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Mapping of potential risk of ship strike with fin whales in the Western Mediterranean Sea

A scientific and technical review using the potential habitat of fin whales and the effective vessel density

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1 INTRODUCTION

The general aim of this report is to detail the estimate of potential strike risk of fin whales in the western Mediterranean Sea. After a brief background on the strike risk for fin whales and the existing models to map the risk, the used theoretical formulation of the potential strike risk and related parameters are described. The results are finally presented and discussed.

The EC-JRC and collaborative research groups propose here to use the whale potential habitat and maritime traffic information to estimate the distribution of the potential risk of ship strike. The seasonal fin whale essential habitat and its variability are identified and the hypothesis is raised of disturbances from dense maritime traffic. The implementation of Marine Protected Areas (MPAs) in this context would support the EU Integrated Maritime Policy, the Marine Strategy Framework Directive and the Blue Growth initiative (COM-2012/494).

2 RATIONALE

2.1 Ship strike risk issues

Fin whales (*Balaenoptera physalus*) are found to concentrate in high densities in the Mediterranean Sea. High availability of prey is the most plausible reason why densities encountered in the Mediterranean Sea are higher than those estimated for the North Atlantic Ocean (Forcada et al. 1996).

With 30% of all international maritime traffic originating from or directed to Mediterranean ports or passing through its waters and concentrated within only 0.8% of the global ocean surface, traffic density is extremely high in the Western Mediterranean Sea[1]. At any moment there are approximately 2,000 merchant vessels of over 100 tons in the Mediterranean, totaling at 200,000 vessels crossing it annually, while the fin whale population is estimated of ca. 3,000. At the entry and exit points in the Mediterranean Sea maritime traffic is forced through narrow passages leading to extreme densities. The Strait of Gibraltar with a width of only 14 km was transited by 61,000 ships in 2003. The impacts of this heavy maritime traffic on large cetaceans are numerous.

Fin whale is the cetacean species that has been involved the most in collisions with vessels in the Mediterranean Sea (Laist et al. 2001). Skeletons from museum collections show that ramming of fin whales by boats has been going on for a long time. Italy and France have data suggesting that 26% of the stranded fin whales had been killed by vessels (Notarbartolo et al. 2003). Their long body and high weight make them less mobile than other cetaceans. In addition to the direct damage through collisions, maritime traffic is likely to disturb the whales in relation to noise pollution. High noise levels are known to cause changes in behavior of whales and potentially have long term impacts on the population (see references in Druon et al. 2012) likely exceeding limits of “good conservation status” under the EU Marine Strategy Framework Directive (2008/56/EC) .

2.2 Potential Contribution Of Habitat Modelling

[1] http://www.unepmap.org/index.php?module=content2&catid=001003002

Previous work on the risk of collision for Mediterranean fin whales done by David et al. 2011 used effective whale distribution maps for summer months based on sightings data and shipping traffic data compiled from ferry trajectories between departure and arrival ports.
In the habitat model of Druon et al. 2012 a set of environmental parameters are used to predict the potential favorable habitat for fin whales. The presence of chlorophyll fronts is the most prominent parameter used as it is linked to the availability of prey. We use the potential habitat of fin whales as modelled by Druon et al. 2012 combined with a comprehensive set of Automatic Identification System (AIS) data to evaluate the potential collision threat in the Western Mediterranean Sea. Our approach of using the potential habitat and the full maritime traffic provides a thorough insight of where and when fin whales are at risk of being struck by a vessel at the seasonal and basin scales.

3 THEORETICAL FORMULATION

3.1 Time and Space scales

We selected three periods in May, July and October (2009) to investigate the annual variability of the collision risk since these months cover most of the variability of both the maritime traffic and whale habitat.
Traffic data was collected from the Maritime Safety and Security Information System (MSSIS, https://mssis.volpe.dot.gov/Main/home/). The daily potential habitat of fin whale is derived from the model described in Druon et al. 2012.
Both traffic and habitat data are however integrated **daily** in order to take into account:

- a realistic vessel speed (mean number of AIS messages over a pixel per day),
- a realistic daily variability of both traffic and habitat data.

The monthly mean risk is then computed from daily risk estimates.
Daily traffic density and mean speed are computed over a 4.6 km grid. This grid corresponds to the finer possible resolution for which the collision risk can be estimated with a limited bias when estimating the distance travelled by vessels using the number of AIS messages per pixel and per day (see below for details).

3.2 General formulation

The main formulation of risk of ship strike is adapted from Tregenza et al. 2000:

$$Ncoll = (W + 0.64L) * 10^{-3} * Dcell * Pmax * Hab * T * Cs$$

- *Ncoll* is the number of potential collisions with whales for a given grid cell per day (individuals/day),
- *W* is the damaging width of the vessel (m),
- *L* is the whale length (m),
- *Dcell* is the length of vessel transect that is within a given cell per day (km/day),
- *Pmax* is an estimate of the maximum whale density in the Western Mediterranean Sea (individuals/km^2),
- *Hab* is the potential habitat coefficient for a given cell (no dimension) – this coefficient varies between 0 and 1,

- *T* is the percentage of whale time at the surface (no dimension),
- *Cs* is the coefficient of collision risk related to the vessel speed for a given cell and day (no dimension).

3.3 Frequency of AIS messages

The analysis of one day of MSSIS data in the Western Mediterranean Sea showed that most of AIS messages are stored in that database every 5 or 10 minutes. An average of 3,000 ships was found in the area of interest with higher numbers during July as it is the high season for passenger ferries.

3.4 Distance travelled by vessels in a cell per day

Traffic data (AIS) is daily integrated to provide a number of vessels which travelled through a given grid cell from which an accumulated distance per day is derived. With the hypothesis that the mean distance travelled by vessels in a cell per day (*Dcell*) is normally distributed, it can be estimated by the following (see figure below):

$$Dcell = 0.5 * Dmax = 0.5 * sqrt(R^2 + (R * cos(LATmean))^2)$$

- *Dmax* is the maximum distance which can be travelled by a vessel in a grid cell,
- *R* is the cell resolution in latitude (the projection is equidistant cylindrical),
- *R * cos(LATmean)* is an approximation of the cell resolution in longitude (with *LATmean* being the mean latitude of the area of interest).

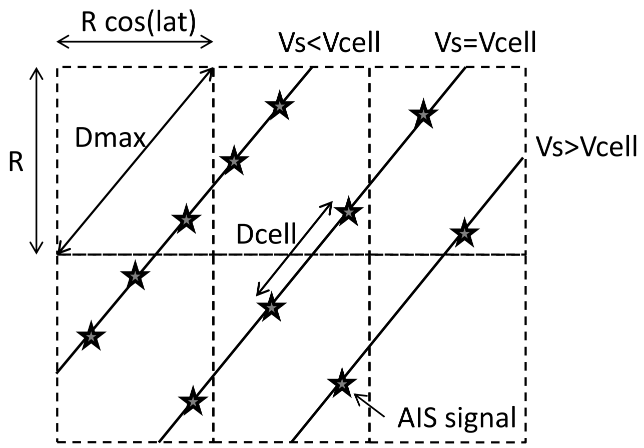

Figure 1. Cell grid in an equidistant cylindrical projection of latitudinal resolution R showing AIS messages for different vessel speeds. The average speed for which there is one AIS message per cell for the same vessel is when the vessel speed Vs = Vcell.

The mean distance travelled by a vessel in a cell of 4.6 km latitudinal resolution in an equidistant cylindrical projection at about 40° latitude is *Dcell* = 2.9 km (*Dmax* = 5.8 km). The data was interpolated according to distance to optimize the coverage and have comparable vessel tracks. The distance between the points was set to 0.0417 degrees in order to have on average one vessel hit per pixel (case above where *Vs* = *Vcell*). The density computation thus simply consists in adding the number of vessel presence per day and pixel.

Vessel speed below 5 knots are removed from the data to represent a more realistic map of moving traffic density and to reduce the processing time. Note from figure 2 below that the collision risk for a vessel speed below 5 knots is almost null.

3.5 Vessel speed coefficient

This coefficient introduces the effect of a varying vessel speed on the collision risk. The analytical formulation of Vanderlaan and Taggart 2007 describing the probability of lethal injury is used here (see below).
This formulation is consistent with the estimation of Laist et al. 2001 (see IWC 2011 for a review) establishing that the risk of collision is likely to strongly decrease for vessel speed below 8 to 10 knots and strongly increase over the speed range of 9-15 knots.
The formulation of the vessel speed coefficient is as follows (Vanderlaan and Taggart 2007, solid heavy line in the figure below):

$$Cs = (1 + e^{(4.89 - 0.41 * Vs)})^{-1}$$

With the vessel speed *Vs* in knots.
This non-linear relationship suggests that below 12 to 14 knots, whales and/or vessels may react in order to reduce the collision risk and/or the injury level.

