicerata						
Acari indet.		●				
Halacaridae gen. sp.				●		
Cnidaria						
Anthoathecata indet.				●		
Anthozoa indet.				●	●	
Bougainvillia muscus					●	
Campanulariidae gen. sp.				●	●	
Clava multicornis				●		
Clytia hemisphaerica			●	●		
Cordylophora caspia				●		
Garveia franciscana			●	●		
Gonothyraea loveni				●		
Hydrozoa indet.		●				
Metridium dianthus				●		
Opercularella lacerata			●	●		
Pachycordyle navis				●		
Sarsia sp.			●	●		
Crustacea						
Acartia sp.		●				
Amphibalanus improvisus			●	●	●	
Aoridae gen. sp.			●	●		
Athanas nitescens						●
Balanidae gen. sp.				●	●	

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Balanus crenatus			●	●		
Calliopius laeviusculus				●		●
Carcinus maenas		●		●		●
Centropages hamatus		●				
Copepoda indet.		●				
Corophiida indet.		●				
Decapoda indet.			●			
Evadne nordmanni		●				
Gammaridae gen. sp.				●		
Gammaridea indet.		●				
Gammarus sp.			●	●	●	
Gammarus locusta				●		
Gammarus oceanicus				●		●
Gammarus salinus				●	●	●
Gammarus zaddachi				●		
Grandidierella japonica						●
Harpacticoida indet.		●				
Hemigrapsus sp.				●		
Hemigrapsus takanoi			●	●	●	●
Idotea balthica				●		
Isopoda indet.		●				
Jaera (Jaera) albifrons agg.				●		
Ligia oceanica				●		
Microdeutopus gryllotalpa			●	●	●	●
Monocorophium insidiosum			●	●	●	●
Oithona similis		●				
Palaemon elegans				●		
Phtisica marina					●	
Podon/Pleopis sp.		●				
Praunus inermis				●		
Pseudocalanus sp.		●				
Sessilia indet.		●				
Sinelobus sp. nov.			●	●	●	●
Stenothoe monoculoides					●	
Temora longicornis		●				
Temora longicornis/Centropages hamatus		●				
Echinodermata						
Asterias rubens				●	●	●
Entoprocta						
Barentsia matsushimana			●			
Insecta						
Halocladius variabilis			●	●	●	
Orthocladiinae gen. sp.				●		
Telmatogeton japonicus			●	●		
Mollusca						

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Barnea candida			●			
Bivalvia indet.		●		●		
Brachystomia scalaris			●		●	
Calliopaea bellula				●		
Cardiidae gen. sp.			●			
Corbula gibba			●			
Elysia viridis				●		●
Flabellina sp.					●	●
Gastropoda indet.		●				
Kurtiella bidentata			●			
Limecola balthica			●			
Littorina sp.			●	●		
Littorina littorea		●		●		●
Musculus subpictus			●	●	●	
Mya sp.			●	●		
Mya truncata						●
Mytilidae gen. sp.			●	●	●	●
Mytilus edulis			●	●	●	●
Parvicardium exiguum			●			
Peringia ulvae			●	●		
Pusillina sarsii					●	
Retusa truncatula			●			
Rissoidae gen. sp.			●			
Scrobicularia plana			●			
Nematoda						
Nematoda indet.		●		●		
Cephalothrix sp.						●
Lineidae gen. sp.				●		●
Nemertea indet.			●			
Oligochaeta						
Baltidrilus costatus			●	●		
Enchytraeidae gen. sp.				●		
Paranais sp.			●			
Paranais litoralis			●			
Tubificinae gen. sp.			●			
Tubificoides benedii			●			
Pisces						
Anguilla anguilla						●
Ctenolabrus rupestris						●
Gobiidae gen. sp.				●		
Gobius niger						●
Gobiusculus flavescens						●
Mugilidae gen. sp.				●		
Neogobius melanostomus						●
Platyhelminthes						

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Polycladida indet.					●	●
Rhabditophora indet.				●		
Polychaeta						
Alitta succinea			●	●	●	●
Ampharete sp.			●			
Arenicola marina			●			
Bylgides sarsi			●	●		
Capitella capitata agg.			●		●	●
Capitellidae gen. sp.			●			
Dipolydora quadrilobata			●			
Exogone naidina			●		●	
Fabricia stellaris			●			
Fabriciidae gen. sp.			●			
Fabriciola baltica			●			
Harmothoe sp.		●			●	●
Harmothoe imbricata			●	●		●
Harmothoe impar					●	●
Hediste diversicolor			●			
Lagis koreni			●			
Marenzelleria viridis			●			
Mediomastus fragilis			●			
Microphthalmus sp.			●			
Neanthes sp.				●		
Neoamphitrite figulus				●		
Nereididae gen. sp.			●	●		
Nereimyra punctata			●			
Pherusa plumosa						●
Pholoe sp.					●	
Pholoe inornata			●			
Phyllodoce sp.						●
Platynereis dumerilii				●	●	●
Polychaeta indet.		●				
Polydora ciliata			●	●	●	●
Polydora cornuta		●	●	●	●	●
Polynoidae gen. sp.				●		
Pygospio elegans			●			
Scolelepis bonnieri				●		
Scoloplos armiger			●			●
Spionidae gen. sp.		●	●			
Streblospio sp.			●			
Streblospio shrubsolii			●			
Syllidae gen. sp.			●			
Terebellides stroemii agg.			●			
Trochochaeta multisetosa			●			
Porifera						

