United Nations Environment Programme
Mediterranean Action Plan
Regional Activity Centre For Specially Protected Areas

IMPORTANT AREAS FOR THE CONSERVATION OF CETACEANS IN THE GULF OF LIONS SHELF AND SLOPE AREA: SYNTHESIS OF EXISTING DATA ON CETACEANS AND THREATS

With financial support of the European Commission

RAC/SPA – Tunis, 2013

This document has been prepared in the framework of the project for supporting the establishment of MPAs in open seas, including deep seas, with financial support of the European Commission.

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Di-Méglio Nathalie, Léa David

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CONTEXT

The RAC/SPA works since 2008 to the creation of a network of representative MPAs in open seas, including deep sea, in the Mediterranean Sea. Among the twelve priority areas identified is the “Gulf of Lions shelf and slope” (Figure 1), called “Gulf of Lions” area afterward in this document.

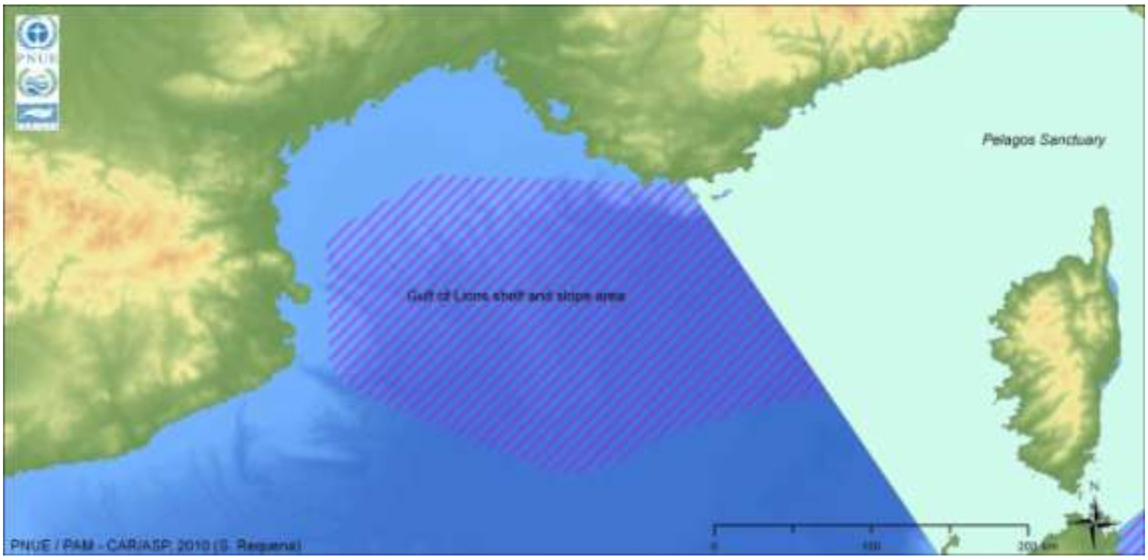

Figure 1 : Map of the « Gulf of Lions shelf and slope » area

In order to support this process and help decision makers of France and Spain, experts have been designed in order to synthesis knowledge on this area. This synthesis will be considered as a first contribution in order to :

- Identify sectors within the “Gulf of Lions area” which should be the object of measures of management, from the point of view of conservation perspective and durable use of resources,
- Aid a preliminary reflection to the measures of management which can be associated with these sites

Therefore this document is an attempt to make a synthesis about cetaceans species present in the “Gulf of Lions” area, based on literature and also on existing databases. Only common or regular species have been taken in account, not occasional ones.

The document begins with the presentation of seven species, from ecology to population and threats. Then three main types of anthropic activity are described, with the associated threats. Afterwards, the status of conservation of these species is synthesized. Finally important areas for cetacean’s conservation are suggested.

CETACEAN SPECIES IN THE AREA «GULF OF LIONS»

Concerning cetacean species, because some large portions of the high seas remain unknown even nowadays, because data are lacking for some period of the year, merely seasons outside summer, it is difficult to dress an exhaustive and representative portrait of what occurs in the "Gulf of Lions" area. So the choice as been made to present, when possible, not only map of distribution based on data collected at sea, but also modelisation of habitat suitability for some species. These maps allow gaining some knowledge on areas barely prospected.

The fin whale

Ecology

Fin whales (Balaenoptera physalus) in the Mediterranean are known to be preferentially "pelagic" (Figure 2) : their preferential habitat begin after the 2000 m isobaths. But they can occur in slope and shelf waters as well, depending on the distribution of their prey (Beaubrun et al., 1999 ; Gannier et al. 2002, Notarbartolo di Sciara et al. 2003, Panigada et al. 2005). They favour upwelling and frontal zones with high zooplankton concentrations (Cotté et al., 2009; Laran et al., 2008 ; Di-Méglio 1999; Delacourtie et al., 2009).

Distribution and population

Genetic analyses based on both mitochondrial and nuclear DNA indicated differences between the Mediterranean population and fin whales in Atlantic coastal waters of Spain, Canada, Greenland, and Iceland (Bérubé et al. 1998) but with some gene flows (Palsbøll et al. 2004). Recently, satellite tagging shows that most of the fin whales of the north-western Mediterranean sea may stay there year round but some travel through the near Atlantic at least (Bentaleb et al., 2011 ; Figure 3).

Fin whales are regularly encountered all year round throughout the north-western basin where abundance are far higher than elsewhere in the Mediterraean sea (Notarbartolo *et al.,* 2003; Cotté *et al.,* 2009). The concentration is the highest in summer in highly productive portions of the Corsican, Ligurian, Tyrrhenian sea and offshore the Gulf of Lions (FIGURE 4; Delacourtie *et al*., 2009; Monestiez *et al*., 2006) and less in winter (Gannier 2005; Di-Méglio *et al.,* 2010). Animals present a high degree of site fidelity for this summer feeding ground (Zanardelli *et al.,* 1998). Breeding and calving grounds have yet to be identified (Notarbartolo di Sciara *et al*., 2003), although some behavior witnessed in the western Mediterranean Sea could be linked to reproduction (Di-Méglio *et al*., 2009) and each year calves are sighted or stranded in this part of the western basin. Distribution and acoustic studies lead to the hypothesis that fin whales come from the southern part of Spain in spring, swimming between continental coasts and Balearic Islands, to reach the corso-ligurian sea in summer. Then they migrate back to the south-west in autumn (Castellote *et al.,* 2008 ; Di-Méglio, 1999 ; David *et al.,* 2001). So this species could frequent the offshore Gulf of Lions from spring until autumn at least, several individuals staying even in winter (Bentaleb *et al.,* 2011). The habitat suitability (FIGURE 2) and kriging maps (FIGURE 4) show that the area "Gulf of Lions" would cover a large portion of favourable and used area of the fin whale.

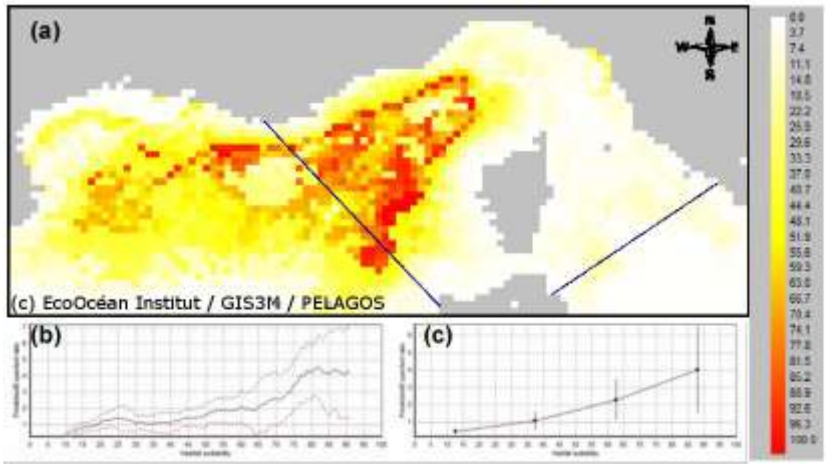

Figure 2 *: (a) Habitat suitability map (in red) for the fin whale. ENFA modeling with data collected in prospecting effort, from 1998 to 2008. (b) Curve of the ratio predicted value versus expected value (mean and SD, continued) and (c) the same represented in classes.*

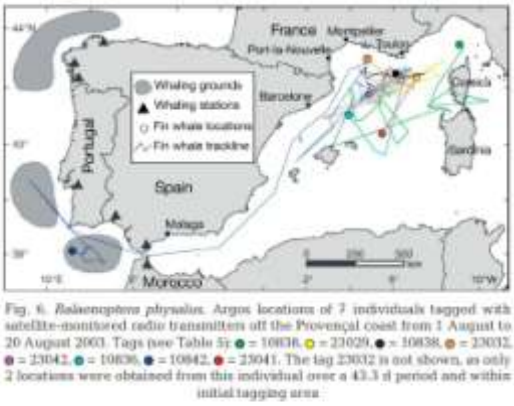

Figure 3 : Argos locations of 7 individuals tagged with satellite-monitored radio transmitters off the Provençal coast from 1 August to 20 August 2003 (Bentaleb et al., 2011).