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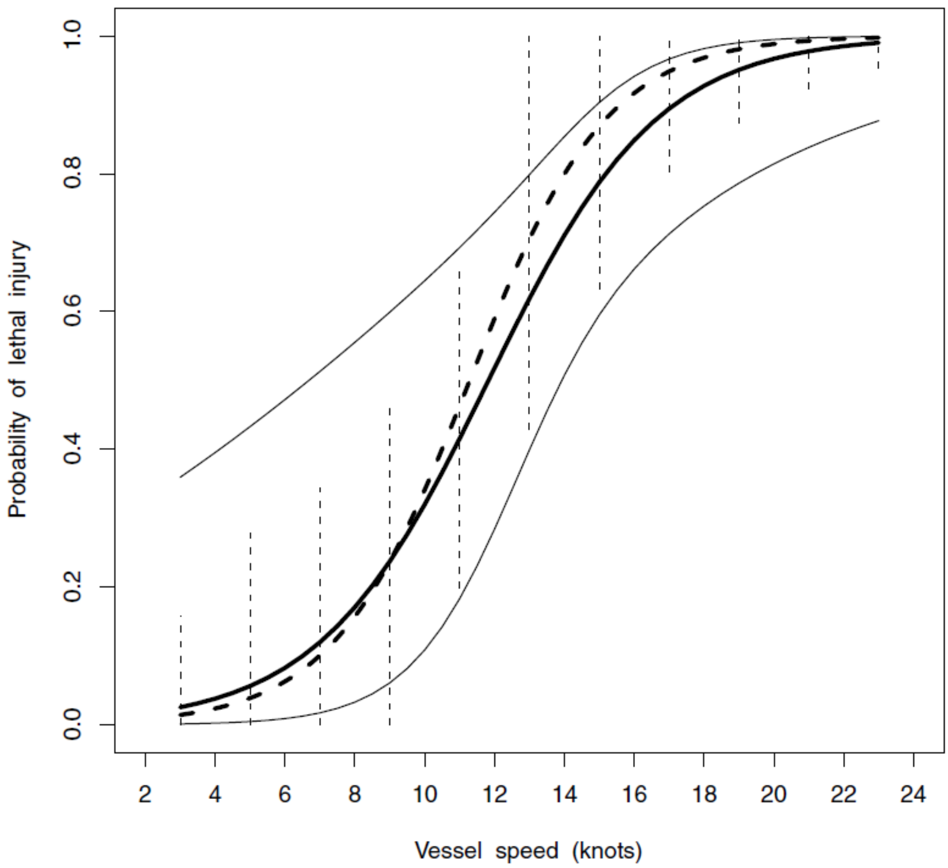


Figure 3. Probability of a lethal injury resulting from a vessel strike to a large whale as a function of vessel speed based on the simple logistic regression (solid heavy line) and 95% CI (solid thin lines) and the logistic fitted to the bootstrapped predicted probability distributions (heavy dashed line) and 95% CI for each distribution (vertical dashed line) where each datum (Δ) is the proportion of whales killed or severely injured (*i.e.*, lethal injury) when struck by a vessel navigating within a given two-knot speed class. There are no data in the 4–6 knot speed class.

Figure 2 . Figure extracted from Vanderlaan and Taggart 2007.

3.6 Mean and maximum whale density

The precise estimate of the whale density over a large area is difficult because of the low observation effort. Estimates of mean density within the Pelagos area during summer were performed showing a range from 0.0091 to 0.02408 individuals.km^{-2} (Forcada et al. 1995, 1996, Gannier 1997, 1998, 2001, see Mayol 2007 for a review) with the exceptional value of 0.097 individuals.km^{-2} of Gannier 2006. Since the lowest densities are the most recent estimates (e.g. in 2001-2004, 0.014 individuals.km^{-2} Laran et al. 2010), a mean density (*Pmean*) of 0.01 individuals.km^{-2} was retained.

The application of the potential habitat model (Druon et al. 2012) in the Pelagos area showed that, as a mean value during July and August, the potentially favorable habitat represents 12% of the sea surface, leading to an estimate of the maximum density of :

$$Pmax = Pmean / 0.12 = 0.083 \text{ individuals.km}^{-2}$$

In the present approach, the whale density therefore displays an important variability in space and time as suggested by the model of potential habitat (Druon et al. 2012).

3.7 Potential habitat coefficient

The potential habitat coefficient (*Hab*) introduces the spatial and daily variability of the whale potential presence in the collision risk. The model of potential habitat (Druon et al. 2012) showed that 80% of the fin whale sightings in the Western Mediterranean Sea are within two cells (~ 9 km) of a favorable habitat with a regular decreasing presence moving away from the potential habitat. A value of 1 is thus allocated to the coefficient *Hab* in cells identified as a potential habitat, a value of 0.5 to cells bordering the potential habitat, a value of 0.3 is given to cells located to a distance from one to two cell size (~4.6 to 9.2 km), a value of 0.1 is given to cells located to a distance from two to three cell size (~9.2 to 13.8 km) and a zero value is allocated to the other cells further from the potential habitat (see Table 1).

Table 1 – Distance of cells from the potential habitat in number of cells and corresponding value of the potential habitat coefficient (*Hab*).

Distance from potential habitat (in number of cells)	0	1	2	3	≥ 4
Hab coefficient	1	0.5	0.3	0.1	0

4 PROCESSING STEPS

4.1 Initialization

For processing the data we used MATLAB with the database toolbox, the image processing toolbox and the M_map package from:
http://www.eos.ubc.ca/~rich/map.html

The data was stored in an SQL data base maintained by the JRC Maritime Affairs unit. Once the connection established with the database using MATLAB, the database query and extraction is performed. For each day we had the list of ships crossing the Western Mediterranean and for every ship the AIS data was downloaded.

4.2 Description of AIS data

An AIS transceiver sends the vessel identification number (MMSI, see below), the position, vessel speed and the heading relative to the North every 2 to 10 seconds depending on a vessel's speed while underway and every 3 minutes when at anchor. Additional information is sent every 6 minutes including IMO number, name of the ship, ships dimensions and time. We observed a reduced frequency from 5 to 10 minutes in the MSSIS database. The AIS messages are received by antennas on land from a maximum distance of ca. 54 km (clear weather and antenna in relatively high altitude) but messages are also transmitted from ship to ship so that AIS messages may be received even if located several hundreds of kilometres off shore in case of high traffic density. The absence of antenna and/or low maritime traffic is likely to explain the lower data frequency off of Libya and Algeria for instance.

Satellite AIS receivers were recently launched in low-earth orbit (first launch in 2008) and are covering nowadays most of oceans (data not used presently).

IMO number

The International Maritime Organization (IMO) number is a unique identifier assigned to ships when constructed by the World Register of Ships. It consists of the three letters "IMO" followed by the seven-digit number. This is a unique seven digit number that is assigned to propelled, sea-going passenger ships of 100 gross tons and above and cargo ships of 300 gross tons and above. The IMO number is designed to identify ships and is kept when the ship's owner, country (flag) of registry or name changes.

MMSI

The Maritime Mobile Service Identity (MMSI) is a series of nine digits which are sent in digital form over a radio frequency channel in order to uniquely identify ships. Unlike the IMO number, the MMSI number is not always kept when the ownership changes. This is why we used IMO number to identify the vessels and MMSI when the IMO number was missing.

Vessel speed

The vessel speed was also obtained through the AIS message. The speed over ground was used with a 0.1 knots resolution and a range of 0 to 102 knots (189 km/h). For each vessel the 75th percentile of the speed was calculated and used over the trajectory of the ship for the whole day. This process was retained as a good approximation of the vessel speed since its variability is usually low once the cruise speed is reached (see example on figure 3).

The vessel velocities lower than 5 knots were removed from the data set. At a velocity lower than 5 knots the whales are able to escape and are assumed to have a negligible risk of being hit by the vessel (see figure 2).

