Marine Management Organisation

Mapping UK shipping density and routes from AIS

June 2014

Mapping UK Shipping Density and Routes from AIS

MMO Project No: 1066

Project funded by: The Marine Management Organisation

Report prepared by: ABP Marine Environmental Research Ltd

Disclaimer

This report contributes to the Marine Management Organisation (MMO) evidence base which is a resource developed through a large range of research activity and methods carried out by both the MMO and external experts.

The opinions expressed in this report do not necessarily reflect the views of the MMO nor are they intended to indicate how the MMO will act on a given set of facts or signify any preference for one research activity or method over another. The MMO is not liable for the accuracy or completeness of the information contained nor is it responsible for any use of the content.

Credits

Front cover image provided by kind permission of Associated British Ports (http://www.abports.co.uk).

This report should be cited as

MMO (2014). Mapping UK Shipping Density and Routes from AIS. A report produced for the Marine Management Organisation, pp 35. MMO Project No: 1066. ISBN: 978-1-909452-26-8.

First published June 2014.

Contents

Figures

Tables

Glossary

Beam – the width of a vessel at the widest point, or a point alongside the ship at the midpoint of its length.

Draught – the depth of a ship's keel below the waterline.

'International Maritime Organization, or IMO – is a specialised agency of the United Nations responsible for measures to improve the safety and security of international shipping and to prevent marine pollution from ships.

Length overall, or LOA – the maximum length of a vessel's hull measured parallel to the waterline, usually measured on the hull alone, and including overhanging ends that extend beyond the main bow and main stern perpendicular members. For sailing vessels, this may also include the bowsprit and other fittings added to the hull.

Maritime and Coastguard Agency, or MCA – is a UK Government Agency involved in coordinating search and rescue (SAR) at sea through Her Majesty's Coastguard (HMCG), ensuring that ships meet international and UK safety standards, monitoring and preventing coastal water pollution and testing and issuing Merchant Navy Certificates of Competency (licences) for ships' officers and crew.

Nautical mile – a unit of length corresponding approximately to one minute of arc of latitude. By international agreement it is exactly 1,852 metres

Traffic Separation Scheme, or TSS – is a management routeing system overseen by the IMO. The traffic-lanes indicate the general direction of vessel movement. Within a TSS all vessels move in the same direction or vessels may cross the TSS lane at a 90° angle.

Transit – a track taken by a vessel at sea.

Vessel – includes every description of water craft, including displacement, non-displacement, wing-in-ground-effect (WIG) vehicle and seaplanes.

Vessel Traffic Service, or VTS – is a marine traffic monitoring system established by harbour or port authorities, similar to air traffic control for aircraft. Typical VTS systems use radar, closed-circuit television (CCTV), VHF radiotelephony and automatic identification system to keep track of vessel movements and provide navigational safety in a limited geographical area.

1. Introduction

This report provides information about the Marine Management Organisation (MMO) commissioned project to map UK shipping activity and routes from Automatic Identification System (AIS) data. The project was carried out by ABP Marine Environmental Research Ltd (ABPmer) using data supplied by the Maritime and Coastguard Agency (MCA). The project is called 'Mapping UK Shipping Density and Routes from AIS: Open Source Data and Methods' (MMO project 1066). For a technical explanation of the processing methodology and tools developed within the project, please read the associated MMO report Mapping UK Shipping Density and Routes technical annex' (MMO, 2014)[1].

This project has developed flexible data processing tools and associated geographic information system (GIS) procedures to decode and display AIS data. Through the use of common routines and methodology, future AIS processing and analysis can be conducted by UK administrations to a consistent and commonly agreed approach. In addition to the creation of tools and routines for AIS data processing, the project has also created a national AIS dataset for 2011 and 2012 using MCA AIS data records collected by the network of UK receiving stations.

1.1 What is AIS?

AIS is a maritime navigation safety communications system adopted by the International Maritime Organization (IMO) to provide vessel information, primarily for the purposes of maritime safety. AIS data provides a source of information which can be used to spatially represent vessel movements within the receiving range of transmissions.

The technology works with transponders which automatically broadcast information at regular intervals by Very High Frequency (VHF) transmitter. The AIS system is capable of handling well over 4,500 reports per minute and updates as often as every two seconds. To manage the automatic transmission and receipt of messages, AIS uses 'Self-Organised Time Division Multiple Access' (SOTDMA) technology to meet this high broadcast rate and ensure reliable ship-to-ship communications. AIS technology allows the display of information previously only available to modern Vessel Traffic Service (VTS) centres and provides much clearer information allowing mariners to more accurately identify and contact any vessel within VHF range.

AIS signals are broadly classified as 'Class A' and 'Class B', where AIS-A is carried by international voyaging ships with gross tonnage (GT) of 300 or more tonnes, and all passenger ships regardless of size. AIS-B is carried by smaller vessels and is aimed at smaller commercial vessels, the fishing sector and recreational vessel users. There are currently 27 different AIS message types which are used in combination to provide AIS-A and AIS-B services.

The most commonly used data from AIS messages is the position of a vessel at any given time which is combined with voyage information about the vessel's trip.

---

[1] http://www.marinemanagement.org.uk/evidence/documents/1066_Shipping_Tools_Report.pdf (AIS software tools are available on request)

Position reports are broadcast very frequently (between 2 to 10 seconds, depending on the vessels speed, or every 3 minutes if at anchor) whilst static and voyage related reports are sent every 6 minutes. Other types of messages include search and rescue transmissions, Aid to Navigation (buoys, lights and beacons) and Base Stations which provide meteorological, hydrological and navigation safety information.

1.2 Uses of AIS data for marine planning

AIS has a range of uses for marine planning, the most important of which is the identification of sea area use. This is most frequently presented as vessel density per unit area, which summarises the use of sea areas as a scaled grid. The period of time that the data represents is very important when looking at AIS density grid outputs, the sample size can be anything from hours to yearly data. Also of importance is the scale of the grid; the smaller the area of interest, the finer the grid needs to be to ensure appropriate resolution of data display.

AIS data can also be presented visually as transit lines. These are track lines created from individual vessel point positions, which form a track or ‘transit’ when jointed together into a single line. Transit lines are normally classified into vessel type based on the information from the AIS signal. Table 1 provides a description of the typical vessel types which can be established from the transmitted AIS signals. If a greater refinement of vessel type is desired, the AIS data is normally joined with another form of information, such as a ship classification database.

Within the context of marine planning, AIS has recently been used by UK administrations for the following purposes:

- England’s MMO has published information derived from AIS and used it to inform marine plan policies within the East Coast plan areas
- Marine Scotland has provided AIS information within its publication ‘Scotland’s Marine Atlas’.

Table 1: Example of vessel type grouping.

Group	Type	Sub-type
1	Non-port service craft	• Search and rescue vessels • Towing & Towing where length of the tow exceeds 200m or breadth exceeds 25m • Medical transports (as defined in the 1949 Geneva Conventions and Additional Protocols) • Ships according to Resolution No. 18 (Mob-83) • Other special craft (56 & 57 reserved for local use)
2	Port service craft	• Pilot vessels • Tugs • Port tenders and vessels with anti-pollution

Group	Type	Sub-type
		facilities or equipment
3	Vessels engaged in dredging or underwater operations	• Vessels engaged in dredging or underwater operations • Vessels engaged in diving operations (see note)
4	High Speed Craft	-
5	Military or law enforcement vessels	-
6	Passenger vessels	-
7	Cargo vessels	-
8	Tankers	-
9	Fishing vessels	-
10	Recreation	• Pleasure craft, Sailing vessels
Note: 'Vessels engaged in diving operations' are predominantly commercial diving operations, for example, related to underwater maintenance.		

1.3 Limitations of AIS

AIS is a relatively new technology (circa 2000 onwards) for which long-term records are infrequently kept due to the amount of physical disc space needed to store the transmitted messages. For the UK, the most robust data source is the MCA's archive of AIS data which has been used to generate information within this project.

Whilst AIS information provides an accurate representation of the received data, it is what 'is not' received that provides the greatest limitation. AIS-A provides characterisation of commercial shipping (AIS-A) but misses the bulk of non-AIS vessels, including:

A) Commercial Vessels below 300 GT
B) Recreational Vessels
C) Fishing Vessels
D) Military/Government vessels whilst on deployment.

It is considered likely that a 40 nautical miles reception radius for AIS-A will be achieved by the MCA AIS network subject to various factors such as the power of the transmitted signal, the height of the transmitting ship's aerial and meteorological conditions. Poor reception could be as little as 20 nautical miles, or as much as 350 nautical miles for powerful transmissions during appropriate atmospheric conditions.

The MMO project 1042 carried out an evaluation of MCA AIS-A data against records from the Port of Southampton's VTS database. This showed that during the sample period, approximately 16% of the commercial vessel transits identified in the Port of Southampton's dataset were not identified in the MCA's AIS dataset. It was concluded that a range of possible causes were plausible, including non-receipt of messages by the land based receiving station, non-transmission of the messages by the ship or 'data-collision' where the database is unable to store the quantity of received messages due to the volume of data.

Further limitations of AIS data relate to the quality of the received records, where potential sources of error exist within the data. For example, AIS transponders may be switched on or off during a ship's passage or be defective, thereby not capturing the full transit. In addition, errors with the positioning system can provide inaccurate locations. Voyage data is largely user entered, and therefore has inherent limitations due to operator error or misrepresentation of information. Transmitted information such as Maritime Mobile Service Identity (MMSI) (vessel identification) numbers, vessel type or dimensions can also be incorrectly entered, thereby providing a degree of uncertainty. In MMO project 1042, a confidence assessment concluded that around 2% of recorded vessels were not the ship type identified in their transmission.

AIS-B is a non-mandatory form of AIS typically used by small commercial craft, fishing vessels and recreational vessels. To prevent overloading of the available bandwidth, transmission power is restricted to 2 Watts, giving a range of up to 10 nautical miles. Information regarding use patterns by these types of craft from AIS sources alone will therefore significantly underplay the true frequency and use patterns. To provide a complete picture, other forms of information should be used to augment AIS-B data including the fishing craft Vessel Monitoring System (VMS) and radar/visual observations.

2. Creating Shipping Information for 2011 and 2012

The following section provides a description of the AIS data used in this project, and an overview of the method applied to process the data into shipping activity and routes. If further technical detail is required, this can be found in the MMO report 'Mapping UK Shipping Density and Routes technical annex (MMO, 2014)[2].

2.1 Raw input data

The MCA provided twelve UK-wide, seven-day periods of AIS-A and AIS-B data from 2011 and 2012. The data sets were sampled from the first seven days of each month, commencing with January, at two-month intervals. The even spread of data from selected weeks and months over the two-year period reduced any seasonality effects for combined (annualised) datasets. This approach is consistent with previous AIS projects, for example, the MMO project 1042 (http://www.marinemanagement.org.uk/evidence/1042.htm) and data contained within the Maritime Data website (Maritime Data, 2014), created for the Department of Energy and Climate Change (DECC) (http://www.maritimedata.co.uk).

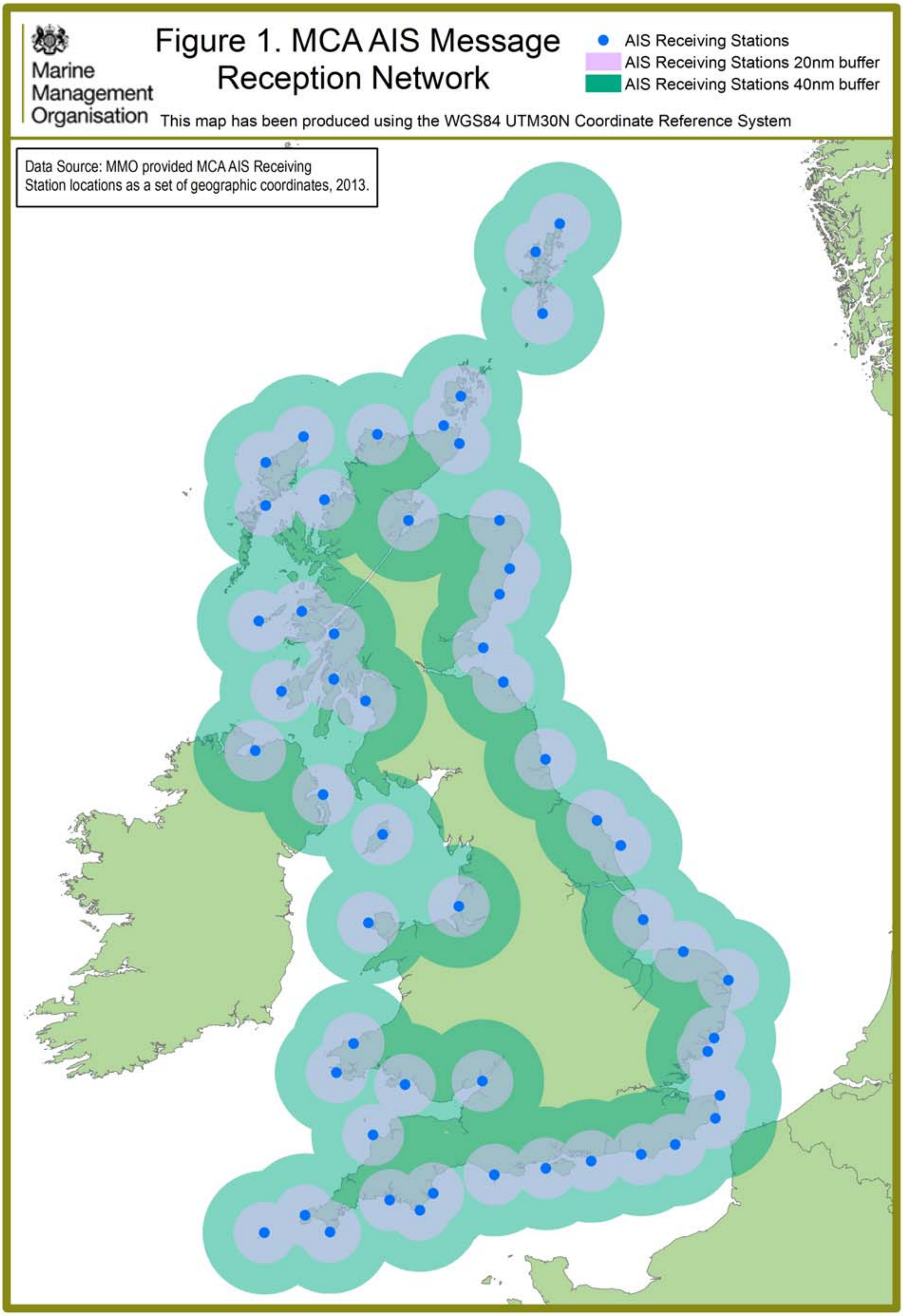
MCA data was provided for the following periods:

- 2011: 1st to 7th from each of the following: January, March, May, July, September, November
- 2012: 3rd to 9th January*
- 2012: 1st to 7th from each of the following: March, May, July, September, November.

