



*North  
SEE*



A North Sea Perspective on Shipping,  
Energy and Environmental Aspects  
in Maritime Spatial Planning

## **Transnational Maritime Spatial Planning in the North Sea: The Shipping Context**

Report on Work-package 4 of the NorthSEE Project



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# I. Introduction

## Objective

The two principal aims of this report are to:

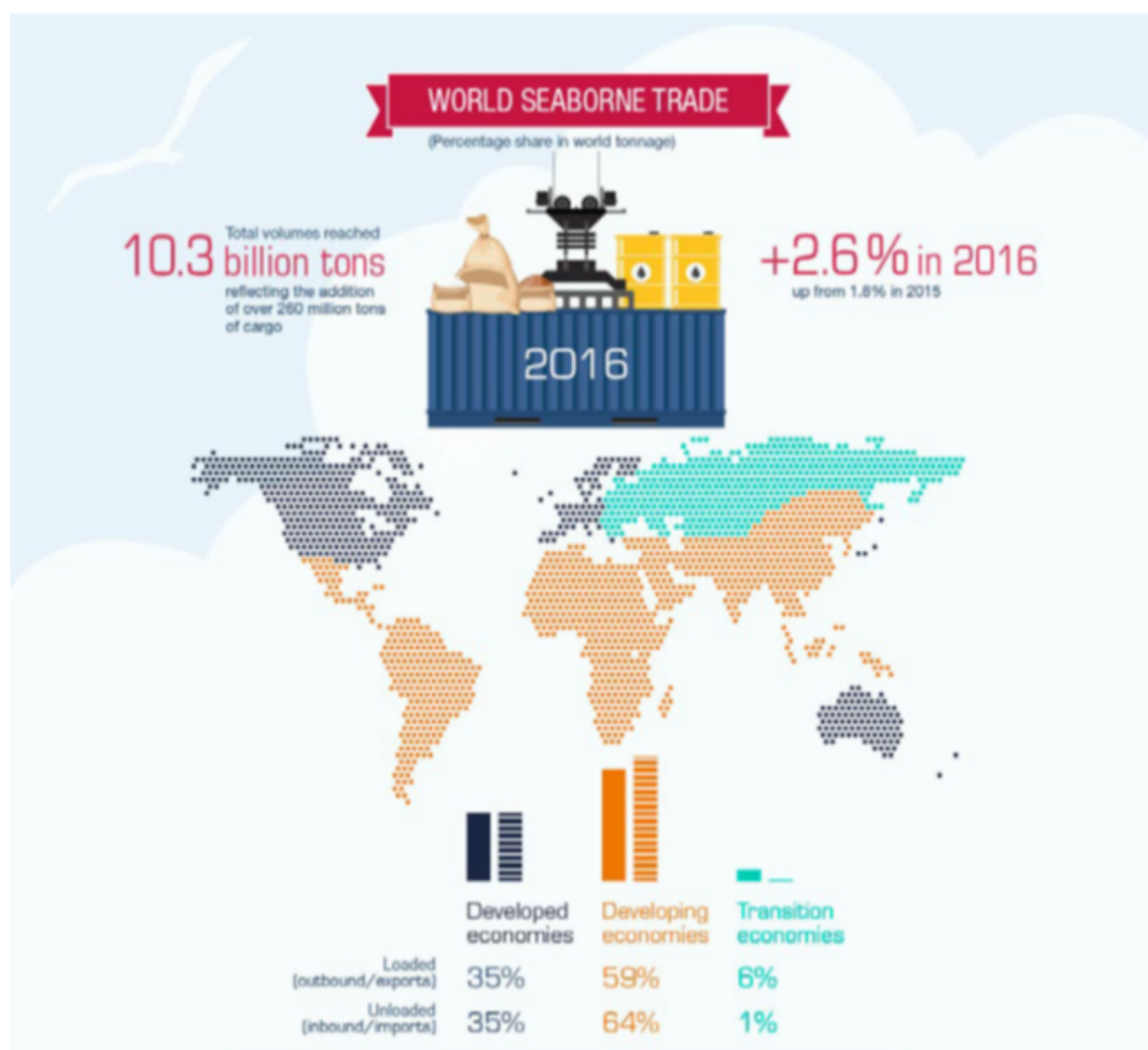
- give an overview of shipping routes currently used by vessels in the North Sea and compare them with routes described in national maritime spatial plans of the North Sea countries.
- provide an analysis of future trends of shipping and other maritime activities and how they affect each other, with emphasis on offshore wind farms.

## International geopolitical impact of shipping

The shipping industry is a global industry. Likewise, it could claim to be the industry which, more than any other makes it possible for a truly global economy to function. It connects countries, markets, businesses and people, allowing them to buy and sell goods on a scale not previously possible.

The reality is that the needs of a rapidly growing world population can only be met by transporting goods and resources between countries. The liner shipping industry has made this process more efficient and changed the shape of the world economy. This benefits consumers by creating choice, boosting economies and creating employment. Costs for the consumer are kept down and efficiencies are improved, as well as minimizing environmental impacts.

Approximately 90% of the world's trade is done by ships (according to the International Maritime



Unctad, review maritime transport, 2017

Organization). Shipping is dynamic and changes according to fluctuations in the economy, changing trade types and trade routes continuously. With the changing climate, shipping will also need to adapt to changes and take advantages of new routes and regulations. Some shipping trends however, have and are likely to stay the same in the immediate future. For instance, resources from the developing world and consumer products from Asia are generally shipped to Europe and North America for sale and consumption (REF).

2/3 of the seaborne trade is dry cargo. Most of these goods are coal and iron, transported by bulk carriers around the world. Other dry goods are shipped by containers in large container vessels who do mostly east-west routes.

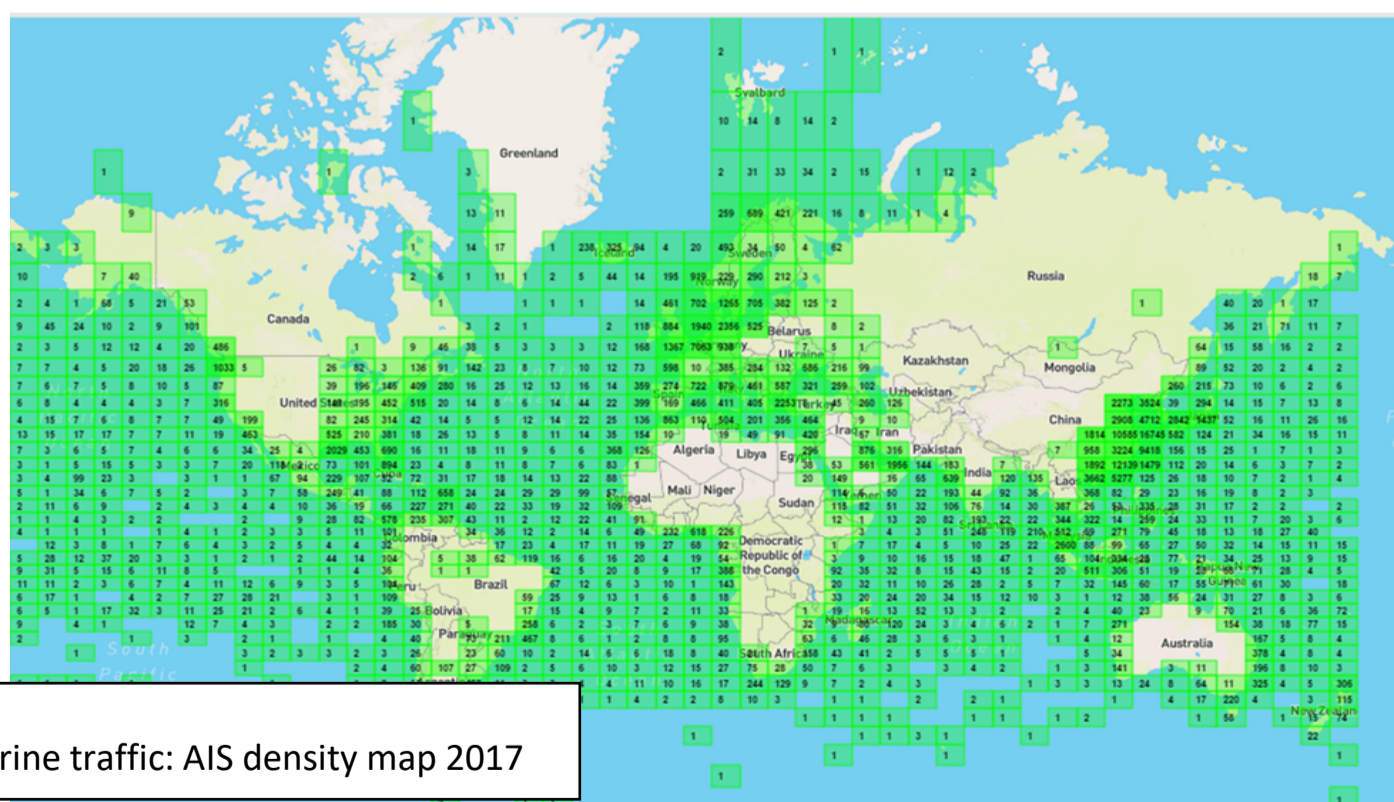
Did You Know?

**Shipping is the lifeblood of the world's economy**

If all ships should disappear by tomorrow, half the world would freeze to death because of the lack of energy and half the world would starve to death because of the lack of food.



The nature of demand and supply of goods means that ships sail all over the world and the distribution of goods are different for different areas. This has an equal implication on traffic routes and congestion for shipping. With over 7.600 ships passing through hotspot areas of the North Sea region, it happens to be one of the busiest shipping grounds in the world, only behind the South China Sea. The following map shows the amount of ships passing globally in just one day.



Marine traffic: AIS density map 2017



With up to 7.600 ships passing the hot spots of the North Sea, it is one of the most crowded seas in the world - only the South China sea has more busy waters. And although a lot of countries around the North Sea have a significant amount of ships sailing their flag, it is most likely that most of the ships sailing these waters are not European flagged. The three biggest flag states Panama, Liberia and Marshall Islands hold almost 70% of the entire fleet. This doesn't mean in turn that the owners are residents of these countries. The three biggest ship owner countries are Greece, Japan and China.

Rank (dead-weight tonnage)	Country or territory	Number of vessels	Dead-weight tonnage	Foreign flag as a percentage of total (dwt)	Rank (dollars)	Total value (million dollars)	Average value per ship (million dollars)	Average value per dead-weight ton (dollars)
1	Greece	4 199	308 836 933	78.76	3	72 538	17.3	235
2	Japan	3 901	223 855 788	85.89	2	77 898	20.0	348
3	China	5 206	165 429 859	53.97	4	65 044	12.5	393
4	Germany	3 090	112 028 306	90.77	8	38 412	12.4	343
5	Singapore	2 599	104 414 424	39.02	7	39 193	15.1	375
6	Hong Kong (China)	1 532	93 629 750	23.98	9	25 769	16.8	275
7	Republic of Korea	1 656	80 976 874	81.98	11	20 928	12.6	258
8	United States	2 104	67 100 538	85.73	1	96 182	45.7	1 433
9	Norway	1 842	51 824 489	64.62	5	58 445	31.7	1 128
10	United Kingdom	1 360	51 150 767	80.55	6	40 671	29.9	795
11	Bermuda	440	48 059 392	98.93	13	19 691	44.8	410
12	Taiwan Province of China	926	46 864 949	90.62	17	10 857	11.7	232
13	Denmark	920	36 355 509	56.00	15	18 694	20.3	514
14	Monaco	338	31 629 834	100.00	23	7 903	23.4	250
15	Turkey	1 563	27 732 948	71.57	20	9 055	5.8	327
16	Switzerland	405	23 688 303	92.58	22	8 458	20.9	357
17	Belgium	263	23 550 024	67.81	27	6 505	24.7	276
18	India	986	22 665 452	27.35	25	6 938	7.0	306
19	Russian Federation	1 707	22 050 283	67.38	19	9 081	5.3	412
20	Italy	768	20 609 725	29.36	10	23 184	30.2	1 125
21	Islamic Republic of Iran	238	18 838 747	68.80	32	2 799	11.8	149
22	Indonesia	1 840	18 793 019	7.96	26	6 613	3.6	352
23	Malaysia	644	18 351 283	51.07	16	14 641	22.7	798
24	Netherlands	1 256	18 033 334	64.72	12	19 970	15.9	1 107
25	United Arab Emirates	883	17 876 272	97.30	24	7 406	8.4	414
26	Saudi Arabia	283	15 659 518	77.97	30	4 101	14.5	262
27	Brazil	394	14 189 164	72.25	14	19 676	49.9	1 387
28	France	452	11 931 397	69.93	18	10 616	23.5	890
29	Canada	376	10 235 954	75.48	28	5 231	13.9	511
30	Kuwait	86	10 208 147	49.92	31	3 749	43.6	367
31	Cyprus	277	9 257 094	63.95	33	2 711	9.8	293
32	Viet Nam	943	8 801 765	17.84	29	4 161	4.4	473
33	Oman	49	7 490 956	99.92	34	2 215	45.2	296
34	Thailand	393	7 022 484	27.84	35	1 949	5.0	278
35	Qatar	117	6 640 467	87.56	21	8 827	75.4	1 329
<b>Subtotal, top 35 shipowners</b>		<b>44 036</b>	<b>1 755 783 748</b>	<b>70.30</b>		<b>770 109</b>	<b>17.5</b>	<b>439</b>
<i>Rest of world and unknown</i>		<i>6 119</i>	<i>91 847 146</i>	<i>64.30</i>		<i>58 509</i>	<i>9.6</i>	<i>637</i>
<b>World total</b>		<b>50 155</b>	<b>1 847 630 894</b>	<b>70.01</b>		<b>828 618</b>	<b>16.5</b>	<b>448</b>

Source: UNCTAD secretariat calculations, based on data from Clarksons Research.

Notes: Propelled seagoing vessels of 1,000 gross tons and above, as at 1 January. For a complete listing of nationally owned fleets, see <http://stats.unctad.org/fleetownership> (accessed 9 September 2017).



Flag of registration	Number of vessels	Vessel share of world total (percentage)	Dead-weight tonnage	Share of world total dead-weight tonnage (percentage)	Cumulated share of dead-weight tonnage (percentage)	Average vessel size (dead-weight tons)	Dead-weight tonnage growth, 2016–2017 (percentage)
Panama	8 052	8.64	343 397 556	18.44	18.44	45 237	2.75
Liberia	3 296	3.54	219 397 222	11.78	30.23	66 706	5.66
Marshall Islands	3 199	3.43	216 616 351	11.63	41.86	67 968	7.76
Hong Kong (China)	2 576	2.77	173 318 337	9.31	51.17	68 695	6.23
Singapore	3 558	3.82	124 237 959	6.67	57.84	36 942	0.21
Malta	2 170	2.33	99 216 495	5.33	63.17	46 297	5.14
Bahamas	1 440	1.55	79 842 485	4.29	67.46	56 625	0.79
China	4 287	4.60	78 400 273	4.21	71.67	20 555	2.12
Greece	1 364	1.46	74 637 988	4.01	75.68	66 999	1.60
United Kingdom	1 551	1.66	40 985 692	2.20	77.88	30 495	10.42
Japan	5 289	5.68	34 529 405	1.85	79.74	8 574	6.60
Cyprus	1 022	1.10	33 764 669	1.81	81.55	33 798	1.82
Norway	1 585	1.70	21 900 458	1.18	82.73	16 319	6.89
Indonesia	8 782	9.43	20 143 854	1.08	83.81	4 269	7.58
India	1 674	1.80	17 253 564	0.93	84.74	10 899	5.34
Denmark	654	0.70	16 893 333	0.91	85.64	28 344	-1.73
Italy	1 430	1.53	15 944 268	0.86	86.50	13 477	-2.32
Republic of Korea	1 907	2.05	15 171 035	0.81	87.31	9 008	-10.80
Portugal	466	0.50	13 752 758	0.74	88.05	32 744	54.97
United States	3 611	3.88	11 798 309	0.63	88.69	6 329	0.75
Bermuda	160	0.17	10 957 895	0.59	89.27	69 795	2.44
Germany	614	0.66	10 443 699	0.56	89.84	20 084	-6.15
Antigua and Barbuda	964	1.03	10 153 044	0.55	90.38	10 609	-9.68
Malaysia	1 690	1.81	10 058 653	0.54	90.92	7 412	4.70
Russian Federation	2 572	2.76	8 277 175	0.44	91.37	3 292	-2.95
Turkey	1 285	1.38	8 200 982	0.44	91.81	8 055	-3.83
Belgium	185	0.20	8 039 665	0.43	92.24	50 883	-3.57
Viet Nam	1 818	1.95	7 991 039	0.43	92.67	4 745	2.96
Netherlands	1 244	1.34	7 619 143	0.41	93.08	7 263	-5.31
France	547	0.59	6 966 582	0.37	93.45	17 033	0.90
Islamic Republic of Iran	739	0.79	6 583 064	0.35	93.80	11 253	34.49
Philippines	1 508	1.62	6 135 144	0.33	94.13	5 203	-3.63
Cayman Islands	161	0.17	5 549 056	0.30	94.43	36 268	28.52
Thailand	781	0.84	5 374 875	0.29	94.72	8 269	0.13
Kuwait	161	0.17	5 155 256	0.28	95.00	38 761	-3.85
<b>Top 35 flags total</b>	<b>72 342</b>	<b>77.65</b>	<b>1 768 707 283</b>	<b>95.00</b>	<b>95.00</b>	<b>24 449</b>	<b>4.02</b>
<b>Rest of world</b>	<b>20 819</b>	<b>22.35</b>	<b>94 530 523</b>	<b>5.07</b>	<b>5.07</b>	<b>4 541</b>	<b>-12.80</b>
<b>World total</b>	<b>93 161</b>	<b>100.00</b>	<b>1 861 851 750</b>	<b>100.00</b>	<b>100.00</b>	<b>24 062</b>	<b>2.94</b>

Source: UNCTAD secretariat calculations, based on data from Clarksons Research.

Notes: Propelled seagoing merchant vessels of 100 gross tons and above, ranked by dead-weight tonnage; beginning-of-year figures. For a complete list of all countries, see <http://stats.unctad.org/fleet> (accessed 9 September 2017).



## Seafarers

There are 1.6 million seafarers sailing around the world of which majority stay on board for several months within a year. In addition to the risks associated with physical conditions of the ocean, including severe storms, seafarers are also exposed to piracy and terrorist attacks, a growing concern in areas including the Gulf of Guinea and the Malacca Strait.

Approximately 51% of the seafarers hold positions as officers, compared to 49% that are employed as ratings; that is, non-officer sailors such as able seafarer or ordinary seafarer (in 2005, the ratio was 45% officers compared with 55% ratings). For the first time in history, the proportion of officers is higher than that of ratings, reflecting technological advances and lower demand for manual on-board work, as well as emphasising the importance of economies of scale in the shipping industry. A crew of 14 or 15 seafarers is required to manage and operate a container ship or dry bulk carrier of 10,000 gross tons whereas a ship 10 times the size (100,000 gross tons) does not require 10 times more seafarers, but can operate well with 19 or 20 seafarers.