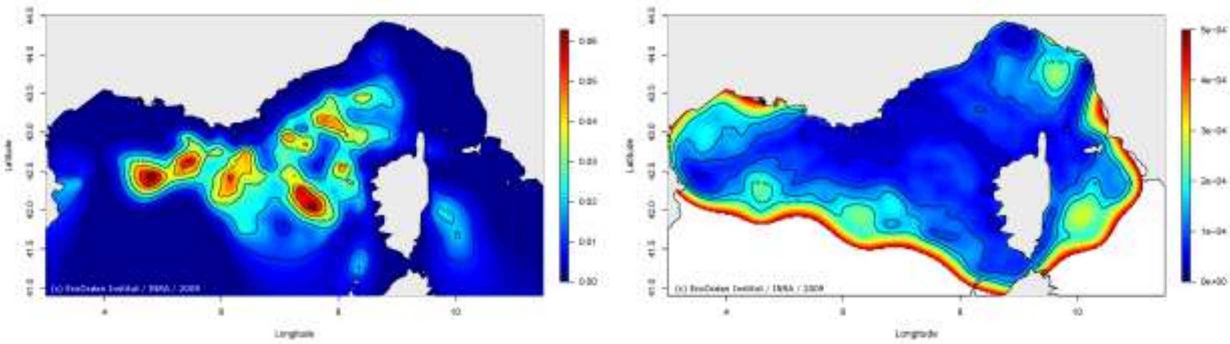

Figure 4 : Kriging values of the sighting rate of fin whale expressed in terms of nb of sightings per km (left) and variance of the sighting rate (right), for the period 1994-2008. (Delacourtie et al., 2009)

Fin whales in the western Mediterranean sea feed mostly in summer on a single euphausiid species, *Meganyctiphanes norvegica* (Orsi Relini *et al*., 1998 ; Astruc, 2005). They may feed also on *Nycthiphanes couchii* (Canese *et al*. 2006) or even on small pelagic fishes.

Considering population estimates, studies yielded estimates of 3,583 fin whales (S.E. 967, 95% C.I. 2,130-6,027) over a large portion of the western Mediterranean in 1991 (Forcada *et al*., 1996). In the Corsican-Ligurian-Provençal basin, corresponding to the PELAGOS Sanctuary, estimates evoluate from 901 individuals (S.E. 196.1, 95% C.I. 591-1,374) in 1992 (Forcada *et al*. 1995), to 715 individuals (95% C.I. 421–1,215 in 2001 (Gannier 2006) and 147 (CV=27.04%; 95% C.I. 86-250) in 2009 (Panigada *et al*., 2010). In summer in the area offshore the Gulf of Lions, the relative abundances of fin whales are between 0,013 et 0,043 individuals per km (Di-Méglio, 1999 ; Gannier & Bourreau, 1999), whereas in the corso-ligurian sea it is comprised between 0,022 et 0,029 ind.km^{-1} (Di-Méglio, 1999 ; Gannier, 2005). Globally for the Mediterranean Sea it is 0,017 ind.km^{-1} and 0,012 ind.km^{-1} in the PELAGOS Sanctuary (Delacourtie *et al.*, 2009).

Threats

The main direct threats for this species in this area are ship strikes (Cagnolaro and Notarbartolo di Sciara 1992, Panigada *et al*. 2006, Weinrich *et al.* 2006 ; David *et al*.,2011 ; David and Di-Méglio, 2011). The increasing speed of vessels and the increasing number of vessels, mainly ferries, bears watching in this regard. Shipping noise and disturbance or harassment from leisure boats and unregulated whale watching (Airoldi *et al*., 1999 ; Beaubrun, 2002), is another source of concern. Contamination by organochlorines and trace elements impacts the fitness of these animals and may not be negligible (Fossi *et al*., 2003 ; Tapie *et al*., 2011).

The sperm whale

Ecology

The sperm whale (*Physeter macrocephalus*) is known to be an "oceanic" one (**FIGURE 5**). This species prefer the continental slope, including canyons and also highly productive open waters with thermo-saline fronts, like those associated with the ligurian current and eddies (Gannier et Praca 2007; Arcangelli *et al*. *in press*). These places consist certainly mostly of sectors of high abundance of mesopelagic cephalopods, the species' preferred prey.

Distribution and population

Genetic data suggest that sperm whales in the Mediterranean constitute a separate population (Drouot *et al*., 2004 ; Engelhaupt, 2004). Mature males segregate from social units staying more southerly whereas they move to northern part of the Mediteranean Sea in summer (Drouot *et al.,* 2004). In the Gulf of Lions mainly isolated male mature were encountered, but occasionally social units with females and young, even neonates are sighted in the north-western Mediterranean Sea (Di-Méglio and David 2008, Moulins & Würtz 2005) confirming that calving takes place there.

In the occidental basin, sperm whales are particularly abundant in the Gulf of Lions (2.2 $\times 10^{-2}$ ind.km^{-1} (Gannier *et al*., 2002), then in the Ligurian Sea, the waters between the Balearic Islands and the Iberian sea where they found favourable habitat (FIGURE 6, FIGURE 7).
The movements of sperm whales are unclear and individuals are seen but long range movements have been discovered through photo-identification between the Ligurian Sea, the Gulf of Lions, the Balearic Sea and the Strait of Gibraltar (Carpinelli *et al*. 2011 and *in press*). The area "Gulf of Lions" would largely covers high habitat of sperm whale.

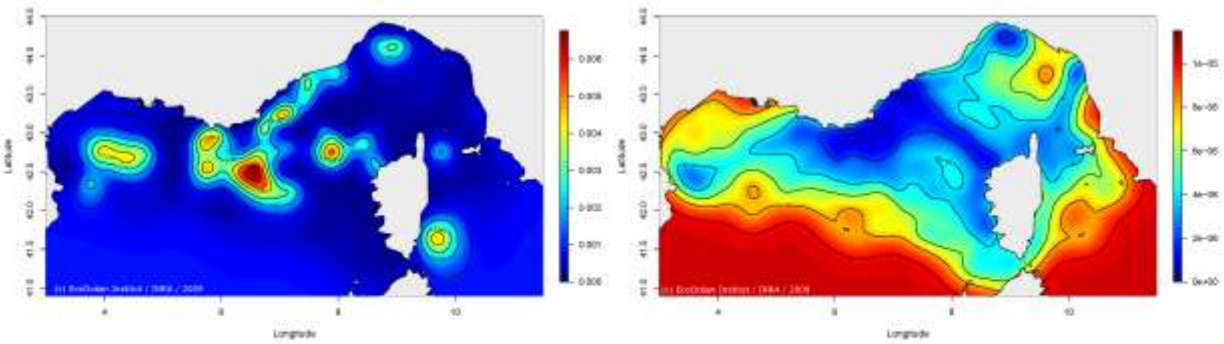

Figure 5 : Kriging values of the sighting rate of sperm whale expressed in terms of nb of sightings per km (left) and variance of the sighting rate (right), for the period 1994-2008. (Delacourtie et al., 2009)

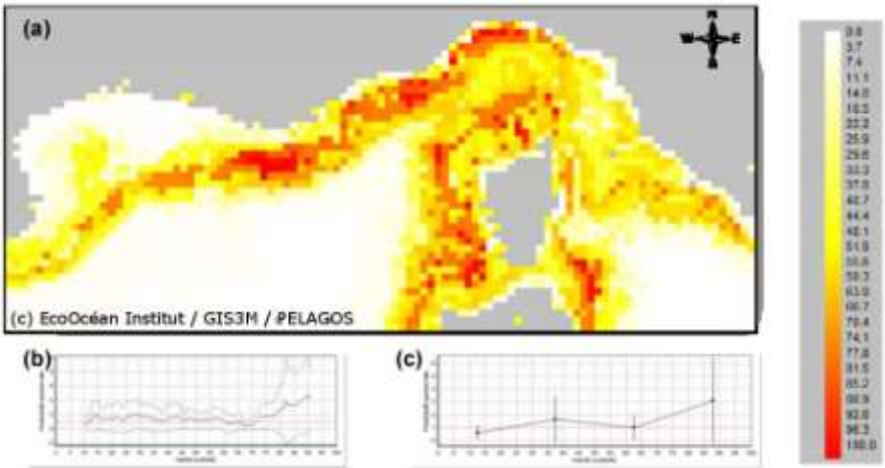

Figure 6 : (a) Habitat suitability map (in red) for the fin whale. ENFA modelisation with data collected in prospecting effort, from 1998 to 2008. (b) Curve of the ratio predicted value versus expected value (mean and SD, continued) and (c) the same represented in classes.

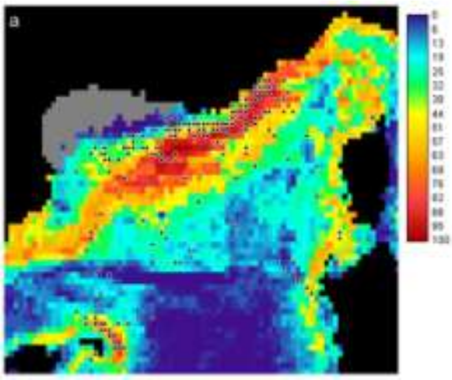

Figure 7 : Habitat suitability maps for sperm whale through ENFA modelisation. The grey area was removed from the analysis. Black dots represent the location of presence cells used in the model for this species. (Praca and Gannier, 2008).

Comparing historical records (Bolognari 1949, 1950, 1951, 1957) to recent results (Notarbartolo di Sciara *et al*. 1993; Marini *et al*. 1996), the number of sperm whales seems to have globally decreased.
Sperm whale population could reach now hundreds of individuals but not thousands (Notarbartolo and Birkun, 2010).

Threats

The most likely cause of recent decline of sperm whales in the Mediterranean is entanglement in driftnets (Notarbartolo di Sciara 1990; International Whaling Commission 1994 ; Tudela *et al.* 2003; ACCOBAMS 2003; Pace *et al.* 2005) even in recent years offshore Toulon (David 2005). The second most threat is the disturbance from intense marine traffic (development of 'highways of the sea') and collisions with vessels (David et Di-Méglio, 2011; Pesante *et al*. 2002). Underwater noise from seismic airguns prospections, military operations are other sources of concern (Notarbartolo di Sciara & Gordon 1997) as well as pollution by contaminants (Laran *et al*., 2010).