* Note: Data validation checks identified that data from 1st to 2nd January 2012 was incomplete; therefore the date range was amended to the next nearest date range with consistent records which was 3rd to 9th January 2012.

The MCA has a wide ranging UK shore based reception and monitoring network. Their network of reception stations is shown in Figure 1 together with the corresponding indicative reception radius of 40 nautical miles. The range of reception can be variable and is dependent on factors including signal propagation conditions, sea state, the height of the transmitting and receiving antenna and the strength of the vessel transmitter. Reception could be as little as 20 nautical miles, or as much as 350 nautical miles for powerful transmissions during appropriate atmospheric conditions. In the context of the factors that act to control AIS reception range it is considered likely that on average a 40 nautical mile reception radius will be achieved by the MCA AIS receiver network. This receiver range covers 47% of UK waters out to boundaries of the UK Continental Shelf limit. The same coverage assumptions do not apply to AIS-B which has a smaller power output with ranges of up to 10 nautical miles.

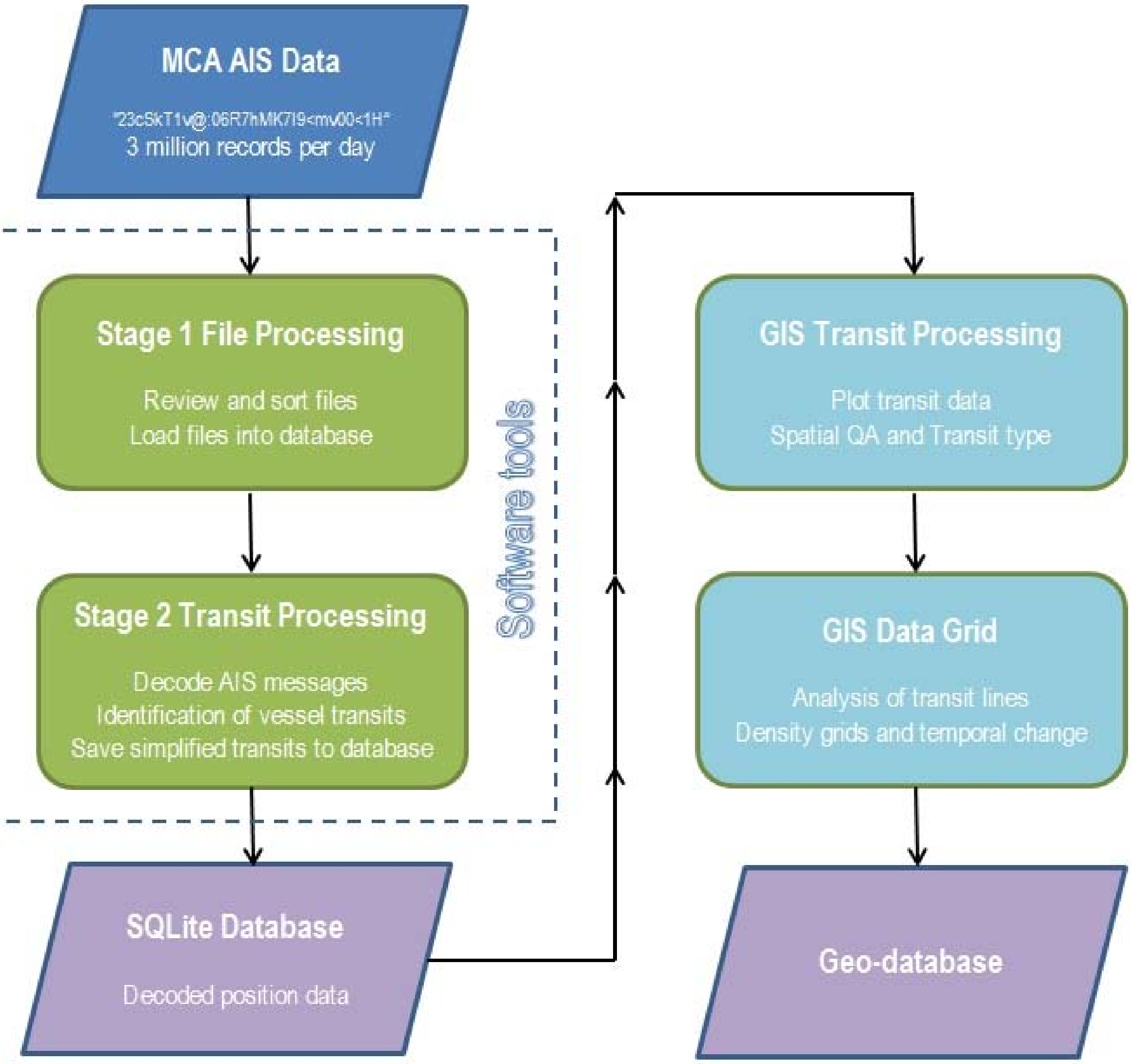
[2] (AIS software tools are available on request)


Marine
Management
Organisation
Figure 1. MCA AIS Message Reception Network
AIS Receiving Stations
AIS Receiving Stations 20nm buffer
AIS Receiving Stations 40nm buffer
This map has been produced using the WGS84 UTM30N Coordinate Reference System
Data Source: MMO provided MCA AIS Receiving Station locations as a set of geographic coordinates, 2013.

2.2 Processing summary

To process the MCA raw AIS messages from their encoded format into a geodatabase required the development of a number of processing tools and Geographic Information System (GIS) processing methodologies. Figure 2 provides a process flow diagram of the steps involved.

Figure 2: AIS data processing stages.



The processing stages shown in Figure 2 have been designed to allow the loading of bulk MCA AIS files in raw format which are processed as discrete 'packages' of information. The output geodatabase covers the time-period of the input data, within the context of the MMO project 1066, the raw AIS messages were provided in week (seven-day) blocks of AIS-A and AIS-B data creating geodatabase outputs from the project in seven-day datasets. Geodatabases can be combined to provide larger datasets, depending on the requirement of the user.

The software tools and GIS routines summarised in Figure 2 have been developed to run on a MS Windows based PC with GIS software 'ESRI ArcGIS 9.3' and extensions installed. The AIS decoding and thinning tools do not require any software installation or large scale processing ability, the software tools have been provided as open source (Intellectual Property (IP) free) products.

The derived AIS data products from this project have been provided in a GIS Geodatabase with the intention that this will be made freely accessible (within the bounds of data protection rules and requirements of anonymisation) in line with the Government's principles on open data.

2.3 Accuracy of the information

To validate the information, a database of vessel characteristics provided by Lloyds List was used. This process of validation has been included in the processing stages as part of the GIS Transit Processing (see Figure 2). It has been purposely designed as a routine in itself, as validation data will not always be available. This will be especially useful where there may not be a complete set of database information with which to compare AIS records with, such as AIS-B records for recreational craft.

The vessel type and draught, as reported in the AIS signal, was validated against data provided by Lloyds list. This identified that out of the AIS messages from 2012, on average 63% of the vessel transits in the dataset could be matched with validation data from Lloyds List. Out of the transits that could be checked, on average 13% of the ship type required correction and 14% of the vessel draughts were outside of their plausible values. Where a vessel draught was found to be greater than its maximum stated draught (from Lloyds List information) the draught was changed to the maximum stated draught as the Lloyds data is considered to be more reliable.

3. Shipping Patterns

Processing of the national AIS data has been achieved through the creation of vessel transits (defined by the reported Speed Over the Ground (SOG) following the method outlined by Calder and Schwehr (US Hydro 2009)). Each vessel transit line has attributes describing the date, time, vessel type, vessel dimensions and transit classification. Following the code of practice in the Information Commissioners Office publication on anonymisation; vessel transit line identification has been anonymised (ICO, 2012). By combining vessel transit data, a weekly density grid at a resolution of $2km^2$ (2,000m by 2,000m cell size) has been produced.

3.1 Density grids (total vessel density)

Based upon the MCA sample time periods selected as set out in Section 2.1, the average weekly vessel density for 2012 is shown on Figure 3. This image shows areas with no vessel transits during the period of sampling (the six one week periods described in Section 2.1) which are displayed as ‘white’ through to areas of high traffic density with a peak of 1,300 transits shown as ‘purple’. The following report sections provide an overview of the National UK vessel density for 2012. To aid the description, various transect lines have been established to quantify the vessel transits and identify the ships types using different areas around the UK. These tables are shown in full in Annex A.

