BE AWARE

Bonn Agreement
Accord de Bonn

Technical Sub-report 5: Existing and decided risk reducing measures

Bonn Agreement
Accord de Bonn

Co-financed by the EU –
Civil Protection Financial Instrument

Photo: Maritime and Coastguard Agency (UK) Graphic design: Ungermeyer, Berlin

BE AWARE

Bonn Agreement
Accord de Bonn

DOCUMENT TITLE: Existing and decided risk-reducing measures
TASK: H1.3
AUTHORS: Anders Madsen (anma@cowi.dk)
Magdalena Utko (maut@cowi.dk)
Carsten Jürgensen (crj@cowi.dk)

PUBLISHED ON: 19-02-2014

COWI

MARIN

Bonn Agreement
Accord de Bonn

Co-financed by the EU –
Civil Protection Financial Instrument

The Greater North Sea and its wider approaches is one of the busiest and most highly used maritime areas in the world. With the ever-increasing competition for space comes an increased risk of accidents that could result in marine pollution.

Currently the area has no overall risk assessment for marine pollution; risk is mapped with a variety of national risk assessments which are undertaken with differing methodologies; thus reducing comparability.

The BE-AWARE project is therefore undertaking the first area-wide risk assessment of marine pollution using a common methodology that allows the risk to be mapped and compared under different scenarios.

The project outcomes will improve disaster prevention by allowing North Sea States to better focus their resources on areas of high risk.

The project is a two year initiative (2012-2014), co-financed by the European Union, with participation and support from the Bonn Agreement Secretariat, Belgium, Denmark and the Netherlands, with co-financing from Norway.

Contents

Executive Summary

Risk Reducing Measures (RRMs) of various kinds that already are established in the wider North Sea Area and those that have been decided upon to be established before 2020 are included in the analysis.

The overall aim of BE-AWARE has been to develop an area wide description of accidents and spill frequencies. In order to recognize various local differences the area was divided into 5 sub-areas. Within each of these sub-areas the frequency of different accident types has been calculated for both the existing situation and the future 2020 scenario. The frequency for individual spill sizes has also been calculated for each of the sub-areas.

This technical sub-report is on risk reduction measures that have been decided upon and that most likely will be implemented by 2020. Additional RRMs that may be decided to be implemented will be discussed and potentially modelled in the next phase of the BE-AWARE project. The list of different risk reduction measures included is given below:

- Pilotage
- Systematic calls to vessels falling under the pilotage recommendation
- VTS centres
- Traffic separation schemes (TSS)
- Electronic Chart Display and Information System (ECDIS)
- Bridge Navigational Watch Alarm System (BNWAS)
- Alcohol limits
- Double hull at the cargo tank
- Double hull at the bunker
- International reporting systems
- Escort towing in narrow shipping lanes
- Emergency towing of ships with problems
- Regular emergency response exercises

For each of the above issues the measures are described. Since the measure affects the overall risk level at different processes in the maritime activities the measures will be described individually. The risk reducing effect for all measures is described along with the process that is affected. In addition, some measures will be described in terms of where in the North Sea they are applied (maps). Since the measures are of different character, their effects are described verbally and not in tabular form which would require that the values be directly comparable.

1. Introduction

1.1 Scope

This report deals with the risk reducing measures (RRMs) that are currently implemented or are planned to be implemented in the Greater North Sea and its wider approaches. The risk reduction comprises the risk for accidents in maritime activities and includes accidents with ships, platforms and wind farms. The relevant risk scenarios have been identified and discussed in the Method note. They comprise the following events occurring in the open sea with vessels of a gross tonnage of 300 and above:

- Ship accidents (ship-ship collisions, groundings, fire, foundering etc.)
- STS operations and bunkering at sea
- Collisions with fixed objects (platforms and wind turbines)
- Spills from offshore oil installations.

The RRMs included in the present study are those that have been decided upon and that most likely will be implemented by 2020. Additional RRMs that may be decided to be implemented will be discussed and potentially implemented in the model in a next phase of the BE-AWARE project.

2. Risk-reducing measures (RRMs)

2.1 General

The accident model components described in the previous chapter treat all vessels in an idealised way that ignores many ship-specific and regional characteristics such as pilotage, surveillance such as VTS centres or obligatory routing such as TSS etc. Most of these characteristics have a risk-reducing effect, whereas some others can lead to additional risk. This section describes the most relevant risk-reducing measures (RRMs) and the way they are modelled. Relevant phenomena that are an increasing risk are equally described.

The effect of the respective RRMs is expressed by means of a risk reduction factor. A risk reduction of e.g. 20 percent means that the risk is reduced to 80 percent of its initial value and corresponds to a risk reduction factor of 0.8.

2.2 Pilotage

The fraction of the total number of ships using a pilot depends on the area they are sailing in, the sailing direction, the load state, the ship type and the ship size. In addition, the pilotage fraction cannot be expected to be the same at present (2011 scenario) and in the future (2020 scenario). The areas affected with pilotage rules are presented in Figure 2-1.

