Mare Gaps Challenge:
Oil platform leak:
South Arne (rehearsal)
Refined assessment

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Refined assessment report

IMARES Wageningen UR

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Summary

This brief report is a refined assessment –made within 72 hours after receiving the notice- of a (simulated) oil spill accident. The severity of the spill incident has been adjusted, since the initial assessment –which was concluded in about 24 hours.

Please note that it has not been QA-controlled. For the purpose of the simulated oil spill the timeliness of the response needs to prevail.

1. Introduction

This document is part of a project for the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE): "Growth and innovation and ocean economy – gaps and priorities in sea basin observation and data", work package 4: "Challenge 3: Oil Platform leak". It covers the Greater North Sea, including the Kattegat and the English Channel.

The "Oil platform leak challenge" will deliver:

- A preliminary assessment, providing a document within 24 hours describing a first indication of impact;
- Complete impact assessment, providing a document within 72 hours describing a refined impact assessment (underlying document);
- Main assessment, providing an understanding of whether suitable datasets are available to provide input for emergency response to pollution incidents, including limitations of severe time pressures.

The main focus of this refined impact assessment is to:

- Assess possible threats to coastal habitat, species or tourist beaches and if so;
- Give a first indication of the locations that are most likely to be under threat.

2. Challenge description

This section describes the information of the oil spill which IMARES received.

Date:	28-07-2014
Time:	08:00 #
Location:	South Arne platform #
Oil type:	light crude oil (very similar to Ekofisk blend) #
Oil volume released:	approx. 1918 m^2/day #
Still leaking?:	Yes. Not specified in initial notice. But further information on the status of the incident was received a day later. This indicates that the spill is on-going.

Initial notice of the incident was received by e-mail and contained to following information and question: "The South Arne platform in Danish waters has had a major disaster. Terrorists have taken control of the rig and are diverting the production into the sea. Can you find out where the oil goes and what impact it has on human activity and the ecosystem?"

The start of the incident was set at 08:00 of the morning when the notice was received at around 08:45.

Additional information on the status of the incident as received one day on:
"Terrorists have hostages so no progress yet on closing valves."

The additional information, presented above, has been interpreted to signify the following in relation to question remaining after the initial assessment (24 hours into the incident). Valves are there to be closed, therefore no damage has been done to the platform or parts of the technical installation. The 87000 m3 storage tank is still intact and no oil is being leaked or intentionally released from this tank. The flow of the oil spill remains equal to the estimated daily production rated of approx. 1918 m^2/day.

Further information was needed to assess the situation for each of the items marked with #. More on this in a later section.

3. Method and assumptions

The methodology chosen for modelling the oil spill trajectory is the GNOME model from NOAA (REF).
To assess the risk to the ecosystem as well as human acvitities, a post-analysis in GIS (ArcGIS) is done.
For the post-analysis modelled results from GNOME are saved and converted for use in the GIS.

Both parts of the system have been tested and preset/-loaded with data to aid in giving a quick response.

4. Input

This section describes the data used as input for the challenge.

4.1.Release information

The location of the South Arne platform (a production platform in the western part of the Danish sector of the North Sea) was retrieved from available GIS-datasets.

WGS84 UTM 31	Easting	576574.698984	Northing	6215535.853003	(meters)
WGS84 Geogr	Longitude	4.230333	Latitude	56.078833	(decimal degrees)
		4 13.81998		56 4.72998	(degrees minutes)
		4 13 49.1099		56 4 43.7988	(deg min sec)

Water depth at the location is about 60 m.

Spill volume was determined based on a recent report on Oil and Gas Production in Denmark (2013), where a total production volume of 700.000 m^3 is given for the South Arne location. This translates to a (mean) daily production volume of 1918 m^3.
The platform also produces gas, which is not stated as being released to the environment. For the purpose of this exercise an assumption has been made that no gas is being released.

The potential exists for a much larger release of oil as the South Arne platform contains an 87.000 m^3 storage tank (which is emptied into a tanker once full). The supposed terrorist could find a method of releasing this oil into the environment, adding volume to the spill. If they devise a means of pumping this oil out the off-loading pipeline, they could create a second spill location at the end of this 2 km long pipeline.

From the internet information on the type of oil produced from the South Arne field was gathered.
As it comes from the same/similar formation as the Ekofisk and Tor fields in Norway, and is close in characteristics found for South Arne and Ekofisk blend crudes, the released oil can be characterised as a light crude.

4.2.Environmental parameters

Winds and currents were retrieved from MyOcean.eu and from GlobalMarineNet.com (predicted winds only). And prepared for use with GNOME using prepared R-scripts.

4.3.Physical model parameters

GNOME only allows for a few basis choices for specifying the type of oil being released. For the modelling of the trajectory of the spilled oil the available 'medium crude oil' was selected. This is a heavier oil that does float on water, but has a lower content of components that easily evaporate. The modelled amount of oil remaining on the water will therefore be an overestimate. In reality the remaining amount of oil will be smaller.

4.4.Gnome model runs

Initial assessment (24 hour time frame).
The GNOME model was run with four scenarios for the initial assessment.