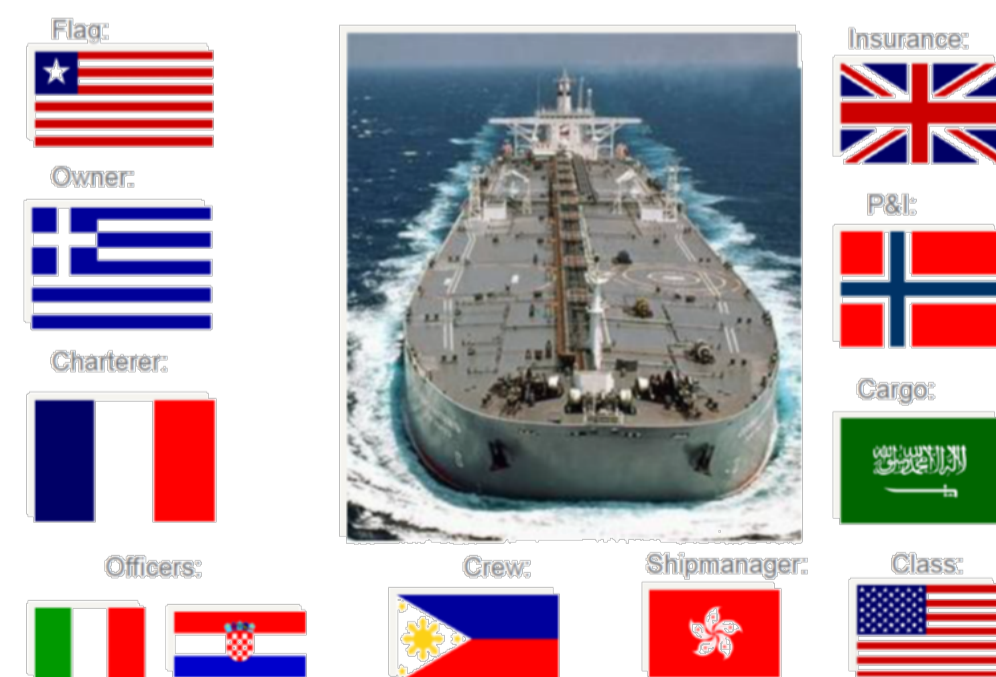
Between 2005 and 2015, global demand for seafarers increased by 45%, which is roughly in line with the growth of the world fleet within the same period. The highest numbers of seafarers are residents of China (243,635), followed by the Philippines (215,500), Indonesia (143,702), the Russian Federation (87,061), India (86,084) and Ukraine (69,000) (Baltic and International Maritime Council and International Chamber of Shipping, 2016).

### Estimated five largest seafarer supply countries

	FOR ALL SEAFARERS	FOR OFFICERS	FOR RATINGS
1	China	China	Philippines
2	Philippines	Philippines	China
3	Indonesia	India	Indonesia
4	Russian Federation	Indonesia	Russian Federation
5	Ukraine	Russian Federation	Ukraine

\*Source: Country Questionnaire, 2015

Only 9% of the seafarers at sea are female. But on the other hand, almost 71% of the onshore maritime tasks are done by women.





Dealing with the shipping industry means dealing with a globally driven economic sector. Stakeholder consultations will therefore have to take a global form rather than solely consultation of local level. Although, the latter is a very relevant requisite for successful consultation.

## Legislation governing shipping

The following are the major international shipping conventions, adopted by the International Maritime Organization (and the International Labour Organization). However, many other maritime instruments concerning more specific issues are also in force worldwide.

- SOLAS (International Convention for the Safety of Life at Sea, 1974) lays down a comprehensive range of minimum standards for the safe construction of ships and the basic safety equipment (e.g. fire protection, navigation, lifesaving and radio) to be carried on board. SOLAS also requires regular ship surveys and the issue by flag states of certificates of compliance.
- MARPOL (International Convention for the Prevention of Pollution from Ships, 1973/1978) contains requirements to prevent pollution that may be caused both accidentally and in the course of routine operations. MARPOL concerns the prevention of pollution from oil, bulk chemicals, dangerous goods, sewage, garbage and atmospheric pollution, and includes provisions such as those which require certain oil tankers to have double hulls.
- UNCLOS (The United Nations Convention on the Law of the Sea, 1982), also called the Law of the Sea Convention or the Law of the Sea treaty, is the international agreement that resulted from the third United Nations Conference on the Law of the Sea (UNCLOS III), which took place between 1973 and 1982. The Law of the Sea Convention defines the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. The Convention, concluded in 1982, replaced four 1958 treaties. UNCLOS came into force in 1994, a year after Guyana became the 60th nation to ratify the treaty. [1] As of June 2016, 167 countries and the European Union have joined in the Convention. It is uncertain as to what extent the Convention codifies customary international law.
- COLREGS (Convention on the International Regulations for Preventing Collisions at Sea, 1972) lays down the basic "rules of the road", such as rights of way and actions to avoid collisions.
- LOADLINE (International Convention on Loadlines, 1966) sets the minimum permissible free board, according to the season of the year and the ship's trading pattern.
- ISPS (The International Ship and Port Facility Security Code, 2002) includes mandatory requirements to ensure that ships and port facilities are secure at all stages during a voyage.
- ISM (The International Safety Management Code, 1993) effectively requires shipping companies to have a licence to operate. Companies and their ships must undergo regular audits to ensure that a safety management system

### Did You Know?

#### **A ship is a micro world on its own**

Even one ship itself can be a world of its own. For example, the ship owner can be Greek, but the ship sails under the Panama flag. The ships officers are Italian and Ukraine, but the crew is Philippine. The manager Hong Kong, cargo Middle East and the insurance companies are from other states.



is in place, including adequate procedures and lines of communication between ships and their managers ashore.

- STCW (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978/1995/2010) establishes uniform standards of competence for seafarers.
- ILO 147 (The ILO Merchant Shipping (Minimum Standards) Convention, 1976) requires national administrations to have effective legislation on labour issues such as hours of work, medical fitness and seafarers' working conditions. This was superseded by the ILO Maritime Labour Convention, 2006) which entered into force on 30 August 2013.

The diversity of regulations, dealt with on an international level, proves the necessity of this international approach. Due to the multi modal aspect of shipping, regulations are best tackled in the International Maritime Organization where 168 member countries decide on the regulations for shipping.

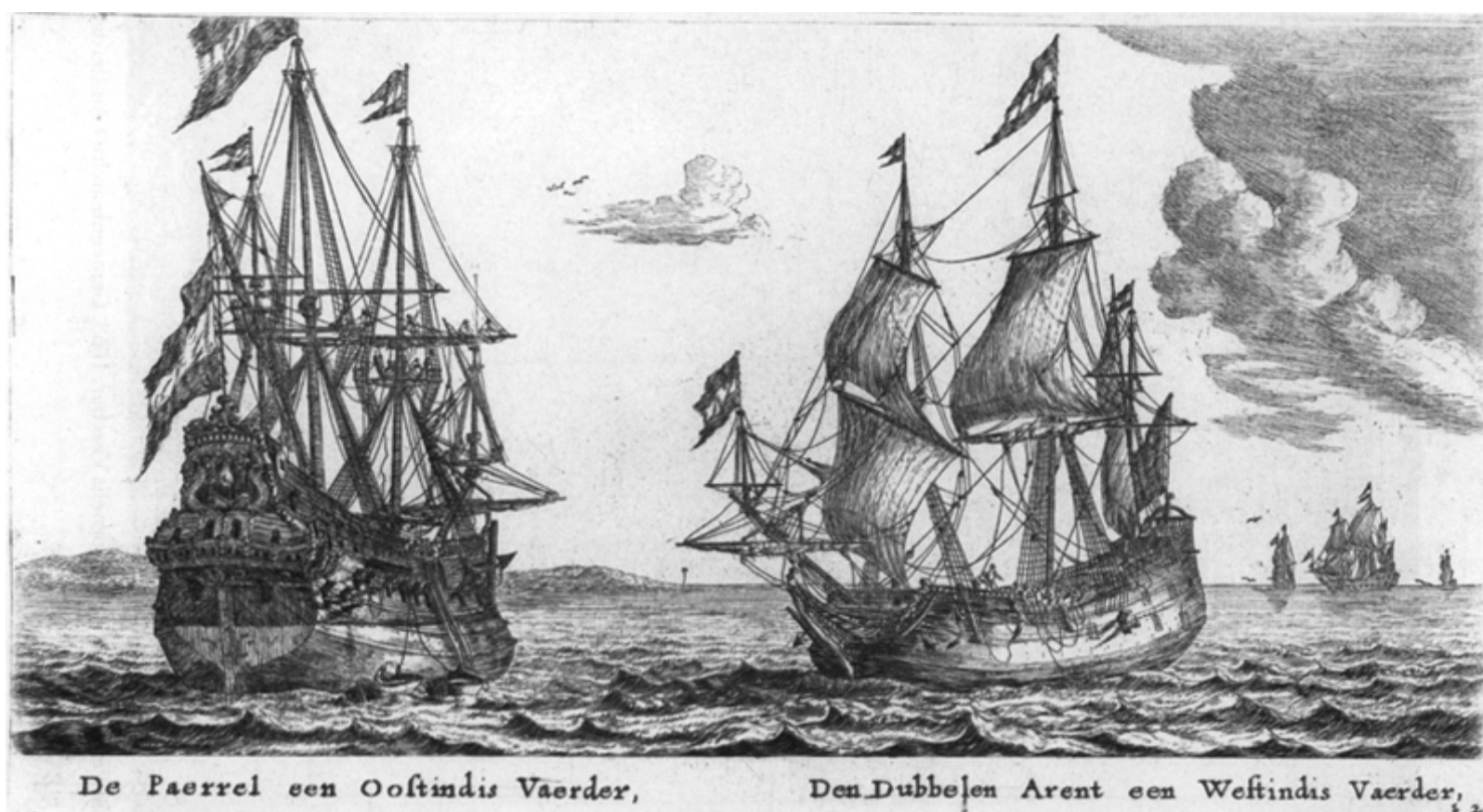
## The history of shipping of the North Sea

The North Sea, though often an area of conflict, has an extensive history of common maritime commerce and trade routes between its coastal nations, whose economies and industries started early to exploit its valuable resources. The earliest records of Roman explorations of the sea begin in 12 BC. Southern Britain was formally invaded in 43 AD and gradually assimilated into the Roman Empire, beginning sustained trade across the North Sea and the English Channel. The Germanic Angles, Saxons, and Jutes began the next great migration across the North Sea during the Migration Period, occurring between AD 300 and 500, conquering, displacing, and mixing with the native Celtic populations. The Viking Age began in 793 AD and for the next two centuries the Vikings ruled the North Sea.

From the Middle Ages until the end of the 15th century, and before the development of good roads, maritime trade on the North Sea already connected the economies of northern Europe, Britain, and Scandinavia with each other as well as with the Baltic and the Mediterranean.

The Netherlands and German speaking lands were the central hub for English Channels and North Sea coastal trade. Organizations such as the Hanseatic League, growing from a few North German towns in the late 1100s, aimed at protecting interests of the merchants and trade, also became increasingly prominent.





*Dutch East and West Indies trading ships around 1650*

Important overseas colonies, a vast merchant marine, and a powerful navy made the Dutch the main rivals of growing England, which saw its future in these three spheres. This conflict was at the root of the first three Anglo-Dutch Wars between 1652 and 1673. Scotland emerged a prominent economic power during the Scottish Enlightenment of the 18th century. Between 1700 and 1815, the North Sea saw only 45 years of peace, and this time could be regarded as the most dangerous eras to sail the sea. Tensions in the North Sea were again raised in 1904 by the Dogger Bank incident. However, the British did not face a challenge to their dominance of the North Sea until World War I started in 1914. During the First World War, the North Sea became the main theatre of the war for surface action. The Second World War also saw action in the North Sea, though it was restricted more to submarines and smaller vessels such as minesweepers, and torpedo boats and similar vessels.

#### Dogger Bank incident

Tensions in the North Sea were again heightened in 1904 by the Dogger Bank incident, in which Russian naval vessels mistook British fishing boats for Japanese ships and fired on them, and then upon each other. The incident, combined with Britain's alliance with Japan and the Russo-Japanese War led to an intense diplomatic crisis. The crisis was defused when Russia was defeated by the Japanese and agreed to pay compensation to the fishermen

After the war, the North Sea lost much of its military significance because it was surrounded by NATO member-states only. However, it gained significant economic importance in the 1960s as several North Sea states began full-scale exploitation of its oil and gas resources. The North Sea continues to be an active trade route. All countries bordering the North Sea has claimed the 12 nautical miles (22 km) of territorial waters within which they exercise exclusive fishing rights. Today, the North Sea has become far more important for economic interests including grounds for fishing and exploitation of fossil fuel and renewable energy, than military interests as its territorial expansion of the adjoining countries has ceased.

## II Spatial impact of current shipping activities

### Introduction

As described above, the North Sea is currently, and has been historically, a sea with intense use and activity. Traditionally mainly used for fishing and shipping, other sea-based activities have progressively increased in number and in space- Examples of additional users are as off shore wind farms, aquaculture, marine protected areas and pipelines to mention a few.

The increase in actors in general, as well as the increase of number of ships trafficking the North Sea raise some questions with respect to planning of activities, risk for interest conflicts as well as impact on the marine environment. In addition, given the transnational nature of shipping, questions regarding communication between states around the North Sea also arise.

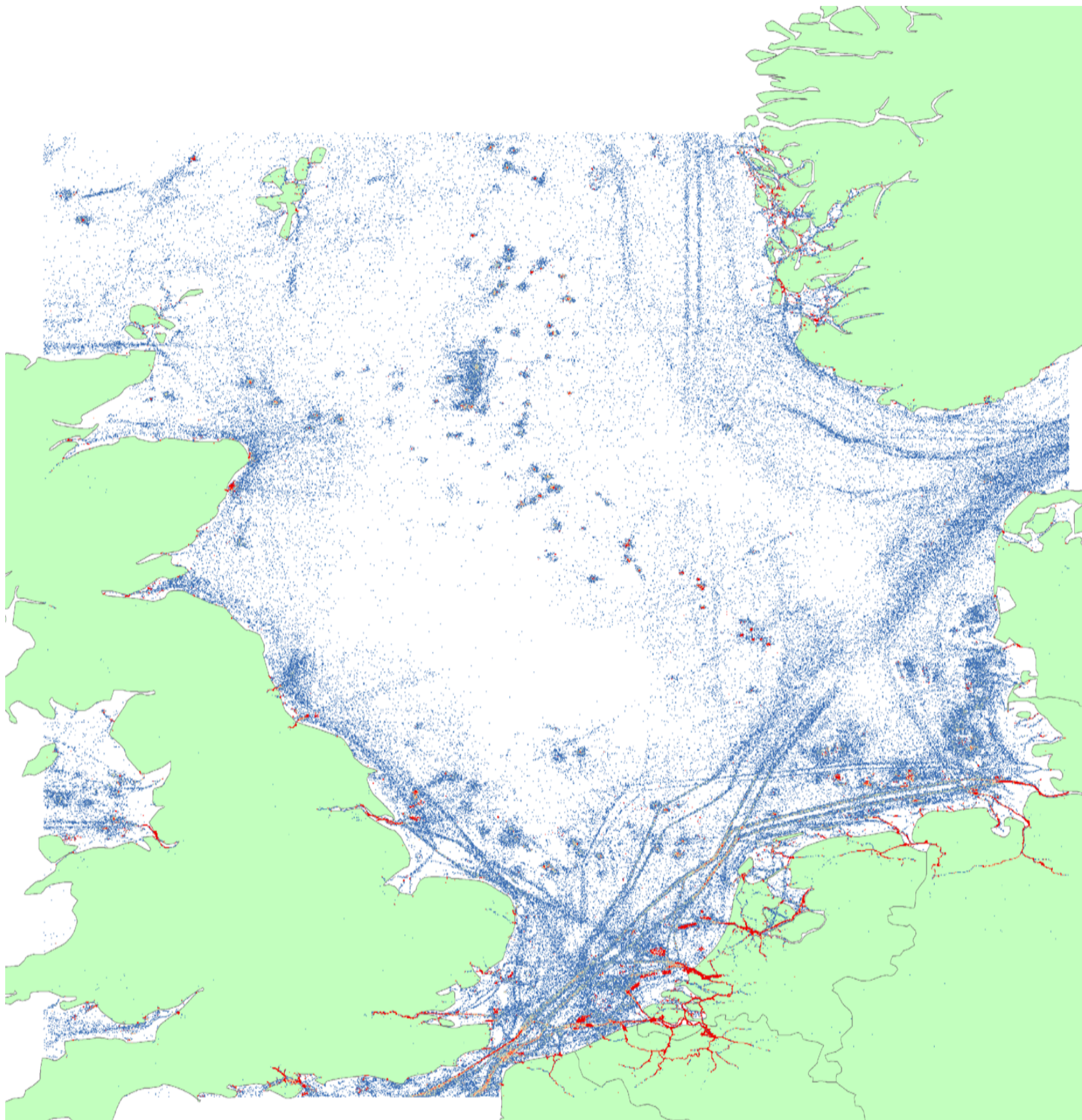
The chapter below intends to address these questions by first looking at the current maritime traffic across the North Sea followed by a description and analysis of designated shipping routes and possible incoherencies between these and the actual current traffic. As one of the main sea-based activities in the North Sea, off shore wind farms will also be taken into account in the analysis.

### Maritime traffic in 2016

Vessel traffic in 2016 has been plotted by EMSA (European Maritime Safety Agency) from AIS data in density map format. This density has been calculated based on number of signals per grid point during a two week period. Red dots in coastal and port areas represent a much higher density of ships compared to areas of blue dots. The four maps below represents seasonal variations in traffic in 2016. From a maritime spatial planning perspective, it is essential to look at seasonal variations in traffic intensity as it may allow for other parallel activities in place of shipping during some parts of the year, in specific areas.



February 2016



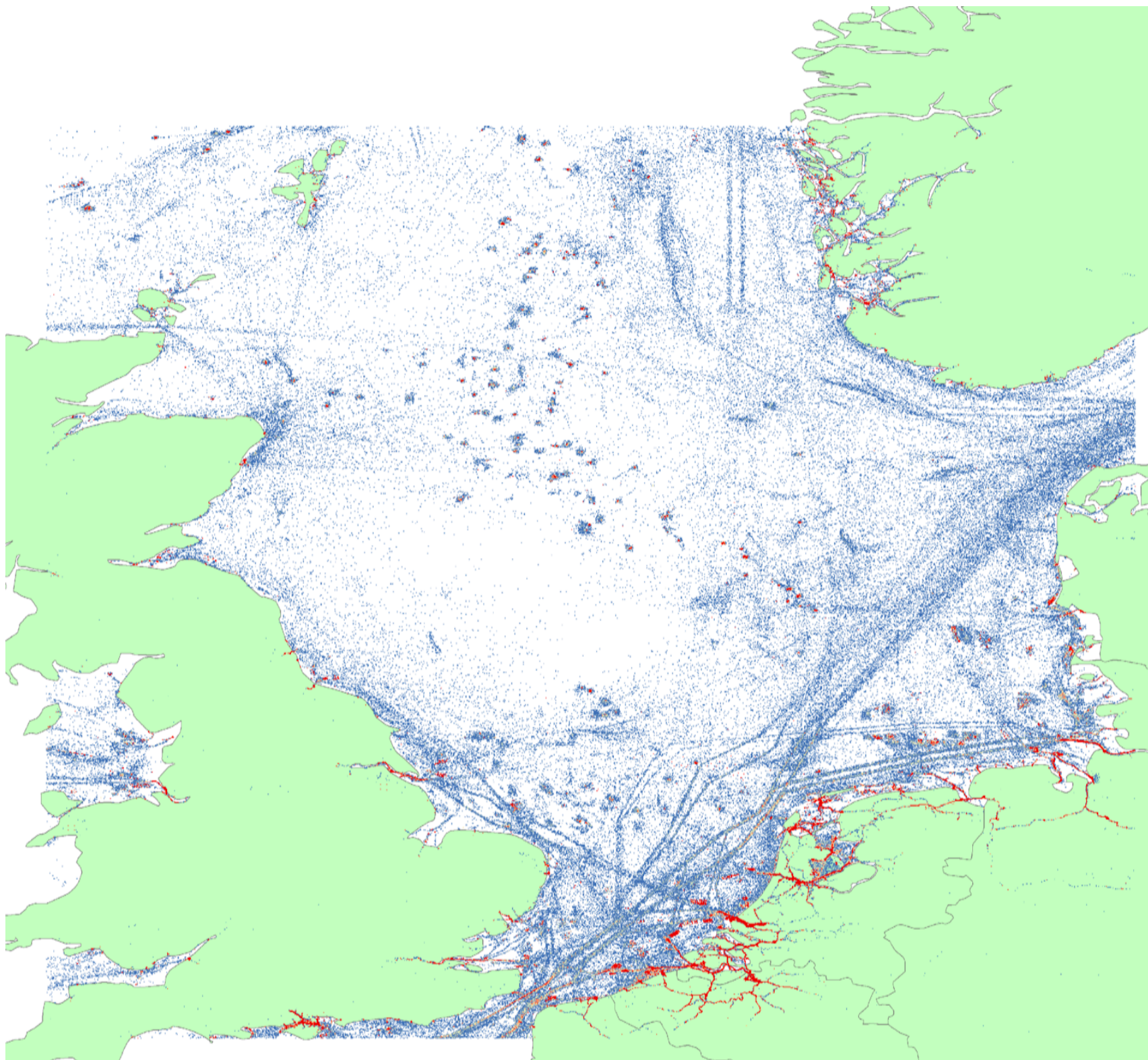
The map shows vessel traffic for the first quarter of 2016, based on AIS data. It has been calculated using AIS transponders on ships. The following ships are required to have a certain transponder:

- Ships of 300 gross tonnage (gt) and above engaged on international voyages
- Cargo ships of 500 gt and upwards not engaged on international voyages
- All passenger ships irrespective of size

The map clearly shows the predominant shipping routes on a North Sea Region scale.