Vessel width

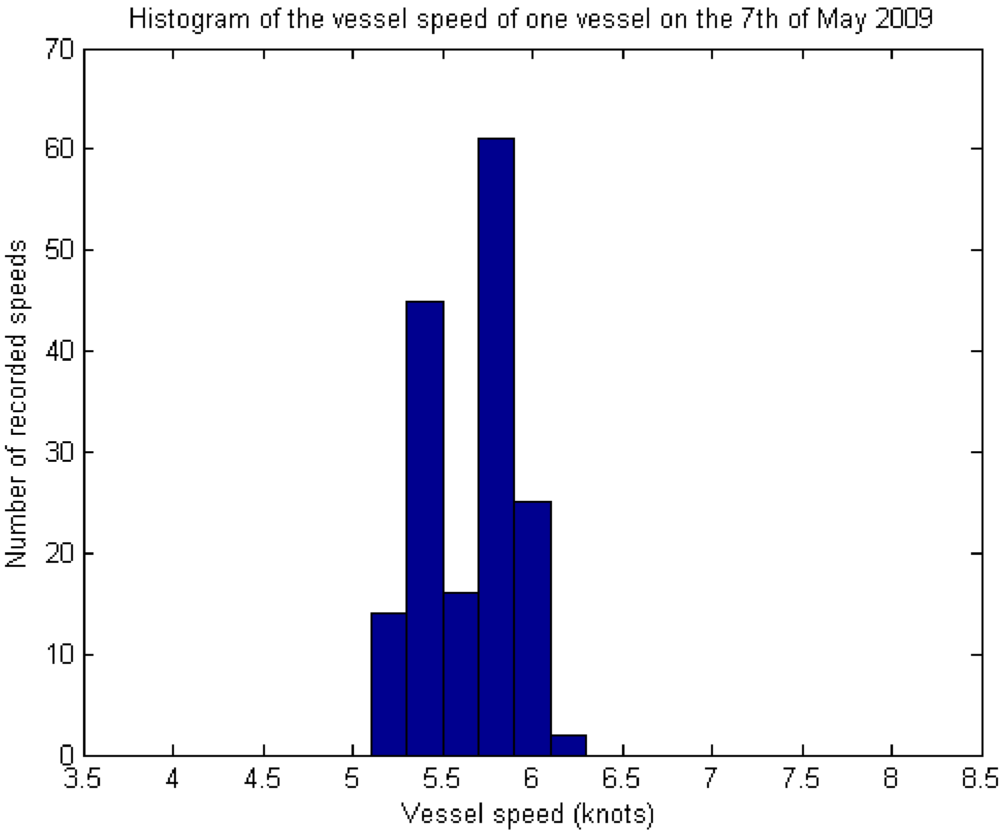
The width of the vessel used in this calculation is the maximum width of the ship. The width is expressed in meters and ranged from 6 to 126 m. In case of absence of ship width in the AIS data, the average value for all ships in the register of 18.97 m is used.

4.3 Interpolation of AIS data

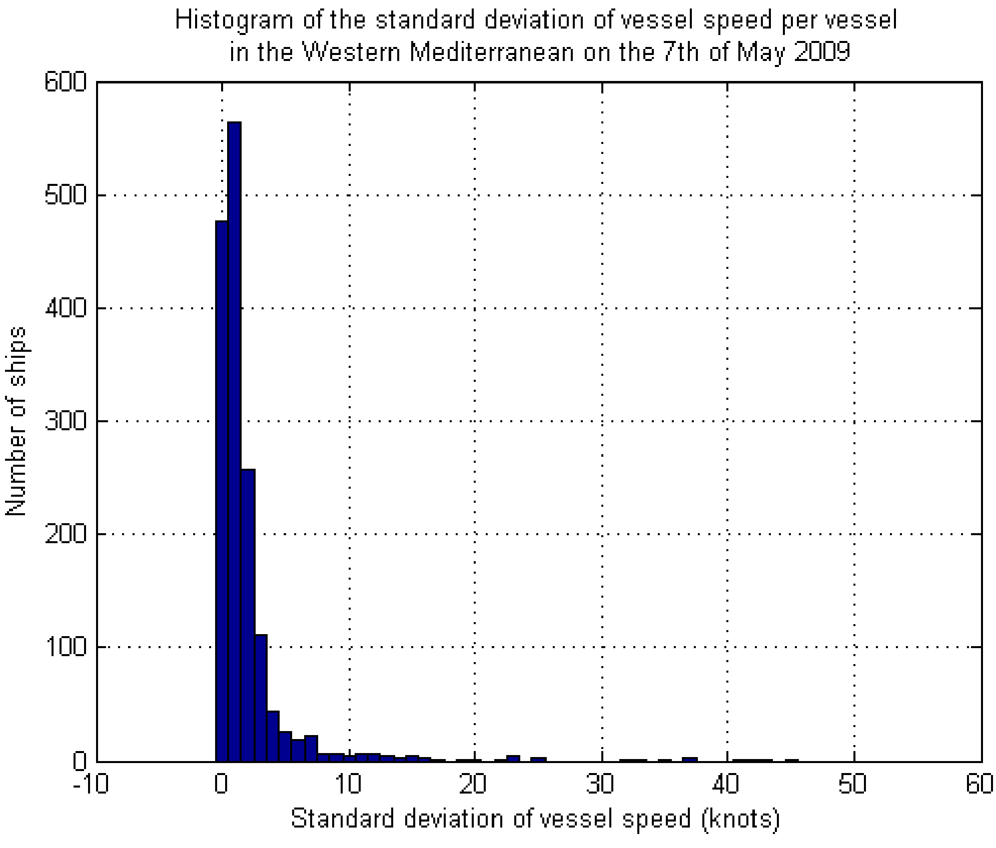
AIS data was analyzed and wrong data such as overland trajectories or impossible speeds were filtered out. The data was interpolated according to the shortest distance so that missing AIS data on a given day (due to lack of antenna coverage or low traffic density) is estimated. In addition, the interpolation distance was set to 0.0417 degrees in order to have, in average, one hit per grid cell as a result for a vessel crossing the area of interest. The vessel density is thus computed by counting the hits of all vessels in each grid cell per day.

4.4 Creation of Intermediate Files

After extraction, filtering and interpolation of the data, we created a single file by ship and by day. This file has a file name indicating the area, date and the ships MMSI number. The file itself contains a grid of ~4.6x4.6 km resolution cells where the vessel speed is stored in each pixel of the transect. The vessel width is the other important parameter for calculation and is appended to the file as a single value.



a



b

Figure 3. Histograms of the range of speed (a) and standard deviation (b) for ships in the Western Mediterranean on the 7th of May 2009.

4.5 Extension of habitat at its boundary

The computation of the habitat coefficient (*Hab*) uses a 3-day composite for a fair spatial coverage while the potential habitat is relatively stable. In addition, a “gradient habitat” at the edge of the most favorable habitat was computed to take into account a more realistic potential distribution of individuals (see section 3.7).