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Chalinidae gen. sp.				●	●	
Halichondria (Halichondria) panicea				●		
Tunicata						
Ascidiacea indet.				●		
Ascidiidae gen. sp.		●				
Ciona intestinalis				●		
Ciona intestinalis agg.					●	●
Oikopleura (Vexillaria) dioica		●				
Bacteria						
Cyanobacteria						
Cyanobacteria indet. (Filament)	●					
Spirulina major	●					
Spirulina subsalsa	●					
Chromista						
Bacillariophyceae						
Achnanthes sp.	●					
Actinoptychus senarius	●					
Amphiprora sp.	●					
Amphora sp.	●					
Asterionella formosa	●					
Bacillaria paxillifera	●					
Centrales indet.	●					
Chaetoceros sp.	●					
Chaetoceros lorenzianus	●					
Chaetoceros subtilis	●					
Coscinodiscus sp.	●					
Coscinodiscus granii	●					
Coscinodiscus radiatus	●					
Cyclotella sp.	●					
Cylindrotheca closterium	●					
Dactyliosolen fragilissimus	●					
Diatoma tenuis	●					
Diploneis sp.	●					
Ditylum brightwellii	●					
Guinardia delicatula	●					
Guinardia flaccida	●					
Leptocylindrus minimus	●					
Licmophora sp.	●					
Melosira moniliformis	●					
Melosira nummuloides	●					
Nitzschia sp.	●					
Odontella aurita	●					
Paralia sulcata	●					

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Pennales indet.	●					
Proboscia alata	●					
Pseudo-nitzschia sp.	●					
Pseudosolenia calcar-avis	●					
Rhizosolenia hebetata f. *semispina*	●					
Rhizosolenia setigera	●					
Rhizosolenia setigera f. *pungens*	●					
Schlauchdiatomeen indet.				●		
Skeletonema marinoi	●					
Thalassionema nitzschioides	●					
Thalassiosira sp.	●					
Thalassiosira eccentrica	●					
Ciliophora						
Mesodinium rubrum	●					
Cryptophyta						
Hemiselmis sp.	●					
Katablepharis sp.	●					
Leucocryptos marina	●					
Plagioselmis sp.	●					
Teleaulax sp.	●					
Teleaulax acuta	●					
Telonema sp.	●					
Dictyochophyceae						
Apedinella radians	●					
Dictyocha speculum	●					
Pseudopedinella sp.	●					
Dinophyceae						
Ceratium fusus	●					
Ceratium tripos	●					
Dinophyceae indet.	●					
Dinophysis norvegica	●					
Heterocapsa triquetra	●					
Prorocentrum cordatum	●					
Prorocentrum micans	●					
Protoperidinium pellucidum	●					
Haptophyta						
Chrysochromulina sp.	●					
Phaeophyceae						
Ectocarpales indet.				●	●	
Ectocarpus sp.						●
Ectocarpus siliculosus				●	●	
Elachista fucicola				●		
Fucus edentatus				●		
Fucus vesiculosus				●		
Petalonia fascia				●		

Port of Kiel	Plankton		Benthos			
Taxon	**PP**	**ZP**	**SS**	**HS**	**SP**	**TR**
Pylaiella littoralis				●		
Saccharina latissima				●		
Spongonema tomentosum				●		
Plantae						
Chlorophyta						
Acrosiphonia sp.				●		
Binuclearia lauterbornii	●					
Blidingia sp.				●		
Blidingia marginata				●		
Bryopsis plumosa				●		
Chaetomorpha linum				●		
Cladophora sp.				●		
Cladophora sericea				●		
Desmodesmus communis	●					
Kornmannia leptoderma				●		
Oocystis sp.	●					
Pachysphaera sp.	●					
Pseudopediastrum boryanum	●					
Pyramimonas sp.	●					
Ulva sp.			●	●	●	●
Ulva intestinalis				●		
Ulva linza				●		
Ulvales indet.				●		
Rhodophyta						
Acrochaetium sp.				●		
Aglaothamnion tenuissimum				●		
Aglaothamnion/Callithamnion sp.				●	●	●
Callithamnion corymbosum				●		
Ceramiales indet.					●	
Ceramium sp.				●	●	●
Dasya baillouviana				●	●	●
Polysiphonia sp.				●		
Polysiphonia fibrillosa				●		
Porphyra sp.				●		
Protozoa						
Discomitochondria indet.	●					
Ebria tripartita	●					
Eutreptiella sp.	●					
Number of Animalia species	0	22	58	61	30	35
Number of NIS Animalia	**0**	**0**	**7**	**8**	**3**	**4**
Ratio of NIS Animalia/Animalia [%]	0	0	12	13	10	11