Run 01:

Start of release:	2014-07-28 08:00
Duration:	1 day
Amount:	1918 m3
Oil type chosen:	Medium Crude (actual oil is closer to a light crude).
Simulation start:	2014-07-28 08:00
Simulation length:	120 hours >end time = 2014-08 08:00
Simulation done:	Monday early afternoon 2014-07-28

Mass balance
Floating after 5 days: 1088 m3 (56.7%)
Evaporated and dispersed: 830 m3 (43.3%)
No oil beached or off of map.

Spill moves slowly east and somewhat northwards. As of yet it does not appear to pose an immediate problem to beaches (whether for nature conservation issues or human activities). Also other land-based human/economic activities are not under immediate threat.

Run 02: (used for GIS-based post-analysis)
As above with updated data for currents (edited motu-client cmd-file for automated download, to match with available data from website. http-download failed on apparently too large of a file size).

Simulation start:	2014-07-28 08:00
Simulation length:	136 hours >end time = 2014-08-02 24:00
Simulation done:	Monday late afternoon 2014-07-28

Results and mass balance are essentially the same.
Floating 1059 m3 (55.2%), Evaporated/dispersed 859 m3(44.6%) no oil beach or off map.

Based on the trajectory of the spill thus far it may reach land either in Northern Jutland or Southern Norway. However locations in the Skagerrak are all potentially under threat, as could the Norwegian coast be up to and including the area around Stavanger.
Difficulty presently is that the forecast for both currents and winds do not extent far enough into the future to calculate a more precise location for a potential landfall. This could be overcome by e.g. continuing with 'average' currents (based on moon phases etc) and climatologically prevailing winds (e.g. decadal data). Such extension are, however, not feasibly within the current time frame (as well as budget and man power).
It should also be noted that the minimum regret splots are much more widely dispersed than the most likely trajectory, but also none of those have reached a shore yet (within GNOME).

Output as QT-movie from GNOME to illustrate the scenario.

Run 03:
Derived from Run 3, but with the spill continuing for 3 days (72 hours). Done to assess the case where the spill is allowed to continue for a longer time.
Simulation start: 2014-07-28 08:00
Simulation length: 136 hours >end time = 2014-08-02 24:00
Simulation done: Monday early evening 2014-07-28

Output as QT-movie from GNOME to illustrate the scenario.

Run 00:
Derived from Run 2, but with a spill start point on the morning of Thursday 24 July. Done for two reasons, both 'what-if'.
What if.. the rehearsal (or our supposed terrorist attack on South Arne) was started on its original day.
What if.. the slick is allowed to move longer(232 hours instead of 136 h), where would it have gone?
As it turns out it takes an initial route to the west (forced by strong Easterly winds), then gets pushed south a bit, but then move in to a similar area and trajectory as run 2. The excursion west and south could very well have taken the slick into German waters and also into their Natura 2000 area on the Dogger Bank. Potentially also the Dutch N2k area could have been affected.
Simulation start: 2014-07-24 08:00
Simulation length: 232 hours >end time = 2014-08-02 24:00
Simulation done: Monday early evening 2014-07-28

Output as QT-movie from GNOME to illustrate the scenario.

5. Results

5.1. Initial assessment

The modelling results from GNOME show the for the time frame for which the model can presently be run (up Saturday 02 Aug 24:00) with forecasted currents and winds, the trajectory of oil slick according to the GNOME best guess result do not take the spill in to particularly problematic areas.

These GNOME results have been documented by providing them as movies (QuickTime).
In these movies the 'best guess' modelling results are shown as black dots, 'minimum regret' results are shown as red dots.

Legend for the QT-movies:
● = 'best guess' modelling result (high likelihood of occurring)
● = 'minimum regret' modelling results (low likelihood, but not impossible)
Name contains either 24h or 72h for initial assessment or refined assessment and two number referring back to the scenario numbers used in this report. For the 72h QT-movies two additional variations have been generated ending +wind has arrows showing wind strength and direction, whereas ending +current has similar arrows showing the direction and strength of the current.

Run 02, shows how a spill of 1918 m^3 moves east then north across the Danish sector. For this run a more detailed assessment of the potential for impact will be given later in this section.
Run 03, shows what happens if the spill is allowed to continue for about three days.

Run 00, was performed mainly to see where the oil spill might go if it were allowed to continue for a longer time. As we have no more forecast data available to take the model results further into the future, this longer time frame was achieved by moving the start of the spill forward to Thursday 24 July, adding 4 days to this simulation.

The post-analysis in GIS shows that the slick will cross an area that is heavily trafficked by merchant vessels, though not formally a shipping route, while sailing between Dutch harbours and Norway (or further). By the end of the simulation the trajectory comes close to a similar area used by shipping sailing between German harbours and Norway (or further).

No Natura 2000 or other marine protected areas are hit by the trajectory between the start of the simulation on Monday 28 July 08:00 and the end of the simulation on Saturday 02 Aug 24:00. The end time is as far as currently available forecasts have allowed us to take the simulations into the future.

There is bound to be fishing activity in the area of the oil trajectory Though currently it does not appear to be especially problematic to fisheries. It is not hitting major fishing grounds.

The trajectory does go near other offshore oil and gas infrastructure in the Danish sector, a.o. platforms on the Valdemar and Tyra fields. The proximity of an oil slick may be disruptive to the continued production on these locations.

The currently analysed trajectory is for just one single day's worth of oil production being released from South Arne. A longer duration of the spill will result in a larger slick and more sea area being soiled. The slick covers an area of around 260 km^2 by the end of the simulation on Saturday 02 Aug. Such a large area does mean that although outside of nature conservation areas, there is at least some risk to wildlife. In this case the main risk is to sea birds and sea mammals (a.o. harbour porpoise).