The pilot whale

Ecology

Pilot whale (*Globicephala melas*) is known as a pelagic species, preferring open and deep waters (FIGURE 8) but can go near the coast in other season (Di-Meglio et David 2011).
The species is regarded as predominantly a squid-eater, but can also feed at least occasionally on pelagic fish (Relini and Garibaldi 1992; Cañadas *et al*. 2002; Olson and Reilly 2002). In summer the groups of pilot whales seen in the north-western Mediterranean Sea contain all calves, supporting the idea that reproduction occurs in this region.

Distribution and population

Estimates of abundance in the North-western Mediterranean Sea is not known. But this species is relatively scarce. It seems more frequent off the provençal coasts and also in the western portion of the Mediterranean sea (Alboran and Balearic Seas). Habitat suitability map (FIGURE 8) shows that the “Gulf of Lions” area would include a good portion of favourable areas for pilot whales.
Population structure is unknown but the working assumption is that only a single subpopulation could be present in the Mediterranean Sea. Pilot whales from Gibraltar and Alboran Sea seem to be resident. In the North-western Mediterranean sea sightings of this species occur mostly in summer but some encounters are reported in other seasons.

Long-finned pilot whales are highly social animals, based on matrilinear groups.

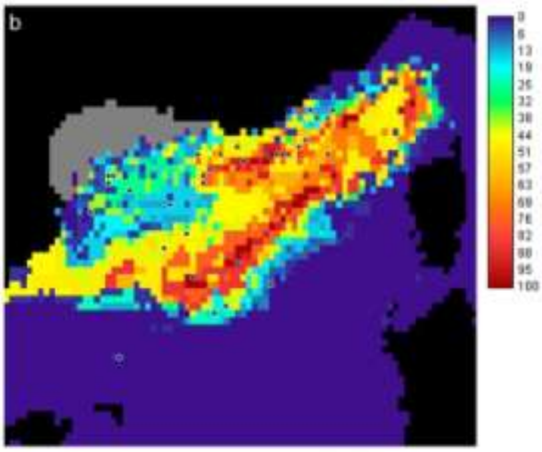

Figure 8 : Habitat suitability maps for pilot whale through ENFA modelisation. The grey area was removed from the analysis. Black dots represent the location of presence cells used in the model for this species. (Praca and Gannier, 2008).

Threats

No serious threats have been identified in the Mediterranean Sea yet. Because they are scarce, mainly in offshore waters, feeding on preys not targeting by fisheries, they are therefore less expose to anthropogenic activities than other cetacean species. However, in summer when they are near the provençal coasts they are exposed to disturbance and harassment from high traffic of leisure vessels and whale-watching activities. Probably collisions with ships are under-estimated (at least two in the Straits of Gibraltar – R. de Stephanis, pers. comm.; two in the Tyrrhenian Sea – Di Natale 1982; one in the NW Mediterranean – Pesante *et al*. 2002). Also by-catch occurs, and the impacts of man-made noise and toxic pollution are not negligible (high levels of organochlorine contaminants such as DDT and PCB, Laran *et al*., 2010).

The Risso's dolphin

Ecology

Risso's dolphins (*Grampus griseus*) prefer deep offshore waters and continental slope areas (FIGURE 9), in particular over steep shelf slopes and submarine canyons (Azzellino *et al* 2006; David, 2000 ; David and Di-Méglio *in press*; Bearzi *et al*., 2010). They occur all year round in the north-western Mediterranean Sea.
Risso's dolphin feed mainly on oceanic cephalopods found in the middle slope (Blanco *et al.,* 2006; Astruc, 2005).

Distribution and population

Risso's dolphins in the Mediterranean Sea are genetically differentiated from those in the eastern Atlantic, impliying that gene flow between the two areas is limited and that the Mediterranean animals constitute a distinct population (Gaspari *et al* 2006).
High abundance of Risso's dolphins occurs in the Ligurian-Corso-Provençal basin, and also in the Gulf of Lions (Azzelino *et al*., 2008; David 2000; Delacourtie *et al*., 2009). The "Gulf of Lions" area would include an interesting portion of the favourable habitat of this species.
Photo-identification results show high site fidelity and movements from Gulf of Genoa until the east part of the Gulf of Lions (Lara *et al*., 2009 ; Di-Méglio 1999).
Animals are then using this area as a foraging ground (Gaspari *et al* 2006) and also calves are always seen in summer at least.

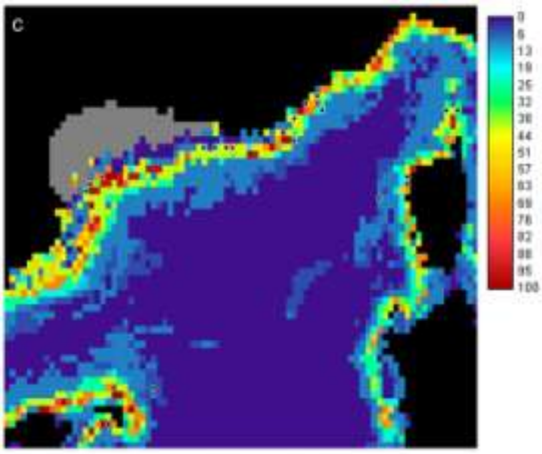

Figure 9 : Habitat suitability maps for Risso's dolphin whale through ENFA modelisation. The grey area was removed from the analysis. Black dots represent the location of presence cells used in the model for this species. (Praca and Gannier, 2008).

Line-transect abundance estimates exist only for the western central Mediterranean, where aerial surveys from 2001-03 resulted in an estimate of 493 Risso's dolphins (95% C.I. 162-1,498) in an area of 32,270 km2 (Gómez de Segura *et al.*, 2006).
In all surveyed areas, encounter rates have been low (i.e.: Ligurian-Corso-Provençal basin, 0.098 per km – Tethys Research Institute).

Threats

Risso's dolphins are victim of by-catch by longlines and gillnets. They can suffer from harassment and disturbance generated by high traffic of leisure vessels and whale-watching (Miragliuolo *et al*., 2001), merely where continental slope is near the coast (Provence, Corsica islands). Being a deep-diving species, Risso's dolphins are potentially threatened by anthropogenic noise (commercial shipping, seismic prospection, military exercises, etc). Also, like other odontocetes, these animals carry substantial contaminant burdens (Fossi & Marsili 2003 ; Laran *et al*., 2010). Being a squid eater, Risso's dolphins suffer from plastic debris ingestion (Bearzi *et al*., 2010).

The Bottlenose dolphin

Ecology

Bottlenose dolphins (*Tursiops truncatus*) in the north-western Mediterranean Sea are mostly sighted over the shelf, in coastal/inshore waters (Gnone *et al*., 2011 ; FIGURE 10). However, they are also regularly found near deep canyons on the continental shelf border and even offshore in pelagic waters (Dhermain *et al*. 1999; Delacourtie *et al*., 2009; FIGURE 11).
Mediterranean bottlenose dolphins are opportunistic feeders with a preference for demersal preys, fish or cephalopods, and also epipelagic fishes (Blanco *et al*. 2001, Astruc, 2005).
In the Gulf of Lions continental shelf where trawlers occur, bottlenose dolphins are in some way linked to this activity as in other Mediterranean sectors (Bearzi *et al*. 1999).

Distribution and population

Mediterranean bottlenose dolphins exhibit population structure based on toxicology and diet (Borrell *et al*. 2005) and genetics (Natoli *et al.* 2005). Comparison of genetic samples indicated differences among contiguous local populations from east (Gibraltar) to west (Black Sea), but it is likely that in the Gulf of Lions and Provence, there is a unique population (Gnone *et al*., 2011).
Biogeographic and hydrographic features influence the distribution of bottlenose dolphins, the favourable habitat being also fragmented by anthropogenic degradation. Adding an ecological specialisation in foraging activity lead in the separation of regional sub-populations (Natoli *et al.* 2005 ; Gnone *et al.,* 2011). But this does not exclude exchanges, and photo-identification results

show that some Bottlenose dolphins have move from the Ligurian sea to Corsica and other from Provence to the Gulf of Lions (Gnone *et al.,* 2011 ; Dhermain *et al*., 1999).
Information on status and trends of the subpopulations is fragmentary because of the evident substructure and the diversity of the monitoring efforts. In the Gulf of Lions, Renaud (2001)

give some elements concerning an increase (a come back) of this species in this area from the beginning of the 90s. The last survey in this part of the Mediterranean Sea in 2000 gives an estimation of 200-209 individuals (Ripoll *et al*., 2001) and several dozens in the Provence area (Labach *et al*., 2009). This should be now re-evaluate. For comparison, a large collaborative study based on photo-identification yielded an estimate of 884-1023 individuals in the whole PELAGOS Sanctuary (Gnone *et al*.,2011).