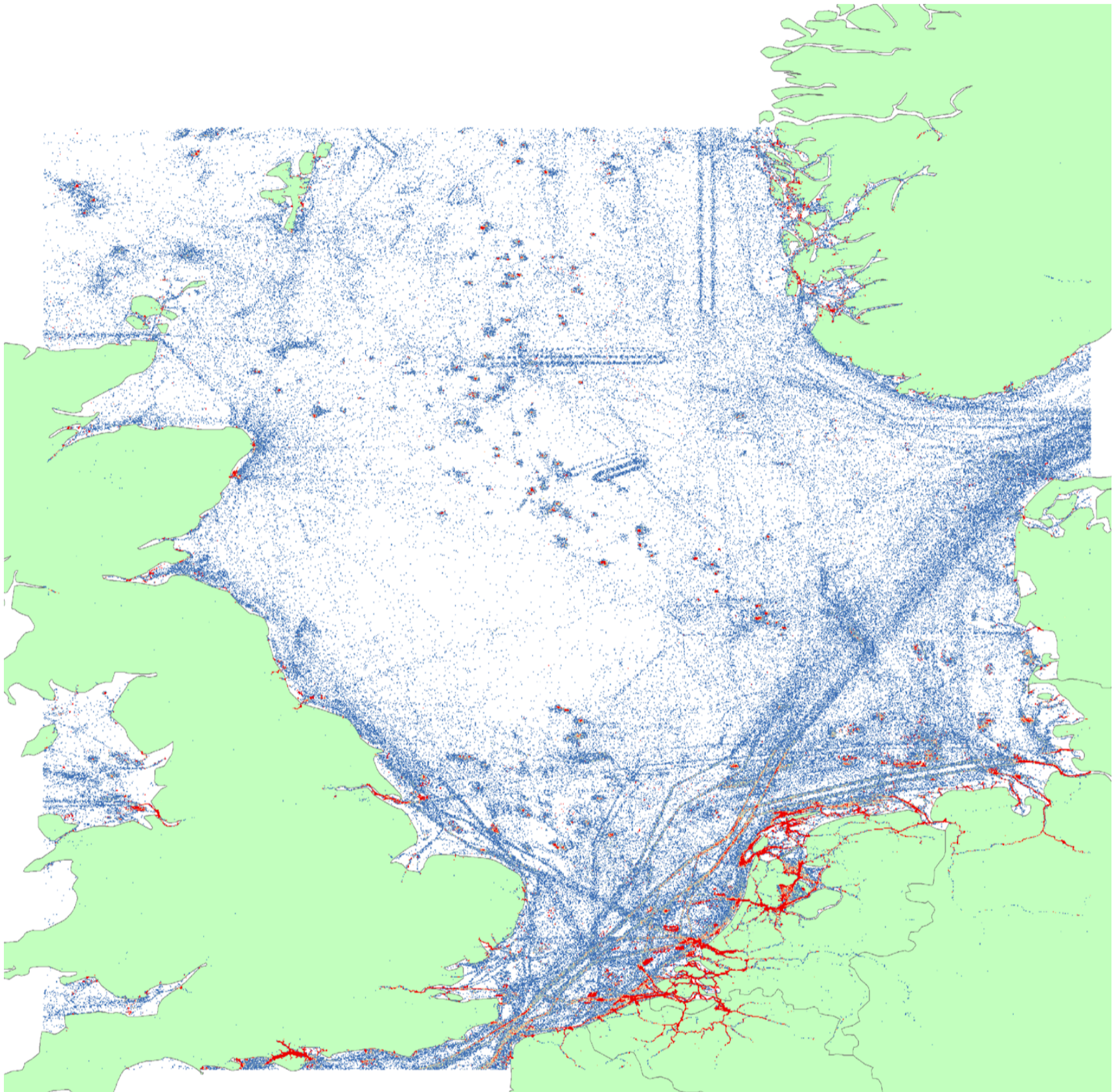
May 2016



It is clear that all areas of the North Sea are predominantly occupied by shipping activities, although the highest concentration of shipping activities are located along the coastal and central parts which are trafficked by transit ships and supply vessels.



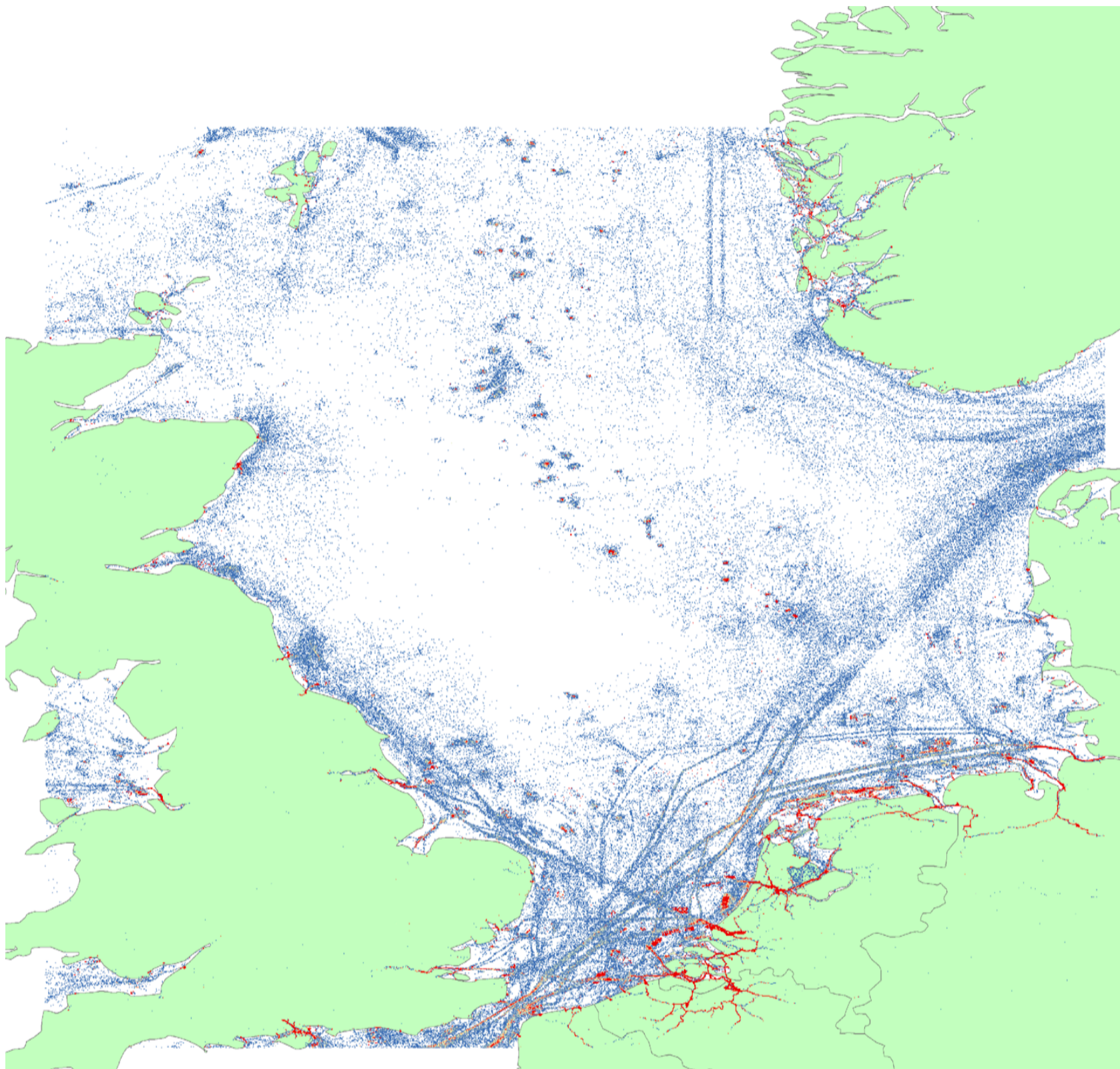
August 2016



Summer months are clearly the busiest in all parts of the North Sea including the coast of UK, that is, the route from the English Channel to the entrance of Skagerrak and around the south coast of Norway. Subsequently, port areas and inland waters are also busier (red areas).



November 2016



The last quarter of the year shows less activity as compared to other quarters. It is visible in particular in coastal and inland waters as well as in the route from the English Channel to the northern part of Denmark.

## AIS national data authority and supplier

As mentioned above the European Maritime Safety Agency (EMSA) tasked all national governments in the North Sea to collect AIS information from their maritime areas and supplement it with data from other countries through the North Sea Data Exchange Agreement between Belgium, Denmark, Faroe Islands, France, Iceland, Ireland, Netherlands, Norway, Sweden, and the United Kingdom. The Helsinki Commission (HELCOM) has a similar data exchange agreement between its member states Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. This agreement also includes Norway, who is non-member.





Shipping traffic is monitored via the Automatic Identification System (AIS). Regulation 19 of SOLAS (International Convention for the Safety of Life at Sea, Chapter V) requires all ships of 300 gross tonnage (gt) and above that engages on international voyages, cargo ships of 500 gt and above that does not engage on international voyages as well as all passenger ships irrespective of size, to have an AIS on board. This requirement became effective for all ships by 31 December 2004.

The table below shows national authorities in the North Sea countries that are responsible for collecting AIS data as well as how they are supplied with data.

Country	Responsible Authority for collecting and storing AIS data	Data supplier
Sweden	Swedish Maritime Administration	Network of shorebased AIS stations
Norway	Norwegian Coastal Administration	Network of shorebased AIS stations Satelites
Belgium	Flemish Region VTS service	Network of shorebased AIS stations
The Netherlands	Rijkswaterstaat Water Verkeer & Leefomgeving (since 2014, previously the Coast Guard collected it and stored in MARIN)	Rijkswaterstaat, Coastguard, Port of Rotterdam, Scheldt Radar Network
Uk	Maritime and Coastguard Agency	Network of shorebased AIS stations Satelites Raw data is processed at Marine Scotland
Denmark	Danish Maritime Authority	Network of shorebased AIS stations
Germany	The Federal Waterways and Shipping Administration	Network of shorebased AIS stations

## IMO routing measures and priority areas for shipping - Current situation

Ships' routing establishes an international predetermined path for ships to navigate in order to avoid navigational hazards such as collisions and subsequent damages to ships, crew members, and the marine environment. IMO is the only internationally recognized competent body for establishing such systems, and its responsibilities are enshrined in the SOLAS convention Chapter V.

Traffic separation schemes as well as other ships' routing measures have now been established in most of the heavily congested shipping areas around the world including the North Sea. In addition to the traffic separation schemes, other ships' routing measures that exist include:

- ▶ *Two-way routes*

A two-way track for guidance of ships through hazardous areas.

- ▶ *Recommended tracks*

A route of undefined width, for the convenience of ships in transit, which is often marked by centreline buoys

- ▶ *Deep water routes*

Routes within defined limits which have been accurately surveyed for clearance of sea bottom and submerged articles

- ▶ *Precautionary areas*

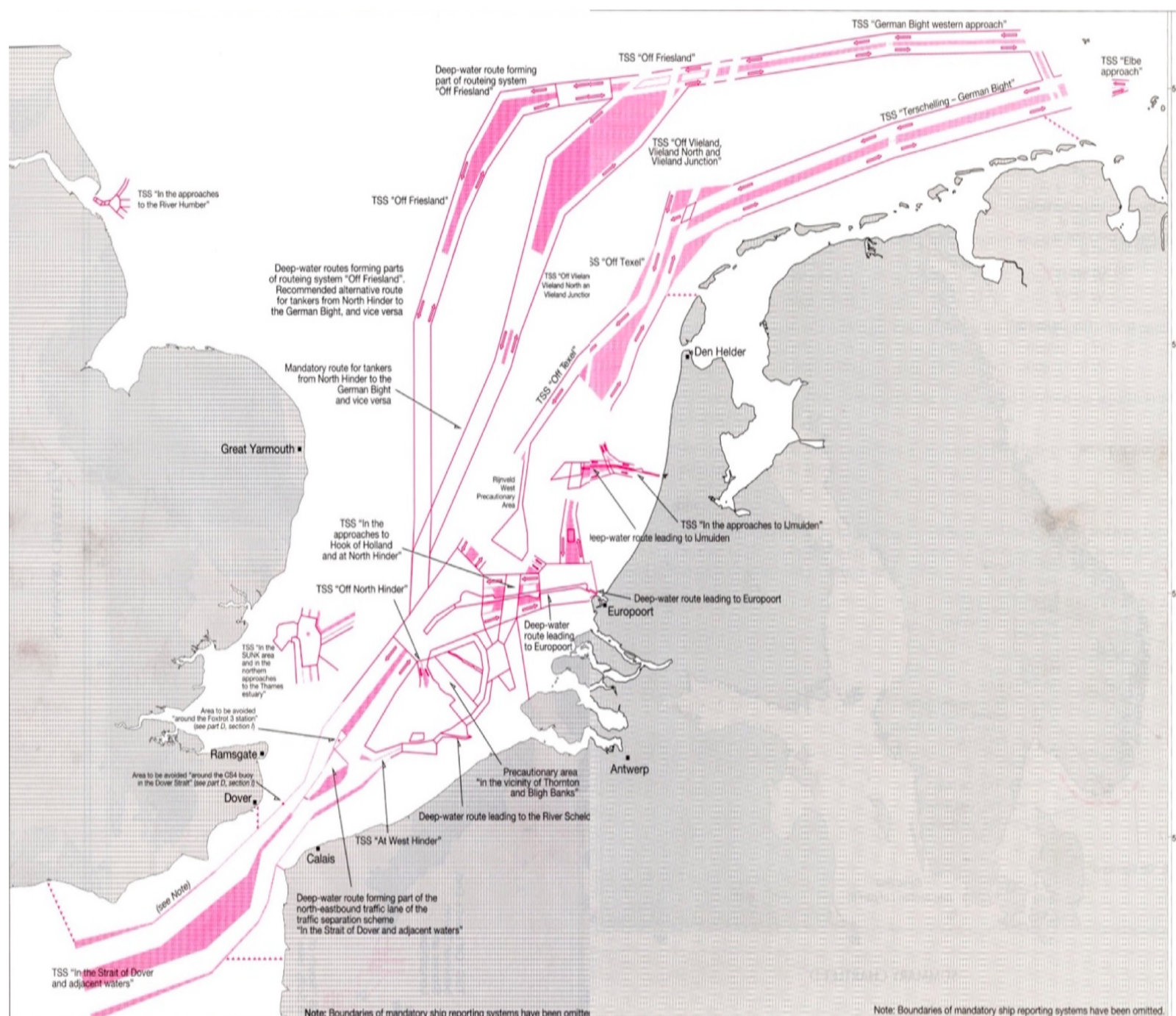
An area within defined limits where ships must navigate with particular caution and within which the direction of flow of traffic may be recommended

- ▶ *Areas to be avoided*

An area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or by certain classes of ships



Given the intense maritime traffic in the southern part of the North Sea the following ships' routing measures have been adopted by the IMO.



IMO adopted routing measures in the south North Sea (Source: IMO Ships Routing measures 2017)

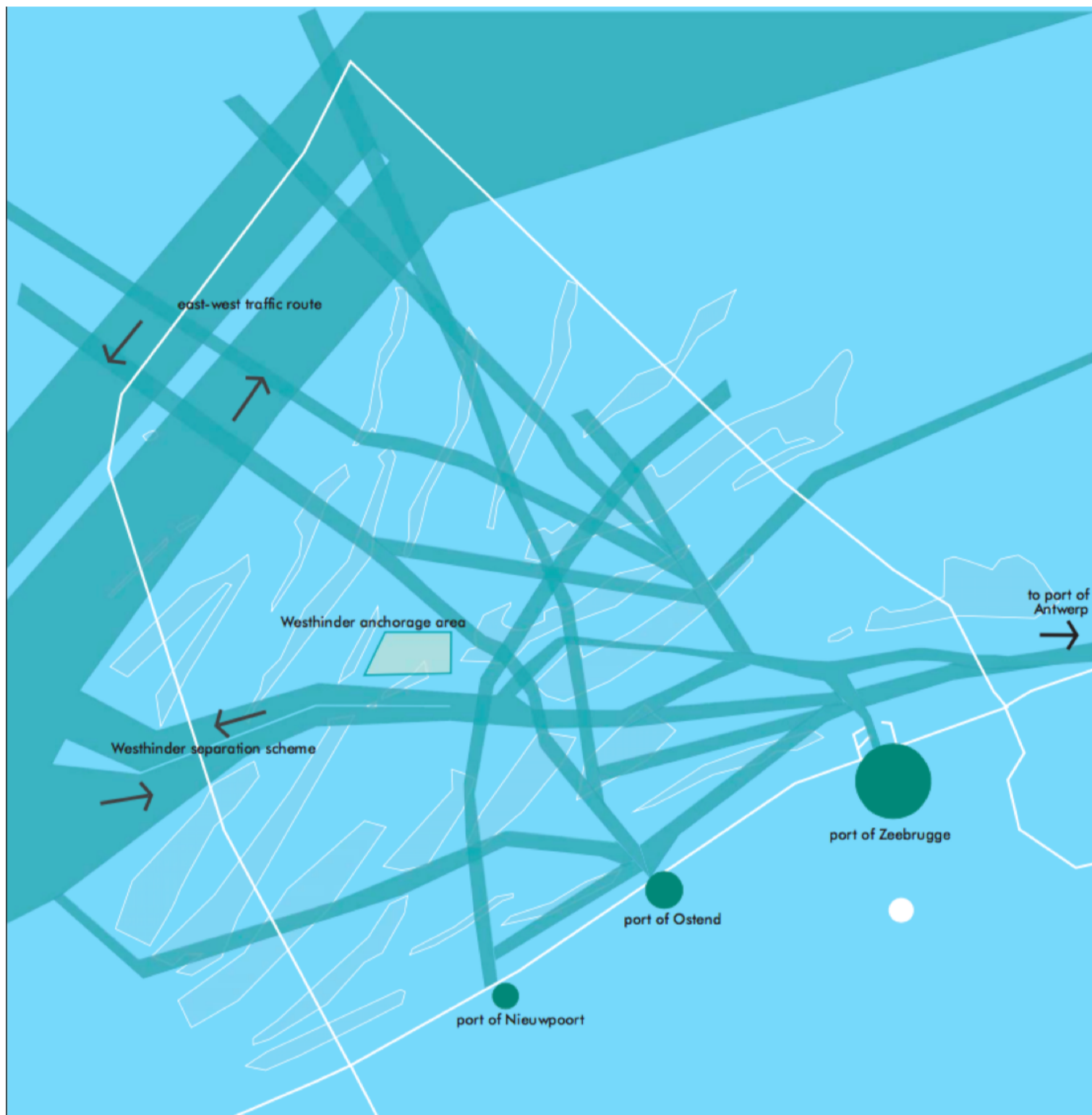
## Nationally designated priority areas for shipping

In the national MSP plans, countries have designated certain areas as priority areas for shipping. This means that shipping is prioritized in these areas before other types of activities when planning for use and management of the area. However, other activities may take place as long as they do not interfere with shipping.