5.2. Refined assessment

Two days into the (simulated) oil spill incident at South Arne, a new modelling run of the spill was initiated. For this new and updated datasets for wind and currents were obtained and prepared for use in the GNOME model to simulate the oil spill trajectory. The GNOME results were then exported and processed for a post-analysis in GIS (ArcGIS) a.o. to assess risk to marine protected areas and human activities.

RUN 04:

Start of release:	2014-07-28 08:00
Duration:	5 day (two past days and three days into the future at the time of simulation)
Amount:	9590 m3
Oil type chosen:	Medium Crude (actual oil is closer to a light crude).
Simulation start:	2014-07-28 08:00
Simulation length:	160 hours >end time = 2014-08 08:00
Simulation done:	Wednesday 2014-07-30 ~13:30

Mass balance

Floating after 5 days:	5706 m3 (59.5%)
Evaporated and dispersed:	3884 m3 (40.5%)

No oil beached or off of map.

Run 05:

As run 04, but with smaller timestep used in simulation. For the purpose of this excercise there is no discernable gain in doing this. It may be relevant in more constricted space (or when a spill is coming near to a beach or other shore line.

Performed: Wednesday 30/7/2014 ~14:00

Run 06:
As run 04 but with an extended simulation period (+24 hours) as it turns out a final day of available current forecast was left unused (wind forecast extends farther anyway).

Simulation duration: 184 hours > End of simulation = 04/08/2014 24:00
Performed: Wednesday 30/7/2014 ~18:00

This is the best run for the refined assessment and QT-movies of the GNOME simulation have been prepared. In addition to the movies for the initial assessment two more movies show how either the currents or the wind interacts with the trajectory of spilled oil.
The results of this scenario are used for the post-analysis in GIS.

The final area covered by the oil spill as simulated here is ca. 1900 km^2 by Monday 2014-08-04 24:00.

5.3.Threatened location

Include an indication of the type of the threatened location as either coastal habitat or species on the one hand or tourist beach on the other hand.

- Provide an indication of the locations that are most likely to be under threat

Based on predicted weather patterns (mainly wind fields) and therewith improved predicted trajectory of the oil slick

The platforms Cecile, Nini and Nini E are in the path of the oil slick and the slick is expected to reach these locations sometime Saturday 2014-08-02.
Some threat remains to offshore platforms on the Valdemar and Tyra fields. These appear to be safe with the slick passing north of these structures.
Some threat may exist to ships travelling in the area, including fishing as well as merchant vessels.
With respect to fisheries, due to the lack of internationally available and geographically explicit datasets it is not possible to make any useful assumption of the impact of this oil spill incident on fisheries. Statistics available from ICES that are relevant to the area are for much wider areas such as the Central North Sea and the Northern North Sea.
The trajectory taken by the oil spill does not appear to take it in to areas where fish surveys, performed for stock assessment are intensively sampling.
Surveys for herring eggs and larvae do not sample the area, and the spawning season starts later. This is judged from the months for which this survey runs starting in August thru December and on thru January and February.
Surveys for eggs and larvae of cod and plaice do sample in the area of the trajectory, but again in other months of the year (December, January and February).

- Are there any protected areas threatened?

Include a more detailed description of the characteristics of the predicted impacted locations (habitat or species found there etc.)

No marine protected areas are threatened.

However the trajectory of the oil spill does take it very close to the Danish Natura 2000 area Jyske Reve/Lillefiserbanker (DK00VA257), by the time the simulation end: Monday 2014-08-04 24:00. This area is protected for the presence of reefs on the sea bed as well as for the presence of harbour porpoise.

- Are there any tourist beaches threatened?

Include a more detailed description of the characteristics of the predicted impacted locations

No tourist beaches are threatened, as far as the 'best guess' results are concerned. When considering the 'minimum regret' results, there are three particles that end up on a shorelinve. Two on the coast of Jutland: north of Thyborøn and near Klitmøller and one paritcle that reaches the island of Bressay in the Shetlands. All things considered there islittle risk to beaches and shores, at least for the time frame that the simulation could be run.

- Contact experts, depending on the characteristics of the impacted sites, to determine whether the identified risk of impact predicted impact have been correctly identified.

No additional experts have been contacted. There are no direct impacts to specific sites that require this.

5.4.Response options

Tentatively the best response options for the next few days is to 'sit back and wait'. The main proviso here is that the spill is contained as soon as possible. It seems advisable to consider deploying vessels to the area to either contain and/or remove the oil from the sea surface. Use of dispersants does not seem advisable at this point, but should be reconsidered if concentrations of sea birds or marine mammals are spotted.
Doing nothing at all may be the best solution, as the oil will weather naturally while travelling. When in some more days time bits of the slick do start to get to beaches and shores, with some luck it will have compacted to chunks can be handled by machinery for removing debris and waste from sandy beaches. This may not be wise if the slick is heading for rocky shores such as in Norway.

Diverting shipping away from the location is advisable in the meantime.

The response options outlined above are from the initial assessment and although the severity of the spill has increased, there are no grounds for revising it.