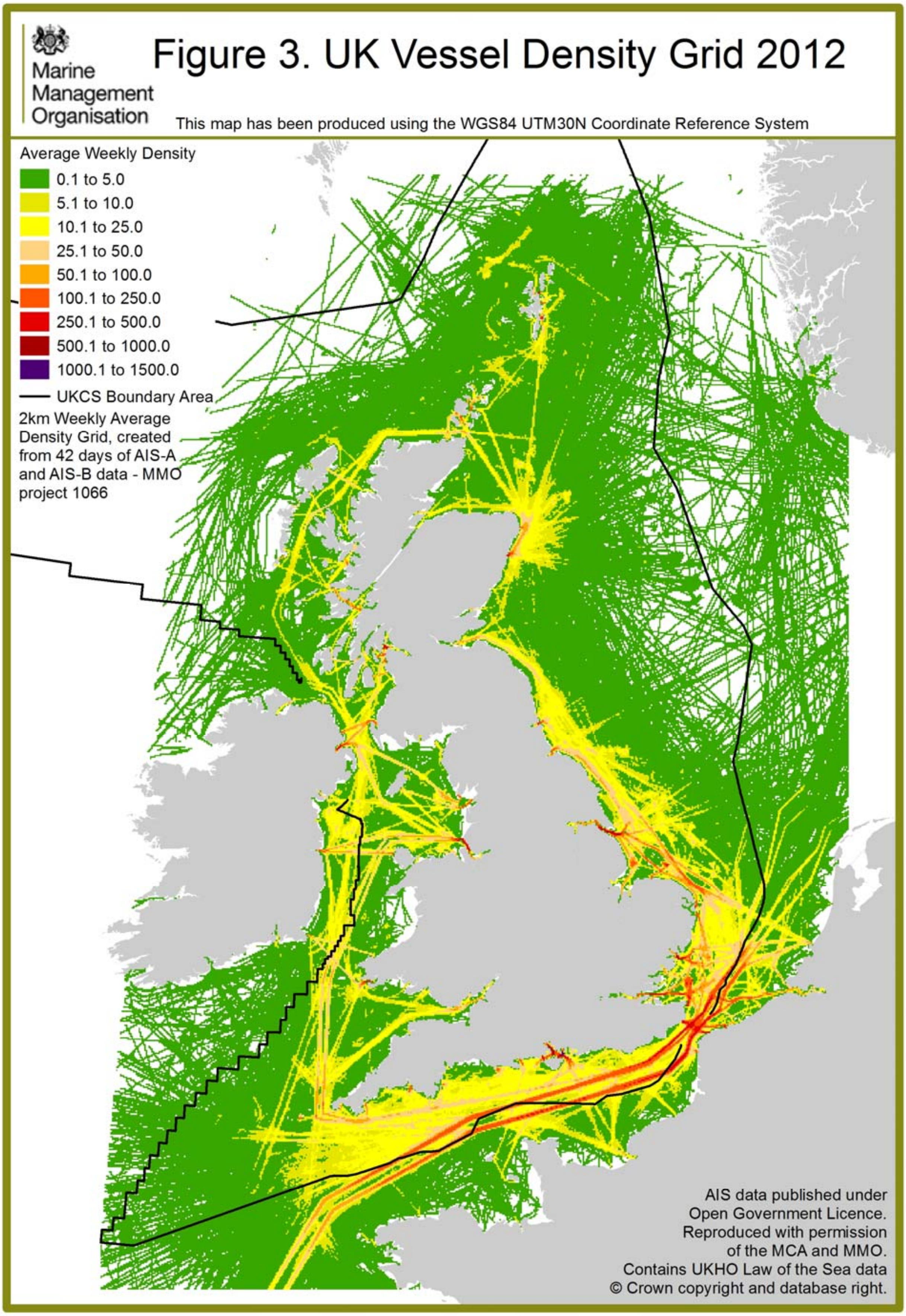
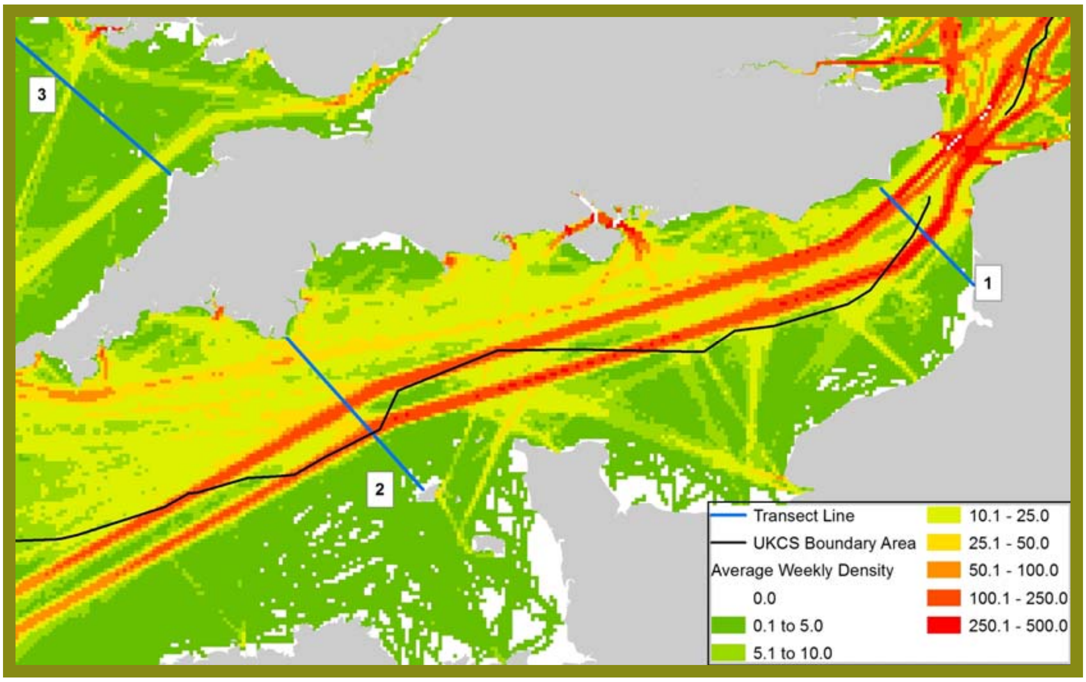

Marine
Management
Organisation
Figure 3. UK Vessel Density Grid 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
Average Weekly Density
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
250.1 to 500.0
500.1 to 1000.0
1000.1 to 1500.0
UKCS Boundary Area
2km Weekly Average Density Grid, created from 42 days of AIS-A and AIS-B data - MMO project 1066
AIS data published under Open Government Licence. Reproduced with permission of the MCA and MMO. Contains UKHO Law of the Sea data © Crown copyright and database right.

Figure 4 shows the South Coast of England, with transits through IMO traffic lanes through the English Channel clearly denoted by high intensity use. The English Channel is one of the world's busiest shipping routes, linking the North and Baltic Seas to the North-West Atlantic. Ships transiting through the central and eastern Channel minimise the risk of collision by following the Traffic Separation Scheme (TSS), which was first established by the UK, France, Belgium and the Netherlands. Opposing traffic is divided into 'lanes', starting in the west with the Casquets TSS and continuing through the Dover Strait TSS. Vessels heading west keep to the northern lane (English side) while those heading east keep to the southern lane (French side).

Figure 4: South Coast vessel density and routes 2012.



On the basis of the 2012 AIS data, 8,409 vessel transits in the 42-day data set (approximately 200 per day) pass through transect 1, in comparison to 7,108 vessel transits (approximately 169 per day) passing through transect 2 (Annex A, Table A1 and A2). The disparity is accounted for by vessels using the port facilities around the Solent on routes between London, East Coast ports and continental ports which do not complete a full passage along the Channel. It should be noted that these are 'average' values based on the sample size of the data set (i.e., six weeks of input AIS data) a yearly evaluation will provide maximum and minimum range either side of this average.

In addition to vessels transporting goods through the Channel, there is also a significant amount of traffic engaged in transporting goods and people across the Channel, between many of the well-known ferry ports such as Dover, Portsmouth, Poole and Weymouth. A large proportion of the shipping in the Channel therefore follows well defined routes, but vessels engaged in other activities, such as fishing or leisure, tend to navigate more freely within the area.

Figure 4 also demonstrates an inshore route running along the South coast linking two way traffic to a point off Land's End, from which two distinct traffic routes can be seen heading in a North-South orientation for traffic transiting into the Irish Sea. Clearly defined routes can be seen into the Seven Estuary, and vessel bound for Milford Haven in Pembrokeshire. Transect line 3 (Annex A, Table A3) provides a summary count of vessels using these routes. This shows 2,309 transits in the 42-day data set (approximately 55 per day) passing through the transect line location.

Figure 5 identifies shipping routes within the Irish Sea. These are composed of North-South routes along the Irish Sea and connecting routes between Welsh, English and Scottish ports with those in Northern Ireland and the Irish Republic. Most notable of these connections are Holyhead and Liverpool to Dublin, Heysham and Liverpool to the Isle of Man and Belfast, and Loch Ryan routes to Belfast and Larne. Transect line 4 (Annex A, Table A4) provides a summary count of vessels passing between Northern Ireland and Scotland, including routes into Belfast and Larne. This shows 1,270 transits in the 42-day data set (approximately 30 per day) passing through the transect line location.

Figure 5: Irish Sea vessel density and routes 2012.

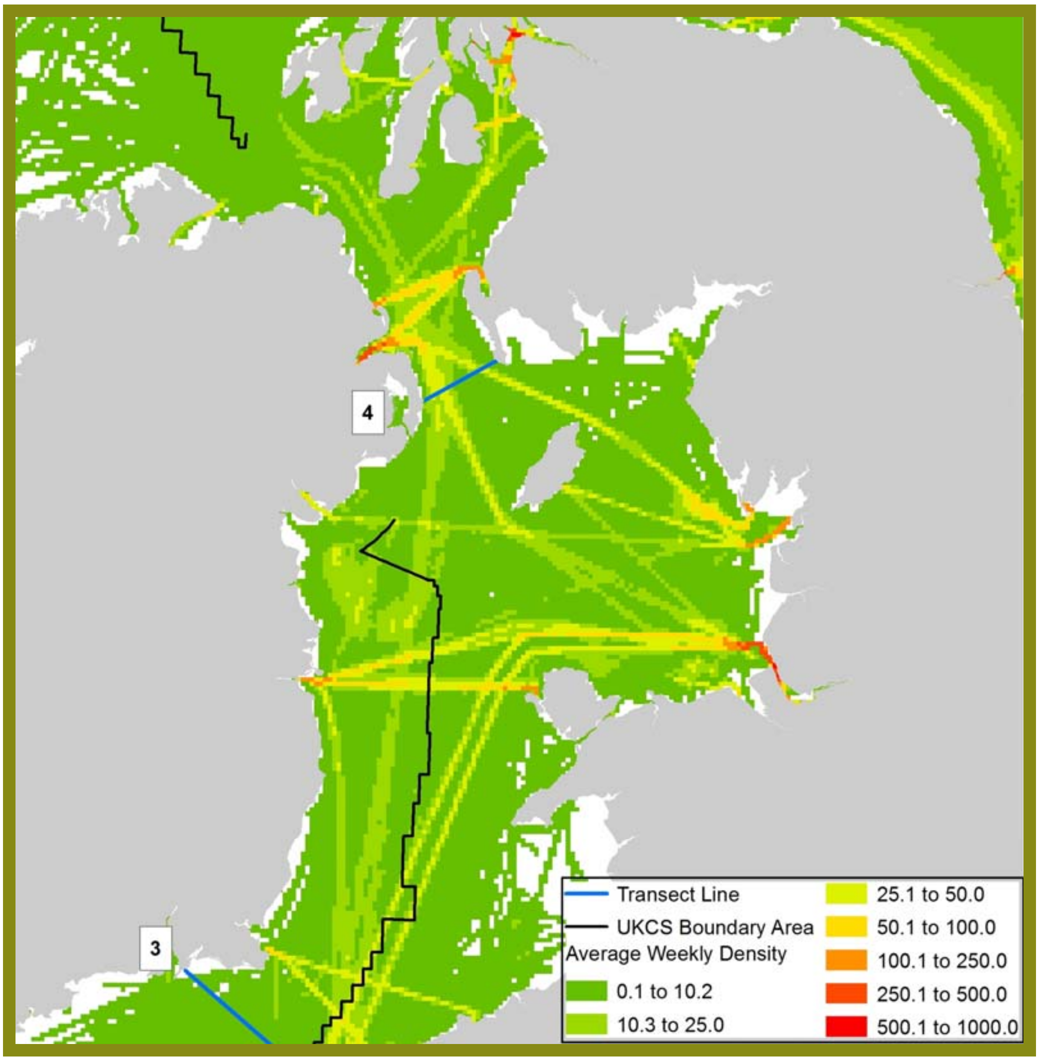
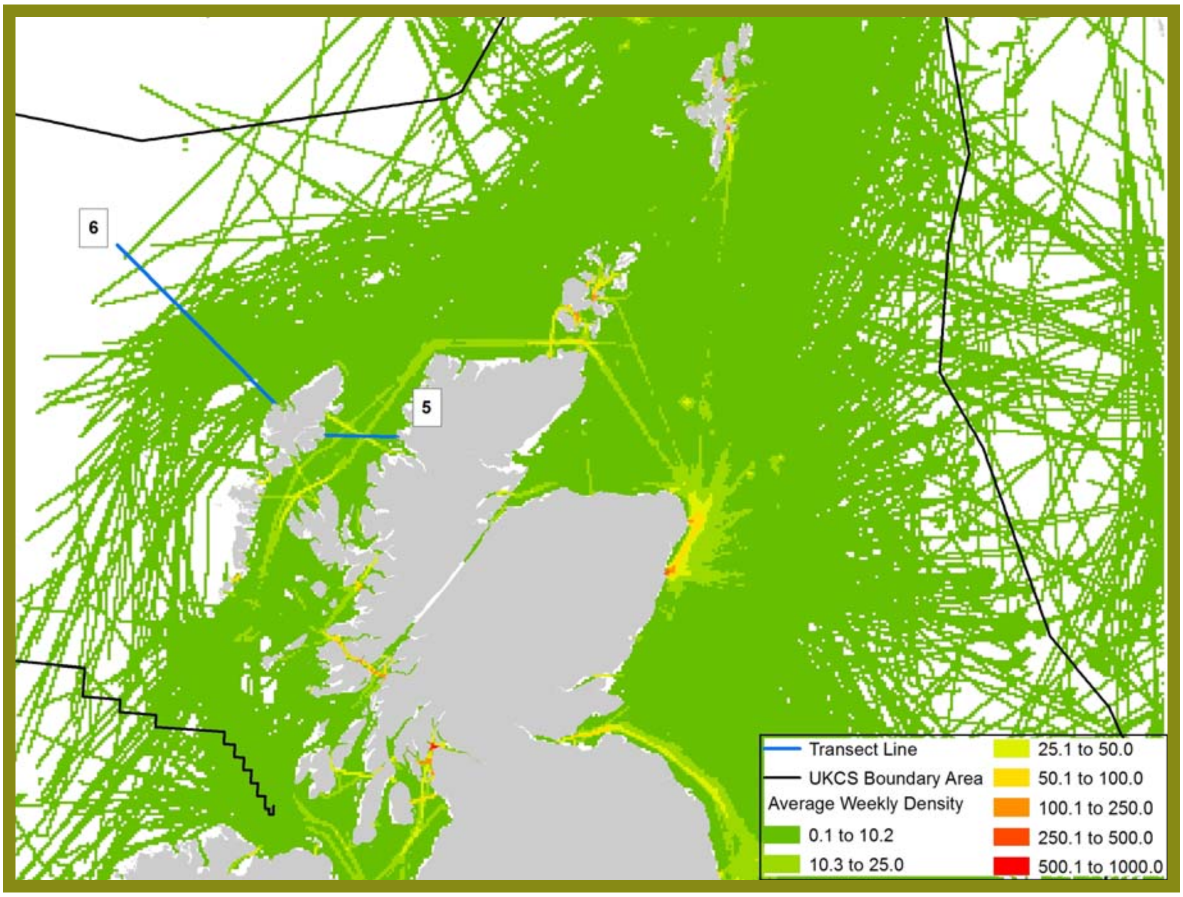


Figure 6 provides a view of vessel activity in Scottish Waters. For ease of description, this can be considered as routes used by shipping making direct passage around Scotland or between Scottish cargo ports, offshore energy installations, and ferry routes that connect the many island communities.