Countries surrounding the North Sea have applied different criteria for designating priority areas for shipping. Below is a description of the basis on which the different countries designation priority shipping areas, as well as maps that shows where these areas are located. Priority and reservation areas are recurring terms used in text.



## Belgium



All dark blue lines are designated priority shipping. This implies that activities that have the potential to interfere with shipping cannot occur in these areas, but does not mean that these areas are exclusive to shipping.

The designation of these corridors is mainly based on AIS records. The spatial distribution of corridors often highlights the importance of good accessibility to the ports. Consideration was given to the economic implications for the ports if ships divert from their traditional routes as a result of obstructions such as offshore wind farms.

## Germany

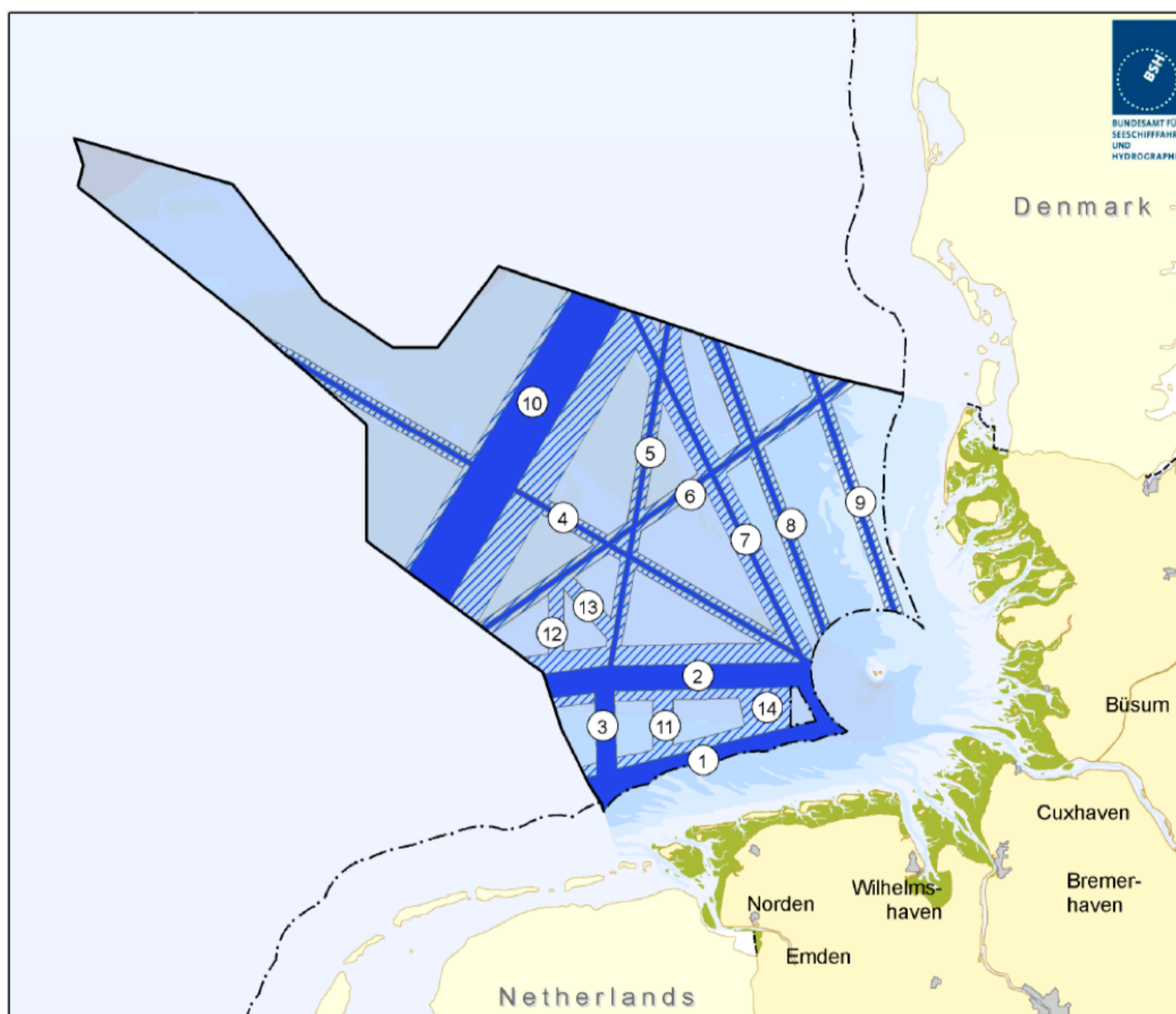
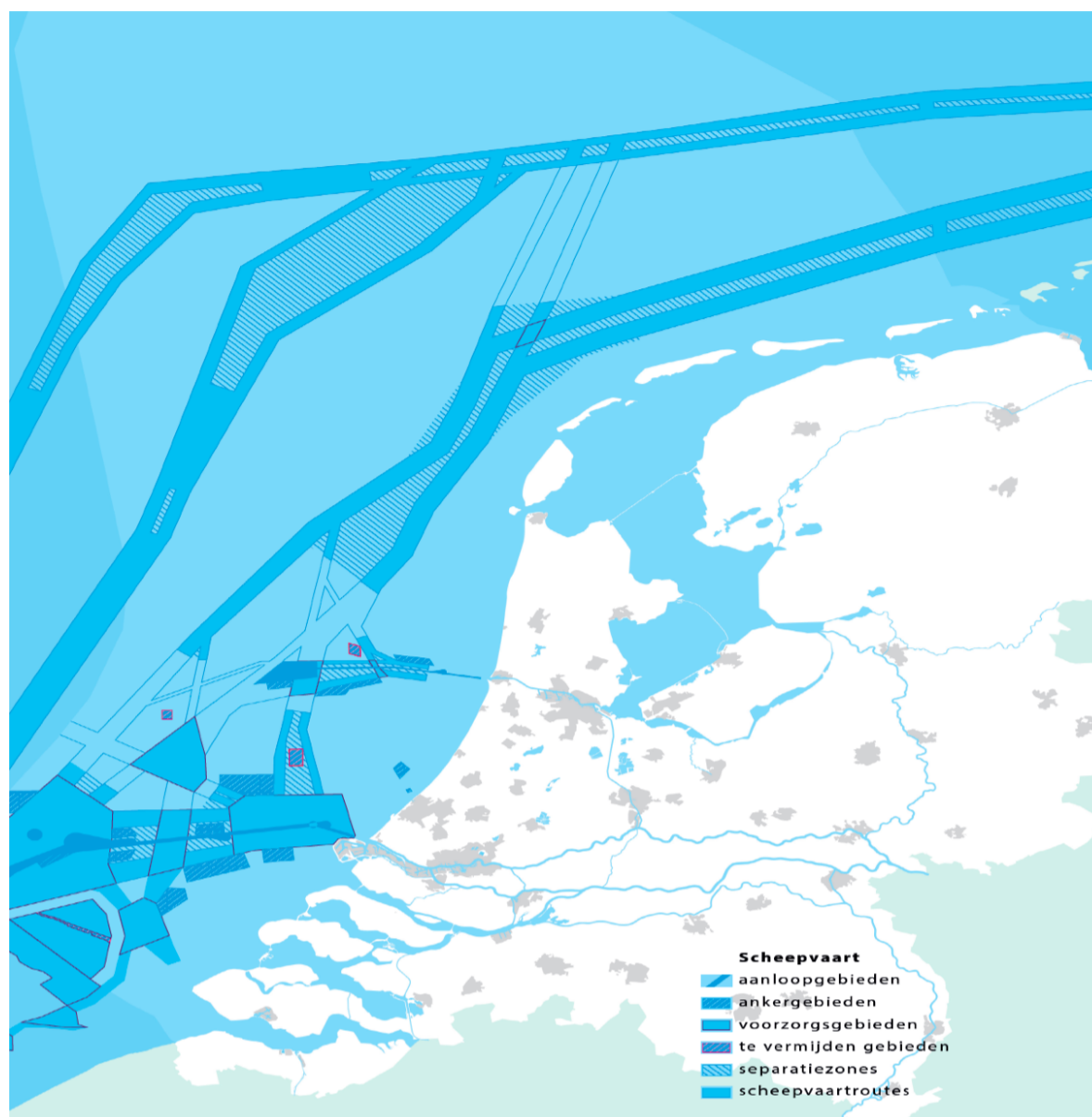


Figure: Numbering of designated areas for shipping in the North Sea

Germany uses three types of zoning for the implementation of its spatial plans. These include “priority areas” where one use (for example shipping, pipelines, etc.) is granted priority over all other spatially significant uses; “reservation areas” where one use is given special consideration in a comparative evaluation with other spatially significant planning tasks, measures and projects; and “marine protected areas” where measures are applicable for the reduction of impacts (e.g., through pollution) on the marine environment.

Priority and reservation areas are based on the width and location of existing IMO routes as well as the current shipping traffic density as of 2009, but also aiming at securing space for anticipated increasing / changing sea traffic (e.g. traffic avoiding future obstacles such as offshore wind farms; Arctic routes opening). Reservation areas provide additional space where shipping is agreed on as most important compared to other non-compatible uses, e.g. as manoeuvring space, resulting in any ban of fixed installations within these areas.

## Netherlands



In the Dutch part of the North Sea, routing measures and other measures apply (such as *clearways* and anchorage) for the purposes of regulating maritime traffic:

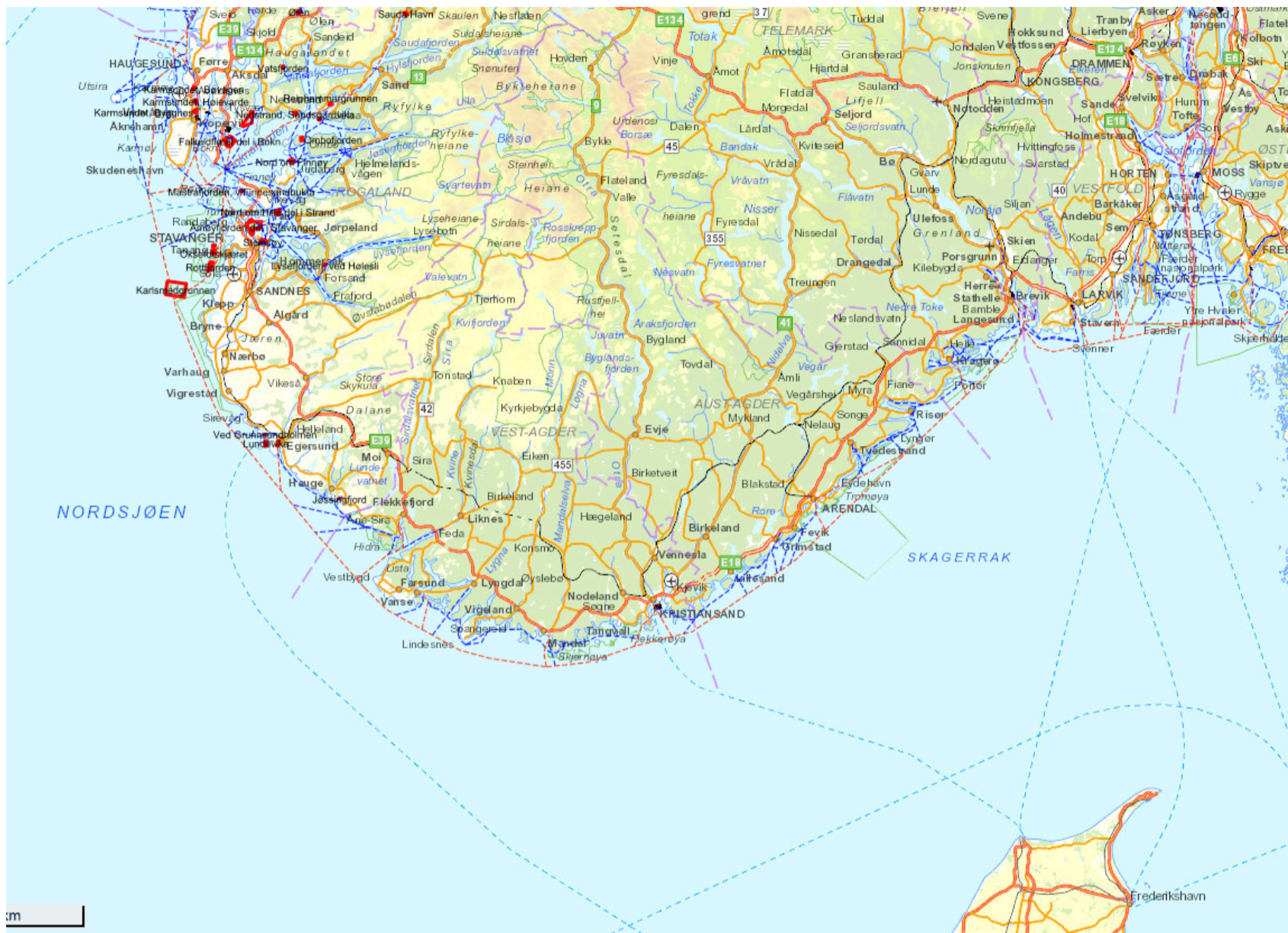
The traffic separation scheme (TSS) and accompanying 'precautionary areas' and *inshore traffic zones* have been established by the International Maritime Organisation (IMO) of the United Nations. The objective of these systems is to regulate traffic so as to prevent vessel collision.

Precautionary areas are areas where vessels must take extra care, as multiple traffic separation schemes converge here.

Tankers in the Dutch part of the North Sea are obliged to follow the deep-water routes designated by the IMO. Furthermore, tankers are under an obligation to take the shortest routes when approaching a port from a deep-water route and vice versa. The reason for setting mandatory routes for tankers is the status of the Wadden Sea as a *Particularly Sensitive Sea Area (PSSA)*. In order to protect this PSSA, the deep-water route is located further out from the coast, ensuring that any oil discharged as a result of an accident can be combated before it reaches the protected area.

*Clearways* are shipping zones between traffic separation schemes in which mining installations may not be built. Vessels are not obliged to use these areas. Recognising that these areas must remain free of obstacles, a clearway holds the status of *recognised sea lane essential for navigation* as referred to in the United Nations Convention on the Law of the Sea. The *clearways* have been established in the regulations accompanying the Mining Act.

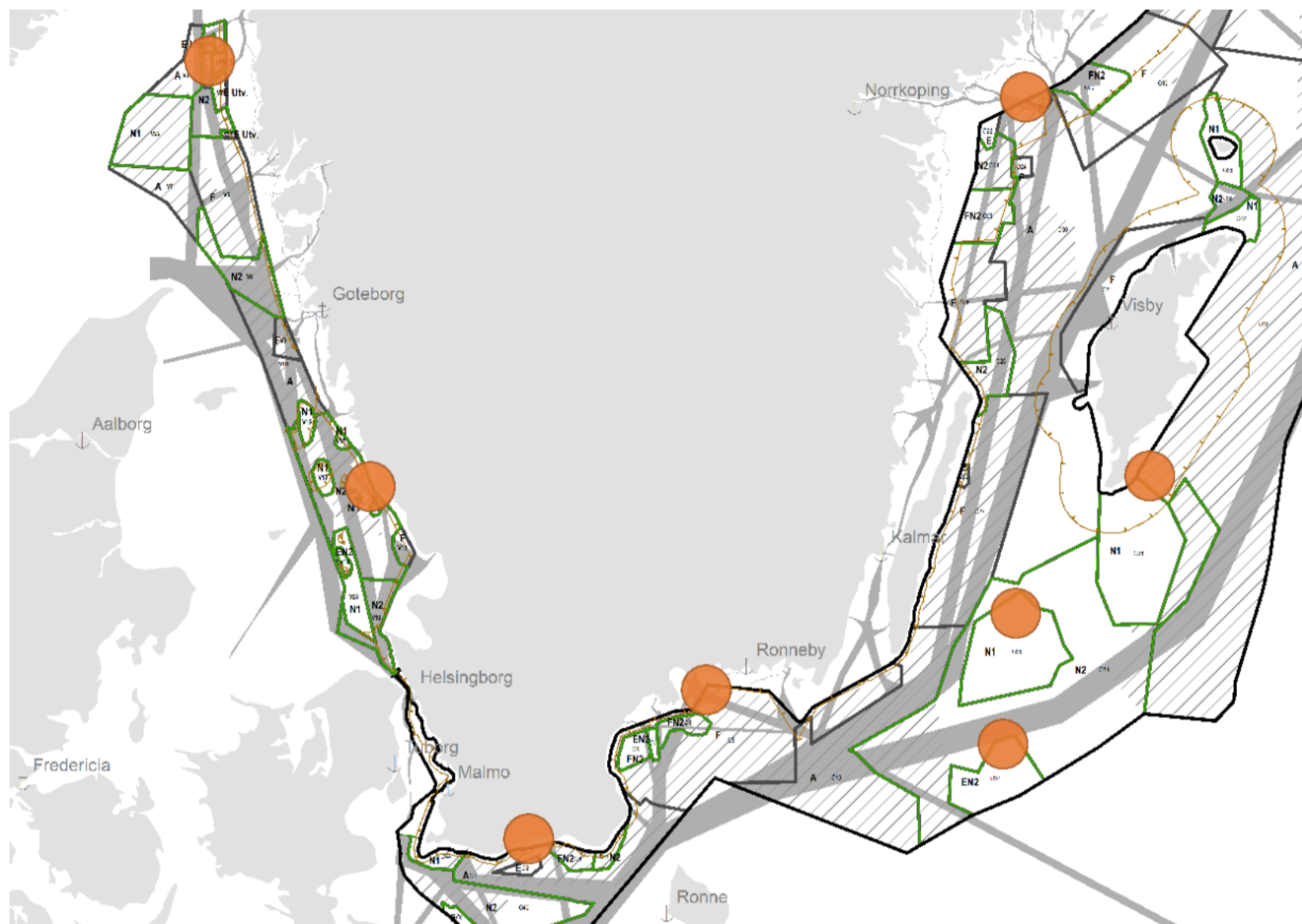
## Norway



Norway has divided its nationally designated shipping routes into two categories; primary and secondary fairway. The main reasons behind the establishment of this structure was:

- To be able to define, in a standardized way, routes and ship usage areas in coastal areas.
- To be able to define and assign responsibilities between municipalities and the state.
- To be able to establish a coordinated definition of different route categories so as to plan and prioritise the means in the best possible way.