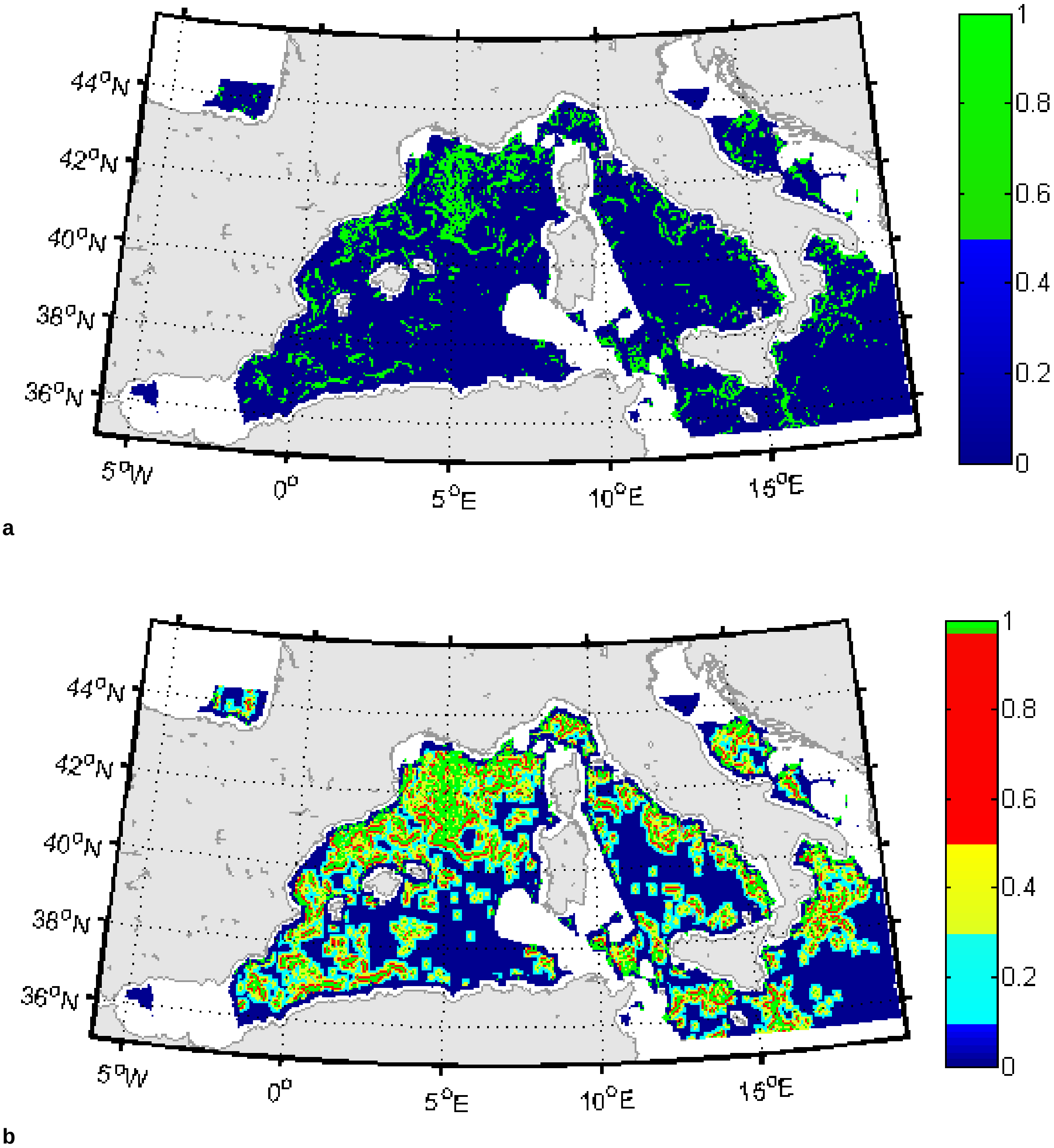


Figure 4. (a) 3-day habitat map of fin whales in the Western Mediterranean Sea centered on the 7th of May 2009 and (b) with the gradient border extension. Feeding habitat has a value of one, no habitat has a value of zero.

The following rules were followed (N.B. *NaN* represents cases where the daily habitat was not derived due to the lack of sufficient environmental data):

habitat & habitat = habitat

habitat & (NaN or NoHabitat) = habitat

NoHabitat & NoHabitat = NoHabitat

NoHabitat & NaN = NoHabitat

NaN & NaN = NaN

We extended the boundaries on the 3-day composite habitat to better capture the potential whale presence (figure 4). During the summer months fin whales gather in the changing feeding grounds so that the whales have to frequently move. A gradient that extends the boundaries by gradually giving less importance to areas further away should be able to better represent the potential of whale presence searching for its most favorable habitat.

A value of 1 is given where the 3-day composite habitat is identified and a respective value of 0.5, 0.3 and 0.1 is attributed when further away from the habitat (see Table 1).

4.6 Computation of the potential ship strike risk

The potential ship strike risk is calculated on a daily basis. For each day we perform a loop over all the vessels from which we gather the positions, the vessel speed and the width. The three day composite habitat map with the extended borders is loaded together with the other parameters. The risk estimate is performed on the common grid for each vessel using the potential habitat and the ship specific parameters including the vessel speed. The risk for all the vessels crossing our area of study for a given day is then summed to derive the daily potential risk of collision (in number of whales per cell of ca. 21 km^2 and per day). The daily potential risk is then summed over a given period.

4.7 Creation of daily parameter maps

The main parameters in the calculation of the potential risk of a vessel striking a fin whale in the Mediterranean Sea are mapped separately as an attempt to visualize their relative importance. The density of maritime traffic provides a fair view of the main maritime routes. The daily map of vessel speed (75th percentile) shows where the high speed vessels travel, while the potential habitat gives an indication of where the highest probability of fin whale occurrence is. These are the main parameters contributing to the spatial variation of the potential ship strike risk to fin whales in the Western Mediterranean Sea.

4.8 Creation of time-integrated composites and coverage maps

The daily outputs are integrated over a multi-day period to show the seasonal variability. The available traffic data was of 31 days in May 2009, 21 days in July 2009 and 11 days in October 2009. The average traffic over these periods can then be easily compared to highlight the differences between the months.

5 OUTPUTS

5.1 Daily maps

The daily maps are made to visualize the distribution of the parameters on a daily basis. The mean vessel speed with the vessel density and the habitat are shown. After computation this results in the potential ship strike risk map. We selected a clear sky day (i.e. with a large habitat coverage), the 4th of July, to show the daily results.

5.1.1 Vessel speed maps

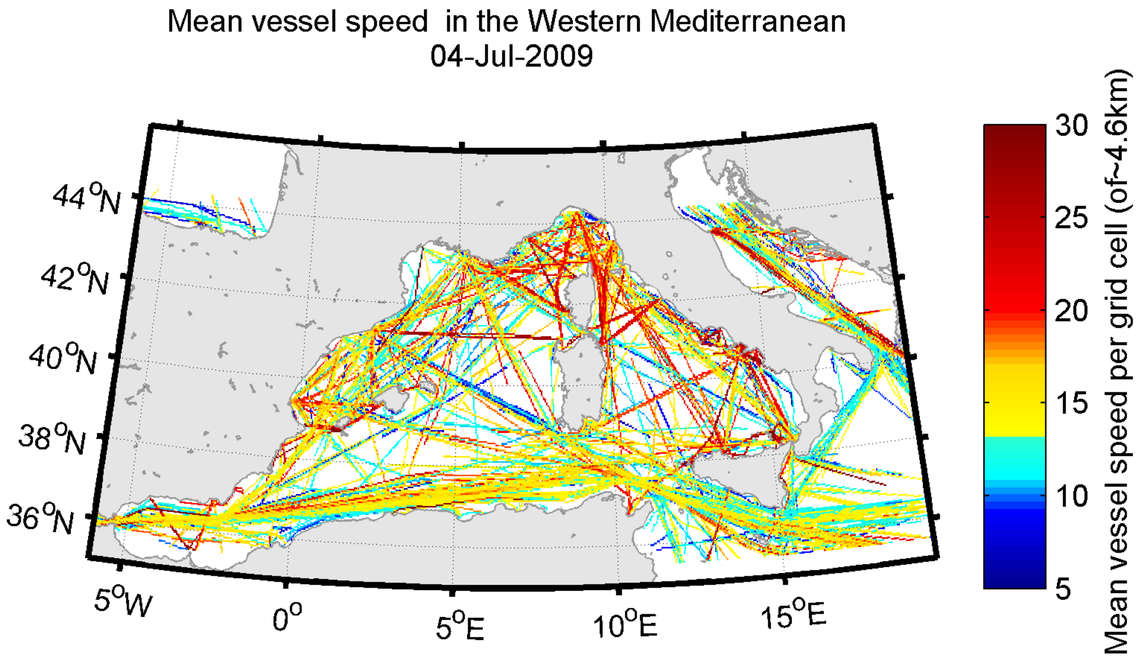


Figure 5. Mean maritime traffic speed on the 4th of July 2009 (knots).

The vessel speed and interpolated positions extracted from the AIS data for July 4th 2009 were used to produce this map (figure 5). The color bar enhances the risk to causing damage to whales. Indeed from figure 2, velocities under 10 knots are considered as low risk for collision while a speed range from 10 to 15 knots represents an increasing risk for fin whales and any speed above 18 knots indicates a high collision risk. The results of the 4th of July clearly show that high speed vessels are abundant in the Liguro-Provençal Basin. These high speed vessels correspond to the ferries connecting Corsica and Sardinia with mainland France and Italy. This area mostly coincides with the Pelagos marine sanctuary, a well-known summer feeding ground for fin whales. The main shipping route between the Gibraltar Strait and Sicily shows lower speed levels likely in relation to the mean of the retained 75th percentile values in areas of extremely high traffic density.

5.1.2 Vessel density maps

The daily vessel density was derived summing by grid cell the number of crossing vessels in a given day (figure 6). The range of the color bar was kept relatively low to vissualize the lower numbers in the Northern basin. With a maximum value of 95 vessels crossing one grid cell of ca. 21 km^2 within 24 hours (ca. 4.5 vessels.km^{-2}.d^{-1}), the Strait of Gibraltar is one of the busiest shipping routes on the globe. Taking a mean

vessel width of 19 m, this traffic density represents a daily crossing surface of about 5.23 km^2 or 25% of the cell surface.
All the main ports in the Western Mediterranean Sea can be seen on the map. We observe that all vessels choose the shortest route. The vessels entering the Mediterranean from the Strait of Gibraltar are concentrated in ship canals, one going north along the Spanish coast while the other one heads East along the North African shore towards Sicily.