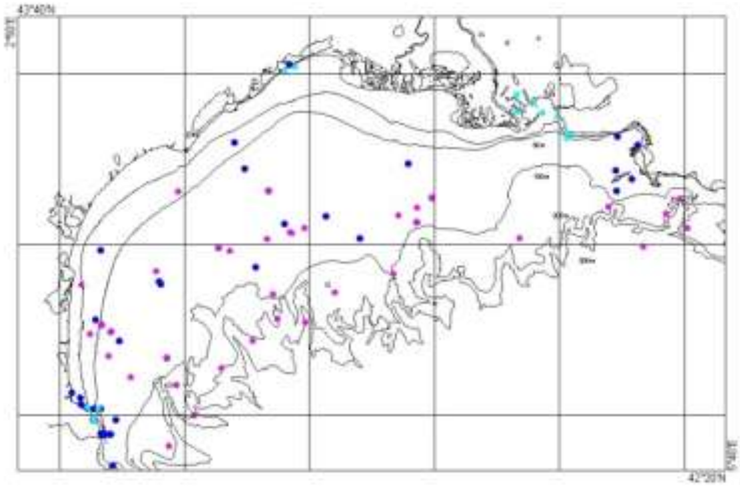

Figure 10 : Sightings of bottlenosed dolphins in the Gulf of Lions, 1991-2000 (Renaud, 2001).

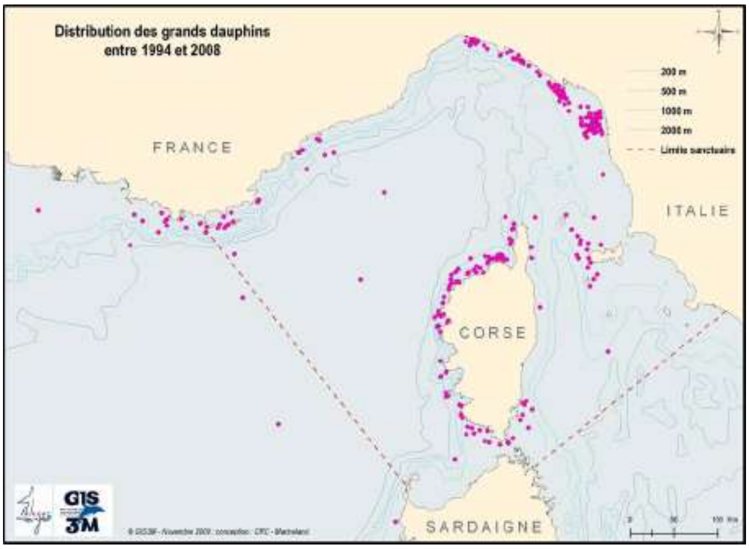

Figure 11 : Distribution of Bottlenose dolphin sightings, 1994-2008 (Delacourtie et al., 2009).

Concerning population trends, the overall pattern leads to the suspicion that the basin population has been reduced by at least 30% over the last 60 years, due to anthropogenic threats (Notarbartolo and Birkun, 2010). Shifts in the frequentation of some sectors could also occur.

Threats

Owing to their occurrence in coastal waters, bottlenose dolphins are exposed to a wide variety of anthropogenic threats. The main threats in recent times include:
1) reduced availability of prey caused by overfishing and environmental degradation;
2) incidental mortality in fishing gear;
3) disturbance from leisure vessels, whale-watching and nautical activities (jet-ski, kayak,…) ;
4) toxic effects of xenobiotic chemicals.

Concerning incidental mortality in fishing gear, trammel and set gillnets, but also drift gillnets are of particular concern. Bycatch in trawl nets exist and seems not negligible, at least in the Gulf of Lions (Ridoux and Van Canneyt, 2011).
In addition to the main threats listed above, noise represent also a potential threat at local scales.

The striped dolphin

Ecology

The striped dophin (*Stenella coeruleoalba*) is the most abundant cetacean species, and can be encountered from the coast to pelagic waters. It typically shows a preference for highly productive, open waters beyond the continental shelf (Notarbartolo di Sciara *et al*., 1993; Gannier, 2005 ; Cotté *et al*., 2010; FIGURE 12). But outside summer striped dolphin exploits also preys over the continental shelf.
Some dolphins realise a nycthemeral movement from the offshore areas to the coastal ones and reverse, some dolphins spending the night feeding over the upper slope and shallow waters (Gannier and David, 1997).

This species feed on mesopelagic fishes, cephalopods and planktonic crustaceans.

Distribution and population

Morphological and genetic studies strongly suggest that the Mediterranean population are isolated from the eastern North Atlantic population, with little or no gene flow across the Strait of Gibraltar (Di-Méglio *et al.* 1996 ; Calzada and Aguilar, 1995 ; Archer, 1997 ; García-Martínez *et al*. 1995) . Inside the Mediterranean there is some clinal variation in body size and tissue pollutants levels suggestive of population structure and/or restriction in gene flow between areas (Calzada and Aguilar, 1995 ; Monaci *et al*., 1998). At a finer spatial scale, there is some evidence of genetic differentiation between inshore and offshore sub-populations in the Ligurian Sea (Gaspari *et al*., 2007).

The striped dolphin is particularly abundant in the Ligurian Sea, offshore the Gulf of Lions, and in the area between the Balearic Islands and Spain mainland.
Reliable abundance estimates are available only for the western basin :

- Western Mediterranean excluding the Tyrrhenian Sea (1991): 117,880 (95%CI=68,379-214,800) (Forcada *et al*., 1994)
- Balearic Sea (1991): 5,826 (95%CI :2,193-15,476) (Forcada and Hammond, 1998)
- Gulf of Lions (1991): 30,774 (95%CI :17,433-54,323) (Forcada and Hammond, 1998)
- Offshore the Gulf of Lions (2010) : 38,600 (95% CI: 25,900 to 53,900) (Cotté *et al*., 2010)
- Ligurian Sea (1992): 14,003 (95%CI=6,305-31,101) (Forcada *et al*., 1995)

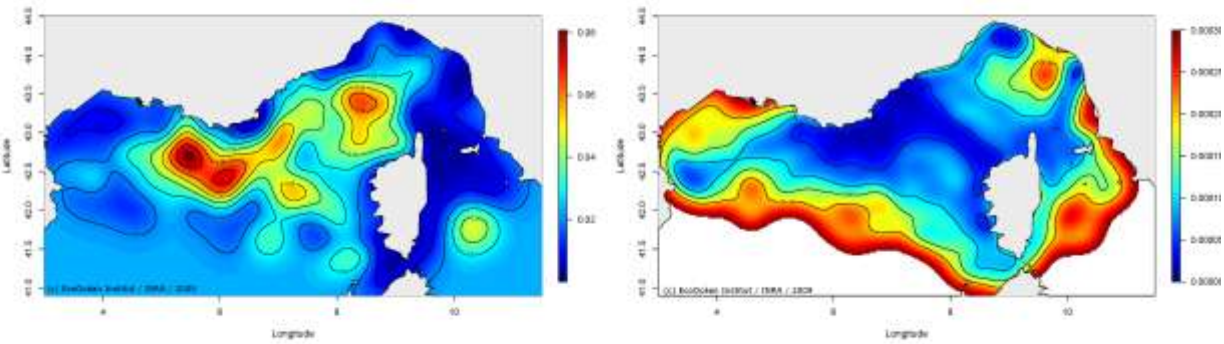

Figure 12 : Kriging values of the sighting rate of striped dolphin expressed in terms of nb of sightings per km (left) and variance of the sighting rate (right), for the period 1994-2008.

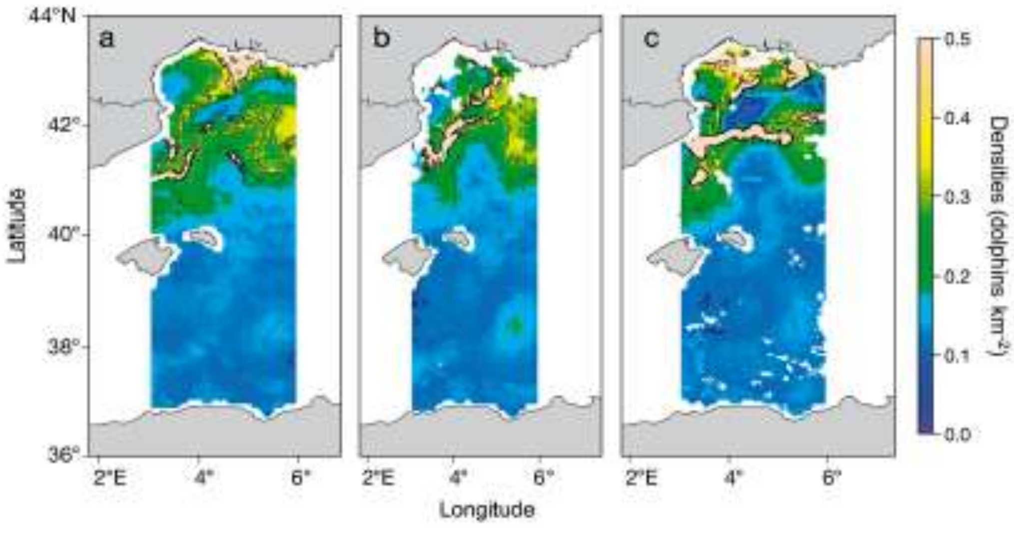

Figure 13 : Stenella coeruleoalba. Predicted striped dolphin densities (dolphins km–2) for (a) 31 July–2 August, (b) 15–17 August and (c) 31 August–2 September 2007. White areas within the strips indicate cloud coverage (Cotté and al., 2010)

Threats

Incidental captures in fishing gears is a major threat for this species. In the past, pelagic drift nets have been a major source of mortality all over the western Mediterranean Sea. Reports of mortality induces by other fishing activities are sparse and collected non-systematically, but they indicate that at least pelagic purseseines, longlines, trawls and gillnets bycaught a significant number of dolphins (Di Natale and Notarbartolo di Sciara, 1994 ; Aguilar and Gaspari, 2010 ; Morizur *et al*., 2010 ; Ridoux and Van Canneyt, 2011).
Tissue levels of several pollutants are high : organochlorine compounds (DDT, PCB), some heavy metals and selenium (Aguilar and Borrell, 2005). The levels exceed threshold levels above which detrimental effects commonly appear in mammals (Aguilar, 2000).
The depletion of fishing resources in the Mediterranean has the potential to affect striped dolphin, because some commercial fish and cephalopod species are part of its diet (Blanco *et al*., 1995).