## Sweden



The dark grey marks the areas where shipping has priority over other activities. As described in the cases of other countries, priority areas for shipping in Sweden also doesn't prevent other activities from using the space. It merely indicates that in case of several competing interest in the same area, shipping should be given priority.

## Denmark

Denmark is in the process of developing a MSP plan. Priority areas for shipping has not yet been made publicly available. In 2018, mapping and information gathering necessary for generating the plan will be done i.e. data on existing uses and conditions as well as data on future uses and developments. A draft plan is intended to be ready for an SEA and a public hearing in 2019.



## Shipping and off-shore wind farms in transnational MSP

Given the large number of off shore wind farms in the North Sea, and the implications it may have for shipping, it is interesting to look closer into how national authorities in the North Sea countries have considered shipping in relation to OWF in the development of their respective MSP plans, as well as if any consultations were done between neighbouring countries in this respect.

### Transnational dialogue

In order to better understand if and/or how transnational dialogues were held regarding shipping and OWF interviews were conducted for the purpose of this report with key representatives from the authorities responsible for MSP in each country.

All respondents of the interviews said that transnational dialogues were held with neighbouring countries with regards to shipping and OWF. However, not in all cases did the dialogues take place within the framework of MSP but rather on a sectorial basis. For example, triggered by the establishment of new OWFs on the border between Belgium and the Netherlands, a common platform for stakeholder discussions was established. The initiative was taken by the Belgian Federal Government Service for Mobility Director General Maritime Transport and also included stakeholders such as ports, pilot associations, coast guards and regions. Discussions in this platform focused mainly on safety issues with regards to the newly designated wind farm areas and the spatial needs of shipping in the same area.

Some of the main concerns that were expressed by the different countries during the transnational consultations were pointed out in the course of the interviews. Given the limited sea area of Belgium, one of the critical issues is the determination of optimal safety distances between ships and OWF. In contrast to the Netherlands, Belgian authorities have opted for 500m safety distance between their shipping lanes and OWFs, whilst the Dutch opt for *at least* 1.87 NM.

From the Dutch authority, an important concern in the transnational consultation with Belgium was whether or not to allow small vessels access through the OWF. In Belgian waters, vessels are not allowed access through the OWF, this in turn poses problems for ships passing through the border area.

In German consultations with neighbouring countries, harmonization of the width of designated shipping lanes in the MSP between Germany and Holland and Denmark was raised as a main concern (see map below for inconsistencies).

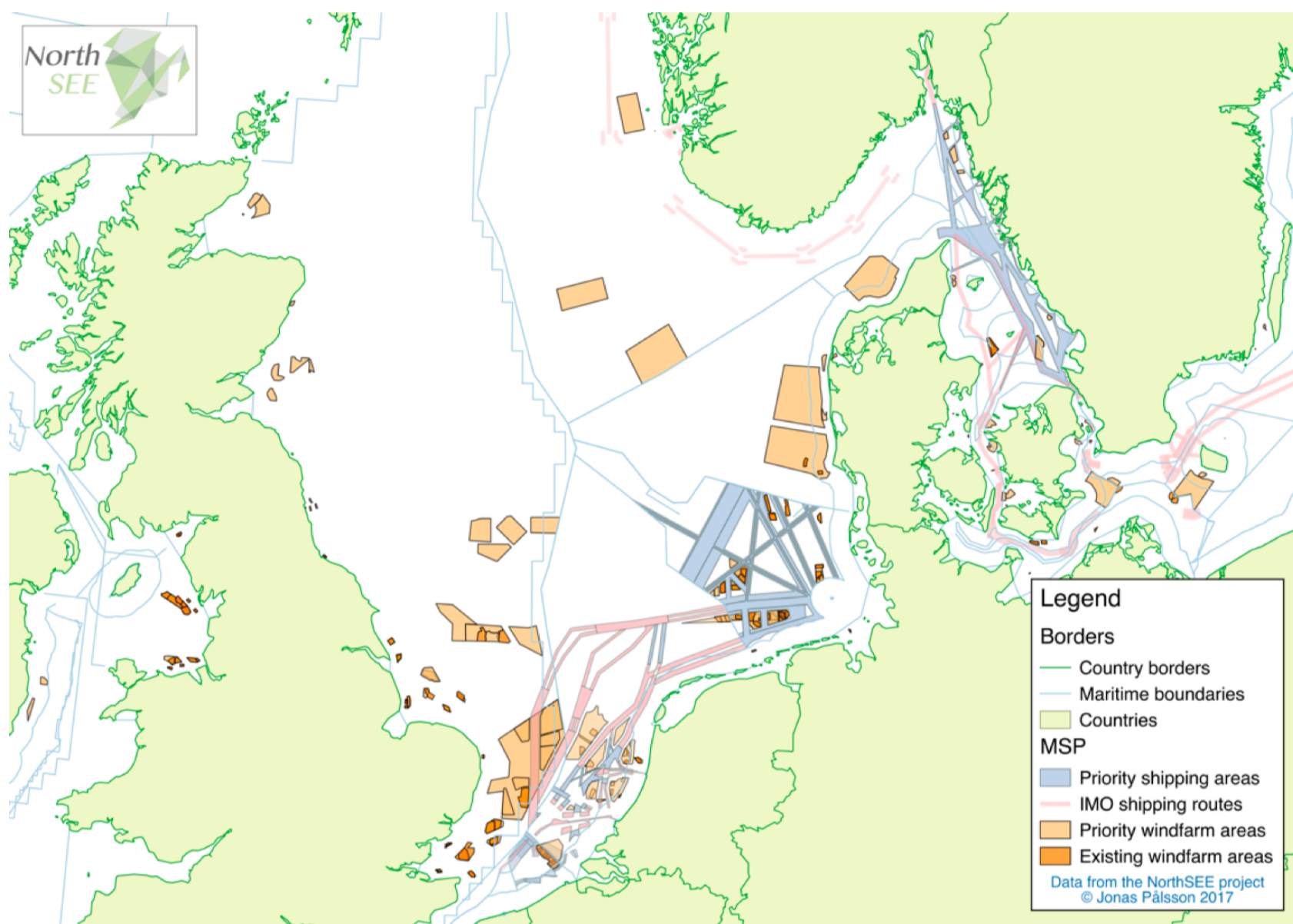
As for disagreements between neighbouring countries, two cases were pointed out. In the consultations between the Netherlands and Belgium, Dutch pilot associations raised concern over compulsory pilots on-board the ships and in the case between Germany and Poland, an unclear border area was cited as reason for disagreements.

Besides the officially designated IMO routes, all countries responded that they had designated other areas with priority for shipping as well. This is also shown on the maps below in blue.

with regards to how the interviewees regarded the efficiency of the transnational dialogues on shipping and OWF, no country expressed any discontent on how they were done and no concrete improvements were suggested to facilitate the dialogue.

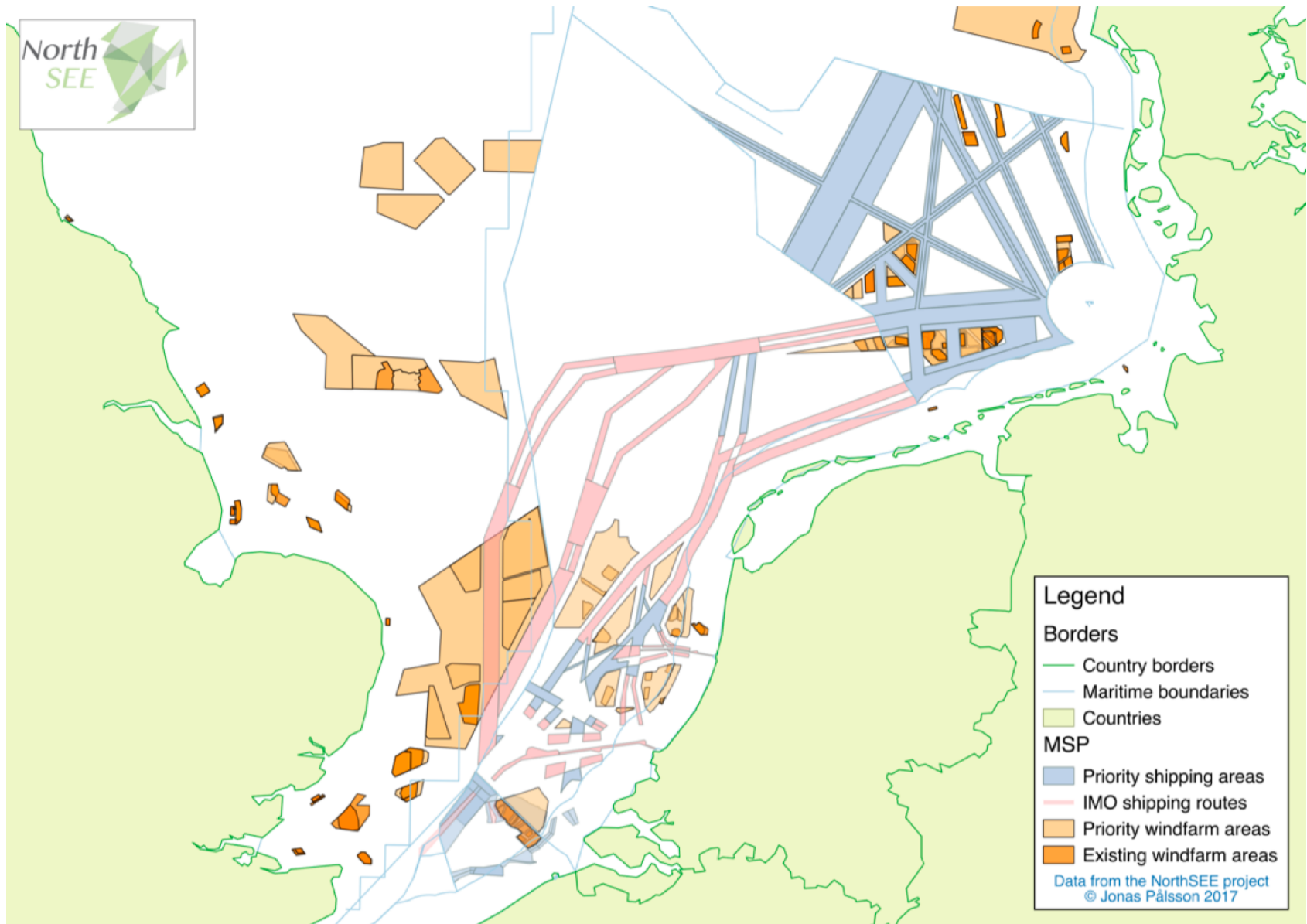


## Designated areas for shipping and OWF in MSP plans



*North Sea map showing wind farms and shipping routes.*

The map shows designated IMO shipping routes, priority areas for shipping and off-shore wind farm areas for the North Sea countries, as they appeared in the respective countries' MSP plans in 2016. In the priority areas for shipping some inconsistencies are visible which will be further described below.

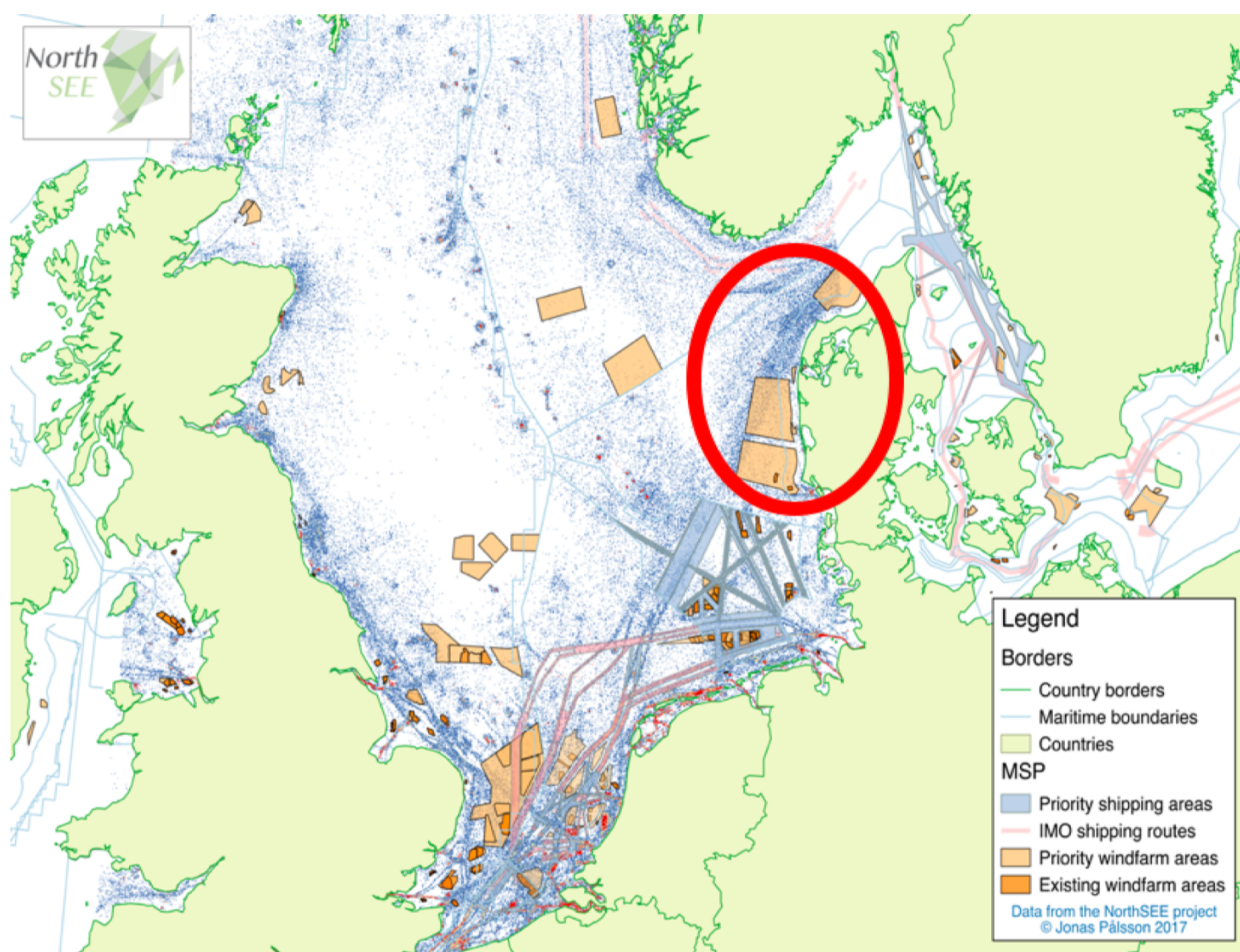


*South North Sea*

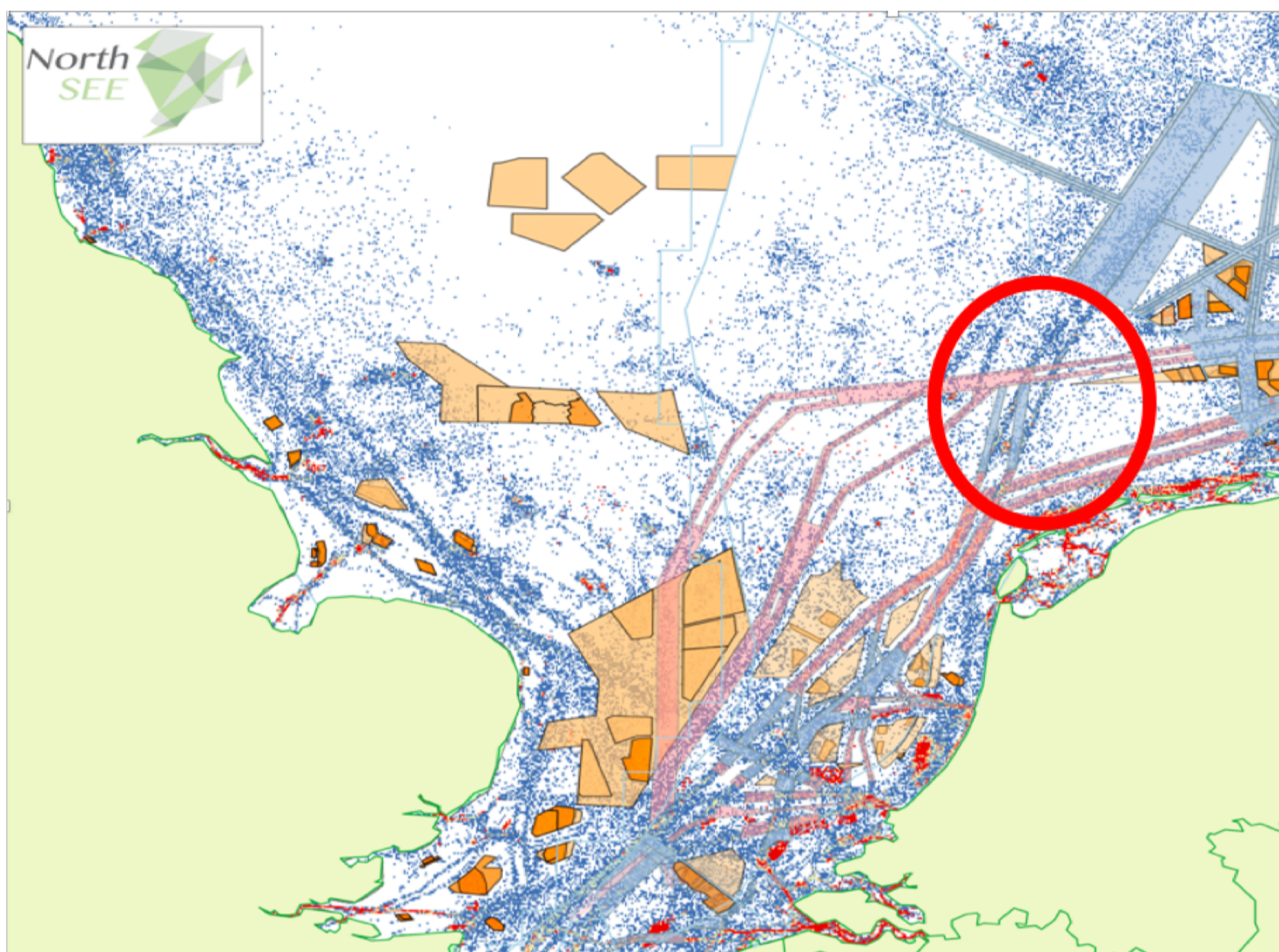
The map shows a more detailed view of the southern part of the North Sea including shipping routes and off-shore wind farms.

## AIS data and MSP plans

In developing a GIS map showing maritime traffic, IMO routing measures and other designated priority areas for shipping, some inconsistencies became evident between what the AIS data shows and what is presented in the MSP plans.



The red circle highlights an area where both intense shipping takes place at the same time as it is designated as areas prioritized for wind farms. It should be emphasised however that Denmark has at the time of writing this report no MSP plan in place and the areas marked for off shore wind farms are hence not part of a MSP plan. Yet, it is still noteworthy that the circled area is subject to interest for both shipping and exploitation of off shore wind farms.



The red circle highlights a discrepancy between the direction of the designated shipping route (blue route) and the ship traffic (blue dots). Although there can be seasonal spatial variations in the maritime traffic, in this case the discrepancy remained even when applying different seasonal AIS maps.