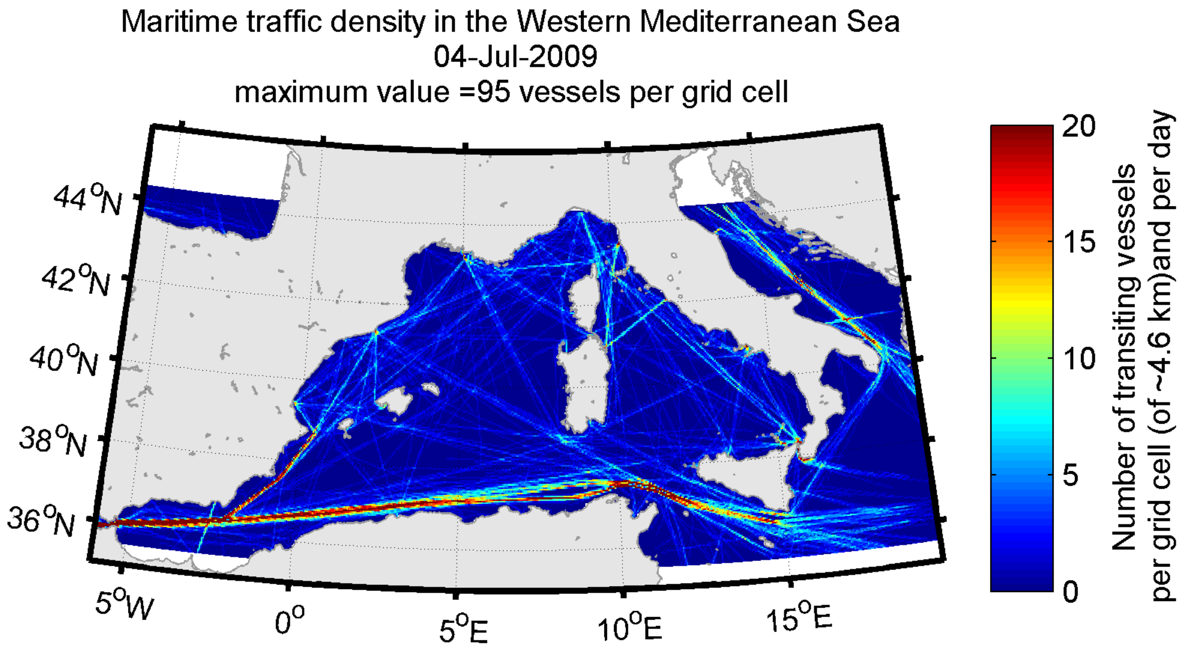


Figure 6. Maritime traffic density on the 4th of July 2009 (number of vessels per cell of ca. 21 km^2 and per day).

5.1.3 3-day composite habitat maps

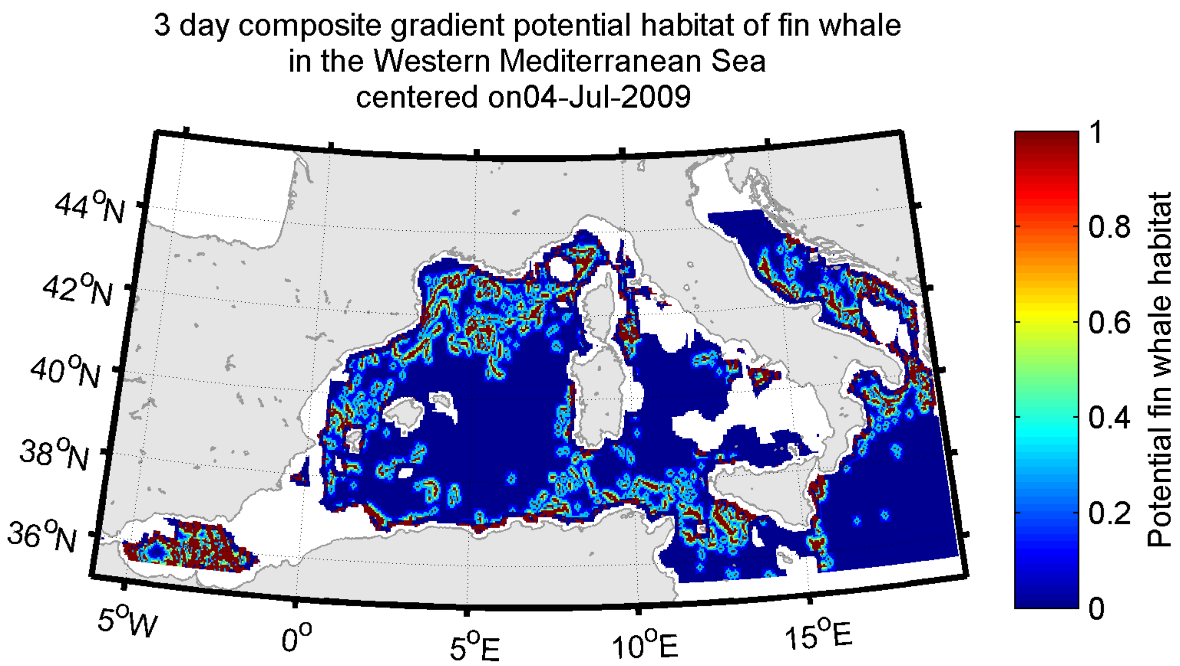


Figure 7. 3-day composite of potential fin whale habitat centered on the 4th of July 2009 (no unit).

The potential habitat of fin whales as shown in figure 7 is a composite of three days centered on the 4th of July 2009 (July 3 to 5th). The habitat boundary were extended using a gradient as described above (see also Table 1). The areas in white are covered by clouds or are too close to land to have chlorophyll-a estimates. The North and South cuts are the limits of the AIS data in our database. We observe an important potential habitat for fin whales in the Strait of Gibraltar, while in the rest of the basin the potential feeding habitat is generally more scattered along the shore line following the general circulation and absent in the centre of the basin.

5.1.4 Maps of potential ship strike risk

The potential ship strike risk is a combination of the previously discussed parameters.

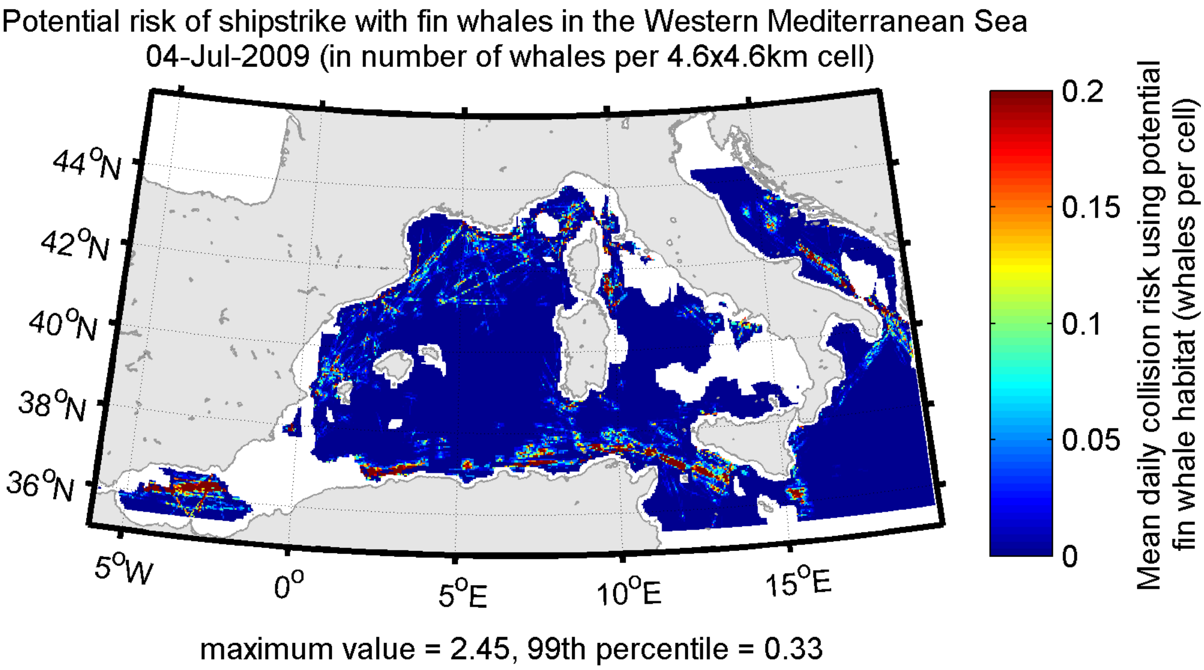


Figure 8. Potential risk of ship strike with fin whales on the 4th of July 2009.