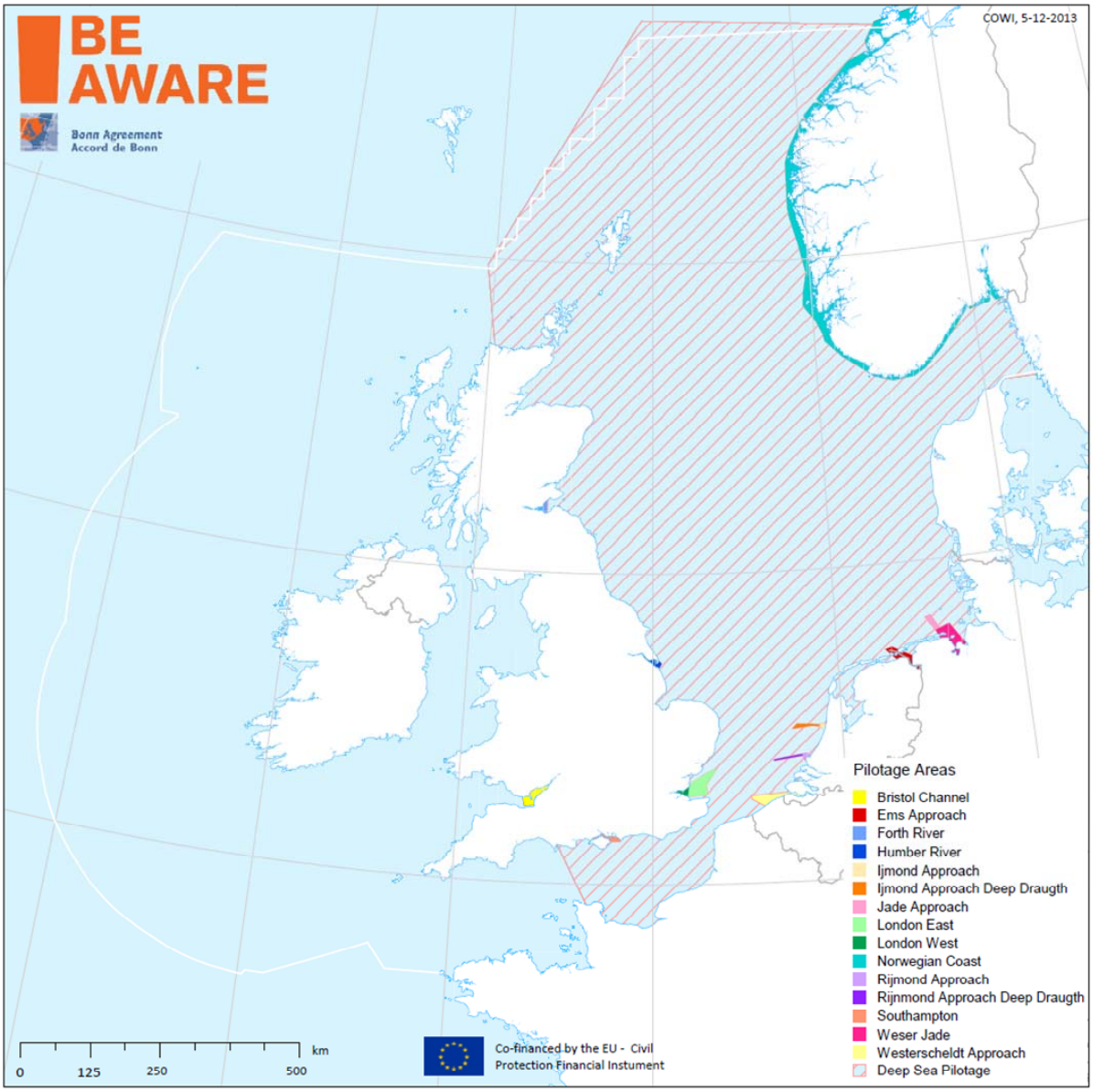

Figure 2-1: Pilotage areas[1]

It is difficult to quantify the risk-reducing effect of having a pilot on board. The effect is situation-dependent in many different ways and subject to phenomena that are difficult to model. However, an analysis of data from different parts permits some basic conclusions. The analysis in Lentz & Kroon, 2010, is based on areas where pilotage is officially recommended but not compulsory. In this way, it has been possible to compare the accident rate of the same type of ships at the same location both with and without a pilot. The analysis shows that a risk-reducing factor of 0.33 is a conservative assumption. This number means that ships with a pilot are estimated to be three times less likely to be involved in collisions and groundings than ships without a pilot.

[1] The pilotage at the entrance to the Elbe, in the German Bight, was not included in this analysis. This will be addressed in the BE-AWARE II project.

2.3 Systematic calls to vessels falling under the pilotage recommendation

Whereas in some areas, pilotage is mandatory, it is recommended, but not obligatory in other areas. Here, authorities have the option of calling every single ship that is potentially affected by the recommendation in order to convince the crew of using a pilot.

This effect is implicitly included in the pilotage model.

2.4 VTS centres

Vessel traffic service (VTS) centres are on-shore traffic surveillance centres enhancing navigational safety in critical areas. Their main interventional tools are warnings and advice, with a directive power, to passing vessels.

The VTS coverage in the different areas has been collected and implemented in the traffic model as presented in Figure 2-2.