The high maritime traffic of leisure boats, whale-watching or nautical activities (jet-ski, kayak) may disturb dolphins when they are near the coasts.

The Cuvier's beaked whale

Ecology

Cuvier's beaked whale (*Ziphius cavorostris*) is a predominantly oceanic species often associated with deep slope habitat and a marked preference for submarine canyons, escarpments or submarine mounts (D'Amico *et al*. 2003; MacLeod 2005; Podestá *et al*. 2006).

The Mediterranean population is genetically distinct from neighbouring populations in the eastern North Atlantic and therefore it has been considered an evolutionarily significant unit (Dalebout *et al.* 2005).

Cuvier's beaked whale is mainly teuthophagic. The most common prey species in the Mediterranean are from the family Histioteuthidae (MacLeod 2005), which are oceanic and meso- or bathypelagic, inhabiting depths of around 1000 m, with a preference for escarpments. Fish may also be an important component of their diet (MacLeod 2005).

Distribution and population

They appear not to be very abundant in the north-western Mediterranean Sea apart in the northern Ligurian Sea (D'Amico *et al.* 2003) : in the western Ligurian Sea Tethys Research Institute totalled only 41 sightings in 16 years (Reeves and Notarbartolo, 2006) ; in the Liguro-provençal and Gulf of Lions, Gannier and Epinat (2008) sighted only twice time this species and in the same area EcoOcéan Institut sighted twice this species in the same canyon in the west part of the Gulf of Lions (FIGURE 14). This may be occasional frequentation or an unknown preferential sector for this species. The area "Gulf of Lions" would cover this potential habitat for this species.

There are no data on abundance or trend for this species in the Mediterranean apart in the Gulf of Genoa (Rosso *et al.,* 2009) were 96-100 individuals are estimated through photo-identification analysis.

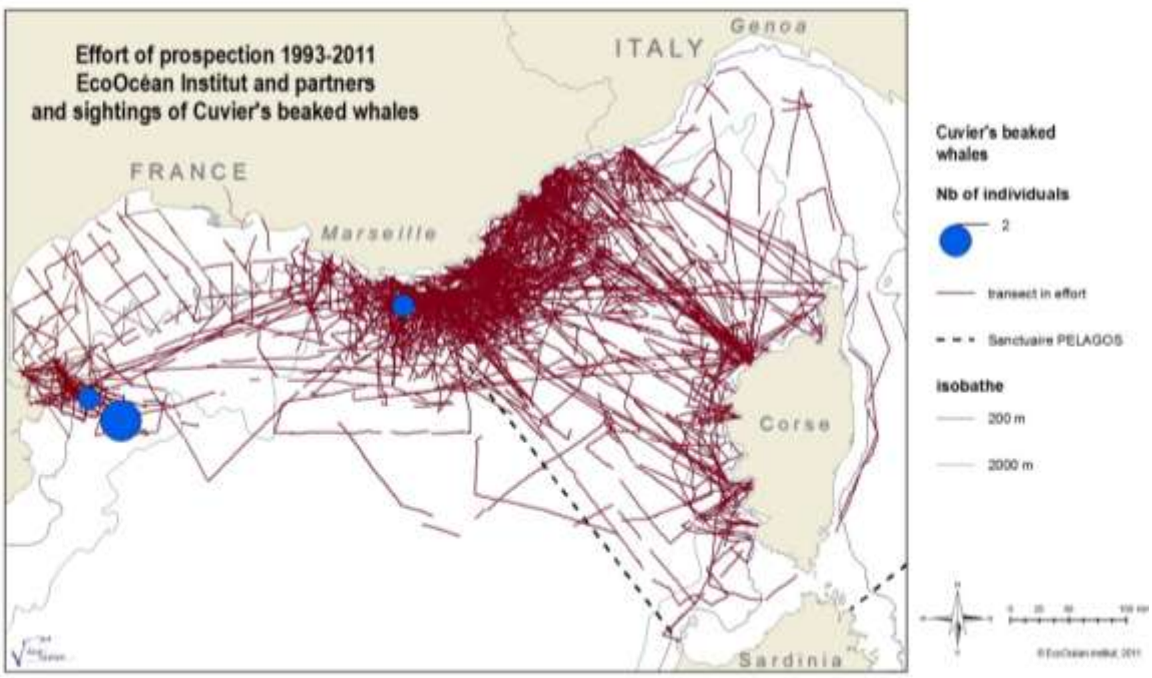

Figure 14 : Prospecting effort from 1993 to 2011 in the northwestern Mediterranean Sea and sighting of Cuvier's beaked whales.

Threats

One major threats for this species is probably manmade underwater noise : military sonars and possibly high-energy sounds from other anthropogenic sources. Recent atypical mass strandings of beaked whales have been linked to high-powered navy sonar and seismic exploration (e.g. Frantzis 1998; Jepson *et al.* 2003; Fernández *et al*. 2005). Two other concerns are bycatch in drift gillnets and the ingestion of plastic debris.

Threats on species and habitats

Marine mammals have to share their environment with several human activities : fisheries, maritime traffic of commercial vessels, nautical activities, oil and gas exploitation, military exercises, etc. These activities can have negative impacts on animals, groups or even population. Cetaceans have then to face several threats, which can be cumulative, as ship strike, by-catch, harassment, habitat degradation or loss, noise or chemical pollutants, etc.
We will mainly develop in this document the threats concerning cetaceans in the "Gulf of Lions" area generated by traffic of commercial vessels, nautical activities and fisheries.

Threats associated with maritime traffic of large commercial vessels

All threats generated by maritime traffic of large commercial vessels have been reviewed by David (2002) and actualised by Notarbartolo and Birkun 2010 and Di-Méglio et al., 2010. The main direct threats are collision (Weinrich et al., 2006) and noise disturbance (Roussel, 2002; Notarbartolo and Birkun, 2010).

The Mediterranean Sea is one of the highest places of maritime traffic of large commercial vessels (REMPEC). The northern part bears the traffic between the main European harbours of Barcelona, Marseille and Genoa (
FIGURE ***15***) all year round. Approximately thousands of vessels cross each season. High numbers of all type of vessel (merchant and passenger) going from the south of European countries to the north of Africa cross also the area of the "Gulf of Lions". The traffic of ferries is higher in summer season (REMPEC, David and Di-Méglio, 2008). There is barely area of the sea left of traffic, and this increasing and continued traffic generate potentially disturbance and ships strike for large cetacean species like fin whale and sperm whale. The slope of the "Gulf of Lions" area seems the area the most at risk for ship strike for both species (FIGURE 16 et FIGURE 17). In the whole north-western Sea, Panigada *et al*. (2006) evaluate between 27 to 40 number of fin whales struke each year, whereas Di-Méglio *et al*. (2010) estimates that nearly 5,8 fin whales and 1,2 sperm whale could be on the pathway of a large vessel each day in summer in the PELAGOS Sanctuary. It could be less in the "Gulf of Lions" area, because of less maritime traffic. But past collision events occur during traject from Marseille to the North African coast and stranded animals found in the Gulf of Lions coast have been struke (Di-Méglio *et al*., 2010). Fin whales represent 95% of collision cases but sperm whale is also severely threatened by this impact, perhaps even more du to its low density (

TABLE ***1***).

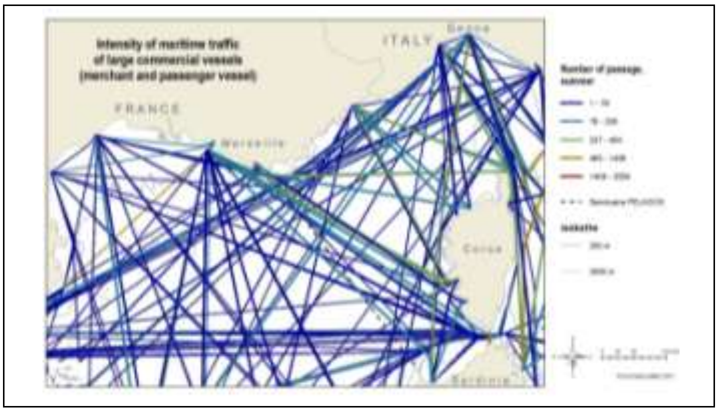

Figure 15 : Route of commercial vessels and summer intensity in terms of number of passage.

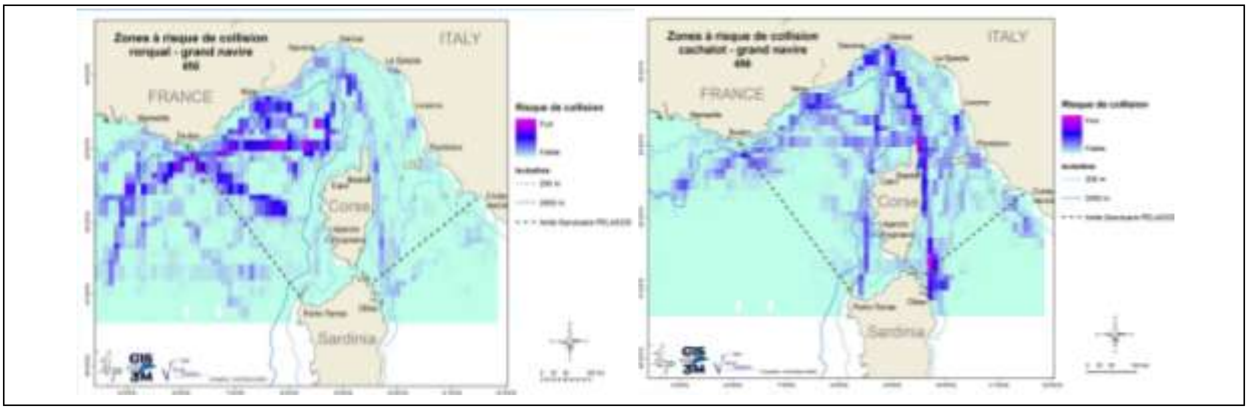

Figure 16 : Zone of risk of collision in summer between large commercial vessels and fin whale (left) or sperm whale (right) based on their habitat suitability map given by the ENFA modelisation (David and Di-Méglio, 2010).