Hence the high potential collision risk occurs where the fin whale habitat coincides with a shipping route. The level of potential risk depends on the quality of the habitat, on the traffic density and on the vessel speed and width. The observed potential feeding grounds of fin whales in the Alboran Sea seem to indicate that the lack of whale observation in this area is not due to a lack of prey. It is hypothesized that hundreds of vessels crossing a narrow sea every day generate levels of noise that might disturb whales (Druon et al. 2012). Indeed, Erbe et al. (2012) showed that cumulative underwater acoustic energy from shipping mapped in the west Canadian Exclusive Economic Zone reached high noise levels in critical habitats for endangered resident killer whales, exceeding limits[2] of "good conservation status" under the EU Marine Strategy Framework Directive. Despite a lower traffic density in the Pelagos Sanctuary

[2] The EU's Marine Strategy Framework Directive (2008/56/EC) specifies indicators to assess the environmental status of marine habitats with respect to low frequency, continuous sound. The annual average ambient noise level in the 1/3 octave bands centered at 63 and 125 Hz, as measured by a statistically representative set of observation stations, has been suggested (Van der Graaf et al. 2012).

area, the demonstrated effective habitat of fin whales reveals that the risk of ship strike is likely to be more frequent than in the Alboran Sea.

5.2 Time-integrated maps

The daily maps are integrated over time for three periods in 2009: 31 days in May, 21 days in July and 12 days in October. The resulting composite maps provide an indication of seasonal mean potential risk of strike that can be compared with each other to detect trends. We produced time-integrated maps for the vessel speed, the vessel density, the potential habitat and the potential strike risk. The presented time-integrated maps are daily computed, thus containing the most of the variability of each variable. Finally the vessel density of each month was compared to the average over three months to highlight the differences (anomaly maps).

See the Discussion section for comments on these products.

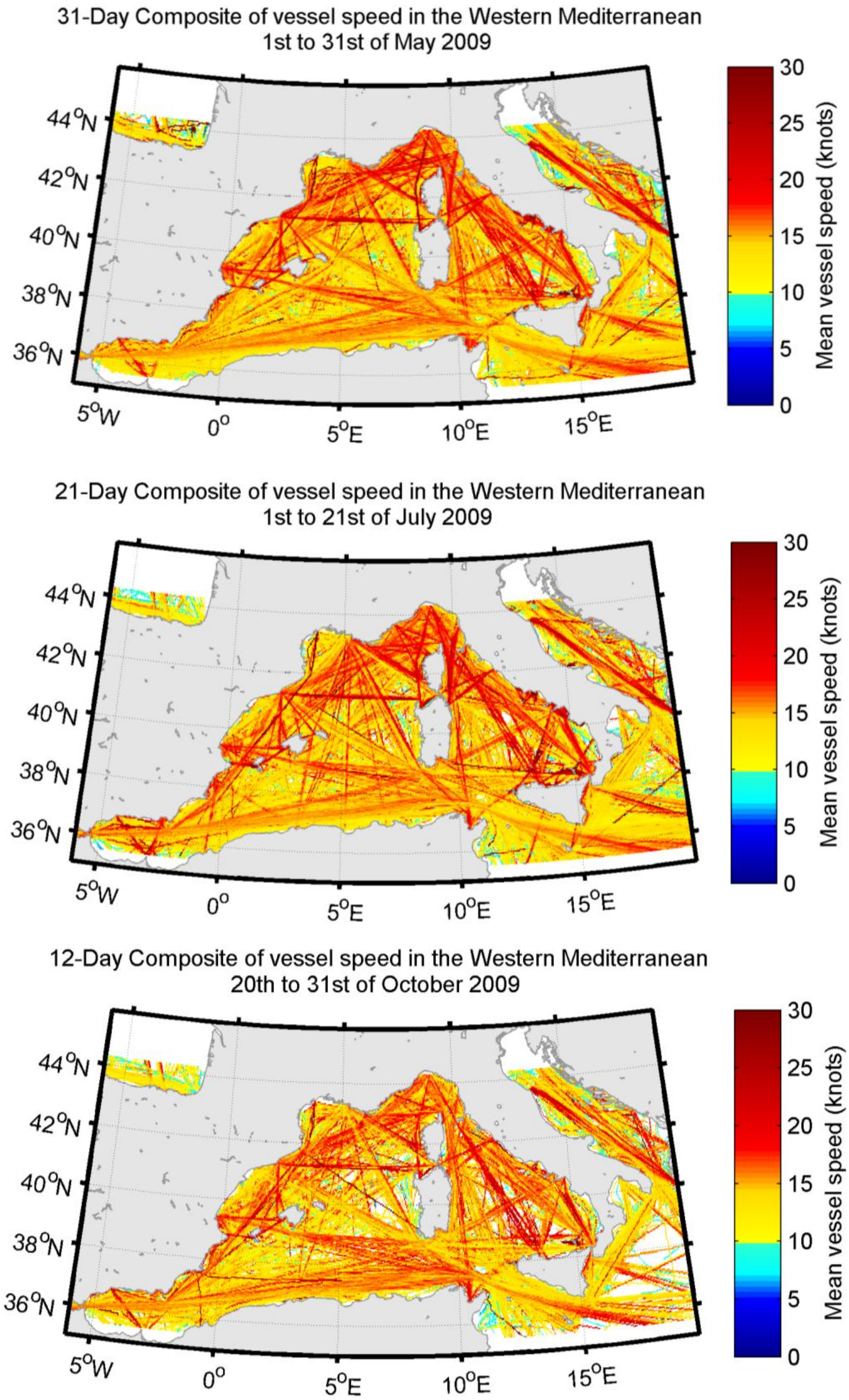


Figure 9. Mean vessel speed for three periods in 2009: a- May (31 days), b- July (21 days) and c- October (12 days).

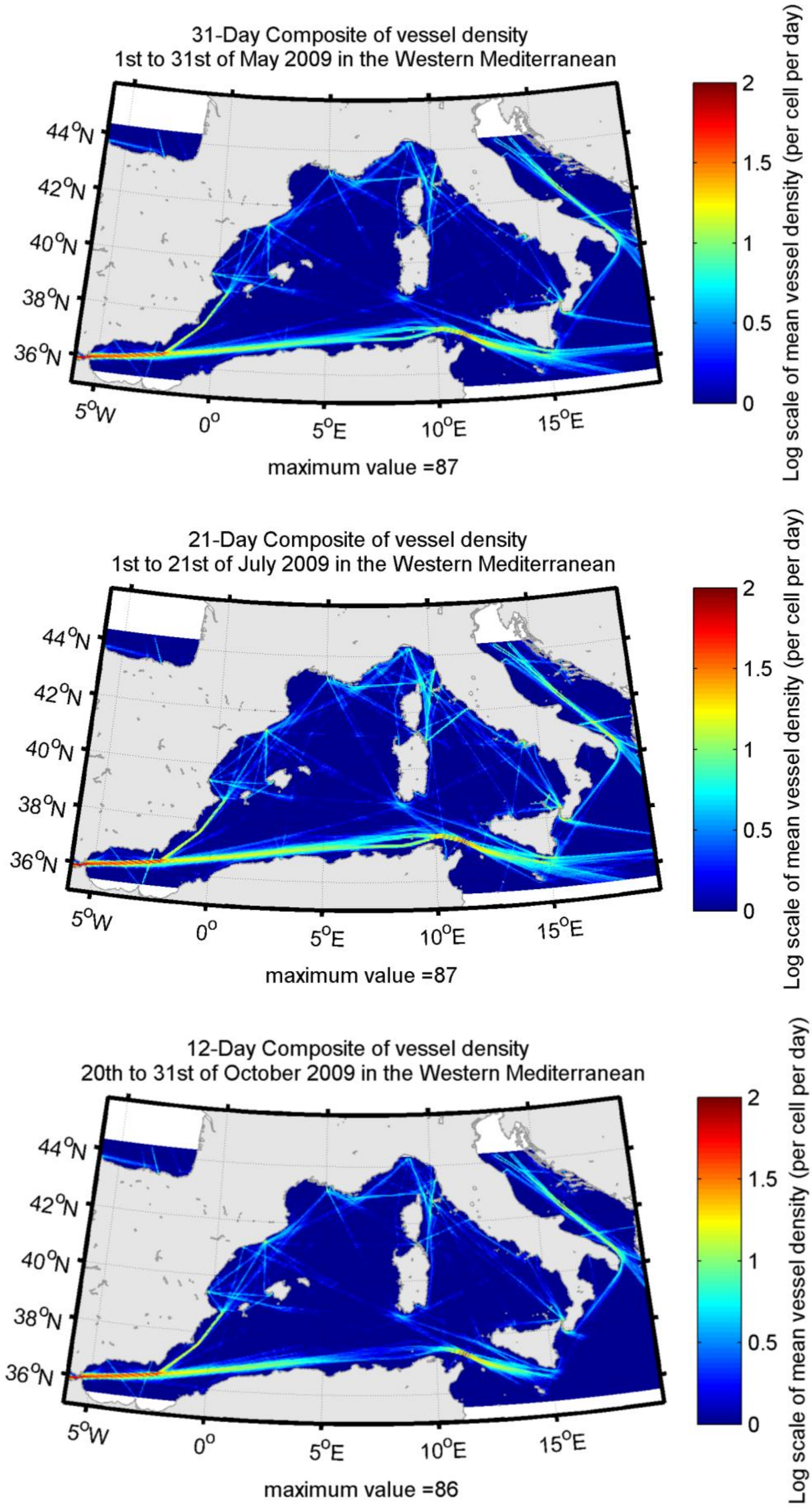


Figure 10. Composite density maps of maritime traffic in the Western Mediterranean for a) 31 days in May 2009, b) 21 days in July 2009 and c) 12 days in October 2009.