Figure 6: Scottish vessel density and routes 2012.



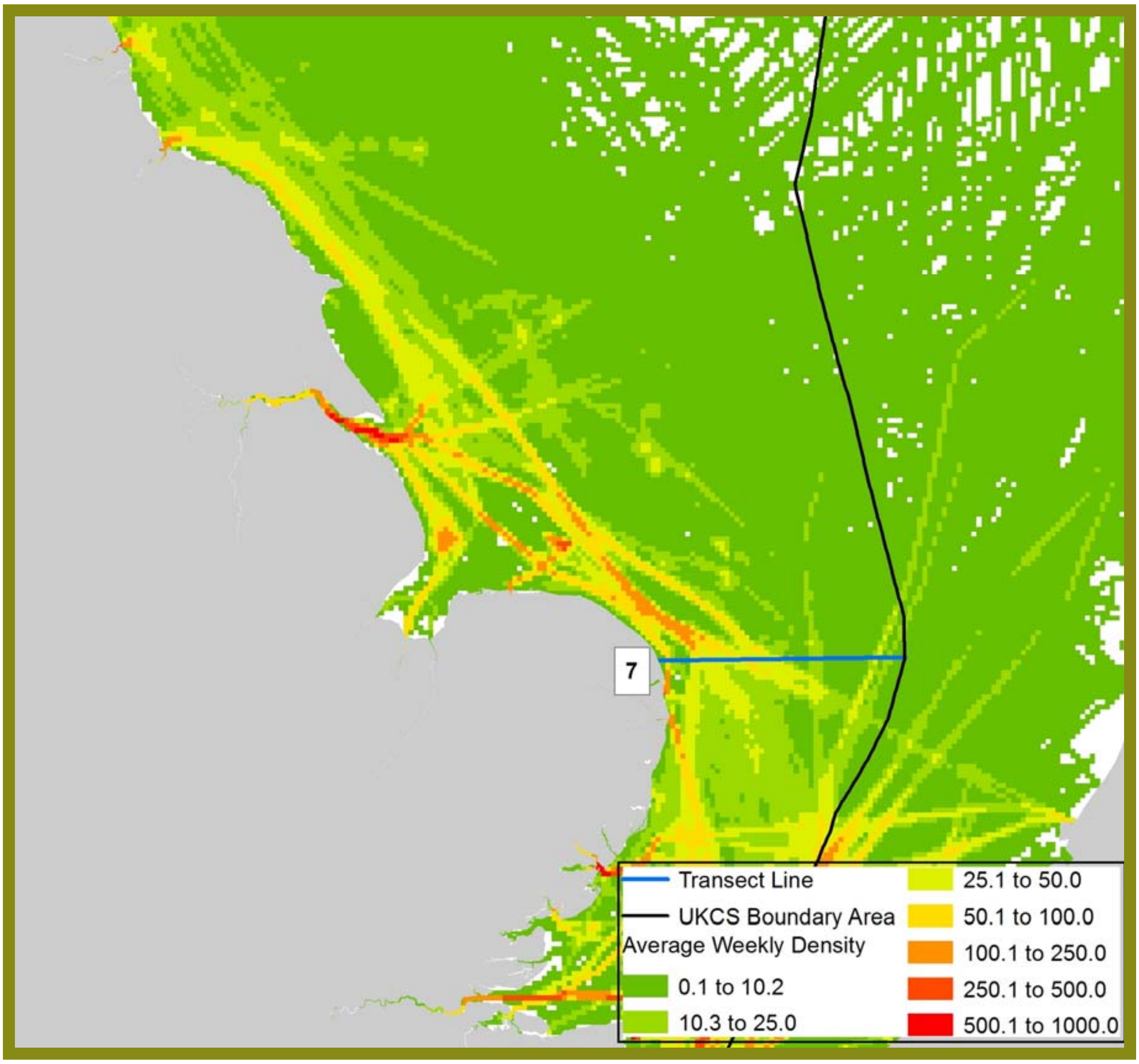
Distinct routeing patterns can be seen through the Minch and the Little Minch, connecting to the Sound of Harris, then along the North coast of mainland Scotland to the Pentland Firth. Transect lines 5 and 6 (Annex A, Table A5 and A6) identify the difference between summary vessel counts through the Minches and vessel traffic to the West of the Outer Isles. On the basis of the 2012 AIS data, 616 vessel transits in the 42-day data set (approximately 15 per day) pass through transect 5, in comparison to 340 vessel transits (approximately 8 per day) passing through transect 6 (Annex A, Table A1 and A2).

Vessels using routes around the North of Scotland include vessels transiting from the Western Atlantic to the Baltic states and Russia, many of which will use the Pentland Firth, making this one of Scotland's busiest seaways. Traffic using the Pentland Firth, combined with traffic using Orkney Ports, Shetland Ports and Scottish Ports on the mainland provides an intensity of shipping in this area.

Figure 6 also shows an intensity of vessel routes to the principal Scottish East Coast ports of Inverness, Peterhead and Aberdeen which all have important North Sea routes radiating from their locations to Oil and Gas installations offshore. Ferry routes are also evident connecting the Shetland Isles with the Scottish mainland. Further down the Scottish Coast, ports around the Firth of Forth also contribute traffic routes into the North Sea.

Figure 7 identifies routeing along the East Coast and out in the North Sea, to the extent which AIS information can provide coverage. The East Coast ports of the Tyne, Tees, Humber and the Wash provide clear corridors of vessel activity. Routes into the North Sea connect to the Baltic States, and most notably, ferry routes to the Netherlands from the Humber. Transect line 7 (Annex A, Table A7) provides a summary count of vessels passing between offshore of East Anglia to the UK Continental Shelf area boundary. This shows 3,605 transits in the 42-day data set (approximately 86 per day) passing through the transect line location.

Figure 7: East Coast vessel density and routes 2012.



3.2 Density grids (by vessel type)

Figures 8 to 12 provide a sequence of vessel type density grids, presented as weekly grids of $2km^2$ resolution. Figure 8 identifies cargo vessels, which as a component of the overall dataset for any given year comprises around 30% of the total AIS dataset. Hence, the patterns seen from cargo vessel activities are broadly the same as those described for the overall density. Figure 8 clearly identifies the significant cargo ports around the UK coast, with clear routeing of traffic highlighted with weekly density of up to 500 vessel transits per week along the English Channel and 100 vessel transits between major cargo ports.

Figure 8 also identifies tanker traffic, with busy tanker ports connected to deep sea shipping routes. Notable tanker ports include Fawley (Southampton), Milford Haven, Liverpool, Ports along the Forth Estuary, the Tees, the Humber and terminals within the wider Thames Estuary. These ports and terminals have weekly density routes of up to 25 to 50 tanker transits per week. It is notable that English Channel routes show a density of up to 250 tanker transits per week passing UK shores within national waters.

Figure 9 shows passenger vessel and high speed craft weekly density grids. For passenger services, frequently used routes of the order of 250 to 500 transits per week can be seen from Dover to the continent. Other routes with frequent use include cross Solent routes, services from Newhaven to France and Portsmouth to the Channel Islands. Routes from Milford Haven and Fishguard to Southern Ireland can be identified, with more intense routes from Holyhead and Liverpool to Southern Ireland. Loch Ryan to Northern Ireland is notable, as is Heysham to the Isle of Man. Many smaller (distance) routes are notable within the Scottish Isles, especially in the Western Isles, the Clyde Estuary, around Oban and routes across the Pentland Firth.

Figure 9 also depicts high speed craft routes; these are most obvious from South coast ports to the Channel Islands and France. Several highly used routes can also be noted between Liverpool and Holyhead to Southern Ireland, plus Liverpool to the Isle of Man. A high speed service also runs between Aberdeen and Lerwick in the Shetland Islands. An intensity of high speed craft making round-trips to near shore areas can be seen from ports along the East Coast including those in the Humber, the Wash, East Anglia and Ramsgate. The majority of these are involved in crew transfers to offshore construction site, predominantly associated with wind farms.

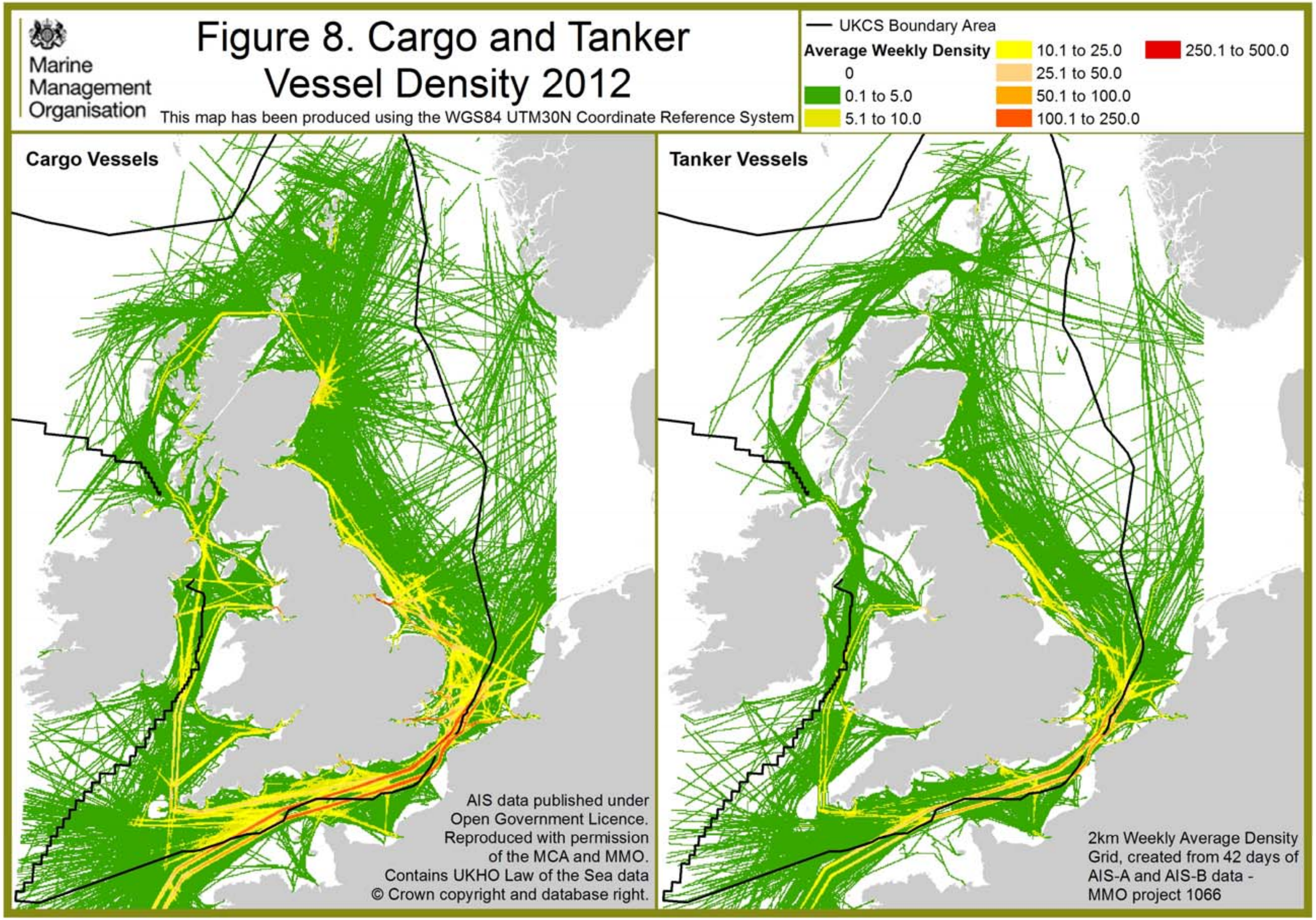
Figure 10 provides a view of weekly density for port service and non-port service craft. For port craft, sea areas with a greater intensity of use include those around larger ports, such as the Humber Estuary, Harwich Haven, the Port of London, Solent ports, Milford Haven, Liverpool and Aberdeen. For non-port craft, which includes a range of vessels often involved in the offshore support industry, various routes can be identified mainly from Scottish and English North Sea ports, to offshore installations. These are mostly in the 0.1 to 5 average weekly density banding.