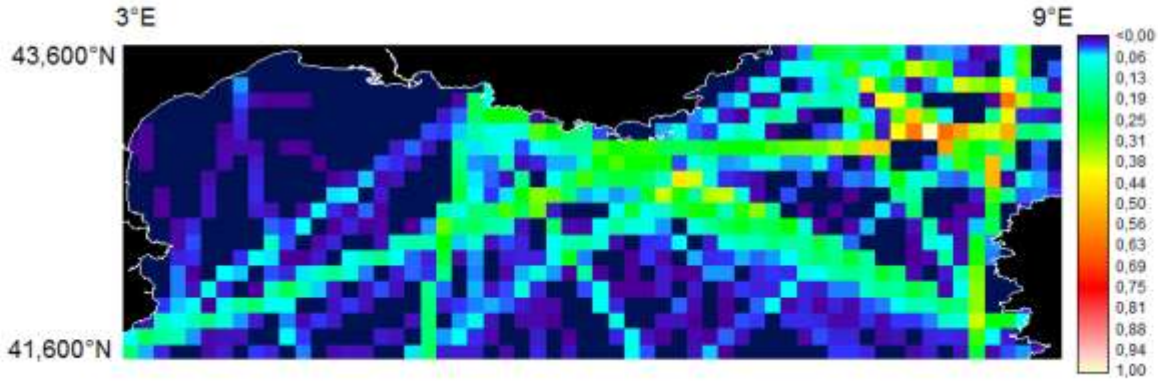

Figure 17 : Overall potential for collision between fin whales and the three categories of large vessels (ferry, Very Fast Ferry and trading vessel) in summer in the north-western Mediterranean Sea. Indicator: from 0 (low potential for collision in blue) to 1 (high potential for collision in white). From David et al., (2011).

Globally, the most recent results about collision events (Di-Méglio *et al*., 2010) give 60 ship strikes of fin whales and 5 with sperm whales between 1972 and 2009 along the French coastline in the PELAGOS Sanctuary and surroundings. Over this period of time, the mean number of known collisions reach 1,51 animals per year. In parallel a mean of 2,2% of living animals photo-identified show marks, scars or traces of collision and 2,6% traces of probable collision (David and Di-Méglio, 2010).

Table 1 : Numbers concerning collision in the north-western Mediterranean Sea (David and Di-Méglio, 2010)

	Nb of animals per day potentially on the pathway of a vessel in summer	Number of ship strikes known*	% of photo-identified animals with marks of collision **
Sperm whale	1,2	5	(8,6 à 10) mean= 9,1
Fin whale	5,8	60	(1,6 à 5,7) mean= 3,3

* from Di-Méglio *et al.,* (2010) ;
** F. Capoulade *com.pers*. and photo-identification catalogue from E*coOcéan Institut*

One other major threat generated by commercial shipping is the noise (Roussel 2002 ; Di-Méglio et al., 2010). Frantzis and Notarbartolo di Sciara (2007) estimate that according to the nowadays traffic of commercial vessel in the Mediterranean Sea there does not exist anymore any quiet area in the basin. As regards future tendencies, Loyd' S MIU (2008) show that the Mediterranean follows the world tendencies of an increasing fleet in size and volume also, leading to growing concerns. Noise pollution can hurt animals, disorient them, mask their own vocalisations and be a cause of stress continuously. This threat can generate punctual direct negative impacts on individuals as indirect negative impacts at the level of the population of a specific area. It is also an aggraving factor, because the high level of sound can diminish the auditive capacities of animals and prevents them from estimating the arrival of a ship in order to avoid it in time.

Threats associated with maritime traffic of leisure boats

Not only large vessel can have a negative impact on cetaceans, small vessels also can be a threat, from disturbance to harassment. The first impact is du only to the density of vessels in an area. Sometimes frequences reaching 100 boats per km² or 150 boats per hour are reported, in highly touristic region (Hyères archipelago, David and Di-Méglio, 2008). Harbours situated along the Gulf of Lions coast .

Then the passage of an intrusive boat over a group of cetaceans can disturb them punctually so they stop their activity to swim away. The repeated “visit” of boats could lead the group to let the area free and search for a sub-optimal area but a calmer one also.
behavioral changes and temporal avoidance of habitat for common bottlenose dolphins have been reported in the vicinity of pleasure boats and the number of recreational boats has been correlated with avoidance of certain areas by dolphins (Underhill 2006; Bearzi *et al*., 2008; Lusseau, 2003).

Along the French coast of the Gulf of Lions exists a lot of harbours, carrying a capacity of motor or sailing vessels ranging from 40 to 3800 units (

Figure 18; Planchot, 2008). The two biggest French Mediterranean harbours are located in this region. But a great part of all these boats navigate rarely offshore (FIGURE 19) : 90% of leisure boats navigate within 3 NM from coast (David and Di-méglio, 2008).

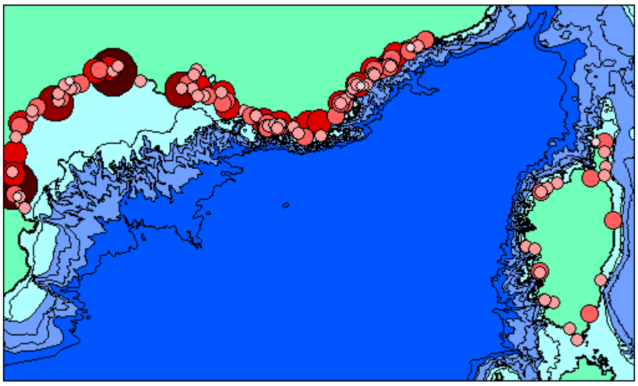

Figure 18 : Carrying capacity of harbours, expressed in number of boats (Planchot, 2008).

Figure 19 : number of leisure boats per 100km in cells of 20x20 MN (Roussel et al., 2000)

The second threat generated by leisure vessel is collision with medium and small cetaceans. Some witnesses confirm that this kind of impact exists: with small dolphins in Ischia (Pace *et al*., 2006), pilot whale in the Strait of Gibraltar (Gauffier *pers.com*) or striped dolphin in the provençal sea (Dupraz *pers.com*.).

The Annexe I synthesizes the threats generated by maritime traffic, from large vessel to leisure boats, on cetaceans at different level.

Fisheries and negative impacts on cetaceans

The Gulf of Lions is one of the highly exploited areas by fisheries. All types of gear are employed, from trawl to longline and net. Most of the fisherboats work over the shelf and shelf edge (FIGURE 20), but some of them exploit also the pelagic area.

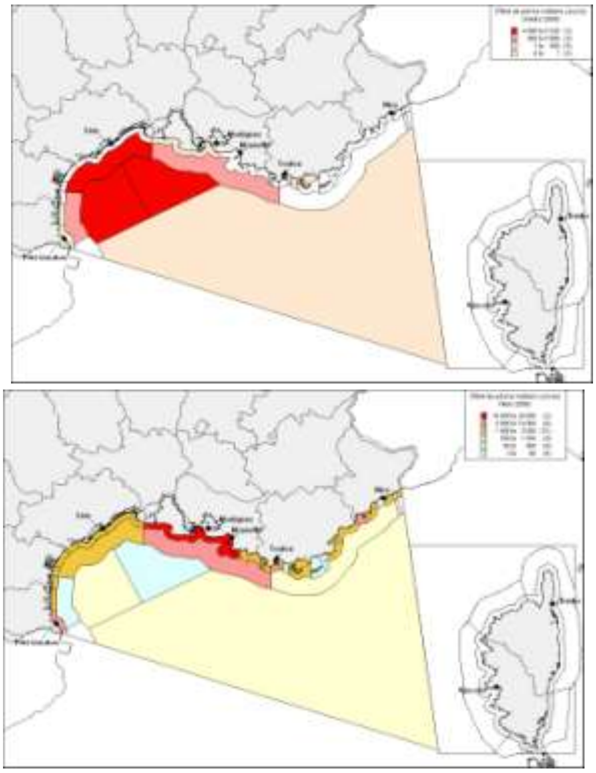

Figure 20 : Fishing effort expressed in number of days at sea in the different coastal, shelf and offshore areas, for trawlers (left) and all type of nets (right). Di-Méglio et al. 2010.

Since 2007, the « thonaille », a small pelagic driftnet used for tuna and swordfish by a french artisanal fleet is banned. It has been estimated that 155 striped dolphins (IC 95%: 114-199) were by-caught by these nets each year (David *et al.*, 2010) and also punctually other cetacean species like sperm whale, pilot whale or Risso' dolphin.