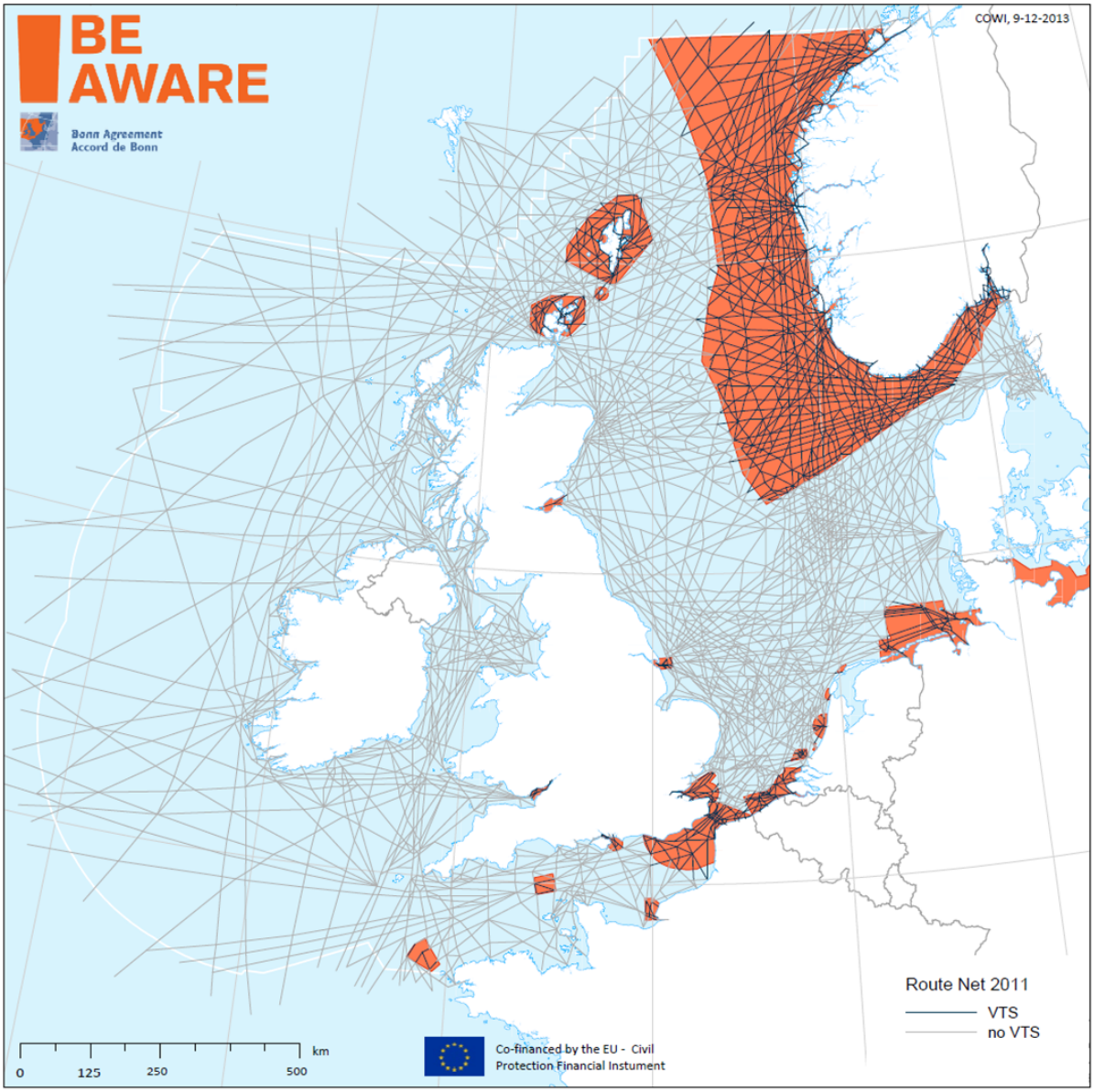

Figure 2-2 Vessel traffic service (VTS) areas and affected routes.

In the 2020 situation, the VTS areas remain the same, but since the route net in 2020 is modified, different routes are affected. The effect of the VTS centres is modelled with a risk factor of 0.5, i.e. a 50 percent risk-reducing effect upon unpiloted vessels with respect to collisions and grounding. The effect upon piloted vessels is modelled with a risk factor of 0.95, corresponding to a 5 percent risk reduction (Oil spill DK, 2007).

2.5 International reporting systems

International reporting systems make it easier to plan and enforce port state controls. In this way, it becomes easier to enforce compliance with safety-relevant regulations.

This section applies essentially to SafeSeaNet. Other reporting systems, especially those related to VTS centres are not modelled here, but in Section 2.4. On 1 January 2011, a new inspection regime based on SafeSeaNet came into force for all ships entering or leaving ports or anchorages in the Paris MoU region (Paris Memorandum of Understanding on Port State Control) (Paris MoU, 2010) . All Bonn Agreement member states are also members of the Paris MoU. The new inspection regime is a means of enforcing compliance with safety rules.

It is estimated that SafeSeaNet will reduce the general accident proneness of all ships by 5 percent (risk-reduction factor of 0.95).

2.6 Traffic separation schemes (TSS)

All currently existing traffic separation schemes are included in the analysis. Sea areas that are located between two TSS are equally modelled as TSS, if the traffic pattern observed via AIS resembles the traffic in a TSS.

Traffic separation schemes have primarily an effect upon route collisions, i.e. head on and overtaking collisions. The AIS-based traffic model mirrors the effects of the TSS. In this way, the risk-reducing effects are automatically taken into account by Fujii's model.

The effect of future TSS is difficult to assess because they are not represented by the present AIS data used in the analysis. Therefore, a number of assumptions are made:

- Head-on collisions: Based on the analysis of the Bornholmsgat (before and after introduction of the TSS (Bornholmsgat, 2008)) it is conservatively assumed that the frequency of head-on collisions will be reduced to a fifth, i.e. by a risk reduction factor of 0.2.
- Overtaking collisions: Based on the Bornholmsgat analysis, it is conservatively assumed that the frequency of overtaking collisions will be doubled.
- Node collisions: According to the logic in Fujii's model, node collisions are not significantly affected by the implementation of a TSS. In reality, navigators can predict more easily where they have to expect crossing traffic which presumably reduces the accident frequency. As a conservative assumption, this effect is disregarded.
- Groundings: A TSS will typically have the effect of keeping ships away from surrounding shallows. Considering that groundings are not the dominant risk contributor, it is chosen to make a conservative assumption by disregarding the expected reduction of the grounding frequency.

Information about existing and future traffic separation schemes within the BE-AWARE project area has been collected and implemented in the traffic model as presented in Figure 2-3 and Figure 2-4 for scenario 2011 and 2020 respectively.