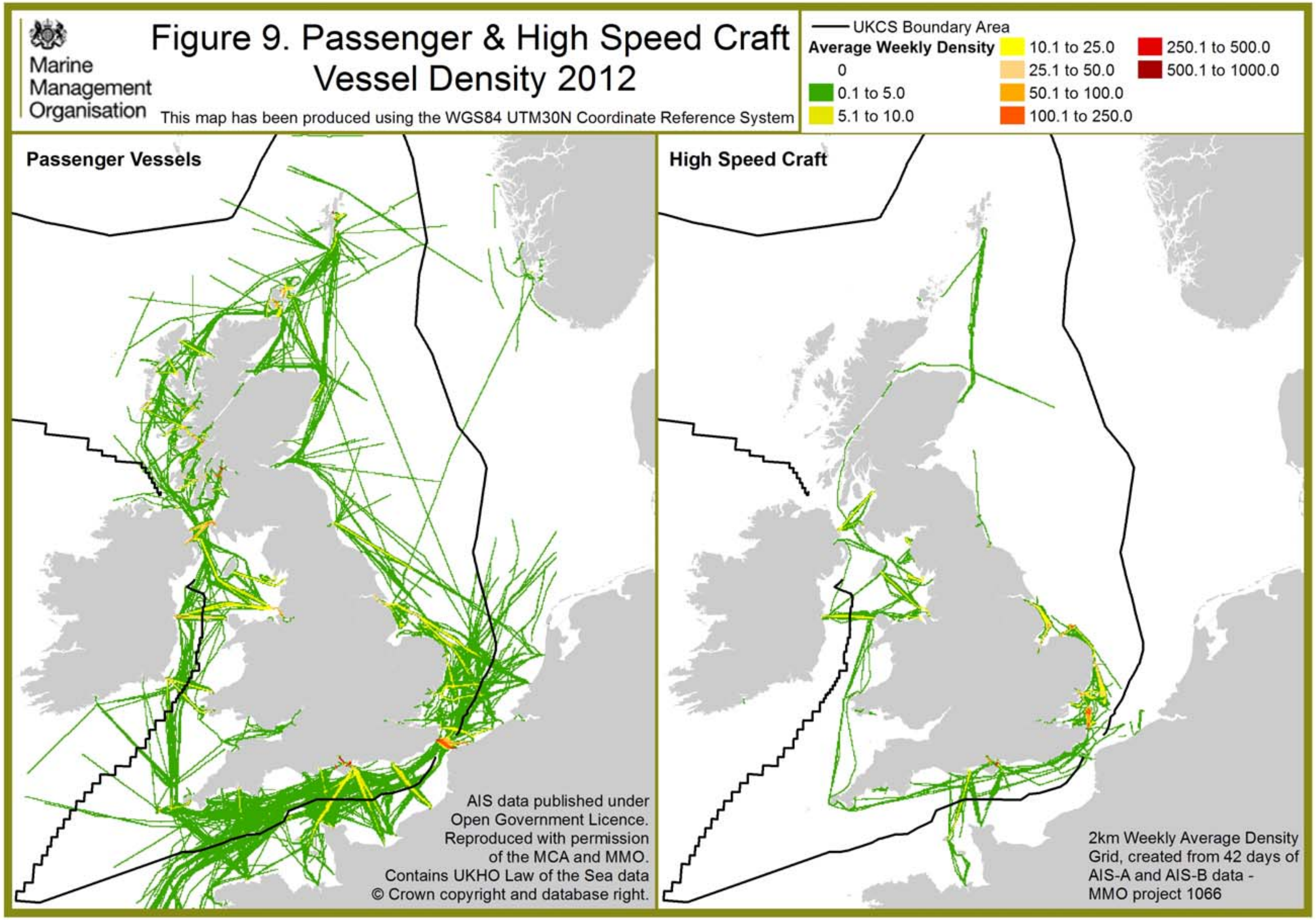
Figure 11 identifies dredging and underwater operations, plus military and law enforcement vessel activity. Dredging and underwater operations provide a relatively even spread of weekly vessel density mostly in the 0.1 to 5 transit range across a wide geographic area of the East Anglian inshore, and offshore areas, the Thames and the South Coast along to the Isle of Wight. Outside of these areas, vessel transits tend to follow established transit routes. This would indicate an amount of the activity is associated with aggregate dredging and/or maintenance dredging activity. Military and law enforcement activity is centred on the South Coast, between Lands End and the Thames, other pockets of activity include the East Cost between the Humber and the Tyne, the Forth Estuary and routes along the Scottish East Coast. A further intensity of use is the Clyde Estuary and connecting sea lochs.

Figure 12 provides a view of fishing and recreational vessel activity. Most of the information used to create these density grids has been derived from AIS-B sources, and therefore provides an inherently smaller spatial extent due to the limited transmission range of AIS-B when compared to AIS-A. It must also be remembered that carriage and use of AIS-B is voluntary, hence any density values shown under-represent the true use significantly.

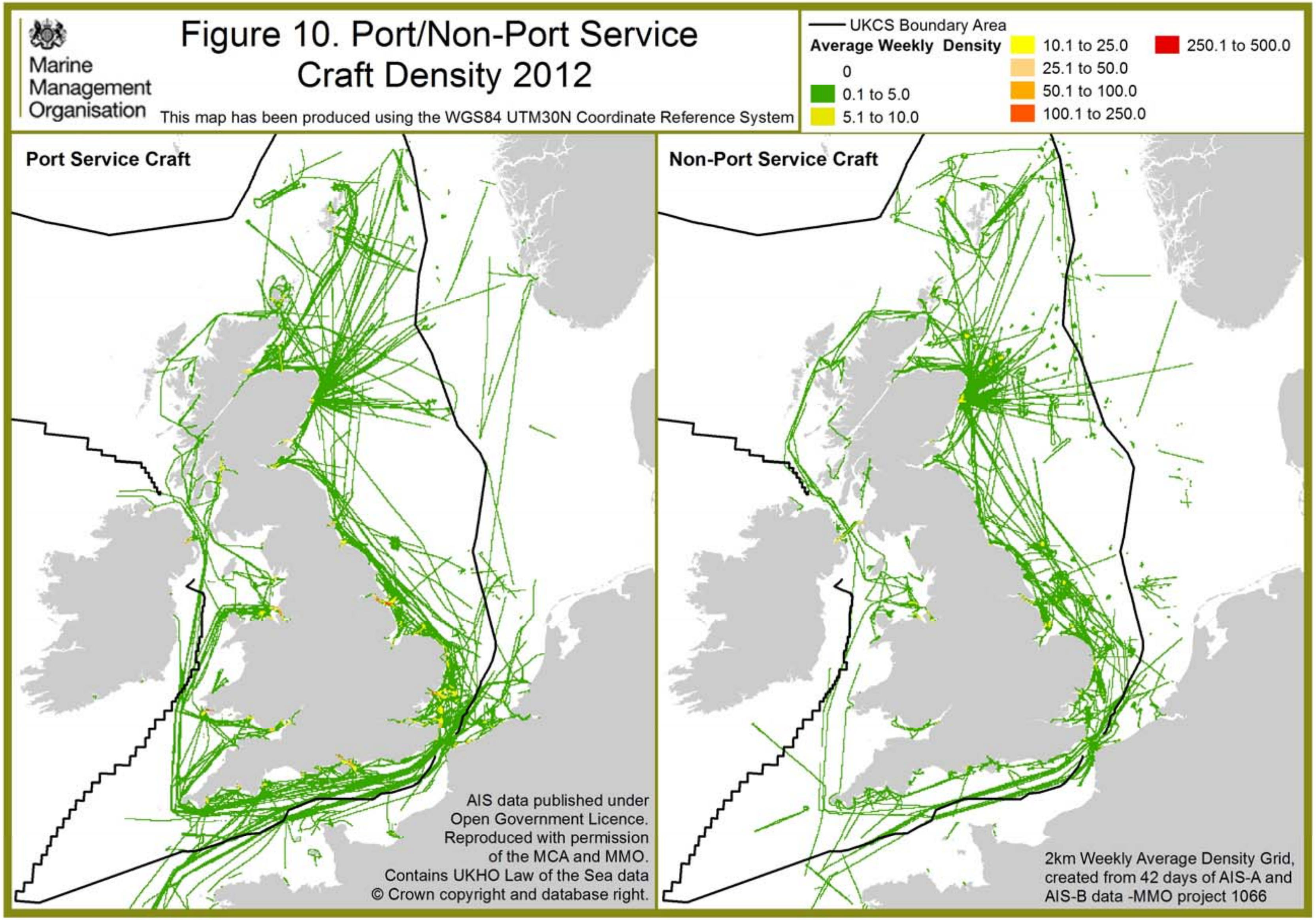
For fishing vessels, a relatively even spread of activity can be observed, with probably the widest geographic scale of sea area use of any of the vessel types but with a low density of 0.1 to 5 vessel transits per week. Few routes can be identified, although there are more intense ‘patches’ of use can be seen off Lands End and the Southern Cornish Coach, the mid-Irish sea on the Southern Ireland side, around Peterhead, the Tyne and the English Channel near Boulogne. However, these patches are not considered to relate to more intensively fished areas, rather they reflect the distribution of fishing vessels transmitting AIS-B signals.

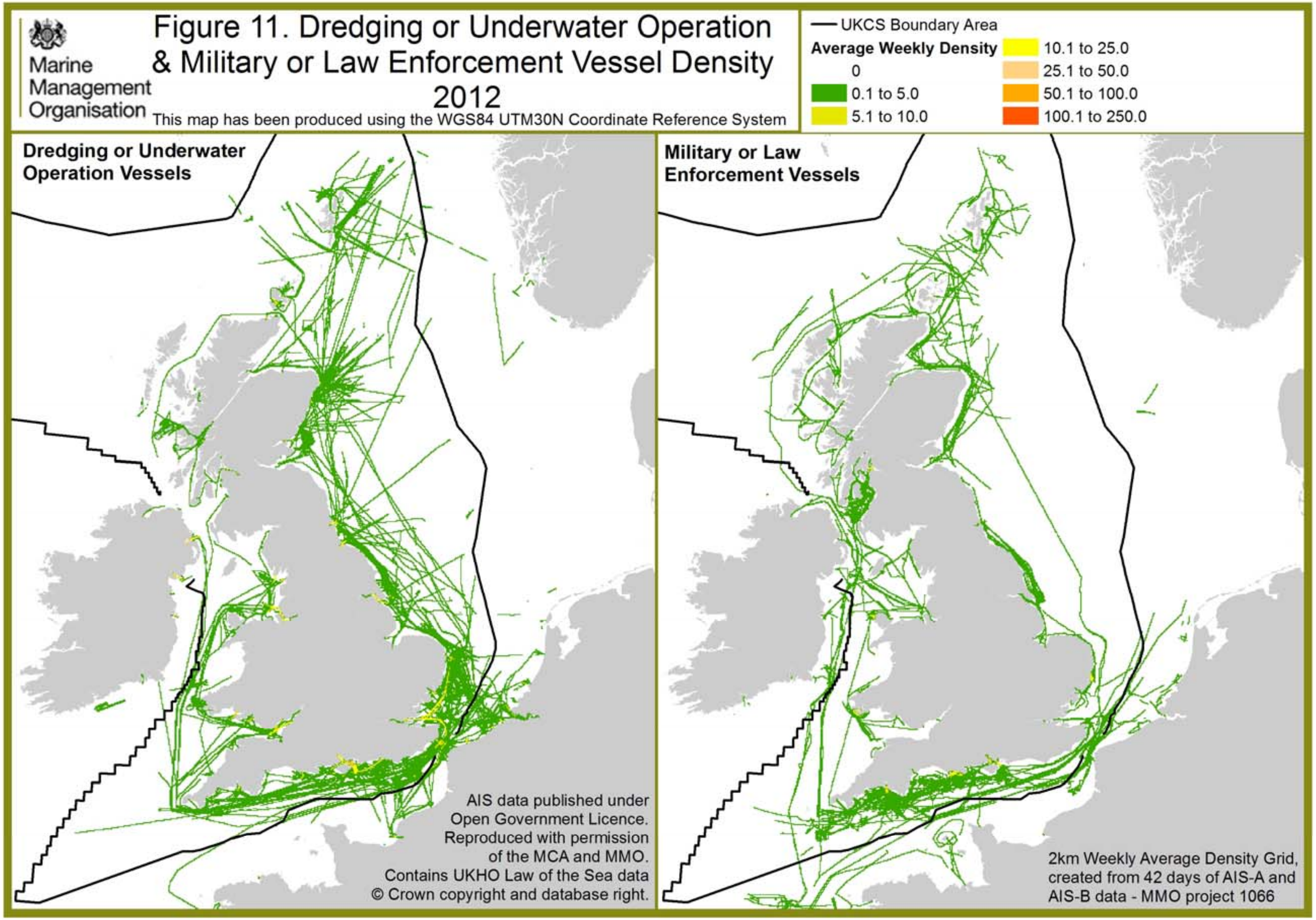
Recreational vessels again provide an even spread of activity, with a relatively even spread of activity through South Coast and offshore areas across to France and the Channel Islands. An intensity of activity can be seen within the Solent with a weekly density average of up to 250 transits. The spread of recreational routes shows clear connectivity along the South Coast, with routes following the coastline. Some embayment’s are missed, however most receive recreational traffic. The Irish Sea and islands of Scotland are subject to recreational activity. Recreational use of the Scottish East Coast and Scottish North Coast shows a lower coverage from vessels transmitting AIS-B signals.