## Summary of chapter II

- ▶ AIS data on vessel traffic in the North Sea shows that the area is intensely trafficked throughout the year, with certain increases in the summer months. In the south part and along the coasts shipping is more intense than in other areas.
- ▶ Ships' routing measures were originally established for safety reasons and points out a predetermined route for ships to sail in order to minimize risk of accidents and other hazards. IMO is the only international body recognised for establishing ships' routing measures. Several routing measures are established in the North Sea, in particular in the southern parts.
- ▶ Individual states have designated certain areas of their sea areas as priority areas for shipping. In these areas, shipping is granted priority over other sea-based activities.
- ▶ North Sea states have had transnational dialogues with regards to planning and designation of shipping routes and OWF. However, these consultations did not always take place under the umbrella of MSP but more on a sectorial basis.
- ▶ Sectorial consultations, as opposed to MSP discussions, run the risk of not taking into consideration effects of sectorial activities on other activities.
- ▶ The absence of a common North Sea platform for MSP discussions on shipping and OWF was not pointed out as a concern or problem during the interviews carried out with MSP authority representatives in the North Sea countries.
- ▶ The EU directive on MSP promotes it as a tool which will provide a holistic approach to management of sea uses.



# III The spatial impact of future shipping activities

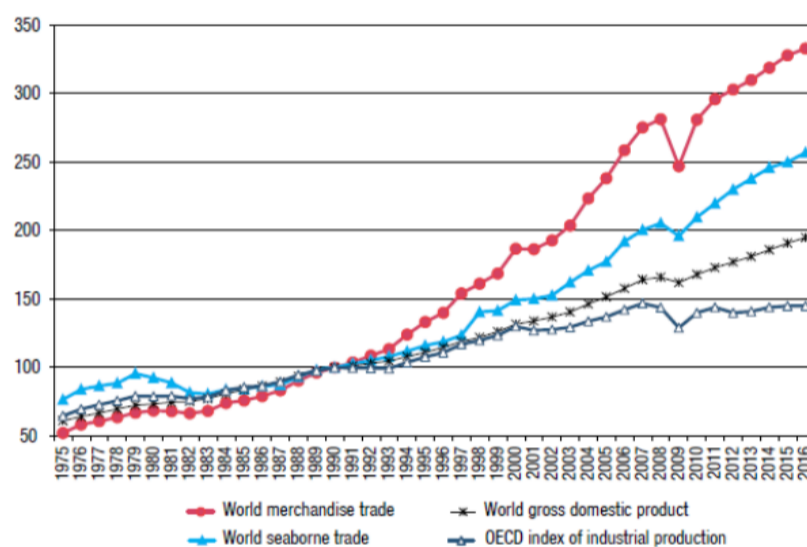
## Drivers and enablers for future shipping activities

### Consumer behaviour

The major influences on the changes and behaviour of ship owners and merchants are market driven.

From the Greeks and Vikings to the British merchants who created the East India Trading Company, shipping has always played a key role in delivering all kind of goods around the world.

Today refrigerated freighters, container ships, car carriers and super tankers transport 90% of the world's food, products and energy. Thus, the world's shipping industry has played an incredibly key role and helped transform the global economy along the way. Each year, some 86,000 ships move more than 9 billion tons of cargo – more than a ton for each person on the planet – across our seas each year.



### THE VILLAGE CALLED THE WORLD

Real globalization started in the first half of 90's. World merchandise trade and world seaborne trade followed the growth of the world GDP for a long time. But during the first half of the 90's they split. World merchandise trade and seaborne trade grew faster than the world GDP and the GDP of the industrialized countries. This is the real start of globalization. This is point where the world became a village. You can buy any product from all over the world for a

Throughout history the oceans have been important to people around the world as a means of transportation. Unlike a few decades ago, however, ships are now carrying goods rather than people. Since the rise of intercontinental air travel, sea travel has become limited to shorter trips (ferry services across the Baltic and North Seas, the Mediterranean, Japan and Southeast Asia) and recreational cruises. The latter have recently experienced a tremendous boom and represent an increasingly lucrative source of tourist income. As markets became increasingly globalized, shipping volumes soared. From the 1950s to the latest global economic crisis, the growth rate of international trade was almost consistently twice that of economic activity as a whole. From 2000 to 2008 the world trade increased by an average of 5.4% each year, while the economic activity, as measured by the global Gross Domestic Product (GDP), increased by only 3% each year. Due to the spectacular rise of trade vis-à-vis economic growth, world



trade since the 1950s has more than tripled to 45% of the global GDP, while goods destined for the processing industry have in fact more than quadrupled.

With respect to the value of the goods, about 23% of world trade is between countries with a common border. This percentage has remained fairly constant over the recent decades. Between continents, however, it differs a great deal depending on their level of development. In Europe and North America the proportion is the highest at 25 to 35 per cent. This trade is predominantly transacted by road and rail. Cargo between countries without a common border is carried out mainly by sea, although increasing quantities of manufactured goods are being forwarded by air. Growth rates for air freight are more than twice as high as those for shipping in recent years. The dominant mode of transport depends on the (relative) transportation costs and the value-to-weight ratio of the goods – the higher the value per unit of weight, the less significant the cost of transportation. Punctuality and reliability are considered more important for valuable commodities.



• The typical cost to a consumer in the United States of transporting crude oil from the Middle East, in terms of the purchase price of gasoline at the pump, is about half a US cent per litre.

• The typical cost of transporting a tonne of iron ore from Australia to Europe by sea is about US \$12.

• The typical cost of transporting a 20 foot container from Asia to Europe carrying over 20 tonnes of cargo is about the same as the economy airfare for a single passenger on the same journey.

**Typical Ocean Freight Costs (Asia-US or Asia-Europe)**

	Unit	Typical Shelf Price	Shipping Costs
	1 unit	\$700.00	\$10.00
	1 unit	\$200.00	\$1.50
	1 unit	\$150.00	\$1.00
	Bottle	\$50.00	\$0.15
	1 kg	\$15.00	\$0.15
	Tin	\$3.00	\$0.05

## COST OF TRANSPORT

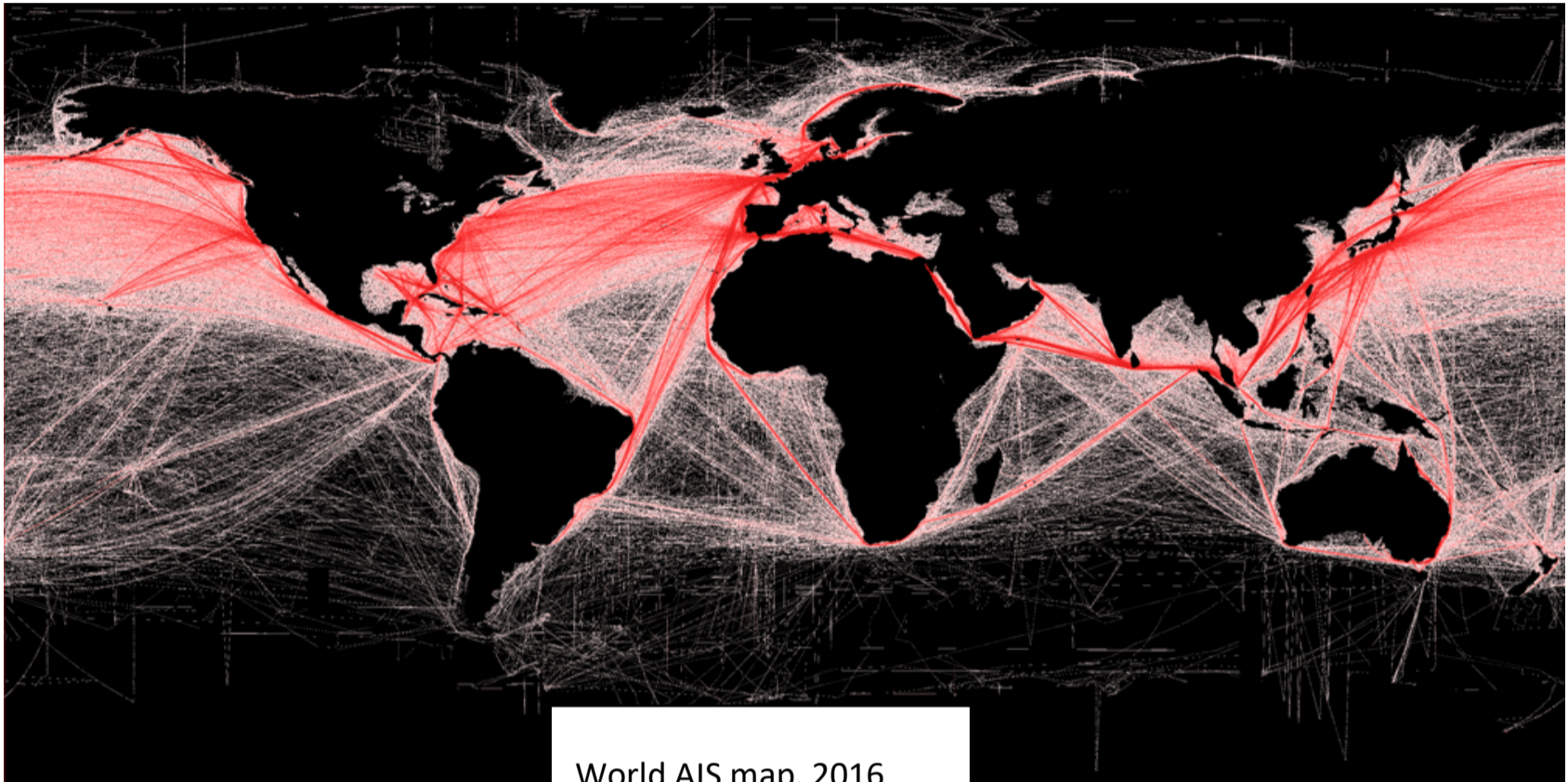
The reason for the rise of seaborne trade is the low transport cost per product. Only 1% on average of the price paid in the shops is transport cost. So for the seller this means that he can sell his product anywhere in the world at a profitable price and offering the same quality as the local product.

Unctad, review marine transport, 2017

According to research by economists, higher-income households purchase higher-quality products. The residents of wealthy countries therefore tend to buy more quality goods. Accordingly, rising incomes influence



the demand for transport in three ways. First, quality goods are more expensive. This means their value-to-weight ratio is higher and the cost of transporting them is lower as compared to their value. Second, as incomes rise, consumers are more likely to purchase expensive products and fancy goods. At the same time, they expect to receive the articles within a very short time. Third, the delivery period in itself is a key element of product quality, having an increasing influence on purchasing decisions; customers are no longer prepared to tolerate long delays. All of these factors have contributed to the even higher growth rates of air freight in comparison to shipping.



## Localization

“Buying local”, consumers’ appetite for local foods is exploding. Not only has there been huge growth in the number of farm-to-table restaurants and farmers’ markets, but grocery chains and big box retailers are elbowing their way in, aggressively expanding and marketing their locally grown offerings for sale.

## Factors fuelling the hunger for local foods

Millennials love local: Today’s Millennials value authenticity and locally made products. They are leading the “buy local” movement which has doubled in size in the last 10 years, according to AdWeek. Edelman Digital found 40% of Millennials prefer to shop local, even if it costs more.

Consumers associate local with “fresh”: Nearly all consumers (93%) associate local with “fresh,” the primary purchasing factor for grocery consumers. That might explain why, regardless of the category, 78% of consumers are willing to pay a premium of 10% or more for local food, up from 70% in 2014. Surprisingly, even lower-income grocery shoppers say they (63%) would pay more for local food. The availability of local foods also impacts retailers’ brand loyalty, as almost 30% of grocery shoppers say they consider purchasing food elsewhere if their preferred store does not carry local foods.

Farmers markets: Strong demand for local foods has driven increase in the total number of farmers markets between 1994 and 2013. This explosive growth has prompted suppliers, grocers and restaurants to adapt by adding locally produced food offerings all year round.



Environmental benefits: local foods are produced as close to home as possible. Buying local supports a more sustainable food system by going beyond the methods used in food production to include every step that brings food from farm to plate, first and foremost, transportation. Sustainable agriculture involves food production methods that are healthy - including reduction of pesticide use – balances demand based on local needs, involves less environmentally harmful equipment and practices, and most importantly, reduces impacts on the environment by decreasing transportation needs.

### Effect on growth shipping industry

Globalization and localization are both trends, amongst many others, that influence the possible growth of the shipping industry. If we take a look at the growth of the respective shipping market, we might predict some trends for the future.

For almost a decade, the world has struggled to cope with huge changes and challenges brought up by the crash of the financial market in 2008. The resulting issues have not always been dealt with in the best possible way, leaving many large economies still in 'recovery' mode.

The full restoration of shipping markets will need several years of solid improvements to lift fleet utilisation rates. Sector overcapacity almost everywhere must be reduced. Governments' support for any industry – including shipping – which is feeling the heat of global competition, might seem like a good thing. But direct subsidies from governments in fact have a negative impact on the global shipping industry as they affect free trade and undermine the level playing field for businesses.

Global GDP growth is currently driven by service sectors and developing/emerging economies which result in a lower "GDP-to-trade multiplier", and thus, generate a lower level of shipping demand than we have been accustomed to in the past.

#### Conclusion and effect on MSP

The shipping industry is highly market driven. Consumer behaviour, such as the demand for foreign products or the wish for local products, as well as timely vs. cheaper transport all has an effect on the growth of shipping industry.

It can be expected that the growth of the shipping industry, and most significantly the quantity of the global fleet, will be limited.

To remain competitive, ship owners must scrap a lot of their old vessels when building new ones. By this, the total number of ships will mostly stay the same, with the exception of the tanker fleet which is growing at the moment. If fleets of old ships are constantly replaced by modern ones, the positive effect of demolishing the old fleet is that the ships sailing around are modern and eco-friendly.

The number of ships sailing the North Sea will be dependent on the development of the EU market. If the demand for foreign goods is low, the number of ships will be low as well. To lower the costs for transportation, shipping companies increasingly use one larger vessel to go to major ports instead of having several smaller vessels going to different ports. The dispersion of the goods is then done with smaller short sea ships.



## New Ship design

Ship designers try to develop new designs to cope with these problems. For example: A research consortium that includes GTT, CMA-CGM and DNV GL recently unveiled the design schematic of Combined Gas Turbine and Steam (COGAS) powered mega-size 20,000 TEU container ship to be fuelled by LNG.

It also include an articulated or coupled two-unit container ship to operate major Asian – European trade routes. The rear section of such a concept ship could be loaded at the Port of Shanghai while the forward section would be loaded at the Port of Hong Kong after the rear section has sailed from Shanghai, with the two-unit European bound ship-train being coupled at Hong Kong.

The articulation coupling would be designed to allow the trailing vessel to sail in the hydraulic “shadow” of the leading vessel to reduce the fuel consumption of the trailing vessel by 70 to 80 percent. While the power of two engine systems would be required to accelerate the coupled ship, energy consumption would decline as the coupled maritime assembly reaches its cruising speed, perhaps allowing the output of a single engine assembly to provide 100 percent of propulsive power as well as auxiliary power. Power cables and a telecommunications line would connect across the articulation between the two units.

While at cruise, computer-controlled electrically-powered propellers (azipods) on both leading and trailing sections would provide both propulsion as well as directional control, allowing the design of the articulation coupling to include flexibility for relative pitching motions, relative yawing motions and even relative rolling motions. Manpower cost and fuel cost are the dominant cost items when a ship sails at sea and a coupled-articulated container ship would offer substantial savings in terms of transportation cost per container while sailing between pairs of nearby super-ports at the Asian and European ends of the voyage.

There are several pairs of Asian major super-ports that are located within relatively close proximity to each other as well as a pair of major European super-ports at Hamburg and the Netherlands. Several of these ports also serve as maritime – maritime transshipment ports where local, inland and coastal vessels interline with mega-size oceanic vessels. The mega-terminal at Port of Colombo, Sri Lanka serves the container transshipment needs of several nations that include Pakistan, India, Bangladesh, Myanmar and Western Thailand while the Port of Singapore can serve the transshipment requirements for nations that include Malaysia, Indonesia, Kampuchea, Vietnam and the Philippines.

The rear section of a two-unit ship train could sail from Singapore to Colombo within 72 hours, Taipei to Hong Kong within 36 hours, Busan to Shanghai within 24 hours or Hamburg to Rotterdam within 24 hours. The major section of the voyage would involve greatly extended distances that allow a two-unit ship-train to realize savings in terms of manpower and fuel consumption. Coupled super-size container ships would have to sail via the Suez Canal to European ports as well as to a possible east coast North American super port, the proposed Nicaragua Canal perhaps being unsuited to transit ship-trains

The future prospect of two-unit mega ships carrying in excess of 35,000 TEU sailing extended voyages and connecting pairs of nearby super-ports at points of origin and destination would place high demand for service on local interconnecting maritime services. Several studies undertaken in the United States indicated that on container loads exceeding 500 TEU that coastal maritime service and inland waterway maritime service realized lower transportation cost per container. Europe’s barge canal system connects to several major ports that include Hamburg and Rotterdam while navigable rivers connect to the Chinese ports of Hong Kong, Shanghai and Tianjin.

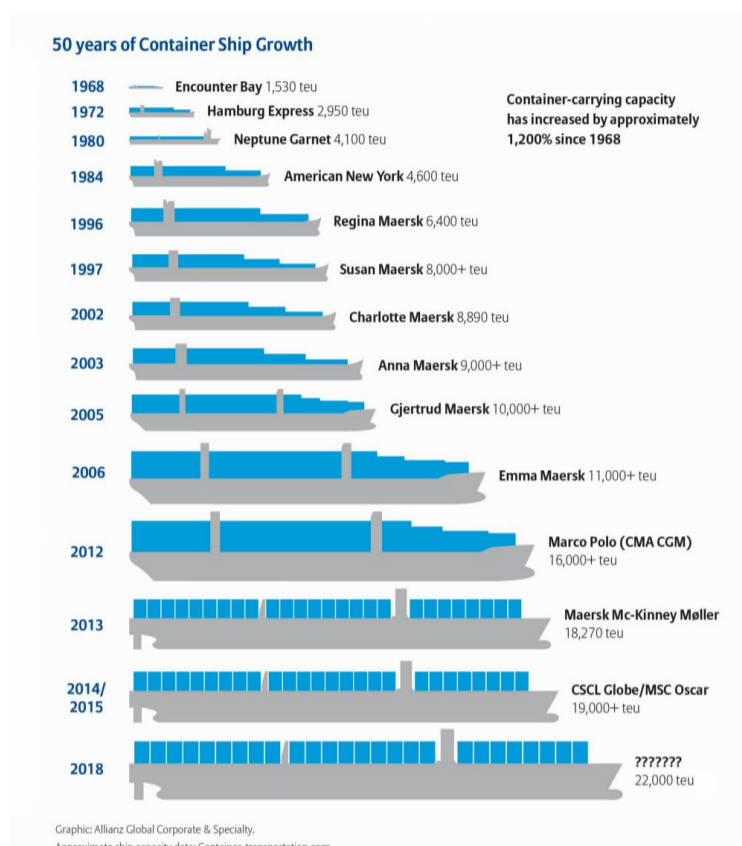
Major navigable rivers extend inland into Pakistan (Indus), India (Ganges), Thailand (Pa Sak), Bangladesh (Brahmaputra), Vietnam/Kampuchea (Mekong) and Myanmar (Irrawaddy) to allow river vessels to interline with coastal ships that will in turn connect to major super ports. A two-unit mega ship arriving at a super port along North America’s east coast could place new emphasis on that region’s coastal ship services with potential to greatly increase the volumes of container traffic shipped along the St Lawrence Seaway. Future summer melting of ice on the deep-draft Canadian side of Arctic could open a northern passage for two-unit super ship.

(Marasinews)



## Ship sizes

Bigger and better - trend is largely a result of containerization and automation which enables the faster loading and discharging of vessels. Since the beginning of this trends, ships have become bigger and longer. Only a few years ago, ships of 10.000 TEU were science fiction. Today, ships of 20.000 TEU are sailing our waters. Every year new plans are created to outsize the currently available megaships and apparently the sky is the limit. However, the sky at sea might be the limit, the ports aren't. These ships find more and more difficulties to enter ports, because of limited maneuverability or draught.