5.5.Graphical output

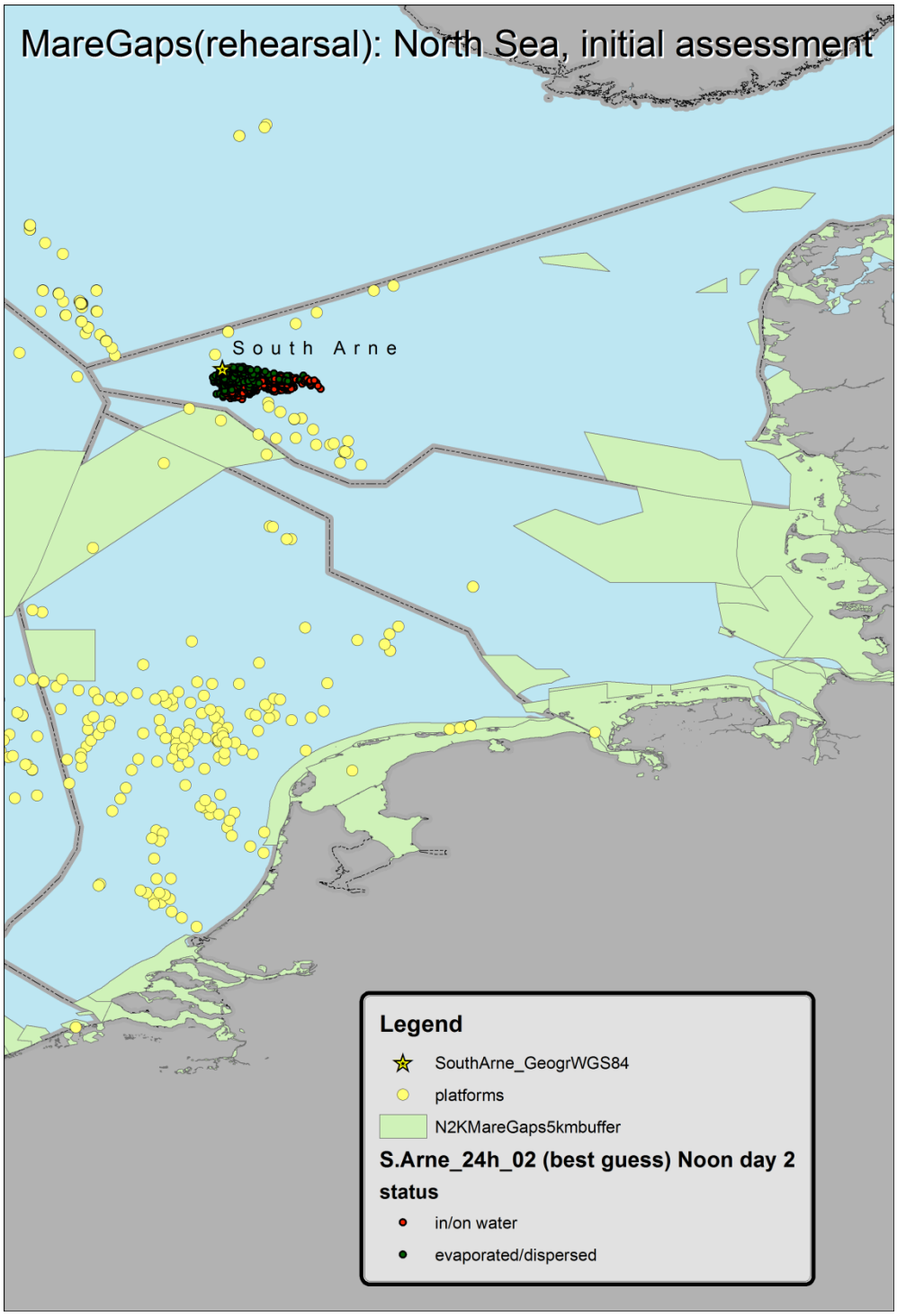

Figure 1 Map of oil spill trajectory after 28 hours (Tue 29 Jul 12:00)