Port of Kiel	Plankton		Benthos			
Taxon	PP	ZP	SS	HS	SP	TR
Number of Bacteria species	2	0	0	0	0	0
Number of NIS Bacteria	**0**	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Bacteria/Bacteria [%]	0	0	0	0	0	0
Number of Chromista species	54	0	0	9	1	1
Number of NIS Chromista	**0**	**0**	**0**	**1**	**0**	**0**
Ratio of NIS Chromista/Chromista [%]	0	0	0	11	0	0
Number of Plantae species	6	0	1	15	4	4
Number of NIS Plantae	**0**	**0**	**0**	**1**	**1**	**1**
Ratio of NIS Plantae/Plantae [%]	0	0	0	7	25	25
Number of Protozoa species	3	0	0	0	0	0
Number of NIS Protozoa	**0**	**0**	**0**	**0**	**0**	**0**
Ratio of NIS Protozoa/Protozoa [%]	0	0	0	0	0	0
Total number of species	**65**	**22**	**59**	**85**	**35**	**40**
Total number of NIS	**0**	**0**	**7**	**10**	**4**	**5**
Ratio of all NIS/All species [%]	**0**	**0**	**12**	**12**	**11**	**13**

Table 35: List of all phytoplankton taxa, number of species and percentage of NIS at individual harbor sites in the Port of Kiel in 2017. SP: spring; SU: summer. Higher taxa were not counted if associated species were identified as well.

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	SP	SU	SP	SU	SP	SU
Bacteria						
Cyanobacteria						
Cyanobacteria indet. (Filament)	●		●			
Spirulina major			●	●	●	●
Spirulina subsalsa			●			
Chromista						
Bacillariophyceae						
Achnanthes sp.				●		
Actinoptychus senarius					●	●
Amphiprora sp.			●			
Amphora sp.					●	
Asterionella formosa					●	
Bacillaria paxillifera					●	
Centrales indet.	●					
Chaetoceros sp.	●		●		●	
Chaetoceros lorenzianus		●		●		●

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	SP	SU	SP	SU	SP	SU
Chaetoceros subtilis	●		●		●	
Coscinodiscus sp.		●				
Coscinodiscus granii		●		●		●
Coscinodiscus radiatus		●		●	●	●
Cyclotella sp.		●		●		●
Cylindrotheca closterium	●		●		●	
Dactyliosolen fragilissimus	●	●	●	●	●	●
Diatoma tenuis			●			
Diploneis sp.					●	
Ditylum brightwellii	●	●	●	●	●	●
Guinardia delicatula		●		●		
Guinardia flaccida	●					
Leptocylindrus minimus	●		●	●	●	
Licmophora sp.	●		●		●	●
Melosira moniliformis			●	●	●	
Melosira nummuloides			●		●	
Nitzschia sp.						●
Odontella aurita			●			
Paralia sulcata					●	
Pennales indet.	●	●	●		●	●
Proboscia alata	●	●	●	●	●	
Pseudo-nitzschia sp.					●	
Pseudosolenia calcar-avis	●	●		●		
Rhizosolenia hebetata f. *semispina*	●		●		●	
Rhizosolenia setigera		●		●		
Rhizosolenia setigera f. *pungens*		●	●	●		
Skeletonema marinoi	●	●	●	●	●	
Thalassionema nitzschioides	●	●	●			●
Thalassiosira sp.	●	●			●	
Thalassiosira eccentrica	●	●	●	●		
Ciliophora						
Mesodinium rubrum	●		●			
Cryptophyta						
Hemiselmis sp.	●	●	●	●	●	●
Katablepharis sp.		●				
Leucocryptos marina		●		●		
Plagioselmis sp.	●	●	●	●		●
Teleaulax sp.		●		●		●
Teleaulax acuta	●		●		●	
Telonema sp.		●				
Dictyochophyceae						
Apedinella radians						●
Dictyocha speculum	●	●	●	●	●	●
Pseudopedinella sp.			●			
Dinophyceae						