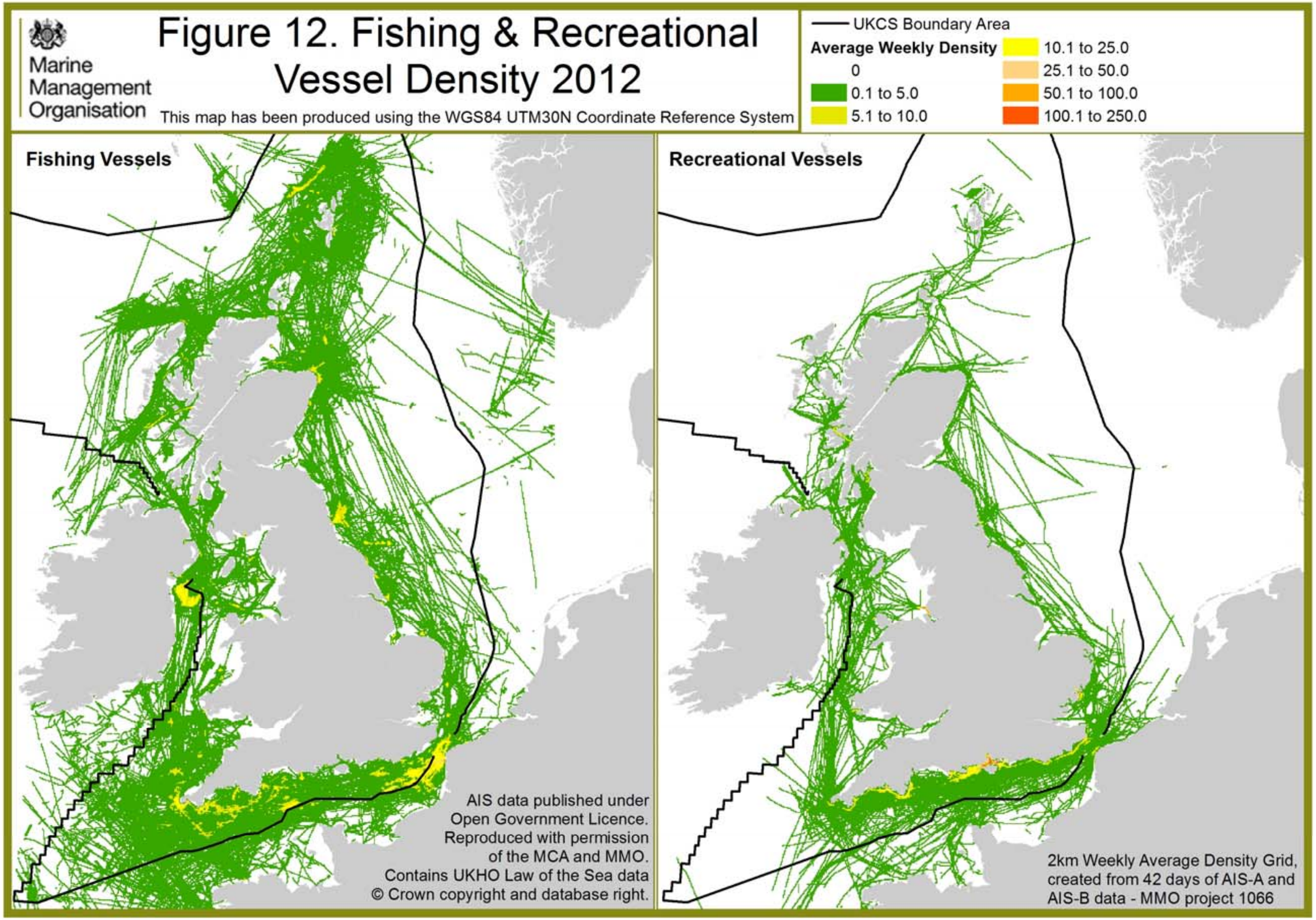

Marine
Management
Organisation
Figure 8. Cargo and Tanker
Vessel Density 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Average Weekly Density
0
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
250.1 to 500.0
Cargo Vessels
Tanker Vessels
AIS data published under Open Government Licence. Reproduced with permission of the MCA and MMO. Contains UKHO Law of the Sea data © Crown copyright and database right.
2km Weekly Average Density Grid, created from 42 days of AIS-A and AIS-B data - MMO project 1066



Marine Management Organisation
Figure 9. Passenger & High Speed Craft Vessel Density 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Average Weekly Density
0
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
250.1 to 500.0
500.1 to 1000.0
Passenger Vessels
High Speed Craft
AIS data published under Open Government Licence. Reproduced with permission of the MCA and MMO. Contains UKHO Law of the Sea data © Crown copyright and database right.
2km Weekly Average Density Grid, created from 42 days of AIS-A and AIS-B data - MMO project 1066


Marine
Management
Organisation
Figure 10. Port/Non-Port Service
Craft Density 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Average Weekly Density
0
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
250.1 to 500.0
Port Service Craft
Non-Port Service Craft
AIS data published under
Open Government Licence.
Reproduced with permission
of the MCA and MMO.
Contains UKHO Law of the Sea data
© Crown copyright and database right.
2km Weekly Average Density Grid,
created from 42 days of AIS-A and
AIS-B data -MMO project 1066


Marine Management Organisation
Figure 11. Dredging or Underwater Operation & Military or Law Enforcement Vessel Density 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Average Weekly Density
0
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
Dredging or Underwater Operation Vessels
Military or Law Enforcement Vessels
AIS data published under Open Government Licence. Reproduced with permission of the MCA and MMO. Contains UKHO Law of the Sea data © Crown copyright and database right.
2km Weekly Average Density Grid, created from 42 days of AIS-A and AIS-B data - MMO project 1066


Marine
Management
Organisation
Figure 12. Fishing & Recreational
Vessel Density 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Average Weekly Density
0
0.1 to 5.0
5.1 to 10.0
10.1 to 25.0
25.1 to 50.0
50.1 to 100.0
100.1 to 250.0
Fishing Vessels
Recreational Vessels
AIS data published under
Open Government Licence.
Reproduced with permission
of the MCA and MMO.
Contains UKHO Law of the Sea data
© Crown copyright and database right.
2km Weekly Average Density Grid,
created from 42 days of AIS-A and
AIS-B data - MMO project 1066

3.3 Changes over time

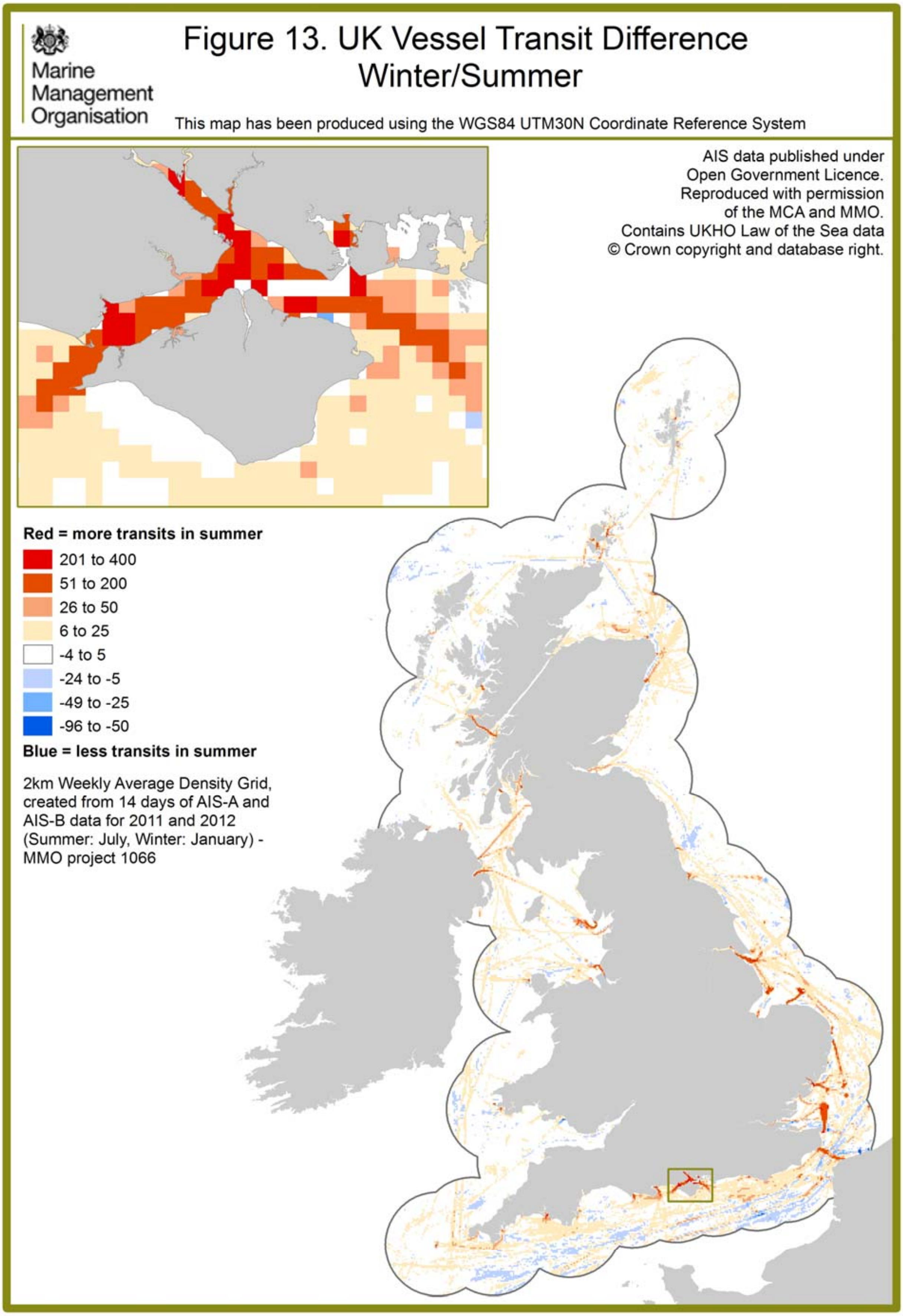
Changes in vessel patterns and sea area use have been considered in temporal comparisons. This is shown in Figure 13 and 14 using a set distance of 40 nautical miles from the AIS receiving station to reduce any effects of signal fad over distance. The temporal assessment was designed to evaluate difference in AIS data, rather than differences in reception range.

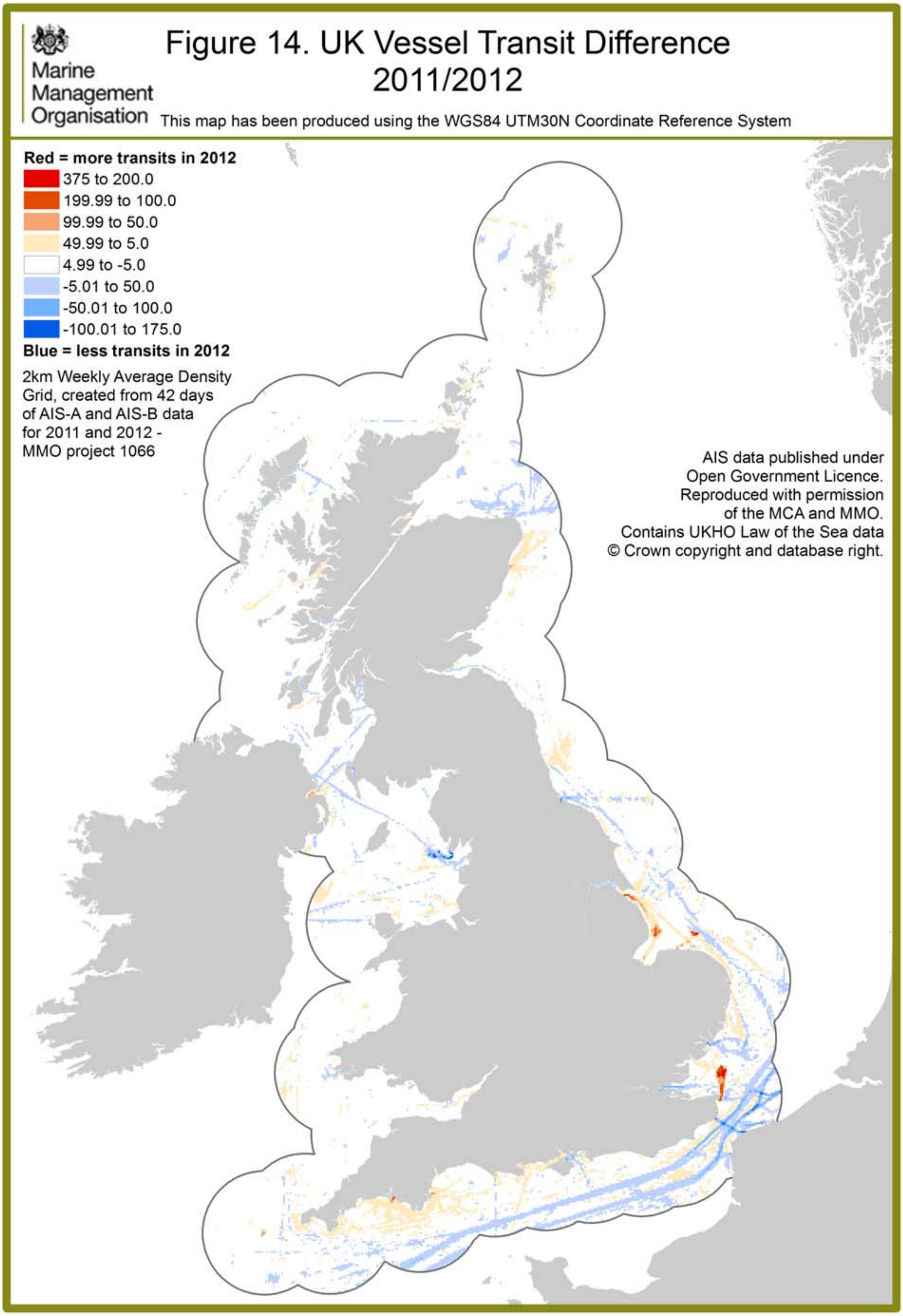
Figure 13 provides a view of differences between ‘winter’ and ‘summer’ vessel traffic. This has been achieved through the comparison of averaged January weekly density from 2011 and 2012, with averaged July weekly density information. The process of averaging datasets across the years seeks to remove sampling error from ‘snap-shot’ vessel traffic which is representative of just one week. Figure 13 shows that additional traffic (in the summer months) shown on the ‘red’ scale. This shows that seasonal differences exist within inshore areas such as the Solent, the Humber and around some of the Scottish sea lochs. It is considered likely these differences relate to recreational seasonal use with higher intensity in summer periods. Differences can also be seen with offshore support works (East Anglia and the Thames area from Ramsgate) with more activity within summer periods. There is very little, if any difference in the main shipping route intensity when comparing summer to winter.