Under the European law (CE) n°812/2004, some French fisherboats operating along the French Mediterranean coasts, mainly trawlers, were followed by independent observers in order to estimate by-catch. The program called "OBSMAM" had for first results an estimation of approximately 70 striped dolphins (CV : 0,53) and 30 bottlenose dolphins (CV : 0,97) bycaught by trawlers in the Gulf of Lions (Ridoux and VanCanneyt, 2011).

But other elements give some indicators of interaction between cetaceans and fisheries : stranded animals. On all species stranded were discovered traces of interaction with fisheries in 2,7 to 38,9% of the individuals, depending on the species (TABLE 2). Mainly nets were responsible of entanglements, but also trawl and purse seine (Sacchi, 2008).

Table 2 : Number of cetaceans stranded from 1968 to 2008, and among them number presenting traces of fishery interaction or cause of death (Sacchi and David, 2008).

Species	Total of stranded animals	Total of animals with traces of fishery gear	% stranded with trace of fishery gear
Fin whale	75	2	2,7
Pilot whale	52	9	17,3
Risso'sdolphin	63	14	22,2
Sperm whale	23	4	17,4
Striped dolphin	1127	164	14,6
Bottlenose dolphin	162	40	24,7
Cuvier's beaked whale	18	7	38,9
Non identified cetacean	26	5	19,2
Non identified dolphin	242	25	10,3
TOTAL	1828	279	15,3

Other threats

In this large open sea area, the « Gulf of Lions », other anthropogenic activities threaten cetaceans. The Mediterranean Sea is a militarily strategic area, and is also of increasing interest for hydrocarbon exploration and exploitation. All military or geological or oceanographic activities involving high-intensity noise carried out in the proximity of some species, like sperm whale and Cuvier's beaked whales are of great concern. Both activities occur in the "Gulf of Lions" area. This kind of high sound exposition can also be an aggravating factor for collision in masking a vessel approach sound or in diminishing the auditory capacities of animals.

Moreover, merely teuthophagous species, like pilot whale, Cuvier's beaked whale or Risso's dolphin seems to be attracted by plastic debris that may be mistaken for squid. Ingestion of plastic debris leads to the contamination and even the death of the animals.
Contaminant levels, particularly of organochlorine compounds are a concern due to their potential effects on reproduction and health (Fossi and Marsili 2003).

Status of conservation of cetaceans and conservation tools

Considering species, no management or conservation measures have been taken as yet specifically for the conservation of several species : sperm whale, pilot whales, striped dolphin or Risso's dolphin, although generic protection laws for cetaceans exist (Table 3).

Table 3 : Conservation status and tools concerning cetaceans species.

Common name	**Scientific name**	**Conservation statuts**	**International and national conservation instruments**
Fin Whale	*Balaenotera physalus*	Vulnerable	Bern Convention, App. II Bonn Convention, App. I, App.II CITES, App.I SPA/BD Protocol, Barcelona Convention, Annexe II French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008
Striped dolphin	*Stenella coeruleoalba*	Vulnerable	Bern Convention, App. I Bonn Convention, App.II (East tropical Pacific, Mediterranean) CITES, App.II SPA/BD Protocol, Barcelona Convention, Annexe II, (Western Mediterranean) French law : Arrêté du 1er juillet 2011
Common bottlenose dolphin	*Tursiops truncatus*	Vulnerable	Bern Convention, App. I Bonn Convention, App.II (North and Baltic sea) CITES, App.II EU Habitats Directive, Ann. II SPA/BD Protocol, Barcelona Convention, Annexe II, Western Mediterranean) French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 december 2007; Decree of 12 January 2008
Long-finned Pilot whale	*Globicephala melas*	Data deficience	Bern Convention, App. I Bonn Convention, App.II (North and Baltic sea) CITES, App.II SPA/BD Protocol, Barcelona Convention, Annexe II French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008
Risso's dolphin	*Grampus griseus*	Data deficience	Bern Convention, App. I Bonn Convention, App.II (North and Baltic sea) CITES, App.II SPA/BD Protocol, Barcelona Convention, Annexe II French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008
Sperm whale	*Physeter macrocephalus*	Endangered	Bern Convention, App. II (Mediterranean) Bonn Convention, App. I, App.II CITES, App.I SPA/BD Protocol, Barcelona Convention, Annexe II French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008
Cuvier's beaked whale	*Ziphius cavirostris*	Data deficience	Bern Convention, App. I CITES, App.II SPA/BD Protocol, Barcelona Convention, Annexe II French law : Arrêté du 1er juillet 2011 Spanish law : Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008

Various kinds of marine protected areas exist or have been proposed throughout the Mediterranean. Although not always specifically intended for one species or another, several measures once implemented, could contribute to their conservation : the PELAGOS Sanctuary, a 90,000 km2 cetacean sanctuary in the Corsican-Ligurian Basin, created in 1999 by Italy, France and the Monaco Principality. Other MPAs are planned. If appropriately managed and coordinated, this network of MPAs may contribute to cetacean conservation.

International protection status include also cetaceans, at different levels, merely bottlenose dolphin is mentioned :

1. CMS and ACCOBAMS.
2. Wildlife treaties (The Protocol of the Barcelona Convention concerning Specially Protected Areas and Biological Diversity in the Mediterranean ; the Bern Convention ; the CITES ; the EC regulation lists the species in its Appendix A, which prohibits trade for primarily commercial purposes).
3. International treaties pertinent for the conservation of Mediterranean cetaceans and/or their habitats, including: the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (the Barcelona Convention) and its protocols;the FAO Code of Conduct for Responsible Fisheries ; the "United Nations Straddling Stocks Agreement"; the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas; the Agreement for the Establishment of the General Fisheries Commission for the Mediterranean (GFCM).
4. Two European Community instruments that are binding for EU Member States are worth mentioning here due to their relevance to at least bottlenose dolphin conservation: Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy, and Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, or "Habitats Directive" whose annex IV protects all cetacean species

While these types of designations, and others not listed here, may benefit cetaceans species at least indirectly, measures likely to provide direct benefits remain to be identified and implemented (e.g. area-,season-, or fishery-specific reductions in fishing effort; curtailment of inputs of particular pollutants)

Considering threats, as disturbance, harassment and hurt (ship strikes), the national French law (Arrêté du 1er juillet 2011) and the Spanish laws (Decree 1727/2007 of 21 December 2007; Decree of 12 January 2008) could largely limit these impacts.
Considering by-catch : pelagic driftnets have been prohibited in Spain and their use has been limited by EU regulations since 2002. Following, a European regulation aims at understanding and reducing by-catch of marine mammals in fisheries, the (CE) 812/2004 from the council of the 26^{th} of April 2004. The FAO and GFCM regulations or agreements.

Considering maritime traffic and perturbation : PELAGOS Sanctuary, ACCOBAMS, Bonn Convention, Bern Convention, Barcelona Convention, CITES, CBD , IMO.
Considering chemical pollution : Barcelona and Bucharest Conventions, IMO, MARPOL.

Considering noise pollution: several conventions include in the definition of pollution « the energy introduce in marine environment by human ». This can constitute the legal baseline for the regulation of noise emission in the sea. The Hydrographic Office of the Spanish Navy has agreed not to use active sonar in that area (C.Gamundi, Subdirector of the Hydrographic Office of the Spanish Navy, pers. comm. in Notarbartolo and Birkun, 2010).

Important areas for cetacean conservation

The area “Gulf of Lions” represents the natural continuation westward of the contiguous PELAGOS Sanctuary, recognised for its cetacean richness (Figure 21). It shares important cetacean habitats and is likely inhabited by the same cetacean populations that occur in the Sanctuary (UNEP-MAP-RAC/SPA. 2010).

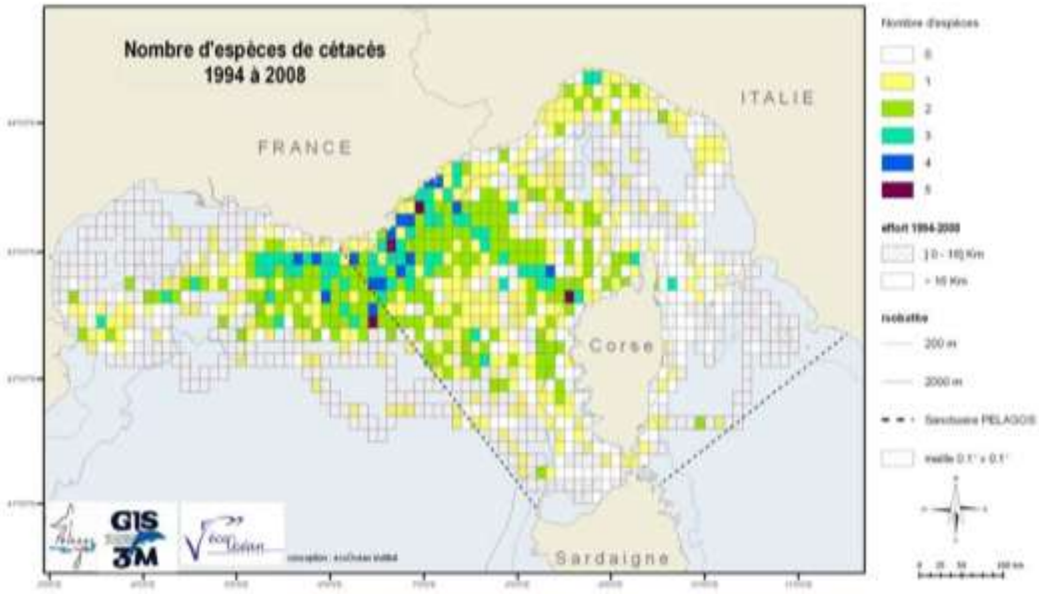

Figure 211 : Fishing effort expressed in number of days at sea in the different coastal, shelf and offshore areas, for trawlers (left) and all type of nets (right). Di-Méglio et al. 2010.