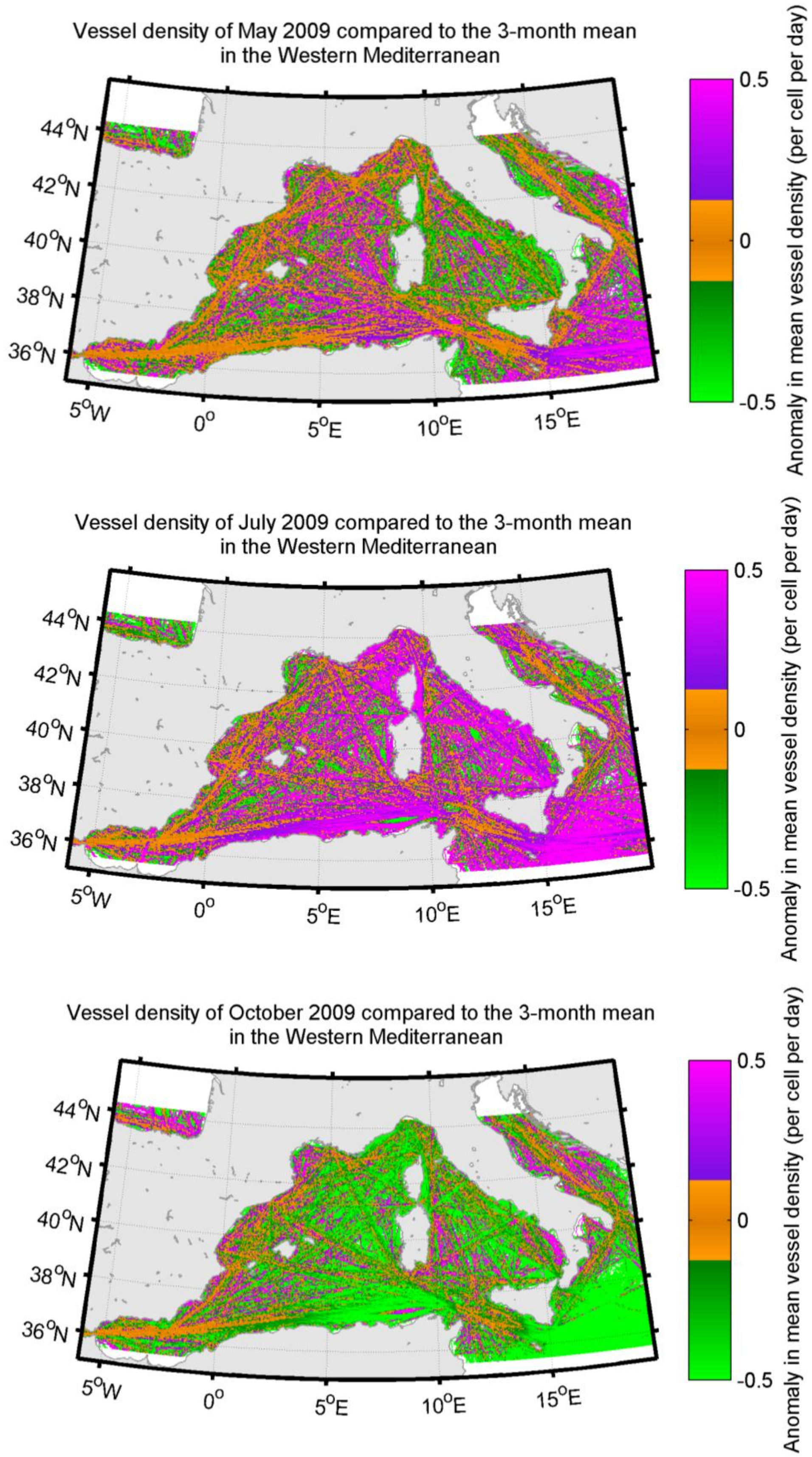


Figure 11. Anomaly maps (relative difference to the three-months mean) of traffic density in the Western Mediterranean for a) May, b) July and c) October 2009.

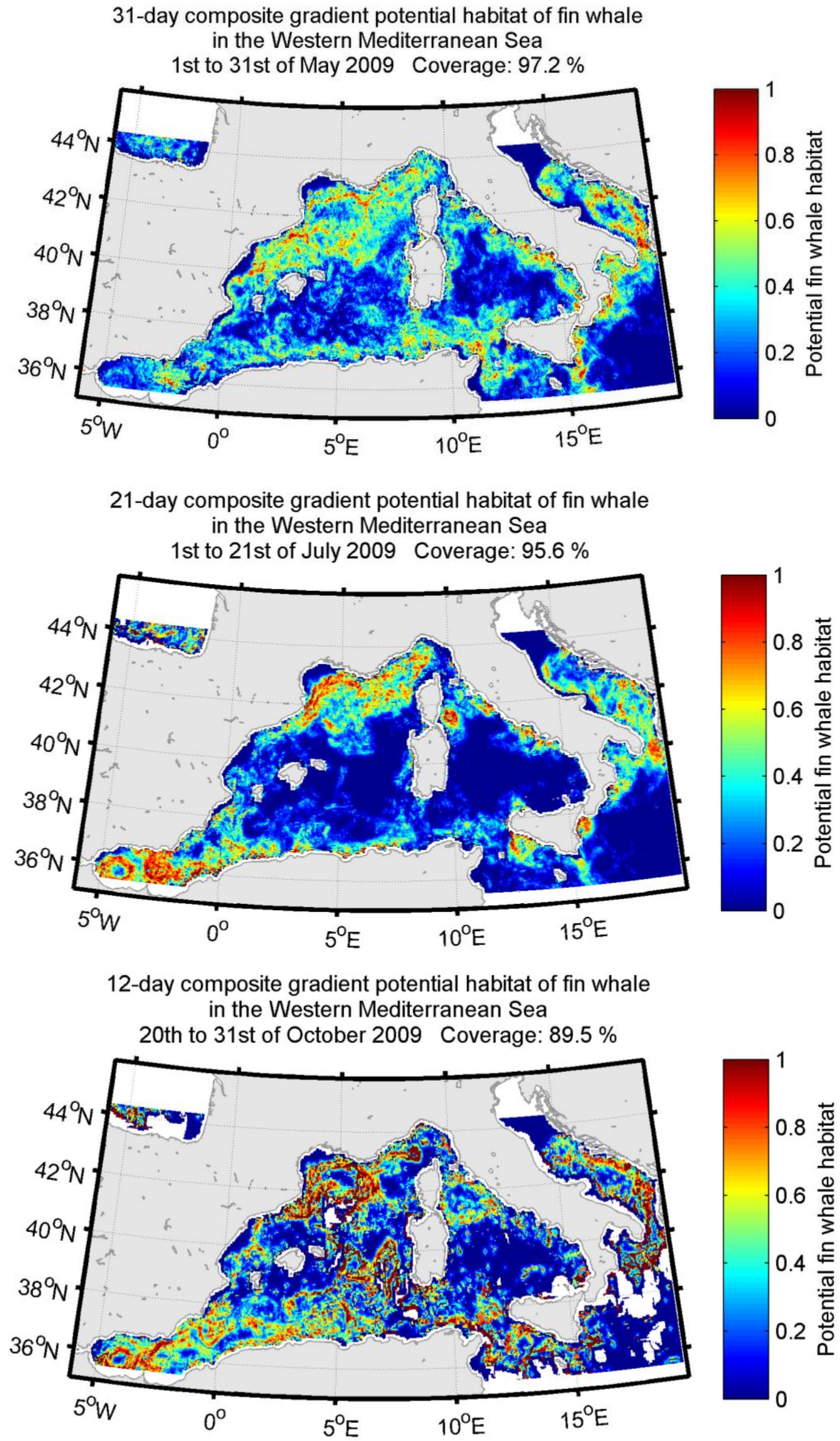


Figure 12. Composite gradient habitat maps of fin whales (*Hab*) in the Western Mediterranean Sea for a) 31days in May 2009, b) 21 days in July 2009 and c) 12 days in October 2009.