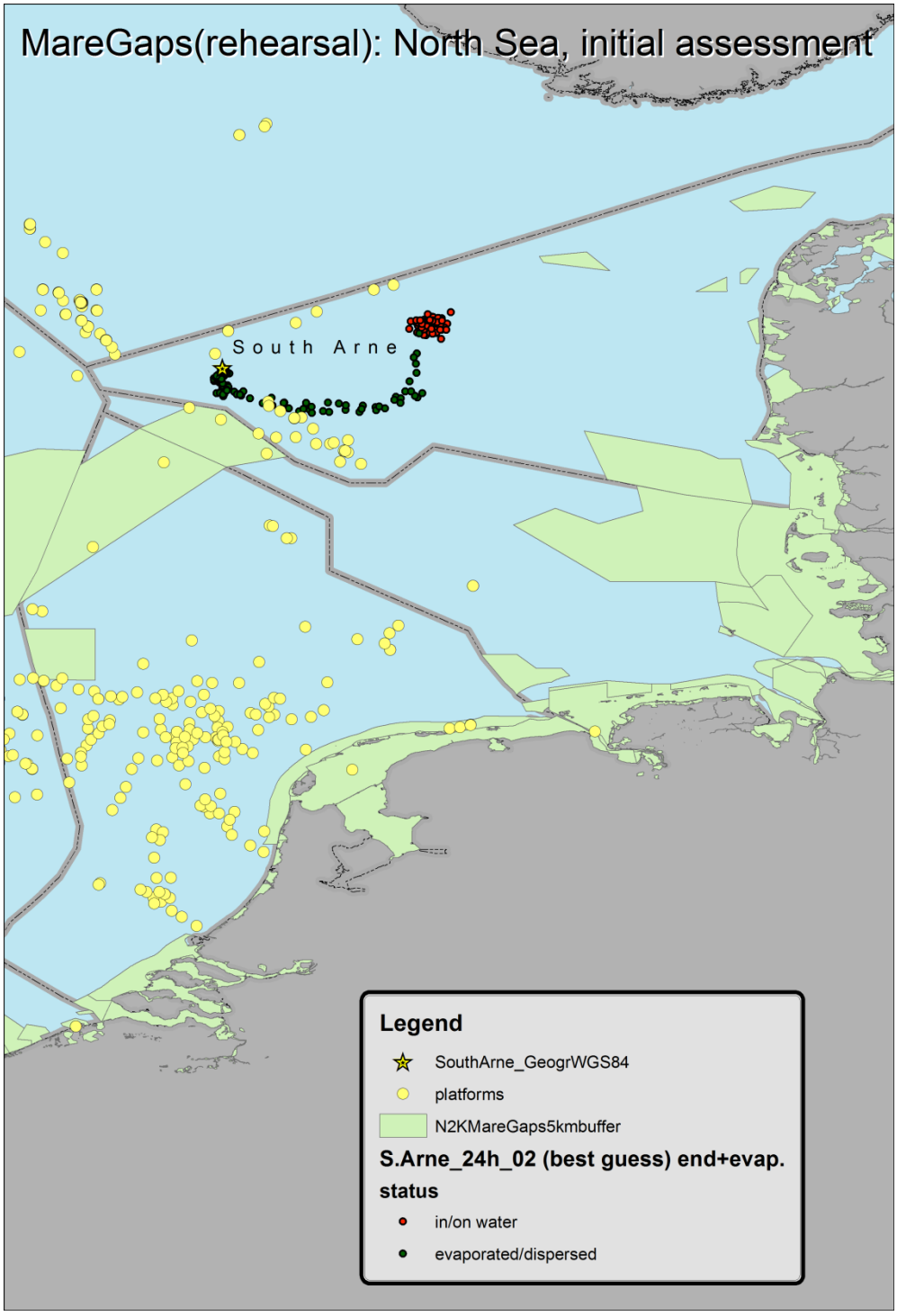

Figure 2 Map of oil spill trajectory after 136 hours (Sat 02 Aug 24:00)

In Figure 2 the green splots of evaporated oil are shown to indicate the path taken by the oil slick towards is end location.