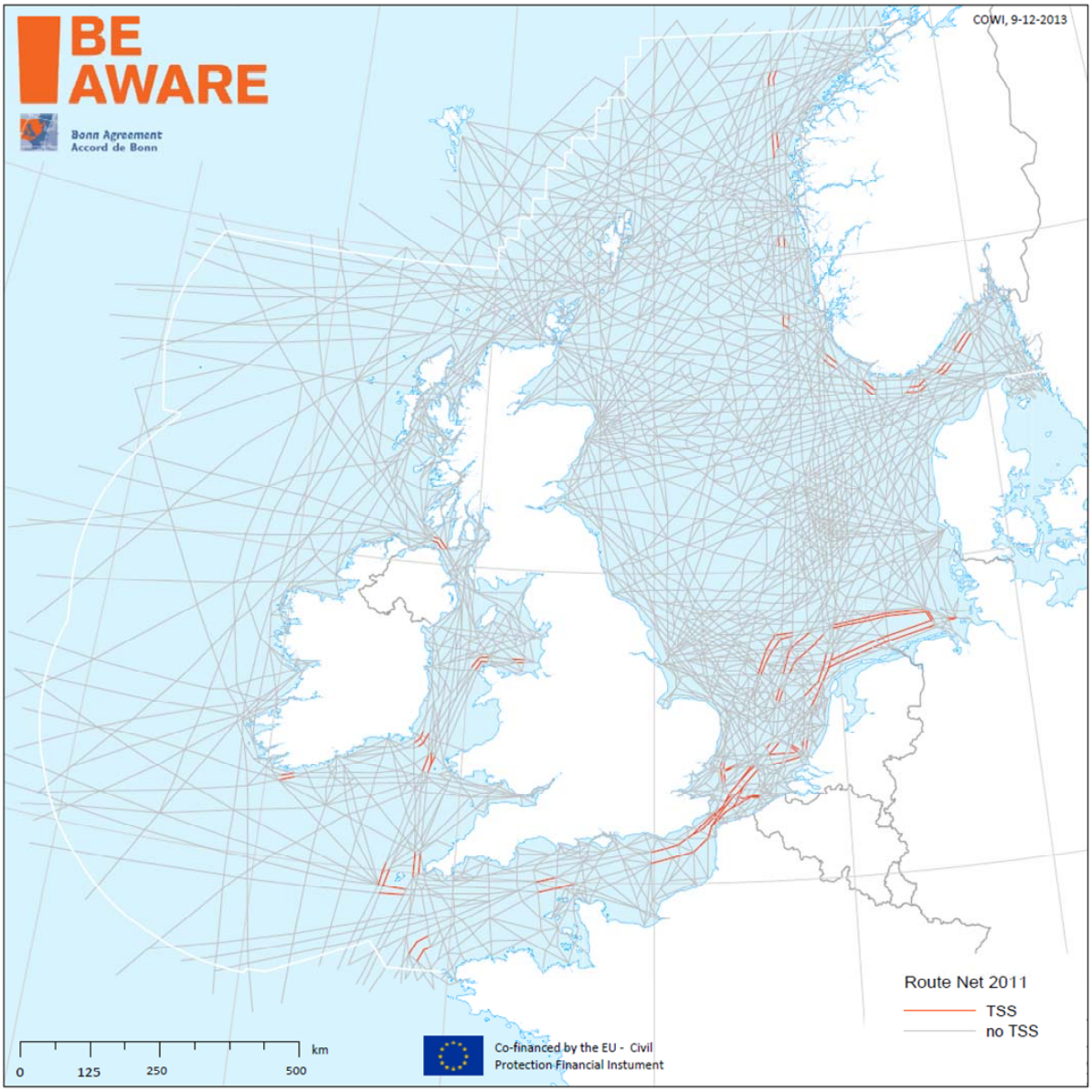

Figure 2-3 Idealised route net representing traffic in year 2011. TSS routes have been marked with a dark colour.