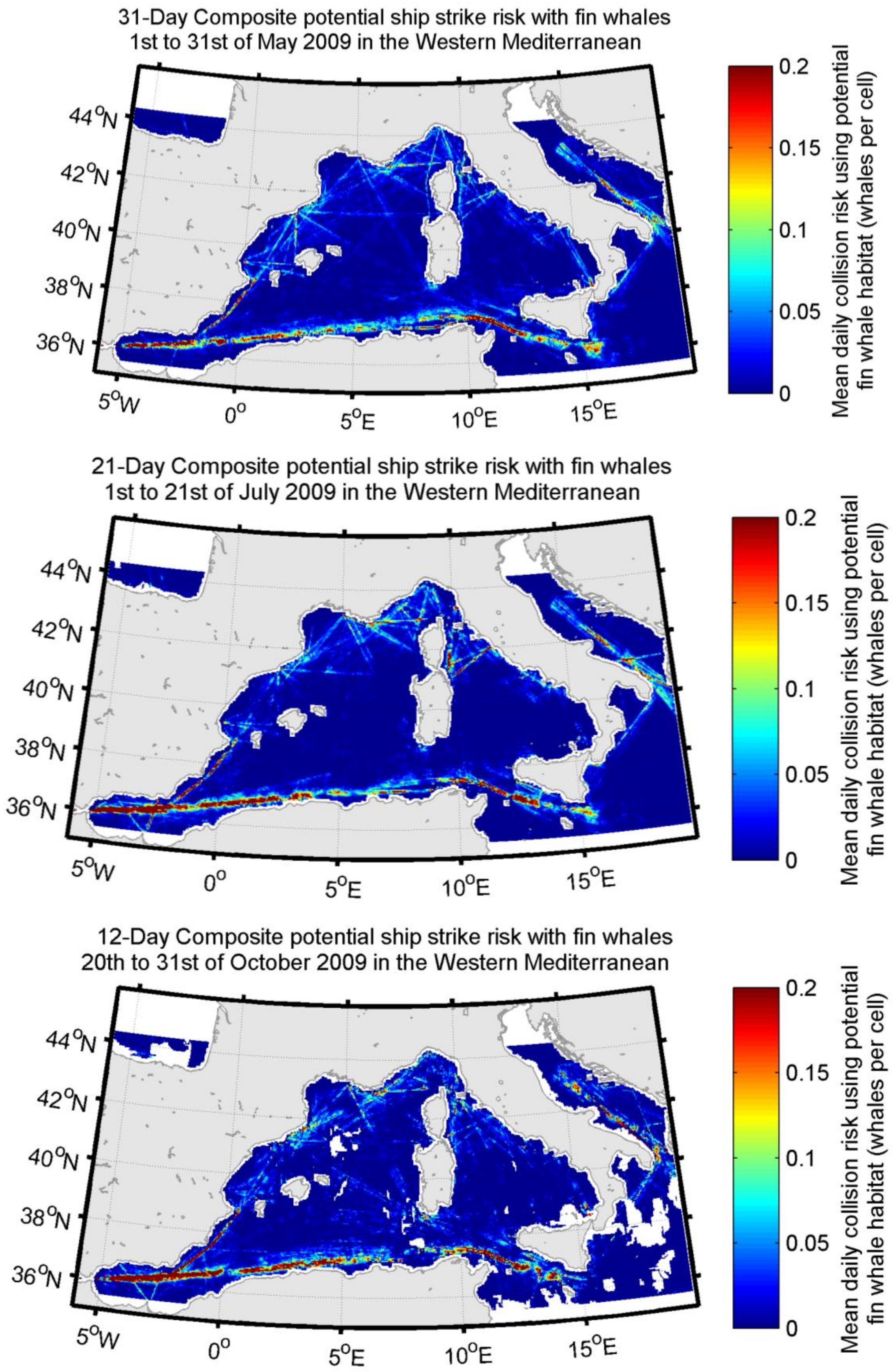


Figure 13. Composite maps of potential ship strike risk of fin whales in the Western Mediterranean for a) 31 days in May 2009, b) 21 days in July 2009 and c) 12 days in October 2009.

6 DISCUSSION

6.1 Vessel speed

All three vessel speed composite maps (figure 9) show relatively high vessel speeds in the northern basin and especially in the Liguro-Provençal Basin. Lower mean speeds are found in the Alboran and Sicilian Straits likely due to the high number of vessels in these areas. Note that the entire area of the Western Mediterranean is crossed on such grid (of ca. 21 km^2) by the maritime traffic over a period of 20 days. Higher speed levels are observed in July most likely due to the high speed ferries and increased rotation of passenger ferries heading to Corsica and Sardinia and back to harbours in France and Italy such as Marseille, Genova and Livorno.

6.2 Vessel density and seasonal anomalies

A log scale was used for the composite density maps to better capture the wide variability of ship densities. The maximum mean density is similar for all three periods: 86 to 87 vessels on average in one single grid cell of 4.6 by 4.6 km per day. The distribution of vessel densities (figure 10) shows a relatively higher level in the south of the Western Mediterranean than in the Northern basin. Note the peak of density in the area around the Pelagos sanctuary in July. The summer months are the busiest in this area due to the passenger ferries. Note also the lower count of AIS data off the Algerian coast or approaching the Lybian waters suggesting a lack of receiving antennas in the former case combined to a lack of relay between vessels in the latter case.

The anomaly maps between the single months and the three-month mean (figure 11) provides a clear picture of the seasonal variability in traffic density. July clearly is the busiest month in terms of vessels transiting the Mediterranean. May is globally an average level and October has significantly less traffic than the other two months. Interestingly the traffic in the Strait of Gibraltar is constant over the different months. The Liguro-Provençal Basin on the other hand has a much higher traffic densities in summer than in May or October in concordance with the concentration of the fin whale favorable habitat.

6.3 Potential habitat

The comparison of potential habitat maps in May and July (figure 12) shows a substantially more spread habitat in May whereas more concentrated in July in close connectivity with the general ocean circulation (see Druon et al. 2012). The Corsica area in the north-west and south-east are prime summer feeding grounds for fin whales. Note that the favorable habitat extends outside of the Pelagos sanctuary including areas of high maritime traffic.

Note the availability of potential habitat maps for fin whales in the Western Mediterranean Sea integrated at different time periods (fortnight, month, annual, annual anomalies, seasonal climatology, decade composite) from 2000 to 2012 (at the type of report printing) on our web site: http://fishreg.jrc.ec.europa.eu/fish-habitat

6.4 Potential ship strike risk

The potential ship trike risk (figure 13) is generally high in the Southern basin in relation to high vessel densities and the presence of favourable conditions for the potential habitat. Fin whales however are rarely seen in these waters potentially suggesting that the high vessel densities cause disturbances to the whales (Druon et al. 2012). An elevated level of potential strike risk in summer is observed in the Liguro-Provençal Basin where fin whales are frequently observed. The present results suggest that the Pelagos Sanctuary should be extended at its boundaries to include major maritime routes. An efficient mitigation measure would consist in limiting the vessel speed when prime feeding conditions occur within the Pelagos Sanctuary. A maximum speed of 10 knots would drastically reduce the risk of fatal collision.

This work also highlights the feasibility of deriving a near real time system where the daily product of potential habitat (one-day shift with the environmental satellite observation) can be used on board of vessel to increase awareness or in complementarity of real-time plotting systems of cetaceans such as the REPCET system (www.repcet. com/ en) which transmits whale sightings in real-time to the participating fleet (Mayol et al. 2008, Di Méglio et al. 2010).

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Abstract

This scientific technical report describes the methodology and analyzes the seasonal results of a ship strike model with fin whales in the Western Mediterranean Sea. The potential risk of ship strike is computed from realistic vessel density (AIS data) and satellite-derived daily potential habitat of fin whales. The selected periods (late spring, mid-summer and autumn) highlight the variability of both maritime traffic and potential habitat of fin whales. The proposed method of combining potential habitat and AIS maritime traffic data provides an added value for policymakers. It shows the feasibility of assessing the seasonal potential risk of ship strikes with fin whales at basin scale. The Liguro-Provençal Basin shows a higher potential risk in mid-summer than late spring or autumn due to a higher traffic of passenger ferries in July-August. The Alboran Sea shows an even higher potential risk but fin whales there are hardly ever observed in this area suggesting a noise disturbance from hundreds of vessels crossing this narrow area each day. These high noise levels are likely to exceed the limit of “good conservation status” under the EU Marine Strategy Framework Directive. This work also highlights the feasibility of deriving a near real system where the daily product of potential habitat can be used on board of vessel to increase awareness or complementary to real-time plotting systems of cetaceans.

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