Figure 14 provides a view of differences between 2011 and 2012 average weekly density. Again, the ‘red’ scale shows increased density values and the ‘blue’ scale shows reduced density values. 2011 has been used as the baseline year, with differences in 2012’s average density used as a comparison. Figure 14 identifies that traffic using the TSS through the English Channel has decreased by around 50 vessels transits per week. This could be reflective of trade decreases to Continental European ports, routes to the UK show the same or marginally increased use.

A notable reduction in vessel transits can be seen between Dover and France and routes into the Thames Estuary. Decreased traffic volumes can also be seen between the Portsmouth area and the Isle of Wight in the Eastern Solent. Increases in vessel transits can be seen between Ramsgate and the offshore wind farm site of London Array (the construction phase of this wind farm completed in December 2012). Further increased traffic can be seen from North Norfolk to Sheringham Shoal offshore wind farm, and to the Lincs offshore wind farm. On the West Coast of the UK, decreased traffic can be seen on routes from Loch Ryan to Northern Ireland and a decrease in vessel transits from Barrow and Heysham to the offshore wind farm sites around Walney.

Figure 13: UK vessel transit difference winter/summer.




Marine
Management
Organisation
Figure 14. UK Vessel Transit Difference
2011/2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
Red = more transits in 2012
375 to 200.0
199.99 to 100.0
99.99 to 50.0
49.99 to 5.0
4.99 to -5.0
-5.01 to 50.0
-50.01 to 100.0
-100.01 to 175.0
Blue = less transits in 2012
2km Weekly Average Density Grid, created from 42 days of AIS-A and AIS-B data for 2011 and 2012 - MMO project 1066
AIS data published under Open Government Licence. Reproduced with permission of the MCA and MMO.
Contains UKHO Law of the Sea data © Crown copyright and database right.

4. UK Shipping Summary

The following Section identifies broad scale UK trends and statistics that describe shipping in UK waters in 2012. This information is based on calculations from 2012's density grid and transit line information.

4.1 Short sea shipping routes

To provide a way to identify transit routes based on a coarse filter, transits have been assigned a 'Vessel Transit Classification' (VTC) using the following definitions:

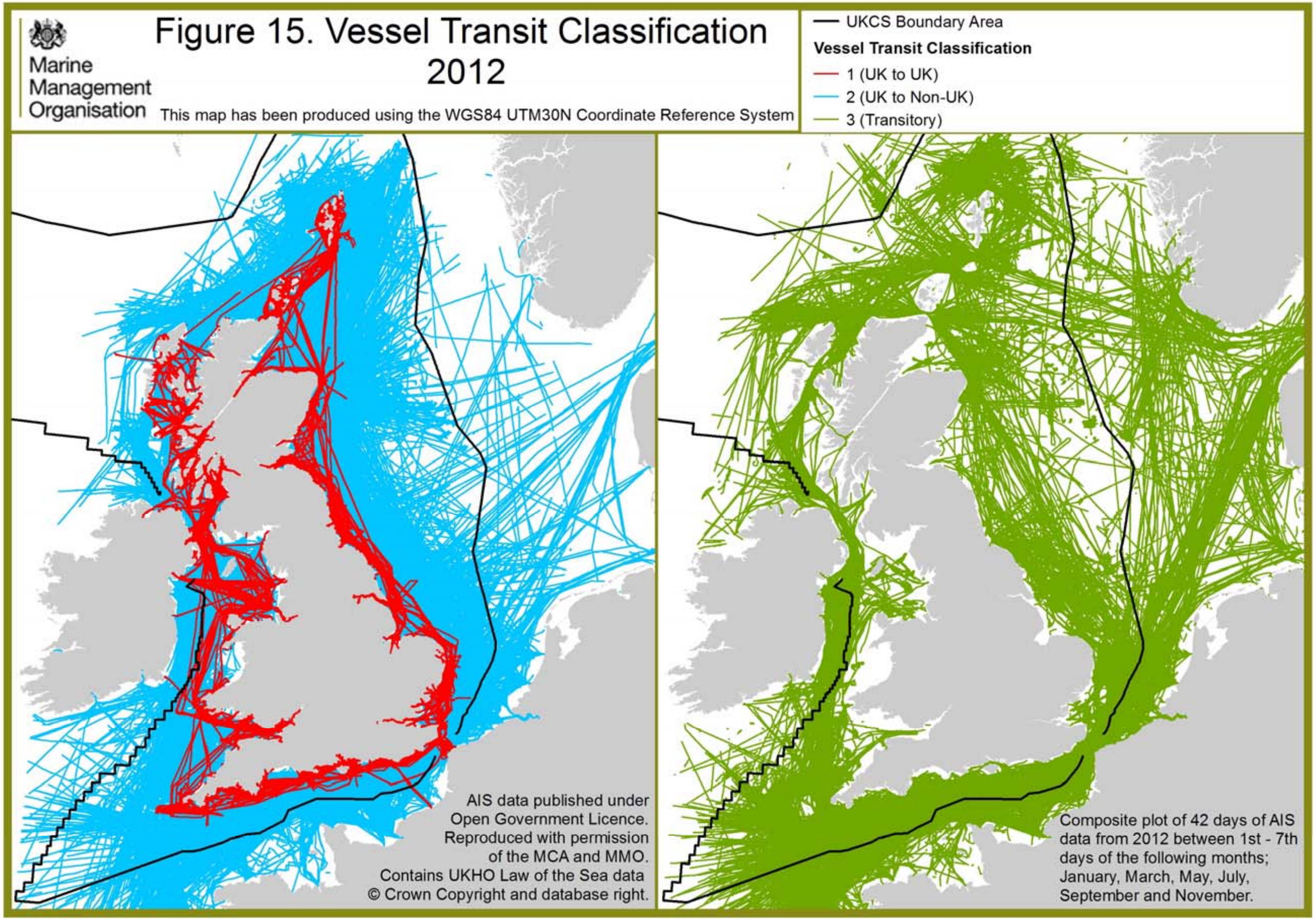
1. Transits that originate and terminate at a UK port (UK 0.5 nautical miles buffer zone around the coast, extended to include anchorage and ship-to-ship transfer area within UK waters)
2. Transits where the vessel has at least one transit within the seven-day data period that originated or terminated at a UK port (UK 0.5 nautical miles buffer zone around the coast, extended to include anchorage and ship-to-ship transfer area within UK waters), but excludes Transits of VTC 1
3. Transits where the vessel has not had any transits within the seven day data period that originated or terminated at a UK port (UK 0.5 nautical miles buffer zone around the coast, extended to include anchorage and ship-to-ship transfer area within UK waters).

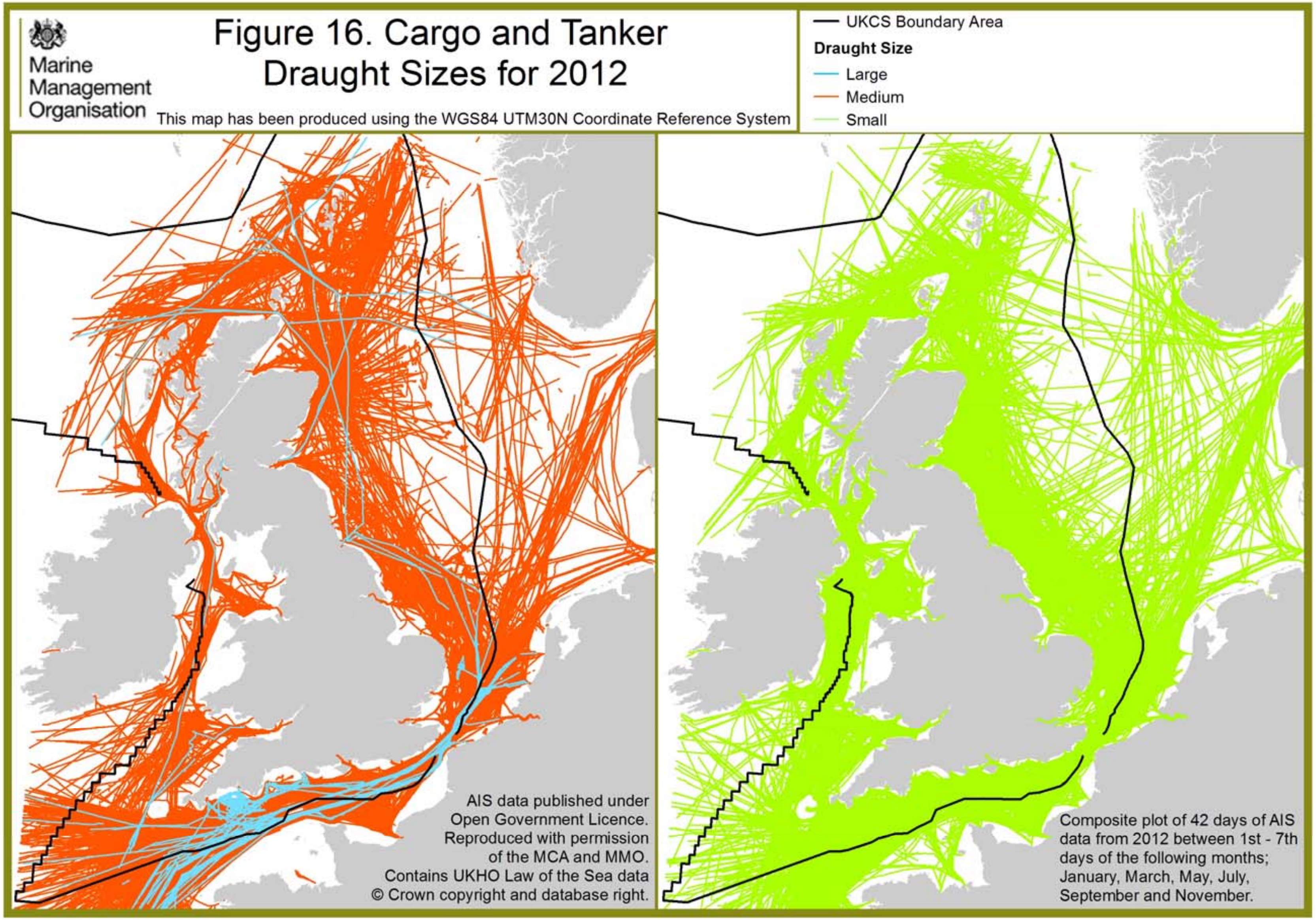
The VTC process has been designed to identify vessels which are involved in UK trade and those that are only transiting through UK waters. To create these transit classifications, zoned areas were created around the UK to identify the start and stop points used by vessels. These zones included charted port anchorages and ship-to-ship transfer areas (for example, the Southwold ship-to-ship transfer area).