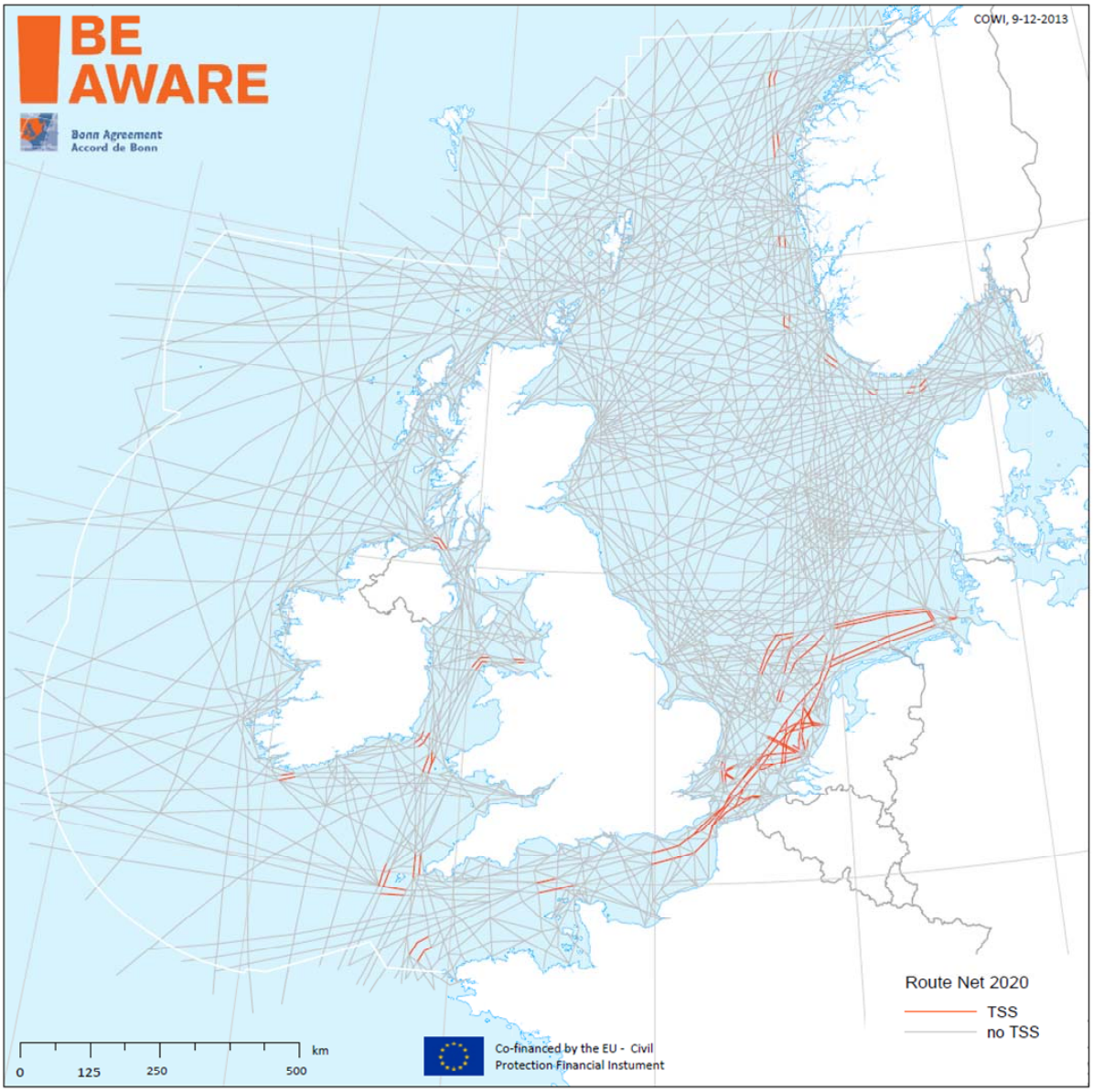

Figure 2-4 Idealised route net representing traffic in year 2020. TSS routes have been marked with an orange colour.

2.7 Electronic Chart Display and Information System (ECDIS)

ECDIS was introduced relatively recently. As a consequence, it is difficult to estimate the number of ships equipped with ECDIS. It is assumed that 75 percent of those ships that will fall under the future IMO rules on ECDIS (see next paragraph) were equipped with ECDIS in 2011. This assumption is based on estimates given by the Danish Maritime Authority with regard to an earlier Danish spill risk analysis (Oil spill DK, 2007) and BRISK project (BRISK, 2012).

In the years between 2011 and 2018, a set of IMO rules concerning ECDIS usage will gradually come into force (IMO, 2009). By 1 July 2018, ECDIS will be obligatory:

- for all passenger ships of 500 GT and upwards
- for all tankers of 500 GT and upwards
- for all cargo ships other than tankers of 10,000 GT and upwards

- for all cargo ships other than tankers of 3,000-9,999 GT, if they are constructed on or after 1 July 2014

These rules are implemented in the 2020 scenario of the BE-AWARE model.

It can be expected that some of the smaller vessels that are not affected by the new IMO rules will be equipped with ECDIS on a voluntary basis. This possibility is disregarded which is a conservative simplification.

ECDIS has a risk-reducing effect primarily affecting the possibility of groundings. It is estimated to reduce the grounding proneness of a ship by 50 percent if the ship is unpiloted and sailing in an area without VTS coverage (risk reduction factor of 0.5). If a pilot is on board or VTS coverage is available, the risk is estimated to be reduced by only 5 % (risk reduction factor of 0.95) (Oil spill DK, 2007).

2.8 Bridge Navigational Watch Alarm System (BNWAS)

BNWAS is a system that strikes an alarm if no signs of human activity are registered on the bridge of a ship. In 2011, BNWAS was not yet covered by IMO rules. As a consequence, it is difficult to estimate the number of ships equipped with BNWAS. It is assumed that more than 50 percent of those ships that will fall under the future IMO rules on BNWAS (see next paragraph) were equipped with BNWAS in 2011. This assumption is based on estimates given by the Danish Maritime Authority with regard to an earlier Danish spill risk analysis (Oil spill DK, 2007) and BRISK project (BRISK, 2012).

In the years between 2011 and 2014, a set of IMO rules concerning BNWAS usage will gradually come into force (IMO, 2009). By 1 July 2014, BNWAS will be obligatory:

- for all passenger ships irrespective of size
- for all cargo ships of 150 GT and upwards.

Considering that the oil spill model only concerns ships of 300 GT and upwards this means that all ships within the scope of the analysis will be affected by the new IMO rules.

The rules are implemented in the future scenario of the existing model.

BNWAS is estimated to reduce the collision and grounding proneness of a ship by 5 percent if the ship is unpiloted (risk reduction factor of 0.95). If a pilot is on board, no additional risk-reducing effect is expected (Oil spill DK, 2007).

2.9 Alcohol limits

There are national alcohol limits for bridge personnel in the territorial waters of Belgium, Denmark, France, Germany, Ireland, Netherlands, Norway, Sweden and UK typically with limit values of 0.2 or 0.5‰ blood-alcohol content. There are no international regulations in force.

The Conference of Parties to the International Convention on Standards of Training, Certification and Watch keeping for Seafarers has decided to limit the blood alcohol content to 0.5‰ for masters, officers and other seafarers while performing designated safety, security and marine environment duties and to prohibit consumption of alcohol within 4 hours prior to serving as a member of the watch. The new regulation entered into force 1st January 2012 (SCTW, 2010).

In accordance with an earlier Danish analysis (Oil spill DK, 2007) and BRISK project (BRISK, 2012), it is estimated that the presence of a general alcohol limit will be followed by 95 % of the affected ships. For the complying ships, it is estimated to reduce the risk of collisions and groundings by 5 percent (risk-reduction factor of 0.95).

2.10 Double hull at the cargo tank

A double hull at the cargo tank most often reduces the risk of spill in cases of grounding or collision.

In 2011 only a small number of medium-sized and large oil tankers in the BE-AWARE area were single hulled. In the case of smaller tankers below 5000 deadweight tonnes, the situation was less clear. Although only around 1 percent of all smaller tankers are known to have been single-hulled, there is uncertainty about the hull status of around 10 % of the ships (see Table 2-1).

In the model, it is assumed that all tankers with unknown hull status are single-hulled.