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	SP	SU	SP	SU	SP	SU
Ceratium fusus		●		●		●
Ceratium tripos		●		●		
Dinophyceae indet.	●		●		●	
Dinophysis norvegica	●			●	●	
Heterocapsa triquetra		●				
Prorocentrum cordatum		●				
Prorocentrum micans						●
Protoperidinium pellucidum	●		●		●	
Haptophyta						
Chrysochromulina sp.	●		●			
Plantae						
Chlorophyta						
Binuclearia lauterbornii	●					
Desmodesmus communis			●			
Oocystis sp.		●		●		
Pachysphaera sp.	●				●	
Pseudopediastrum boryanum			●		●	
Pyramimonas sp.		●		●		●
Protozoa						
Discomitochondria indet.	●	●	●	●	●	●
Ebria tripartita		●		●		●
Eutreptiella sp.					●	
Number of Animalia species	0		0		0	
Number of NIS Animalia	**0**		**0**		**0**	
Ratio of NIS Animalia/Animalia [%]	0		0		0	
Number of Bacteria species	1		2		1	
Number of NIS Bacteria	**0**		**0**		**0**	
Ratio of NIS Bacteria/Bacteria [%]	0		0		0	
Number of Chromista species	37		38		35	
Number of NIS Chromista	**0**		**0**		**0**	
Ratio of NIS Chromista/Chromista [%]	0		0		0	
Number of Plantae species	4		4		3	
Number of NIS Plantae	**0**		**0**		**0**	
Ratio of NIS Plantae/Plantae [%]	0		0		0	
Number of Protozoa species	2		2		3	
Number of NIS Protozoa	**0**		**0**		**0**	
Ratio of NIS Protozoa/Protozoa [%]	0		0		0	

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Total number of species	**44**		**46**		**42**	
Total number of NIS	**0**		**0**		**0**	
Ratio of all NIS/All species [%]	**0**		**0**		**0**	

Table 36: List of all zooplankton taxa, number of species and percentage of NIS at individual harbor sites in the Port of Kiel in 2017. SP: spring; SU: summer. Higher taxa were not counted if associated species were identified as well.

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Animalia						
Chelicerata						
Acari indet.						●
Cnidaria						
Hydrozoa indet.		●		●		●
Crustacea						
Acartia sp.	●	●	●	●	●	●
Carcinus maenas				●		●
Centropages hamatus	●	●	●	●	●	●
Copepoda indet.	●	●	●	●	●	●
Corophiida indet.						●
Evadne nordmanni		●		●		●
Gammaridea indet.					●	●
Harpacticoida indet.	●	●	●	●	●	
Isopoda indet.		●				
Oithona similis	●	●	●	●	●	●
Podon/Pleopis sp.		●	●		●	●
Pseudocalanus sp.	●		●	●	●	●
Sessilia indet.	●	●		●	●	●
Temora longicornis	●	●	●	●	●	●
Temora longicornis/Centropages hamatus	●	●	●	●	●	●
Mollusca						
Bivalvia indet.		●		●		●
Gastropoda indet.	●	●		●		●
Littorina littorea	●	●		●	●	
Nematoda						
Nematoda indet.					●	
Polychaeta						
Harmothoe sp.	●					
Polychaeta indet.						●
Polydora cornuta			●		●	
Spionidae gen. sp.	●	●	●	●	●	●
Tunicata						
Ascidiidae gen. sp.					●	

Port of Kiel	Tiessenkai		Tirpitzhafen		Thyssen-Krupp Hafen	
Taxon	**SP**	**SU**	**SP**	**SU**	**SP**	**SU**
Oikopleura (Vexillaria) dioica		●		●		●
Number of Animalia species	16		15		20	
Number of NIS Animalia	**0**		**0**		**0**	
Ratio of NIS Animalia/Animalia [%]	0		0		0	
Number of Bacteria species	0		0		0	
Number of NIS Bacteria	**0**		**0**		**0**	
Ratio of NIS Bacteria/Bacteria [%]	0		0		0	
Number of Chromista species	0		0		0	
Number of NIS Chromista	**0**		**0**		**0**	
Ratio of NIS Chromista/Chromista [%]	0		0		0	
Number of Plantae species	0		0		0	
Number of NIS Plantae	**0**		**0**		**0**	
Ratio of NIS Plantae/Plantae [%]	0		0		0	
Number of Protozoa species	0		0		0	
Number of NIS Protozoa	**0**		**0**		**0**	
Ratio of NIS Protozoa/Protozoa [%]	0		0		0	
Total number of species	**16**		**15**		**20**	
Total number of NIS	**0**		**0**		**0**	
Ratio of all NIS/All species [%]	**0**		**0**		**0**	