Figure 15 shows two images with VTC transit routeing identified with coloured lines for 2012. The left-hand image shows vessels call at, or departing from the UK (VTC 2), overlaid with vessel transiting between UK ports (VTC 1). It can be seen that short-sea shipping routes link most of the UK coastline, with an intensity of routes within the Scottish Western Isles and routes from the Scottish mainland to the Shetland Islands and the Orkney Islands. A range of routes can also be noted connect England and Scotland to Northern Ireland. A small number of UK to UK (VTC 1) transit lines that seem to connect the UK to non-UK destinations are accounted for by vessels nearing another coast, but not stopping (or having very short periods alongside during which their transit record does not automatically terminate) this is most evident around Dover to the near Continent.

The right-hand image in Figure 15 shows transitory vessels (VTC 3) which do not stop within the defined buffer zone, these vessels are considered to be transitory vessels which do not interact with, or provide trading opportunities with the UK. Within UK waters during 2012, to the extent of the AIS coverage, 22% of vessel transits were UK to UK, with UK to non-UK port destinations (either inbound or outbound) accounting for 51% of transits. Transitory traffic accounts for the remaining 28% of transits within the UK Continental Shelf boundary area, and do not stop at a UK port, anchorages or ship-to-ship transfer areas.

It should be noted that the Isle of Man and the Channel Islands are identified as Crown Dependencies, and therefore traffic transiting to ports in these Dependencies or any other non-UK destination were classified as ‘transitory’. It should also be noted that some transit lines, which appear to be heading for UK ports (for example, within the Wash, Seven Estuary and the Forth Estuary) terminate at the end of the data collection period and therefore fall outside of the definition. These represent a small proportion of the data at a UK scale.


Marine
Management
Organisation
Figure 15. Vessel Transit Classification
2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Vessel Transit Classification
1 (UK to UK)
2 (UK to Non-UK)
3 (Transitory)
AIS data published under
Open Government Licence.
Reproduced with permission
of the MCA and MMO.
Contains UKHO Law of the Sea data
© Crown Copyright and database right.
Composite plot of 42 days of AIS
data from 2012 between 1st - 7th
days of the following months;
January, March, May, July,
September and November.


Marine
Management
Organisation
Figure 16. Cargo and Tanker
Draught Sizes for 2012
This map has been produced using the WGS84 UTM30N Coordinate Reference System
UKCS Boundary Area
Draught Size
Large
Medium
Small
AIS data published under
Open Government Licence.
Reproduced with permission
of the MCA and MMO.
Contains UKHO Law of the Sea data
© Crown copyright and database right.
Composite plot of 42 days of AIS
data from 2012 between 1st - 7th
days of the following months;
January, March, May, July,
September and November.

4.2 Large, medium and small vessels patterns

AIS messages contain transmitted information on vessel draught (at the time of transit). This measure can be used as a proxy for overall size to categorise vessels as either ‘large’, ‘medium’ or ‘small’. To provide guidance on draught classification, this study adopted the information presented in the previous MMO project 1042, which evaluated draught classes for different vessel types. Table 2 presents the draught classifications which have been used within this study.

Table 2: Vessel draught.

Vessel type	Small (m)	Medium (m)	Large (m)
Non-Port service craft	<2	2-7	>7
Fishing/Recreation	<2	2-6	>6
Port Service Craft (Pilot/Tug)	<2	2-6	>6
Vessels engaged in dredging or underwater operations	<4	4-7	>7
High Speed Craft (HSC)	<2	2-4	>4
Military or Law enforcement vessels	<4	4-7	>7
Passenger (Cruise Ship)	<5	5-8	>8
Cargo (Container/Bulk)	<8	8-16	>16
Tanker	<8	8-16	>16

As draught is an attribute field within the Geodatabase, anyone using the information from the Geodatabase can specify their own draught classifications to meet the needs of the required output presentation and analysis.

Figure 16 shows two images of composite transit line plots from 2012 combining tankers and cargo vessels, the combination of these two types of vessels provides around 40% of the vessel total from 2012’s dataset. The coloured lines represent three sizes of vessel. The left-hand image shows Large and Medium draughted vessel, the right-hand image shows only small draught vessels. It can be seen from the deep draughted routes that larger vessels use the TSS in the English Channel to access Continental North Sea ports. The English South Coast is often used as an anchorage point for these vessels (for example, Tor Bay). Large vessels routes can be identified into UK ports including Plymouth, Portland, the Tees Estuary, Forth Estuary Ports and the Clyde. It is also notable that large draughted vessels stop within the Southwold ship-to-ship transfer area off East Anglia. Ports that are often considered capable of receiving ‘large’ draughted vessels should be considered against the draught thresholds identified in Table 2, for example entry to the South Coast ports of Portsmouth and Southampton is depth-limited.

Medium draughted vessels use a range of cargo and tanker ports around the UK, routes are typically through deeper channels (for example, the Nab Channel to the East of the Isle of Wight). Smaller draughted vessels provide the greatest spread of sea area use, with routes into many UK ports with cargo and tanker berthing facilities. It should be noted that many of the smaller tanker transits are associated with bunkering vessels.

4.3 Use of UK sea areas (statistical summary)

Using the 2012 transit line information as shown in Figure 15, it is possible to identify vessel traffic within each national sea area boundaries. As described in Section 4.1, national buffer areas have been used around each country in the UK allowing the calculation of vessels starting, or stopping their transit. The buffer includes an area extending outwards by 0.5 nautical miles from the shoreline, including any additional areas identified as anchorage and ship-to-ship transfer area.

Table 3 provides a summary of vessel transits from the combined 42-day dataset.

Table 3: Transit count within national boundaries 2012.

Country	Transits that pass through the national sea area		Transits stopping or starting in the national buffer		Vessels stopping or starting in the national buffer	
	Count	%	Count	%	Count	%
Scotland	100,908	20.4	45,090	28.2	2,758	23.3
Northern Ireland	9,892	2.0	4,553	2.8	8,174	69.1
Wales	27,740	5.6	9,554	6.0	582	4.9
England	356,196	72.0	100,880	63.0	319	2.7
Total Transits	**494,736**	**100**	**160,077**	**100**	**11,833**	**100**

As a summary of UK statistics, 72% of the vessel transits pass through English national waters, 20% through Scottish waters and around 6% through Welsh waters with 2% in Northern Irish waters. Over the available 42-day dataset, this identifies that around 11,800 vessels called at, or left UK ports, anchorages and ship-to-ship transfer areas, which equates to 69% in England, 23% in Scotland, 5% in Wales and 3% in Northern Ireland.

5. References

ICO (2012). Anonymisation: Managing data protection risk. Code of practice. Information Commissioner's Office, November 2012.

Marine Management Organisation, 2014. 'Mapping UK Shipping Density and Routes technical annex, Project 1066.
http://www.marinemanagement.org.uk/evidence/documents/1066_Shipping_Tools_Report.pdf and
http://www.marinemanagement.org.uk/evidence/documents/1066_AIS_Software Tools.zip (AIS software tools are available on request)

Maritime Data Website, 2014. Department of Energy and Climate Change (DECC). http://www.maritimedata.co.uk/ Accessed 07 March 2014

Marine Management Organisation (MMO) 2013a. 'Spatial Trends in Shipping Activity', November 2013.

Marine Management Organisation (MMO) 2013b. 'Spatial Trends in Shipping Activity AIS derived shipping activity – data standards' November 2013.

Annex A: Transect lines through the 2012 weekly density grid

Table A1: Transit and Vessel Count (42-day period) between Dungeness (England) and Étaples (France).

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	278	3.3	164	3.5
Non-Port service craft	25	0.3	19	0.4
Port Service Craft (Pilot/Tug)	53	0.6	49	1.0
Vessels engaged in dredging or underwater operations	120	1.4	30	0.6
High Speed Craft	10	0.1	10	0.2
Military or Law enforcement vessels	29	0.3	27	0.6
Passenger (Cruise, ferry)	99	1.2	57	1.2
Cargo (Container, Bulk, RoRo, etc.)	4,942	58.8	2,892	61.4
Tanker (Oil, Bunker, Gas)	1,988	23.6	1181	25.1
Fishing	720	8.6	143	3.0
Recreational craft	145	1.7	139	2.9
Total	**8,409**	**100**	**4,711**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A2: Transit and Vessel Count (42-day period) between Start Point (England) and Guernsey (Channel Islands).

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	200	2.8	137	3.1
Non-Port service craft	18	0.2	17	0.4
Port Service Craft (Pilot/Tug)	56	0.8	48	1.1
Vessels engaged in dredging or underwater operations	27	0.4	20	0.4
High Speed Craft	5	0.1	5	0.1
Military or Law enforcement vessels	34	0.5	27	0.6
Passenger (Cruise, ferry)	195	2.7	60	1.4
Cargo (Container, Bulk, RoRo, etc.)	4,459	62.7	2,754	62.4
Tanker (Oil, Bunker, Gas)	1,520	21.4	1,036	23.5
Fishing	345	4.8	103	2.3
Recreational craft	249	3.5	206	4.7
Total	**7,108**	**100**	**4,413**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A3: Transit and Vessel Count (42-day period) between Hartland Point (England) and Hook Head (South Ireland).

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	104	4.5	51	4.7
Non-Port service craft	4	0.2	4	0.4
Port Service Craft (Pilot/Tug)	30	1.3	28	2.6
Vessels engaged in dredging or underwater operations	16	0.7	13	1.2
High Speed Craft	5	0.2	5	0.5
Military or Law enforcement vessels	12	0.5	12	1.1
Passenger (Cruise, ferry)	87	3.8	20	1.8
Cargo (Container, Bulk, RoRo, etc.)	1,139	49.3	572	52.7
Tanker (Oil, Bunker, Gas)	489	21.2	260	23.9
Fishing	376	16.3	76	7
Recreational craft	47	2	45	4.1
Total	**2,309**	**100**	**1,086**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A4: Transit and Vessel Count (42-day period) between Ballywalter (Northern Ireland) and the Mull of Galloway (Scotland).

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	28	2.2	16	3.3
Non-Port service craft	5	0.4	4	0.8
Port Service Craft (Pilot/Tug)	12	0.9	12	2.4
Vessels engaged in dredging or underwater operations	4	0.3	4	0.8
High Speed Craft	15	1.2	4	0.8
Military or Law enforcement vessels	8	0.6	7	1.4
Passenger (Cruise, ferry)	171	13.5	18	3.7
Cargo (Container, Bulk, RoRo, etc.)	746	58.7	259	52.7
Tanker (Oil, Bunker, Gas)	159	12.5	86	17.5
Fishing	72	5.7	37	7.5
Recreational craft	50	3.9	44	9
Total	**1,270**	**100**	**491**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A5: Transit and Vessel Count (42-day period) between Rubha Coigeach (Scotland mainland) to Loch Odhairn (Scotland Lewis).

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	39	6.3	22	7.3
Non-Port service craft	4	0.6	2	0.7
Port Service Craft (Pilot/Tug)	2	0.3	2	0.7
Vessels engaged in dredging or underwater operations	1	0.2	1	0.3
High Speed Craft	0	0	0	0
Military or Law enforcement vessels	3	0.5	1	0.3
Passenger (Cruise, ferry)	153	24.9	16	5.3
Cargo (Container, Bulk, RoRo, etc.)	274	44.5	160	53.3
Tanker (Oil, Bunker, Gas)	83	13.5	55	18.3
Fishing	53	8.6	38	12.7
Recreational craft	4	0.6	3	1
Total	**616**	**100**	**300**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A6: Transit and Vessel Count (42-day period) from Great Bernera (Scotland Lewis) to the extent of data.

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	29	8.5	14	7.8
Non-Port service craft	0	0	0	0
Port Service Craft (Pilot/Tug)	0	0	0	0
Vessels engaged in dredging or underwater operations 3	0	0	0	0
High Speed Craft	0	0	0	0
Military or Law enforcement vessels	4	1.2	2	1
Passenger (Cruise, ferry)	3	0.9	2	1
Cargo (Container, Bulk, RoRo, etc.)	80	23.5	75	38.5
Tanker (Oil, Bunker, Gas)	48	14.1	47	24.1
Fishing	170	50	54	27.7
Recreational craft	6	1.8	1	0.5
Total	**340**	**100**	**195**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				

Table A7: Transit and Vessel Count (42-day period) from Caister-on-Sea (England) to the UK CS Boundary Area.

Vessel type	Transit		Vessel	
	Count	%	Count	%
Unknown vessel type	313	8.7	79	5.3
Non-Port service craft	46	1.3	19	1.3
Port Service Craft (Pilot/Tug)	66	1.8	26	1.7
Vessels engaged in dredging or underwater operations	74	2	27	1.8
High Speed Craft	70	1.9	10	0.7
Military or Law enforcement vessels	8	0.2	5	0.4
Passenger (Cruise, ferry)	254	7	39	2.6
Cargo (Container, Bulk, RoRo, etc.)	1,765	49	713	47.8
Tanker (Oil, Bunker, Gas)	926	26	518	34.8
Fishing	64	1.8	38	2.5
Recreational craft	19	0.5	16	1
Total	**3,605**	**100**	**1,490**	**100**
Note: table values are taken from cumulative transit and vessel types for a 42 day periods from 2012: 03rd to 09th day of Jan, and 01st to the 07th day of: Mar, May, Jul, Sep, Nov				