Table 2-1 Oil and chemical tankers present in the North Sea area, 2011

Tanker size (DWT)	Hull type	Number	Percent
≥ 5000 tonnes	Double	2484	99.0 %
	Double Bottom	20	0.8%
	Single	2	0.08 %
	Unknown	4	0.16%
< 5000 tonnes	Double	224	85.2%
	Double Bottom or Double Sides	10	3.8%
	Single	3	1.1%
	Unknown	26	9.9%

According to the revised regulation 13G (regulation 20 in the revised Annex I which entered into force on 1 January 2007) of Annex I of MARPOL (IMO, 1987), single-hull tankers of 5000 DWT and upwards were to be phased out between 2005 and 2010, all depending on their delivery date. Thus, no medium-sized and large single-hulled tankers will be in duty by 2020.

It is assumed that 20 % of all small tankers (<5,000 DWT) will be single hulled in 2020, as opposed to 11 % of all small tankers today (including tankers with unknown hull status, compare Table 2-1).

The effect of double-hulled cargo tanks is implemented as part of the collision consequence model and the grounding consequence model.

2.11 Double hull at the bunker

Regulation 12A, which is an amendment to Annex I of MARPOL (IMO, 1987) requires that all vessels with a bunker tank volume of 600 m3 or more must be double-hulled at the bunker compartments:

- if the building contract was placed on or after 1 August 2007
- or if the keel was laid on or after 1 February 2008
- or if the vessel was delivered on or after 1 August 2010.

The 600 m^3 bunker capacity roughly corresponds to a 10,000 DWT vessel.

Danish Maritime Administration estimated the fraction of ships to be double-hulled at the bunker to be 10 percent by 2010 (Oil spill DK, 2007). This number is also used for the present scenario of BE-AWARE.

Danish Maritime Administration estimated the fraction of ships to be double-hulled at the bunker to be 50 percent by 2020 (Oil spill DK, 2007).

The effect of double-hulled bunkers is implemented as part of the collision consequence model and the grounding consequence model.

2.12 Escort towing in narrow shipping lanes

During escort towing, a tug boat is permanently connected to a vessel on its journey between the open sea and the port. Escort towing is especially relevant in very narrow shipping lanes.

Escort towing is presently recommended in only one Bonn Agreement country[2], Sweden: The authorities have issued a number of recommendations about the usage of escort towing. The recommendations apply in the Brofjorden to all loaded and unloaded oil tankers (loaded/unloaded) of 20,000 DWT and upwards.

Since there are no statistics on the usage of escort towing, it is assumed that 50 % of all affected ships comply with the recommendations.

In Sweden, it is being considered to make escort towing mandatory in some areas.

At present, the situation in 2020 is modelled in the same way as that in 2011. However, it is possible to consider other scenarios in the model.

The risk-reducing effect of escort towing affects primarily the risk of groundings. Groundings can occur in two basic modes, i.e. as groundings of a manoeuvrable ship and as groundings of a non-manoeuvrable ship, i.e. a ship that has lost propulsion or steering or even both.

- Escort towing mainly prevents groundings of ships that suddenly become non-manoeuvrable. According to an analysis of the Baltic Sea north of the 59° parallel, 15 % of all groundings with a known cause during 1990-2008 were caused by technical faults (Ylitalo et al., 2010). Although technical faults can also relate to events other than loss of power or steering, the latter two events are generally the most important types of technical failure.
- According to the same analysis, 16 % of all groundings occurred because the crew did not appraise the manoeuvring characteristics, current, wind etc. correctly. In such cases, escort towing would equally make a difference.
- Finally, 21 % of all groundings in the analysis occurred due to external factors. Here, wind, waves and currents are assumed to be the main contributor. Escort towing can make a difference also in this case.

Based on the above considerations it can be said that escort towing will affect roughly 50 % of all possible groundings. When considering that escort towing is already in force to some degree in the area analysed by (Ylitalo et al., 2010), the percentage might even be higher. The reason is that escort towing has possibly prevented some groundings which therefore do not appear in the statistics.

If it is very conservatively estimated that escort towing can prevent 50 % of the groundings, where escort towing can principally have an effect (also 50 %, see above). This leads to a risk reduction of 25 % corresponding to a risk-reduction factor of 0.75.

2.13 Emergency towing of ships with problems

Emergency towing is an effective means of reducing the risk of collisions, groundings and thus in spills. Ships in problems can be towed into a port before all the potential spill volume has been leaked. Unmanoeuvrable and/or damaged ships can be towed away before they start leaking, e.g. due to wave action or grounding. In some countries vessels are under contract to act as emergency towing vessels when required on a case by case basis. Also in areas such as the southern North Sea/

[2] According to the national risk assessment in Germany escort towing is excluded from the list of approved risk reducing measures and therefore cannot be recommended within the German coastal waters and the EEZ.

Dover Strait there is a significant private sector tug capacity. However, the vessels included in this study are the so-called “dedicated” vessels, meaning vessels that are state-owned or contracted and that are used for emergency response primarily.