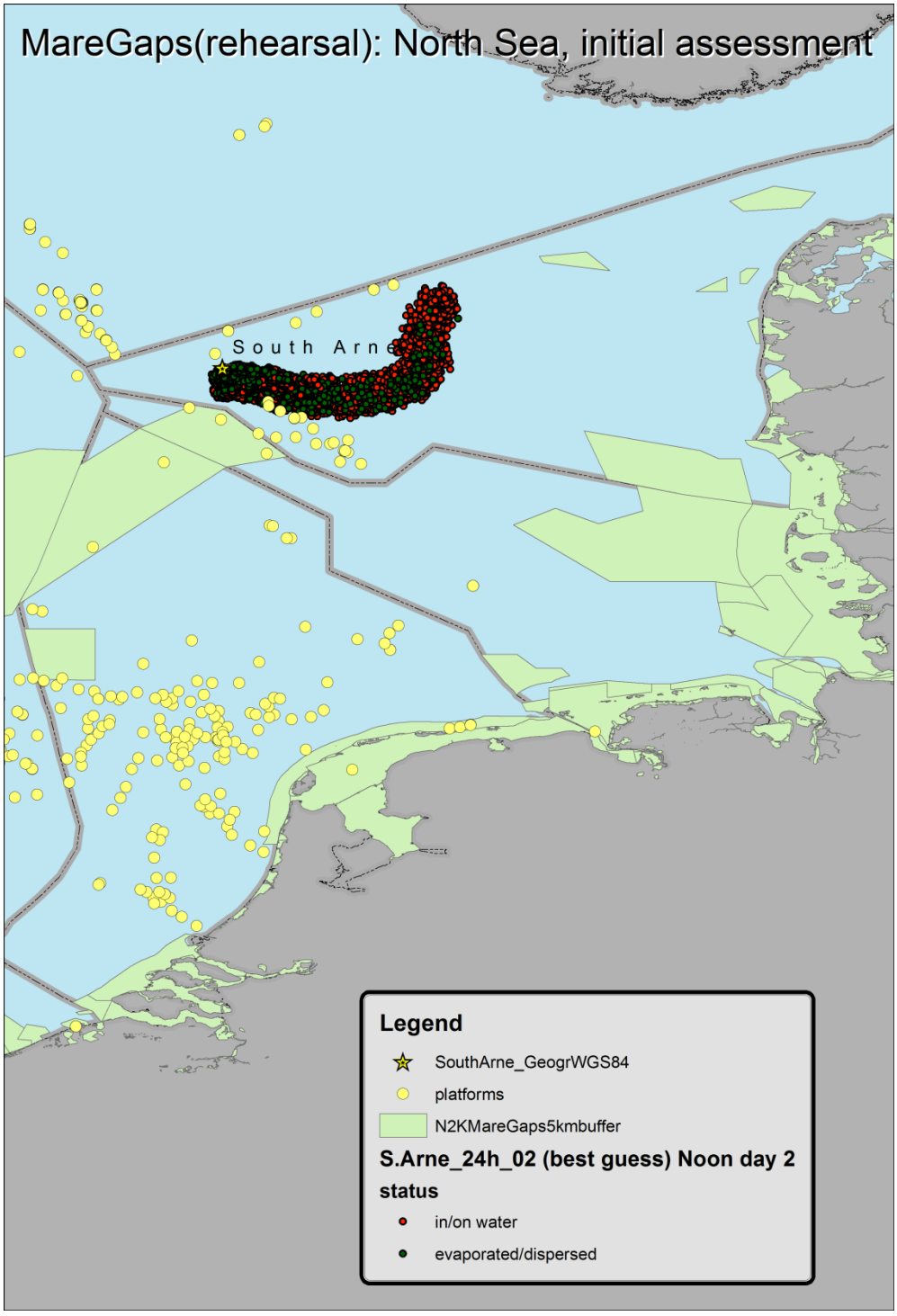

Figure 3 Map of oil spill trajectory for all 136 hour of simulation: Mon 28 Jul 08:00 thru Sat 02 Aug 24:00

In Figure 3 as well as the previous figures the shipping routes are –unfortunately- not shown. They were causing the output to be uninformative (malfunction in producing the graphics files).

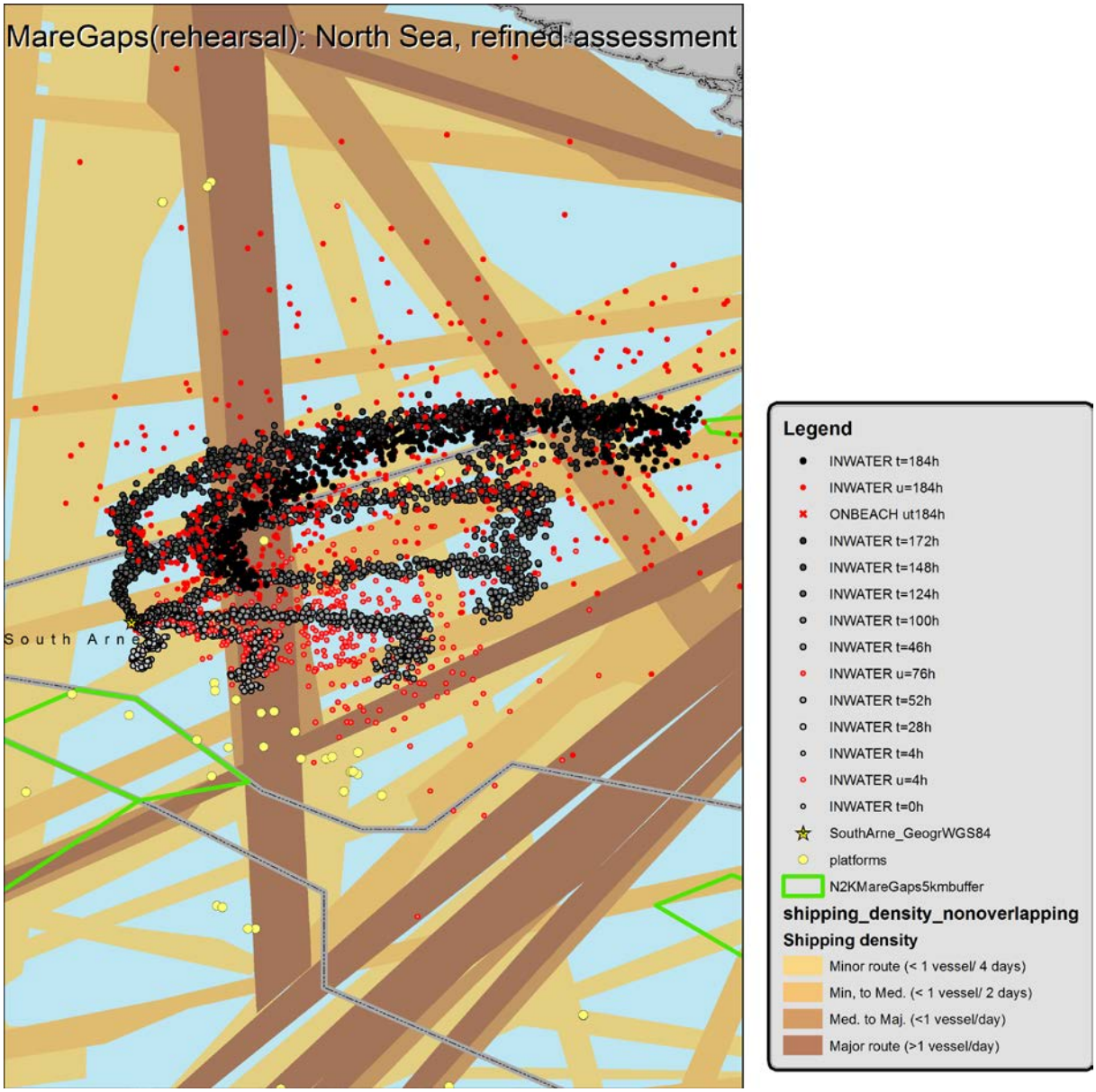

Figure 4 Map of oil spill trajectory for all 184 hour of simulation: Mon 28 Jul 08:00 thru Mon 04 Aug 24:00. The position of the oil spill is shown for noon (12:00) of each day in increasingly darker shades of grey ('best guess' splots). The final position reached on midnight Monday is shown in black. Also shown in increasingly darker shades of red are the uncertainty splots ('minimum regret') for u=4h (noon last Monday), u=78h (noon Thursday) and u=184h (midnight next Monday).