This trend will most likely continue. The new container ships from CSCL (China Shipping Container Lines), which at 19,100 TEU look set to surpass Maersk Line's Triple-E series, which will not be the world's biggest container ships for long. The 22,000 TEU container ships that industry rumours say are underway will also not be able to hold this position for long. This is because there are even bigger ships on the way to the world seas, and these behemoths will be able to carry 24,000TEU, according to Lloyd's Register.

The next generation of giant ships will of course also bring certain challenges, e.g. with regard to technic. The ships can be built in a highly functional way but may create problems in the port terminals. For instance, the massive ships would be able to transit the Suez Canal in terms of draft, but there is a bridge that spans the canal and the ships would likely have difficulties getting under this.

Several ports will experience problems related to draft, for instance, in the Port of Hamburg where the river Elbe is constantly dredged to make room for the new ultra-large vessels that are already sailing the world seas.

Although the limits might be reached as the possibility to react flexible on market changes reduces with size. According to Maersk Line CEO Søren Skou, the ships could become so big that their size could seriously weaken their flexibility, especially in terms of ports and call options, and that this could water down the potential unit cost reductions that could be gained from using bigger ships.



For the next few years, ports and authorities must be prepared for more and bigger ships. According to Lloyd's register, more than 60 mega ships, with lengths over 400m, are being built at the moment.

## Short Sea Shipping

The trends of possible limits of the access of large container vessels into ports show a possible growth of short sea shipping. Large container vessels will make berth in major hubs like Rotterdam. For the transportation of the goods, further inland or to other smaller ports, smaller, more fuel efficient vessels can be used. These vessels will naturally use shipping lanes that are closer to shore.

The EU statistical findings show the trends in short sea shipping from 2005 until present (see Tab. 1). This trend in addition to the knowledge about newly built ships can help to predict the possible future trends in short sea shipping.

### Main EU statistical findings on Short Sea Shipping

The total gross weight of goods transported as part of EU short sea shipping is estimated at 1.8 billion tonnes of in 2015, an increase of 0.9 % in comparison to the previous year. The overall increase in short sea shipping recorded by the main EU ports seemed to consolidate the gradual recovery seen in EU short sea shipping following the economic downturn in Europe in 2009. Even so, the 2015 level of EU short sea shipping still remained below the levels recorded in the years immediately preceding the economic downturn

Tab. 1: Short Sea Shipping (SSS) of goods by reporting country and direction, 2005-2015 (gross weight of goods in Mio tonnes), Source: Eurostat

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015			Growth rate 2014-2015 (%)	Growth rate 2005-2015 (%)
	Total	Total	Total	Total	Total	Total	Total	Total	Total	Total	Inwards	Outwards	Total		
<b>EU-28</b>	<b>1 808.3</b>	<b>1 835.4</b>	<b>1 865.9</b>	<b>1 862.0</b>	<b>1 691.4</b>	<b>1 765.3</b>	<b>1 787.3</b>	<b>1 775.7</b>	<b>1 756.3</b>	<b>1 793.9</b>	<b>1 466.7</b>	<b>1 020.3</b>	<b>1 810.8</b>	<b>+0.9</b>	<b>+0.1</b>
Belgium	108.7	113.1	121.6	128.7	111.7	130.1	125.6	123.9	125.6	134.3	72.4	58.8	131.2	-2.4	+20.7
Bulgaria	17.9	20.0	19.4	20.9	18.2	18.9	21.2	22.1	24.1	21.9	10.7	10.7	21.5	-2.3	+20.0
Denmark	71.6	74.8	76.8	76.7	65.2	66.8	67.7	66.2	66.3	66.6	44.0	31.3	73.1	+9.7	+2.0
Germany	178.6	186.7	192.8	189.9	156.0	157.7	168.3	170.4	171.9	177.0	112.3	65.5	174.1	-1.7	-2.5
Estonia	34.9	37.4	30.0	22.9	22.6	28.3	31.2	25.5	28.3	29.9	8.8	15.0	23.7	-20.7	-32.2
Ireland	37.2	39.6	40.5	38.1	35.0	37.1	36.1	37.0	37.1	36.8	25.1	15.0	40.0	+8.7	+7.5
Greece	89.0	90.9	93.3	89.4	83.3	81.5	78.0	90.5	94.6	96.0	64.0	54.7	98.2	+2.3	+10.3
Spain	192.6	194.2	192.0	187.1	174.3	176.8	187.0	191.1	186.0	196.3	139.3	83.0	196.6	+0.1	+2.1
France (*)	215.2	216.6	215.6	222.1	194.9	194.2	194.3	171.0	166.6	171.9	109.5	65.4	169.3	-1.5	-21.3
Croatia	15.1	15.4	19.2	18.5	16.3	15.5	13.2	12.1	12.1	10.4	8.1	4.3	11.9	+14.2	-26.4
Italy	322.8	323.6	329.8	334.0	308.5	310.7	298.4	285.2	272.0	262.5	216.0	137.2	272.2	+3.7	-15.7
Cyprus (*)	3.9	2.3	2.3	2.7	2.5	2.6	4.4	5.7	6.7	6.7	4.5	2.5	6.9	+3.1	+78.0
Latvia	45.8	46.4	49.4	49.2	48.8	47.0	53.4	61.0	56.3	58.2	6.3	50.2	56.2	-3.4	+22.7
Lithuania	20.7	21.6	23.3	28.6	25.4	28.3	32.2	32.4	31.3	30.7	13.3	18.1	31.3	+2.2	+51.7
Malta	3.2	3.3	3.0	3.1	3.0	3.5	3.0	3.0	2.8	2.9	3.2	0.2	3.4	+16.7	+6.3
Netherlands	253.5	253.0	259.3	250.8	243.8	275.9	242.3	265.6	262.9	272.1	211.9	74.4	286.2	+5.2	+12.9
Poland	42.4	41.6	44.5	39.4	37.7	49.5	48.1	48.8	52.0	54.2	31.4	24.8	55.8	+2.9	+31.5
Portugal	35.4	36.5	36.6	35.2	29.3	35.4	35.7	34.7	39.2	41.7	28.6	21.0	44.9	+7.6	+26.7
Romania (*)	22.1	21.2	19.4	22.8	22.6	24.0	24.6	23.9	26.4	31.3	12.5	18.8	31.3	+0.1	+41.7
Slovenia	7.3	8.7	8.8	8.7	7.8	7.8	7.9	8.8	9.2	9.8	6.1	5.2	11.3	+15.2	+54.6
Finland	83.3	90.9	95.9	97.7	79.0	91.2	94.7	88.0	90.2	89.6	45.6	44.9	85.5	-4.6	+2.6
Sweden	137.2	139.1	144.3	148.0	130.4	148.7	148.0	142.1	145.8	150.5	84.0	72.5	151.5	+0.7	+10.5
United Kingdom	355.2	359.3	365.6	348.4	313.4	316.3	320.1	311.0	306.9	315.7	209.0	145.5	313.5	-0.7	-11.7
Iceland	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Norway	140.2	142.2	144.9	138.9	126.5	140.1	145.4	147.4	152.3	150.3	54.8	114.1	160.4	+6.7	+14.4
Turkey	:	:	:	211.4	214.5	242.6	256.9	254.6	264.0	258.5	159.3	132.0	268.5	+3.8	:

Note: The total figures exclude double counting of the same goods being reported as outward movements by one port and as inward movements by another. Country totals may therefore differ from the sum of inward and outward declarations, and EU-28 totals may differ from the sum of EU country totals (see methodological notes).

(\*) 2009-2015: partially estimated by Eurostat.

(\*) The data reported contain a significant share of declarations to and from unknown ports (see methodological notes).

Short sea shipping made up close to 59 % of the total maritime transport of goods to and from the main EU ports in 2015, about the same as in 2014. However, the share of short sea shipping in total maritime transport



varies considerably between the reporting countries. The predominance of short sea shipping of goods over deep sea shipping was particularly profound in Bulgaria, Denmark, Estonia, Ireland, Greece, Croatia, Italy, Cyprus, Latvia, Lithuania, Malta, Poland, Romania, Finland, Sweden, the UK and in the EFTA country Norway, all with short sea shipping shares of 70 % or more in their main ports.

The top 20 ports accounted for 37 % of the total short sea shipped goods handled in the main EU-28 ports in 2015 (see Tab. 2). Rotterdam in the Netherlands remained the largest EU port for short sea shipping, handling a total of 204 million tonnes of short sea shipped goods in 2015. Among the other top three ports, Antwerpen in Belgium handled 97 million tonnes of short shipped goods in 2015 and Hamburg in Germany handled 50 million tonnes accordingly.

A few of the main deep sea hub ports, such as Rotterdam and Hamburg, as well as Amsterdam in the Netherlands and Algeciras and Valencia in Spain, handle more deep sea shipping than short sea shipping of goods. In contrast, all the other top 20 ports for short sea shipping handled more short sea shipped goods than deep sea shipped goods.

At 135 million tonnes, Rotterdam handled more than 13 % of the total short sea shipped liquid bulk goods reported by the main EU ports in 2015, by far the largest volume of short sea shipped liquid bulk for any EU port. With 19 million tonnes, Riga in Latvia confirmed its position as the EU's largest port for short sea shipping of dry bulk goods. Antwerpen remained the EU's largest port for short sea shipped goods in containers with 43 million tonnes, while Dover remained the largest port for short shipped goods on Ro-Ro units with 27 million tonnes.

These statistics show a slow increase of Short Sea Shipping over the last 10 years. However new technologies and new strategies of the ship owners suggest an even larger increase over the following years.

## Green innovative sector

Over the past decades short sea operators have been investing heavily in the greening of their fleets. Considerable resources and efforts are spent on innovative, green vessels and techniques.

Ferries often remain in a port for an average of six hours and during this time electricity is necessary to run on-board systems, such as heating and galley equipment.

1. Stena Line invested in the infrastructure needed to power two vessels at the same time from the local grid while berthed in the port of Hoek van Holland. As the electricity grid is 50Hz and the on-board ship systems are mostly 60Hz, considerable additional investment was needed on the vessel and ashore. Using the system for a minimum of 80% of the port time reduces the NO<sub>x</sub>, SO<sub>x</sub>, PM (dust) and emissions by 80%.
2. The Dutch shipyard Ferus Smit delivered in 2015 to the SSS joint venture of Erik Thun A.B. and KG Jebsen Cement a dedicated 7,200 DWT cement carrier, the "Greenland", powered by LNG. This is the first LNG powered short sea dry cargo vessel to date. But more are being built at the moment.
3. DFDS is a pioneer in relation to scrubber technology. In 2009 an exhaust gas scrubber able to remove SO<sub>2</sub> (Sulphur dioxide) was developed and installed as a retrofit onboard the vessel Ficara Seaways. From 2009 to 2012 it had been in operation for 5630 hours. The obtained results showed that it was possible to reduce the SO<sub>2</sub> level to under 19 ppm in the exhaust gas. This corresponds to below 0.1 % sulphur in the fuel. The use of scrubbers became more widespread thanks to the project on Ficara Seaways.



All these new technologies and more severe EU environmental legislation make it more interesting for ship owner to invest in smaller, faster, fuel efficient and eco-friendly short sea ships.

### Conclusion and effect on MSP

Ships will become bigger in the future. But this is limited by the strength of the vessel and the access into the ports.

Although ship owners are investing in building new big vessels, there is also an increase of smaller short sea vessels.

The increase of ships on the short sea shipping lanes is likely to have an impact on MSP. It might be important to keep these routes open.

The larger vessels will focus on main hubs. It is important for them to keep the accessibility and opportunities to make berth at these larger ports

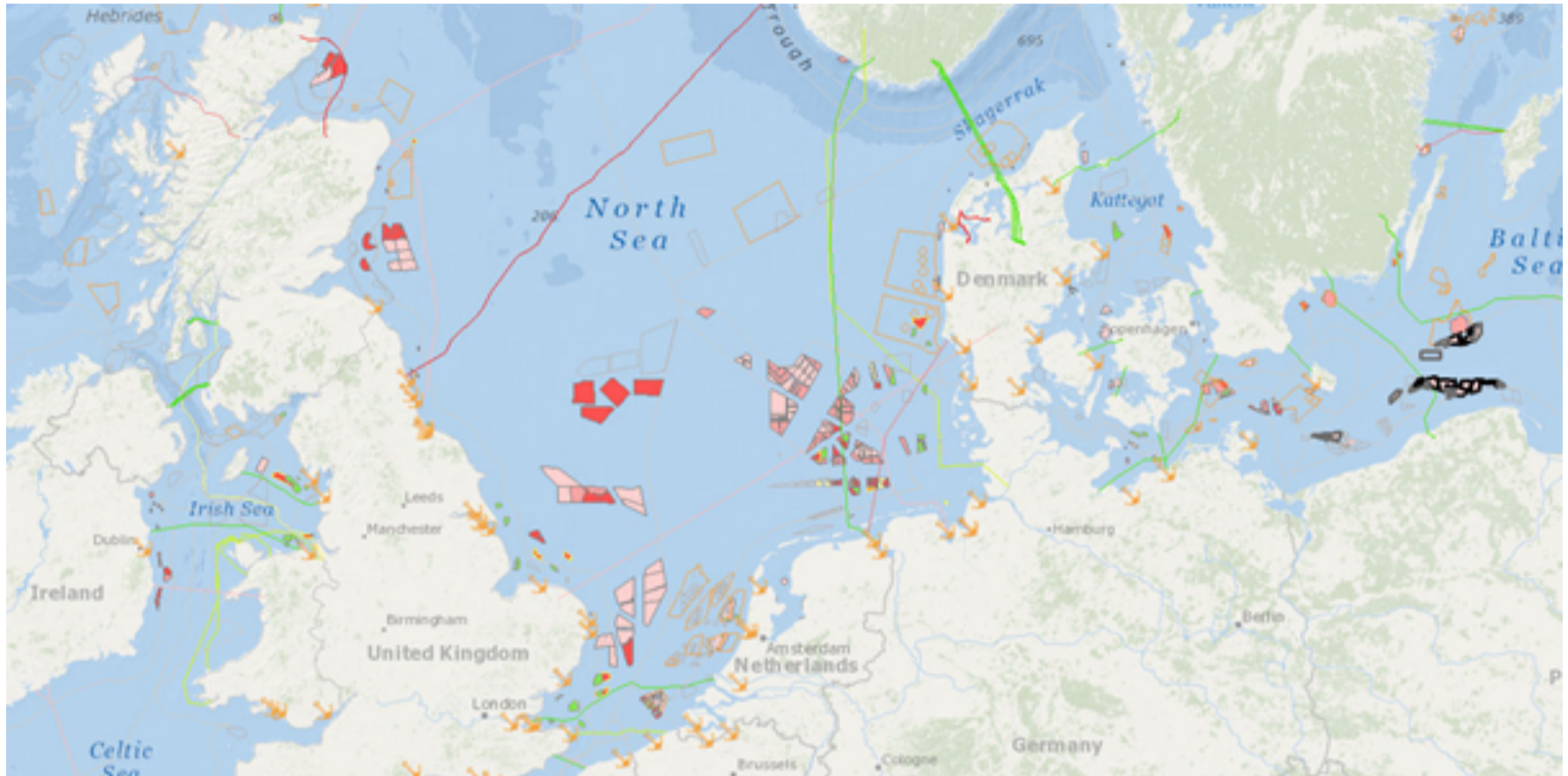
## Ship design and marine technology



A couple of years ago everyone was targeting containers and related trade. It seemed to be the only acceptable way of transporting cargo. What we see today is that slowly but surely shipping companies are once again reinvesting in specialised ship types. This trend is mostly visible in the heavy lifting industry and transportation of chemicals. Extremely specialised ships that are only able to transport parts of offshore windmills have been constructed, pushing the crew to new levels of specialised knowledge about their ships and trade. The richness of the sea as a new territory for developing new activities and technics, has been discovered only recently. A few years ago, the sea was for ships and offshore industries like gas and oil extractions. Now people look at the sea for all possible activities they can imagine. The construction of offshore windfarms is a booming business. A look at the map of the North Sea and Baltic Sea shows us the amount of windfarms that are constructed or might be constructed.



Together with these new activities, there is also an increase of specialised ships. As mentioned above, some new heavy lifting vessels are built to construct these windfarms. But there is need of a whole new fleet of specialised ships to be designed and built for this purpose.



Cable Laying vessel





It must also be noted that the above is not restricted only to large construction vessels. To maintain these offshore energy parks, there is the need for large fleets of transport vessels. vessels to carry small crew members and maintenance personnel in and out of the windfarms is also needed.

For the Belgian windfarm area, which is a relatively small area, it is estimated that there will be 8.000 of these of these small transport vessels movements per year. Covering the entire North Sea area, we are talking about over 250.000 movements a year.

To make it safe for navigation around the windfarms and other offshore industries, there is the need for development of new intervention ships which will stay at sea as guard vessels, but can intervene whenever it is needed and can operate as a station tugboat.



### Freedom ship

Freedom Ship is a floating city project. It was so named because of the "free" international lifestyle facilitated by a mobile ocean colony, though the project would not be a conventional ship, but rather a series of linked barges.

The Freedom Ship project envisions a 1317 m (0.818 mi)-long integrated city with condominium housing for 50,000 people, an airstrip to accommodate turboprop aircraft, duty-free shopping and other facilities, large enough to require rapid transit. The complex would circumnavigate the globe continuously, stopping regularly at ports of call.



### Other activities

The developing of new activities at sea is not limited to energy alone. There is an increase of demand for space for aquaculture, seaweed farming and other new and evolving activities.

All these activities need space at sea and are not only making it more difficult for common cargo vessels to manoeuvre, but also need their own specialized vessels. For each type of activity, a ship is being developed.

There are also the more futuristic ideas of creating floating houses or even villages, large hotel ships and even prisons. Although these ideas are not for the near future, it might be possible that they sail around within 30 years.

### Conclusion and effect on MSP

Although a lot of the future ship developments are not to be expected in near future, some of these specialised ships are already sailing our waters, due to the presence of new activities at sea. Their numbers will certainly increase in the future.

The problem with these vessels is that, they will not follow the standard traffic lanes, used by commercial cargo ships. These specialised ships will go where they are needed and in so doing, will have to cross standard traffic lanes, raising high safety concerns.

When designating an area for an offshore activity of any kind, the national authorities must also take into account specialized or small ships needed for construction and maintenance. It is important to, while creating new shipping traffic lanes, foresee safe crossings for these specialized vessels.

## Fuel and energy

Like every aspect of modern life, including shipping, a green image has become increasingly important. Innovations that reduce the environmental footprint of ships reach from improvements of engines over better propeller performance and high-tech coatings to friction-reducing air cushions and even skysails that are reducing carbon and sulphur emissions. Further advances are to come, as more and more specialised methods are pushing the maritime industry towards a green and environmentally friendly era.

### LNG

One of the most recent and visible signs of this shift has been exemplified by the Port of Rotterdam, the largest port of Europe. It has expanded its gate terminal by a third berth for the loading of small LNG vessels and tankers. This will help distribute LNG not only to other terminals, but most importantly to oceangoing vessels, a venture that had proved difficult in the past due to lack of infrastructure.

One of the driving factors behind the developments from heavy fuel oils (HFOs) towards alternative fuels like LNG can be owed to decisive environmental regulations set out by the International Maritime Organization (IMO). Starting January 2020, a global sulphur cap of 0.5% will be imposed on ships trading outside of emission control areas. Currently, this limit is capped at 3.5%.

“When switching usage from HFO to LNG, there is a significant reduction of emissions. The sulphur oxides are completely removed, nitrous oxide is significantly reduced and so called local emissions particles are basically eliminated. That is clearly one of the major benefits which is enabling shipping to become more green,” says Timo Koponen, Vice President, Flow & Gas Solutions, Wärtsilä Marine Solutions.