At present, there are only dedicated emergency towing vessel (ETV) at two locations on the French coast (Cherbourg, Boulogne-sur-Mer), one location on the Dutch coast (Den Helder), three locations on German coast (Borkum, Helgoland, Amrum), Gothenburg, Sweden and Orkney in UK. Locations of ETVs together with affected routes have been presented in Figure 2-5 for scenario 2011

In 2020 situation, the ETV locations remain the same except for the UK. For an ETV based in the North of Scotland a decision will be taken in May 2015 if this ETV will be maintained, see Figure 2-6)

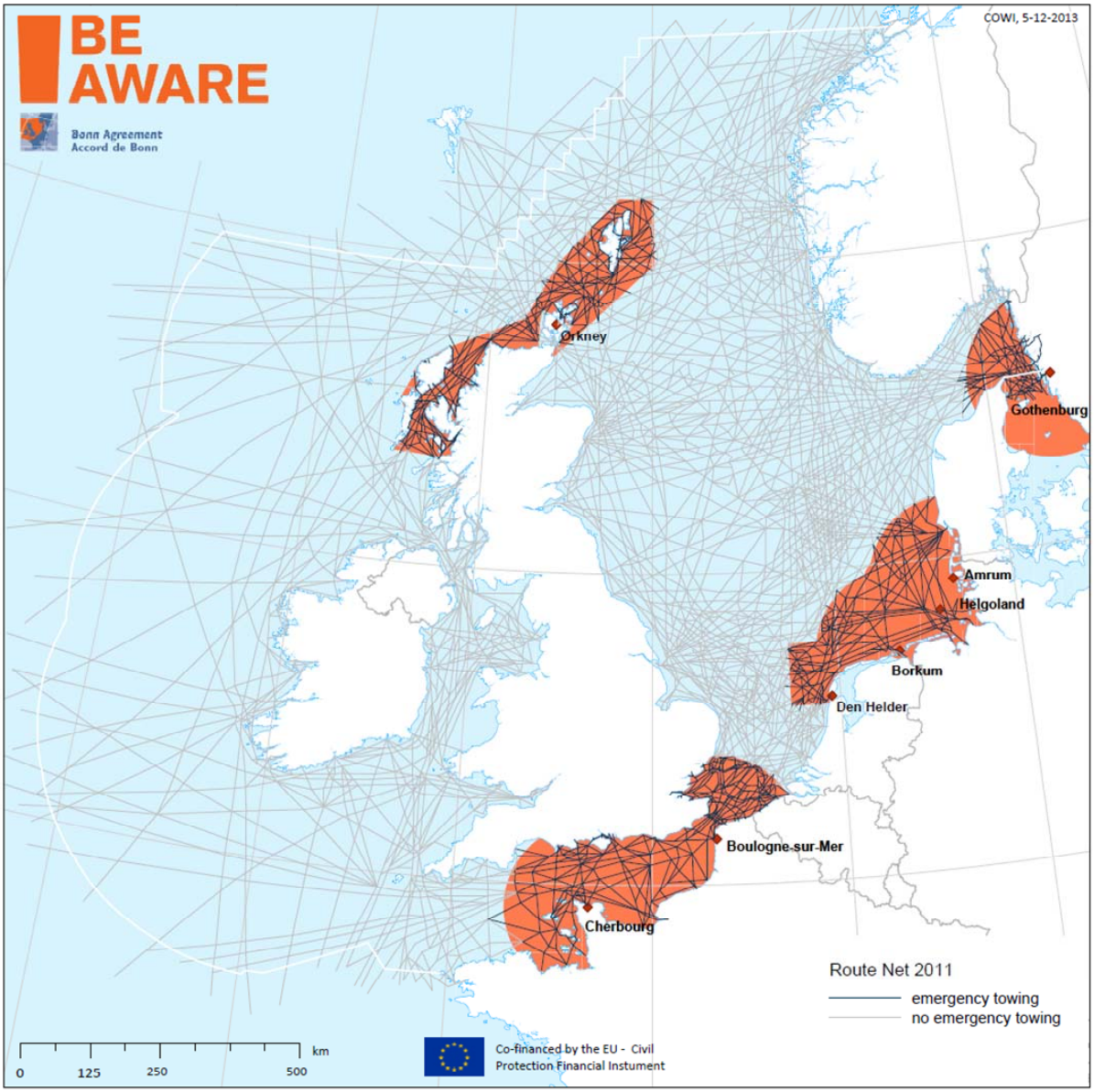

Figure 2-5 Emergency towing areas and affected routes - scenario 2011.