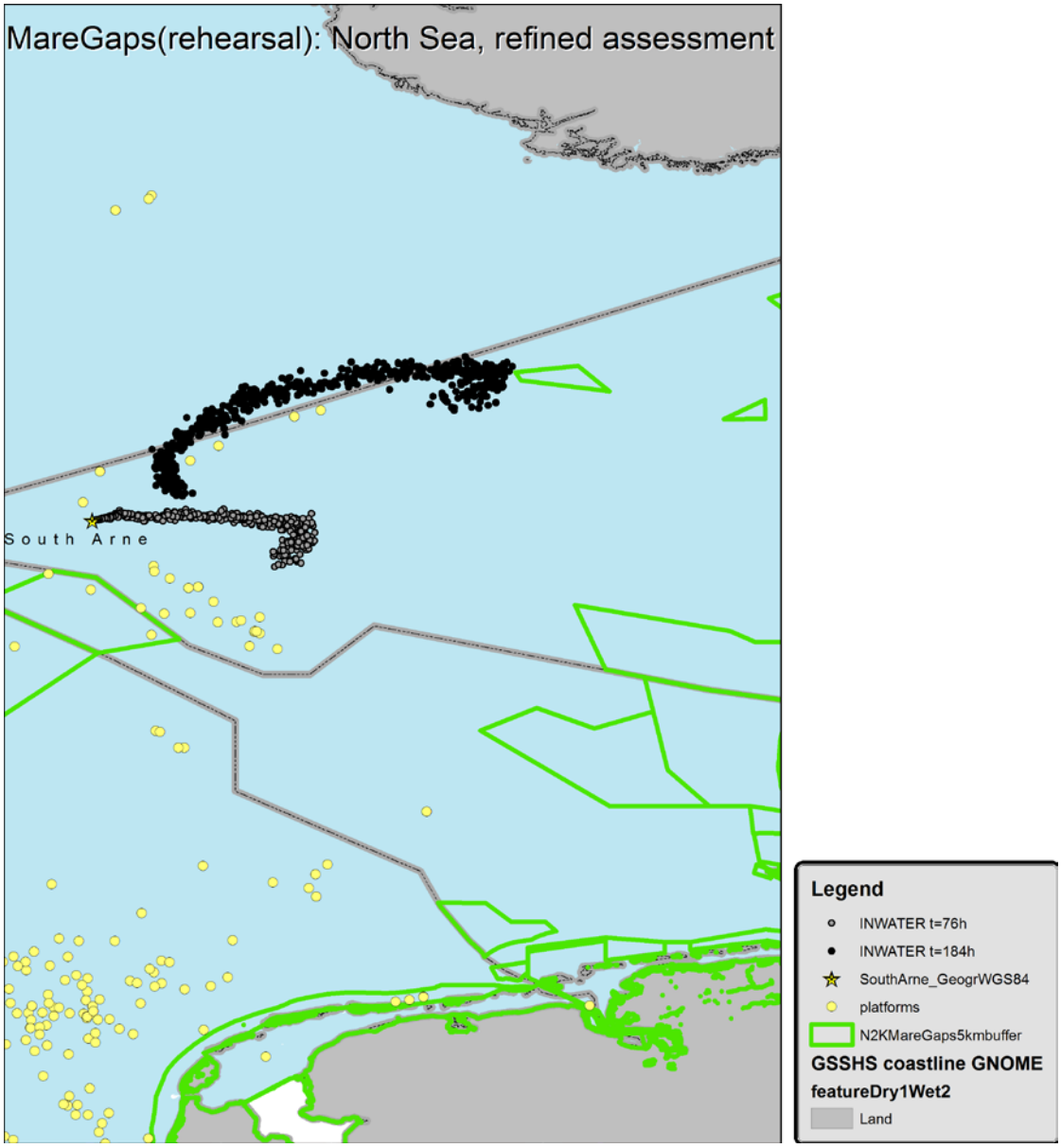

Figure 5 Map of oil spill trajectory positon for t=78h (Thursday 2014-07-31 12:00) and t=184h (Monday 2014-08-04 24:00).