The effect of the IMO regulation in addition to the ‘go green’ attitude of companies is reflected in the demand for LNG fuelled ships.



Globally, about 100 LNG fuelled ships are in operation and 101 LNG fuelled ships are on order, according to international certification body Det Norske Veritas (Norway) and Germanischer Lloyd (Germany) – popularly known as DNV GL1;

In addition to this about 72 ships, either in operation or on order, are in the process of upgrading from conventional fuels to LNG.

Cost plays a key role in boosting demand for LNG fuelled vessels. “We expect the price of the 0.5 per cent fuel to be somewhere in between HFO and marine gas oil (MGO). This will offer an additional incentive to ship owners thinking about switching to LNG, in order to achieve compliance with the upcoming sulphur cap. Generally, we expect to see more interest in LNG as ship fuel and a greater number of new buildings using LNG propulsion. The impact will be felt the most in the deep sea ship segments,” explains Martin Wold, Senior Consultant Environment Advisory at DNV GL.



## Challenges

The greatest limitation for the global adoption of LNG is the lack of infrastructure and bunkering facilities. To address this challenge, companies are providing dual-fuel engines that can run on both LNG and conventional LFO, HFO or liquid biofuels.

According to Timo Koponen, a very important piece of this puzzle is to get more major ports involved with LNG bunkering facilities - like Rotterdam has been. When it comes to bunkering, there needs to be a matrix of different facilities and solutions going forward.



Singapore, which is investing heavily in LNG, is starting to have bunkering facilities all around the Baltic Sea – e.g. at Finnish ports. Other ports are also regarding this as an opportunity to differentiate by being able to bunk LNG, like the port of Zeebrugge.

In areas where there are no LNG bunker facilities in ports, you might expect that the industry will foresee large bunker vessels at sea. For the ports that are further inland, smaller bunker vessels can be used.



LNG's popularity (as an alternative fuel) is gaining momentum in the ever important cruise industry. With a number of 11 LNG vessels on order, the demand for LNG fuel will rise by about 300,000 to 500,000 tons per year. By comparison, we estimate that the consumption of the current fleet in operation adds up to about 250,000 tons per year. Therefore, the decisions made in the cruise sector will have a significant impact on the whole industry. Such bunker volumes will give LNG suppliers the confidence to invest in additional LNG bunker vessels, which will likely be the preferred way of supplying these ships.

By 2020, DNV GL estimates that about 400 to 600 LNG bunker vessels will be operational globally. Given the progress thus far, industry giants believe that it will definitely be one of the most significant alternative fuels going forward.

### Other fuel alternatives

Besides LNG and traditional HFO, there are a couple of other fuel alternatives:

- Biofuel use is increasing; fatty acid methyl ester (FAME) biodiesel is widely available, but increasing societal resistance against FAME will make next generation algae derived bio-oils much more attractive.
- Methanol is generally derived from natural gas feedstocks, but with renewable feedstock being available it has great potential as a clean fuel. Although toxic and flammable, fuel handling and risk management is simpler than for LNG since it is not a cryogenic liquid.



- Hydrogen has traditionally been energy intensive to produce in large quantities and risk management is challenging, however it is potentially both clean and abundant. If efforts to reduce the cost of generating hydrogen reach fruition, then it could potentially become the holy grail of energy; cheap, clean and abundant fuel.
- Nuclear energy is mature, clean and reliable, but acceptance of nuclear energy faces significant political, regulatory and societal challenges.
- Renewable energy, such as wind and solar, will augment fuels, such as gas or oil, but are unlikely to replace them.



It is to conclude that there is no 'one size fits all' best solution. Market fragmentation with operators selecting solutions fitting their own needs is likely, perhaps resulting in multiple fuel policies within an operator's fleet.

On a short term, you might expect an increase of LNG fuelled vessels. On a long-term there will be hybrid systems using fossil fuelled engines, combined with electric systems, powered by solar or wind energy.



#### Conclusion and effect on MSP

The increase of LNG fuelled vessels will not have a strong impact on the traffic lanes. These ships will continue to use the traditional routes. The only potential impact of this new trend is the urge for LNG bunker facilities. Ports which offer LNG facilities may become more attractive. Areas with no LNG ports need to foresee enough space for bunkering at sea. If possible, bunkering can also be done by smaller LNG bunker vessels that will probably use the same routes as the Short Sea Shipping vessels to go between ports.

Alternative systems, hybrid vessels using fossil fuel and renewable energy sources, are not likely to be used significantly in the near future. Thus, there will not be an effect on MSP.

## Digitalization of shipping

Autonomous vehicles are found in all transport sectors. There are autonomous aircrafts reaching from military drones to civilian drones that are being used for transportation of goods, as well as autonomous automobiles such as unmanned busses used at airports and in city centres or car companies that are experimenting with driverless cars.

In the shipping industry, there are already a range of smaller unmanned vessels sailing around. The military uses unmanned underwater vessels for patrolling and minesweeping, autonomous research vessels scan the sea bottom, and windfarm constructors use unmanned underwater robots for cable laying. However, so far there are no bigger unmanned cargo vessels sailing over longer distances. This is about to change.

### *What are the motivations of the industry to invest in unmanned vessels*

1. *Shortage of mariners in Europe*
2. *Reduce "human error"*
3. *Ultra-slow steaming, using ocean currents, leads to lower fuel costs and lower emissions, but also less efficient transport capacity and socially unacceptable voyage durations.*
4. *Lower manning costs*

Kongsberg signed a memorandum of understanding in early November to build "the world's first unmanned and fully-automated vessel for offshore operations".

### Levels of autonomy

Numerous technologies that would enable ships to be unmanned are already available and are being used as well. Many other technical leaps have been achieved in different maritime sectors. This indicates that the barriers to developing unmanned ships are decreasing. It is now up to regulators and classification to catch up with the technological advances.

## HRÖNN

This autonomous vessel, named Hrönn, will use the Trondheimsfjord as test area. It is designed for offshore energy, scientific and fish-farming industries.



Worldwide, the number and scope of projects dedicated to unmanned vessels is increasing, including the world's first designated test area for autonomous ships and European Union-funded research. In October, the Norwegian Maritime Authority and Norway's coastal administration opened the world's first designated test area for autonomous ships, in an area of the Trondheimsfjord in northern Norway.

The Danish Maritime Authority is also working with the Technical University of Denmark on research, while UK-based Automated Ships and Norway's





Lloyd's Register (LR) has set out what is required to class an autonomous ship in its ShipRight design assessment procedure guide. This guidance will help transform autonomous shipping from a theoretical possibility to a practical reality.

LR has proposed six autonomy levels (ALs) for shipping, depending on the technology, systems, and operating procedures involved. These levels should provide clarity to shipping stakeholders about the specific requirements of different automation strategies.

The 6 levels range from AL1 for ships with data collated for on-board decision making, through to AL6 which denotes a fully autonomous ship with no access required during a mission. These should help designers, shipbuilders, equipment manufacturers, and ship owners to accurately specify the desired level of autonomy in designing the ship and for ongoing operations and maintenance. AL1 and AL2 are already operational. AL3 and AL4 are being built at the moment and will sail the North Sea within a few years. AL5 and AL6 are the most uncertain, but it is expected that these kind of ships (on a commercial level) will be reality within 10 to 15 years.

## Law and legislation

One of the major issues regarding unmanned vessels is the lack of clarity of the current legislation. International treaties like UNCLOS, SOLAS, COLREG, do not have specific articles on unmanned vessels.

The International Maritime Organization prohibits ship operations without crew. The International Convention for the Safety of Life at Sea requires all ships to be "sufficiently and efficiently manned," the IMO said.

Safety rules emerged in 1914 in the wake of the sinking of the RMS Titanic two years earlier, which killed more than 1,500 passengers on the ship's maiden trans-Atlantic voyage. Current rules, completed in 1974, have been adapted for new technologies such as introducing mandatory requirements for electronic charts and automatic identification systems for ships. Proponents of greater autonomy hope the rules may be further relaxed.

If you want to develop legalisation regarding unmanned vessel, the first discussion that rises is the definition of an unmanned ship. Numerous different international maritime law conventions apply their own tailor made definitions of a ship.

## AUTONOMOUS LEVEL CLASSIFICATION SYSTEM BY LLOYDS REGISTER

**AL1 and AL2 ships classifications:** For ships classified under this, all actions on-board would be taken by a human operator but there would be decision support from shore. This is already in place with some leading ship owners at some vessels of larger shipping companies. K-Line has developed an integrated vessel operation and performance management system that includes analysis and real-time remote monitoring and decision support.

**AL3 and A4 ships:** Humans are present, but only in supervisory roles which go beyond autopilot operations.

**AL5 and AL6 ships:** Ships are fully autonomous, with decisions actioned without human supervision. These types of ship are being examined by AAWA, which includes DNV GL, Rolls-Royce, Inmarsat, Napa and Deltamarin. The Advanced Autonomous Waterborne Applications (AAWA) project also has the support of operators such as Finferries and ESL Shipping. So, it is likely that by 2020 there will be an autonomous ferry prototype operating between islands in Europe. Whether there will be unmanned cargo ships, tankers or other ship types remains to be seen.

Source: Lloyds register



The lack of legislation slows down the process of developing and deploying unmanned vessels. Ship designers cannot be certain how to design a ship if they do not know which safety code or building regulations apply to them.

Besides the questions of legislation, it is not yet clear how security issues like piracy and the mandate to help distressed ships will be addressed for autonomous ships. Another problem is the level of control on an autonomous vessel, should it be necessary to make radio contact with someone who is in control of an unmanned vessel.

Does the Collision Regulation Convention also apply to unmanned vessels? Two unmanned vessels will agree on who does what, when they are on a collision course in a split of second. They don't need regulations.

Currently, the member states of the International Maritime Organization are working together with the industry to solve these issues, however, this process takes several years. Ship owners will not wait this long and this implies there might be a gap in regulations when the first unmanned ships sail at sea for commercial international voyages.

Because of the legal differences between manned and unmanned vessels and because of difficulties in programming unmanned vessels to predict the behaviour of manned vessels (the human factor is always uncertain), ship owners of unmanned ships are likely to let their ships sail as far as possible away from manned vessels. Especially the first years after introducing unmanned ships, they might need their own shipping lanes.

## Platooning

Platooning with cargo ships: a train of ships in which only the front ship is manned, while the others follow autonomously.



Platooning is not a new phenomenon at sea but it is likely to become more frequent once autonomous shipping is in place.

In the age of autonomous shipping platooning will be characterized by a fleet of unmanned vessels that will be guided by one (manned) leader vessel. This technic could be used for crossing the oceans, but most likely will be used to enter ports that are more inland, like the port of Antwerp or Hamburg.

Ships nowadays need a pilot to come into port because of the difficulties of large ships entering relatively narrow rivers that captains face. With platooning, only the first vessels will need pilotage, and the others will follow its lead. Ports that are willing to invest in advanced pilotage and other sophisticated aids to navigation will attract the unmanned vessels first.

This development in platooning is likely to have an impact on MSP as national authorities must foresee anchorage space for unmanned vessels, away from traditional anchorage, to form vessel associations.

Unmanned vessels do not require the same services as manned vessels when coming into ports. They need a set of specialized services, perhaps even specialized quays to dock. But most of all they need specialized Vessels Traffic Services and aids to navigation, like piloting from the shore.

Canadian naval architects Robert Allan Ltd have unveiled a revolutionary concept with their vision of an autonomous unmanned tug, named RAMora and the flagship of their TOWBoT (Tele-operated Workboat or Tug) series.



The idea of taking humans away from the scene of operating machinery is nothing new of course. Unmanned autonomous vehicles and drones are examples and in the port world Rotterdam's Maasvlakte 2 container terminals are largely automated, their ship-to-shore gantry crane operators located in a building remote from the cranes themselves.

The tragic capsizing of the tug Fairplay-22 in the Nieuwe Waterweg in 2010 with the loss of two lives serves as a reminder of the dangers involved in operations carried out hundreds of times a day in ports around the world. The possibility to reduce the risk for tug crews is a strong incentive for what to some may appear just a little too futuristic.

## Cyber security

There is no talk about unmanned transportation without touching the issue of cybersecurity. Cybercrimes are flourishing. As technology continues to develop, information technology (IT) and operational technology (OT) aboard ships are increasingly being networked together – and more frequently connected to the worldwide web. This brings the greater risk of unauthorised access or malicious attacks to ships’ systems and networks. Risks may also occur from personnel having access to the systems aboard, for example by introducing malware via removable media. Ships are also exposed to interference through electronic navigation devices such as the Global Positioning System (GPS) and lack the backup systems airlines have to prevent crashes.

Ship operators might not know they have already been hacked. Cyber-attacks are more widespread than the shipping industry realises.

### EXAMPLES

Last year, South Korea said hundreds of fishing vessels had returned early to port after its GPS signals were jammed by North Korea, which denied responsibility, and an earlier hack by drug traffickers diverted containers in Belgium's Antwerp port.

Other cases have had a lower profile: U.S. Coast Guard officials have said GPS interference disrupted operations at an undisclosed U.S. port for several hours in 2014 and reported a similar attack at a non-U.S. port, also unnamed, in 2015.

Targets of the cyber attack	Type of attack	Potential impacts
<ul style="list-style-type: none"> <li>• Intellectual property (IP)</li> <li>• Financial information</li> <li>• Personal information</li> <li>• Government information</li> </ul>	Carefully targeted attacks to extract specific data	<p>Compromise of the confidentiality of information.</p> <p>The extraction and/or use of IP, sensitive or personal data, potentially leading to:</p> <ul style="list-style-type: none"> <li>• financial betterment</li> <li>• loss in confidence</li> <li>• reputational damage</li> </ul>
<ul style="list-style-type: none"> <li>• IP</li> <li>• Financial information</li> <li>• Critical national infrastructure / government systems</li> </ul>	Alterations of key data for financial or political gain	<p>Modification of data leading to a compromise in its integrity, which in turn could lead to a loss of confidence in:</p> <ul style="list-style-type: none"> <li>• a government's ability to protect sensitive data</li> <li>• private organisations' products or services.</li> </ul>
<ul style="list-style-type: none"> <li>• IT Infrastructure / networks</li> </ul>	Denial-of-service attack against core infrastructure / networks, leading to reduced or loss of service	A reduction in the ability of an organisation, region, government body or ultimately a whole nation to operate effectively

Figure 1: Cyber security attacks [Source: Analysys Mason, 2011]

In general, there are two categories of cyber-attacks which may affect companies and ships:

- Untargeted attacks, where a company or a ship's systems and data are one of many potential targets; or
- Targeted attacks, where a company or a ship's systems and data are the intended target.

The industry NGO's like Bimco work together with IMO to develop guidelines on cyber protection of vessels.

Cyber security has no effect on MSP, but might slowdown the process of developing unmanned vessels.

### **Conclusion and effect on MSP**

The technologies to design unmanned vessels (even large cargo vessels) already exist. However, the ambiguity of legal status, the economic feasibility, the interaction with manned vessels, and cyber-attacks are all factors that have slowed down the process of developing operational unmanned vessels.

But industry is working together with international organizations to overcome all difficulties and within a few years, the first larger unmanned cargo vessels will set sail. According to the scale of level of autonomy by Lloyd's Register, we will see ships with a minimum crew first. These ships are already being built. Within 5 to 10 years, we might expect vessels with no crew, but completely controlled by shore. The fully autonomous vehicle with artificial intelligence still sounds like science fiction, but will be possible in the future.

Ports that are willing to adapt to this new trend, with adequate services, will have the benefit of operationalizing these vessels first.

The effect of unmanned ships on MSP can be enormous. Specially dedicated routes, solely used by autonomous ships, special anchorage areas, adapted aids to navigation, can all have an impact on spatial planning.

It is however very difficult to take this trend already into account while planning the MSP's of today, because most MSP's are plans for only a few years. Taking into account unmanned vessels sailing around on a commercial level needs a long-term planning of an uncertain development

## Development on shore side - Ports and hinterland connection

Another impact on shipping traffic lanes will be the specific developments of ports. As mentioned before, ports which are willing to invest in LNG bunker facilities will attract LNG fuelled vessels. Ports that are able to accept unmanned vessels are ready for the future.

The growing number of port development projects recognises the need to shift economies and social structures towards more sustainable models. The development of a new or extended port layout requires adequate attention to a number of aspects that guarantee both sustainable port growth and a healthy ecosystem functioning. There is a need for innovative solutions for port development which are in harmony with the ecosystem and robust or adaptable under change by the same time. Through an integrated and ecosystem-based approach, port development can be realized in an inclusive way, providing an economic, environmental and social vital port.

The four keys for the ports of the future are:

- Size
- Speed
- Smart
- Sustainable

Ships are getting bigger and ports will need to be able to adapt to and accept mega ships, otherwise companies will decide to go to more sophisticated ports.

All ships arriving at ports are short in time, as time is usually money. Thus, ports need to be effective and efficient in their handling of ships and must be loaded and unloaded in the shortest time possible.

To be as quick as possible, ports need to be smart and innovative. Unmanned services like automatic straddle carriers can work 24/7. Ships are becoming more technological and ports need to follow suit to make sure that they can provide equal services.

There is a general pressure on every activity to be greener and more sustainable. Ships are becoming eco-friendlier and ports need to adapt as well.



## Summary and Conclusions

The principal aims of this report has been to give an overview of the current situation of shipping and MSP in the North Sea as well as to look ahead and discuss trends and future development of shipping and what consequences it may have for MSP in the North Sea.

Chapter one described the importance of shipping as the major mode of transport for moving goods and people around the world. Approximately 90% of the world's trade is done by shipping according to the International Maritime Organisation (IMO). Chapter one also described the complexity of shipping in terms of the various different laws and regulations that govern shipping as well as the ownership and registration of a ship. Shipping is a truly international business and its global implications are hence evident in all parts of the sea, with varying consequences. The North Sea is considered one of the busiest sea areas in the world.

The aim of Chapter two was to, in a first step, indicate the main shipping routes used by ships in the North Sea and then, in a second step, combine this data with data from national MSP plans to be able to evaluate the compatibility of shipping and other activities. AIS data from the European Maritime Safety Agency (EMSA) clearly show a high concentration of ships in coastal areas throughout the entire North Sea as well as main routes going from the English Channel to the northern tip of Jylland in Denmark and into the main ports in Belgium, the Netherlands and Germany. In some cases, inconsistencies are found between the AIS data and the data coming from national MSP plans. It is however difficult to draw any conclusions on this as the AIS data only represents one year (2016) and variations over the years occur.

As for future trends in shipping and MSP, it is important to keep in mind that shipping is a highly market driven activity and its development is largely determined by the demands for foreign goods and services. The shipping sector is still affected by the financial crises in 2008 and together with the low level of global GDP growth predicted by IMF, growth in shipping is likewise predicted to be slow in the coming years. However, shipping is the main mode of transport for goods around the world and, hence, a major activity to be considered in MSP.

Another important issue to be considered in future trends of shipping is innovation and technological development. The size of vessels was thought to have reached a threshold some years ago but we continue to see a remarkable development in this field. Although there seem to be no limit to how large vessels can be constructed, there is a limit for these ships in port areas. If ports are to accommodate larger ships, there is the need for expansion which will have a direct impact on the surroundings in several ways e.g. spatial, environmental and safety.

New off shore activities like wind and wave farms will also have spatial implications which need to be considered in MSPs. Not only the physical infrastructure itself, but also the supply vessels needed to operate and maintain these activities need to be taken into consideration. These vessels will go where they are needed, which may or may not follow established shipping routes, and hence adds another reflection for the planning and management of shipping in MSP.