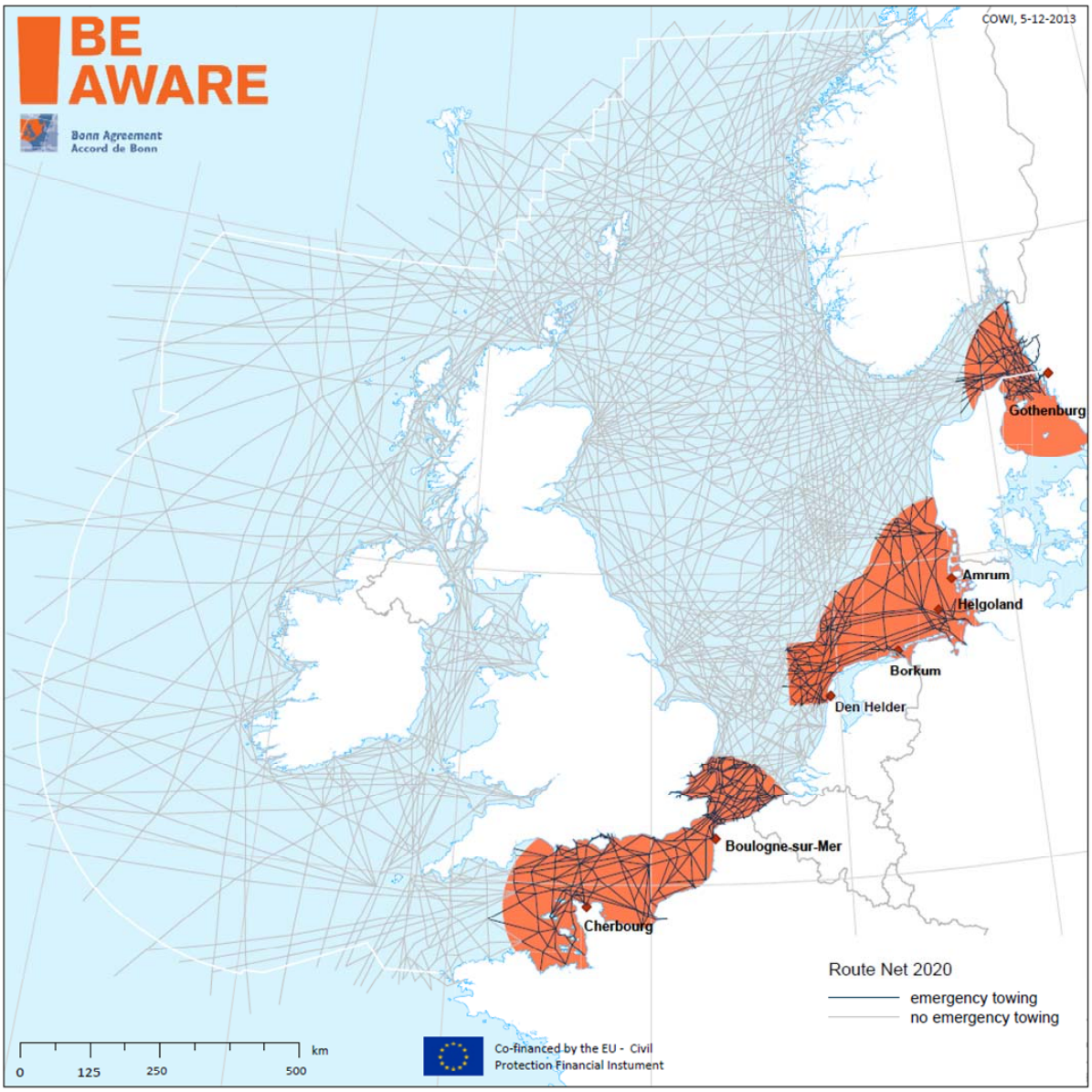

Figure 2-6 Emergency towing areas and affected routes - scenario 2020.

There is no available research or statistics on the quantitative effect of emergency towing. It is therefore assumed that the following effect can be achieved: If a tanker of 5,000 DWT and upwards leaks oil due to an accident, the total spilt tonnage will be reduced by 30 % on average.

2.14 Regular emergency response exercises

Regular emergency response exercises with different types of vessels could be implemented as part of the future emergency response model in BE-AWARE II.

2.15 Monitoring of potentially hazardous ships

Regional reporting systems outside of VTS areas can be established to monitor shipping movements and provide advice and information about navigational hazards. Traffic is monitored by means of the AIS-system and coastal radar. Those tools are used for identification and monitoring potentially hazardous ships. This measure can amongst others apply to:

- ships that are violating the MARPOL convention, that have earlier violated it (reporting system can gather information about the ships involved in violating incidents in the monitored area) or that are suspected of doing so, ships that attract or have attracted attention due to unusual navigation and behaviour;
- ships that have earlier been involved in accidents or Port State Control detentions;
- ships with a larger draught;
- ships that are carrying oil and hazardous substances.

It is assumed that systematic monitoring of potentially hazardous ships can make a difference in areas without VTS coverage or similar systems.

It is assumed that systematic monitoring of potentially hazardous ships reduces the collision and grounding risk for all unpiloted ships in the affected area by 10 percent, i.e. corresponding to a risk reducing factor of 0.9.

Monitoring services have not been reported in the BE-AWARE project area.

3. Abbreviations

3.1 Table of Abbreviations

AIS	Automatic Identification System
BNWAS	Bridge Navigational Watch Alarm System
ECDIS	Electronic Chart Display and Information System
EEZ	Exclusive economic zone
IMO	International Maritime Organisation
LR	Lloyd's Register
RRM	Risk-reducing measure
STS	Ship-to-ship transfer
TSS	Traffic separation scheme
VTS	Vessel traffic service

4. References

Ylitalo et al., 2010 — Ylitalo, J., Hindsberg, L., Ståhlberg, K. and Kujala, P., Grounding Consequences Analysis, Report no. AALTO-AM-21, Aalto University, Dept. of Applied Mechanics, Espoo, 2010

Bornholmsgat, 2008 — Risk analysis of sea traffic in the area around Bornholm, prepared for the Danish Maritime Authority by COWI, COWI report P-65775-002, 2008

IMO, 1987 — International Maritime Organization IMO), Annex I, Regulations for the Prevention

of Pollution by Oil, to International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating hereto (MARPOL 73/78)

IMO, 2009 — International Maritime Organization, Report of the Maritime Safety Committee on it eighty-sixth session. MSC 86/26/Add. 1, 25 June 2009

Lentz & Kroon, 2010 — Lentz, A. and Kroon, I.B., Oil spill risk and the socioeconomic effect of mandatory pilotage. Accepted for publication by International Journal of Engineering Under Uncertainty: Hazards, Assessment and Mitigation, 2010

Oil spill DK, 2007 — Risikoanalyse: Olie- og kemikalieforurening i danske farvande (Risk analysis: Oil and chemicals pollution in Danish waters), prepared for Danish Ministry of Defence by COWI, COWI report 63743-1-01, October 2007

BRISK, 2012 — Project on sub-regional risk of spill of oil and hazardous substances in the Baltic Sea (BRISK), *Model report: Part 4 – Frequency and quantity of spill of oil and hazardous substances*. prepared for Admiral Danish Fleet HQ by COWI, COWI report no. 70618-3.1.3.4, rev. 2.0, May 2012

Paris MoU, 2010 — Paris Memorandum of Understanding on Port State Control, adopted on 11 May 2010, http://www.parismou.org/upload/pdf/amended%20MoU%20clean-%20accepted%201%20November%202010.pdf

SCTW, 2010 — Conference of Parties to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, Manila, the Philippines, 21-25 June 2010. Information obtained from IMO's website (http://www.imo.org/MediaCentre/PressBriefings/Pages/STCW-revised-adopted.aspx) and DMA's website (http://www.sofartsstyrelsen.dk/Nyheder/Sider/Nyeinternationalereglerstrammer oppåalkohologhviletidtilsøs.aspx), both viewed on 17 December 2010