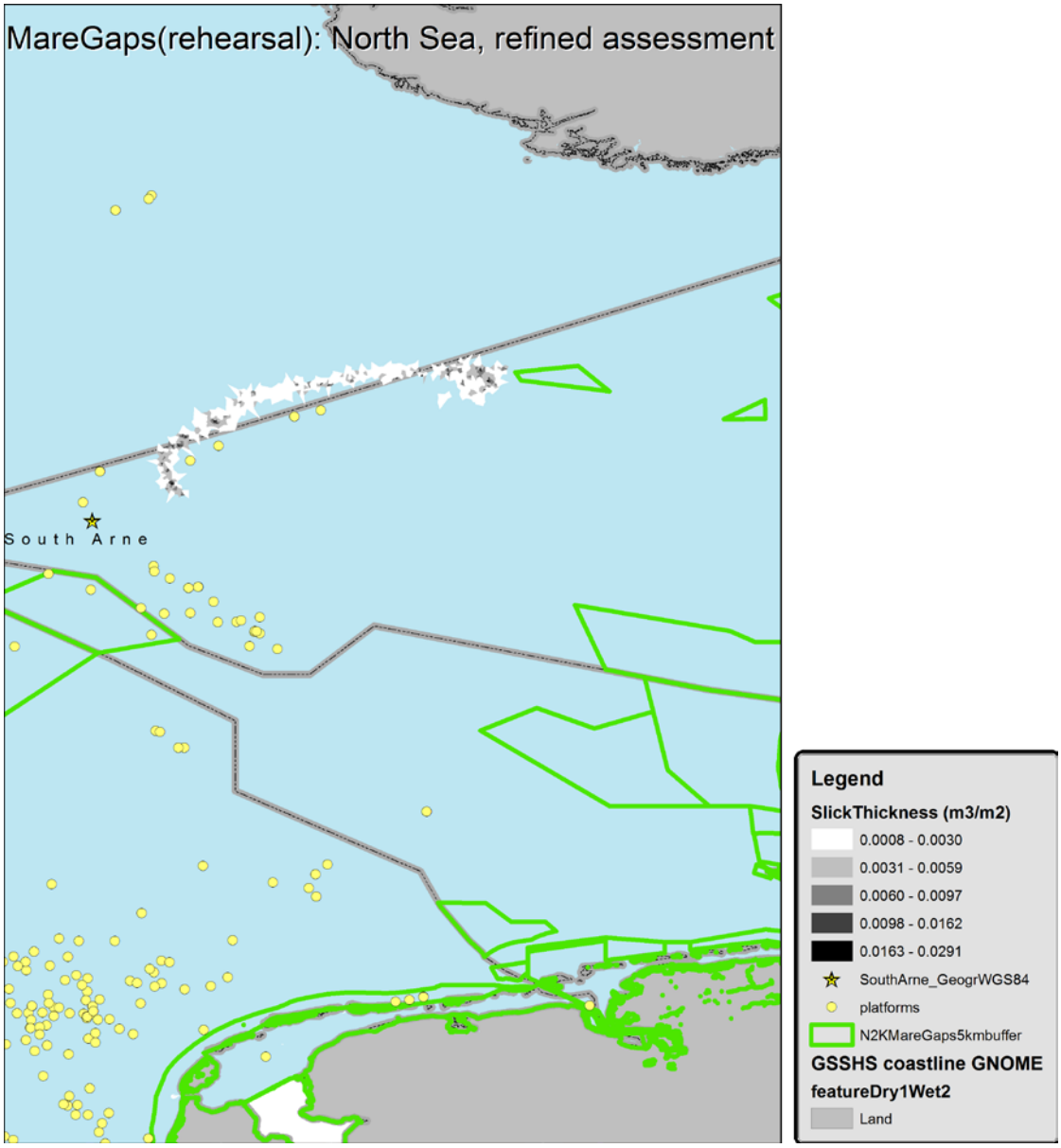

Figure 6 Map of oil spill position after 184 hour of simulation starting Mon 28 Jul 08:00 and ending Mon 04 Aug 24:00. The thickness of the slick has been calculated from the amount in m^3 present in an area. At the lower end of the scale this translates to 0.8 to 3 litres/m2 or an estimated layer thickness of one to three mm.

From Figure 6 it should be clear that this area (ca. 1900 km^2) covered by the oil slick is seriously covered in oil.

6. Conclusion

Based on this refined assessment it is likely that:

- There is not a threat to coastal habitat/species;
  - Threatened species are: harbour porpoise
  - Threatened habits is: reefs (H1170)

Both of these occur outside of designated marine protected areas (e.g. Natura 200), but are also part of the reason why Denmark has a protected area 'Jyske Rev/Lillefiskerban' (DK00VA257). This area appears to be under threat from the oil spill for the next few days beyond the presently possible simulation period.

- There is not a threat to tourist beaches;
    - 'Minimum regret' splots beached show that there is a (very) limited risk of oil on beaches (at least for the time period presently covered by the simulation). It this occurs the most likely location are the shores of northern Jutland.
- The following locations are threatened:
    - Cecile, Nini and Nini E platforms in Denmark.
    - Platforms on the Valdemar and Tyra fields in Denmark
    - De-facto shipping route NL-NO
    - De-facto shipping route DE-NO
    - Sea birds and marine mammals in the path of the oil spill.

The following has been identified as an indication of data gaps limiting the refined assessment:

- Current forecasts as available from MyOcean are currently limiting the length of time the simulation of an oil spill can be taken into the future.
- Lack of data on location of fishery effort and/or importance of areas at sea to fisheries is limiting the possibility to assess the impact that an oil spill accident may have on fisheries in general.
- Datasets both at MyOcean.eu as well as at GlobalMarineNet.com are updated once per day (around 11:00 in the morning). These processes are themselves reliant on other models being run and completing their updates and reporting.

These issues will be addressed within the main report.

Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

Note that this document is not an official IMARES report; the scientific quality of this report has not been peer reviewed.

References

To be added (in the final report).