The northern part of the western Mediterranean Sea appears really as a highly important area for cetaceans globally and for all kind of diet : planctonophageous (Fin whale), teutophageous (Pilot whale, Cuvier’s beaked whale, Risso’s dolphin and sperm whale), ichtyophageous (bottlenose dolphin) and mixt (striped dolphin) (see Figure 22). This is a fact, but perhaps also highlighted by many prospecting effort in the north of the area. So, despite the fact that few prospection occur in the south and the west of the area leading to a lack of knowledge there, it is clear, based on habitat suitability maps and recent studies (Cotté *et al*., 2009 ; Cotté *et al*., 2010 ; Castellote *et al*., 2008) that the species richness and frequentation of this part of the area could be as high as in the Sanctuary PELAGOS.

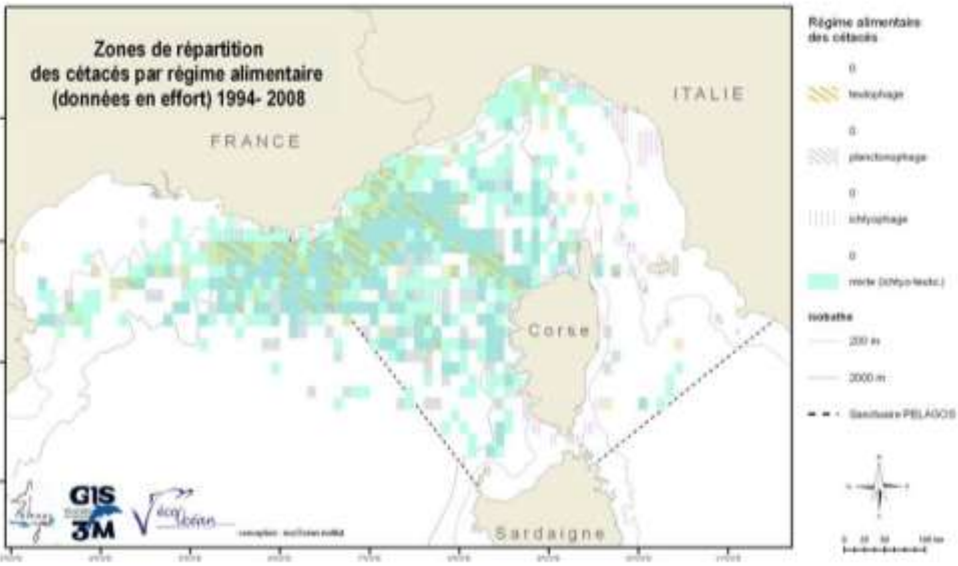

Figure 22 : Distribution of cetaceans species by type of diet (data in prospecting effort, 1994-2008; Delacourtie et al., 2009).

The continental shelf is the habitat of the bottlenose dolphin, from the coast through the shelf edge and canyon's head. The slope appears more frequented by teutophageous species. Risso's dolphins are encountered all along the slope. Concerning sperm whales, Piot whales and Cuvier's beaked whales, they seem to exploit preferentially some peculiar canyon's systemes: Creus and Lacaze-Duthier for the three species and Sète and Marti for the sperm whale and pilot whale (EcoOcéan Institut, unpublished data, Figure 23). Concerning more pelagic waters it appears that the entire area is important for species inhabiting this habitat, like fin whales and pilot whales and even sperm whales, whereas for the coastal bottlenose dolphin the shelf edge and canyon's head are important (Figure 24).

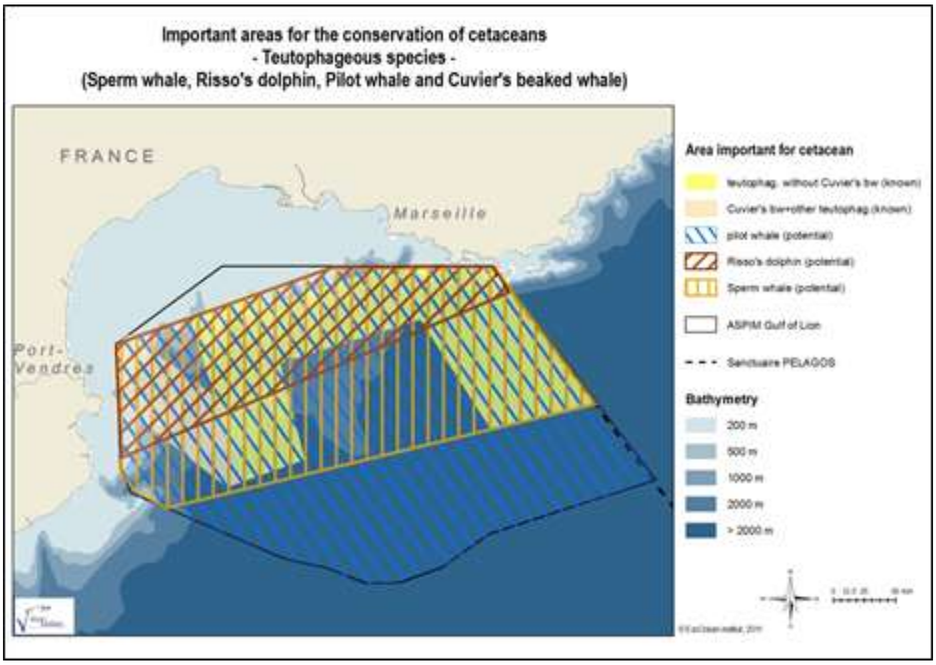

Figure 23 : Important areas (known and potential) for the conservation of teuthophagous species (Sperm whale, Risso's dolphin, Pilot whale and Cuvier's beaked whale) on the continental slope.

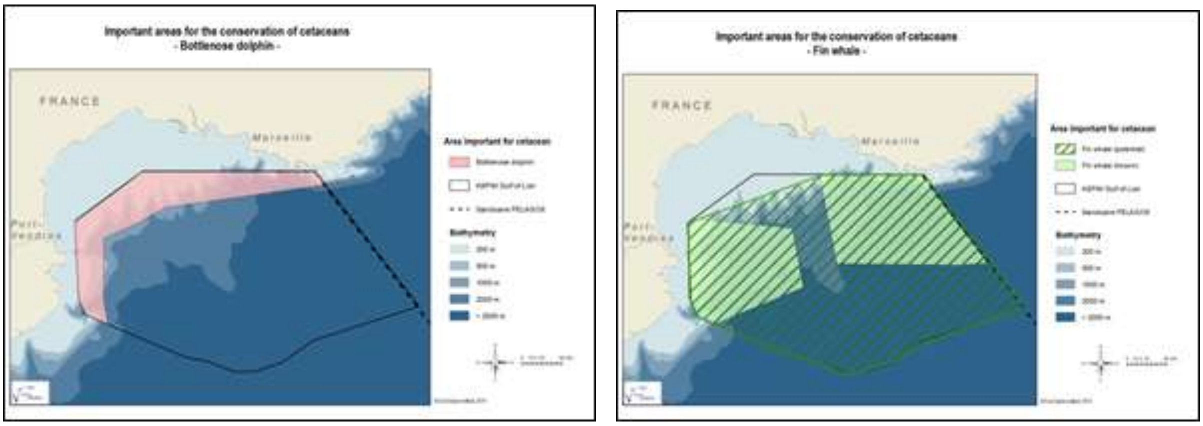

Figure 24 : Important areas (known and potential) for the conservation of bottlenose dolphin (left) and fin whales (right).

Several gaps, as well spatial as temporal, exist for the “Gulf of Lions” area. The recent and ongoing campaigns of acquisition of knowledge for cetaceans and seabirds lead by the French Agency of Marine Protected Area by airplane should help in filling some of these gaps : the program will cover all the area, including the south and west part of the “Gulf of Lions” area, and in two seasons, summer and winter. But it will perhaps not be enough to get precise data on species spending most of their time diving (sperm whale and Cuvier’s beaked whale), as the airplane samples the area with a fast speed and may miss them even if they are in the area.

Concerning threats, more studies are needed to better understand the nature and level of impacts, as well as to test solutions proposed to mitigate these impacts.

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ANNEXE I

Synthesis of impacts generated by maritime trafic on cetaceans (Di-Méglio et al., 2010)

	Type d'effet	Impact à l'échelle de l'individu		Impact à l'échelle de la population	
		Court terme	Long terme	Court terme	Long terme
Dérangement	Comportemental	Fuite horizontale Fuite verticale Comportements plus erratiques Instabilité de groupe Diminution du temps passé à des occupations vitales Evitement temporaire d'une zone Stress	Augmentation des dépenses d'énergie Risque d'accidents de décompression Risque augmenté de prédation Réduction d'acquisition d'énergie Baisse de l'état général de santé Evitement permanent d'une zone Stress chronique	Diminution de la résistance aux maladies et aux parasites Diminution de la lactation Diminution de la survie des jeunes Décalage de la croissance & de la maturité sexuelle	Augmentation du taux de mortalité Baisse du taux de reproduction
Pollution Sonore	Masquage Physique Physiologique Sur les proies	Réduc. champs de communication / d'écholocation Compensation TTS Stress Réduction de ressources alimentaires	Augmentation des dépenses d'énergie et réduction des acquisitions (condition physique réduite) PTS Stress chronique Famine	Risque de rater accouplement Risque augmenté de prédation / collision Baisse de fécondité Transfert d'hormones de stress au nouveau-né -> tout risque aggravé	Baisse du taux de reproduction Augmentation du taux de mortalité Extinction (populations affaiblies / isolées)
Collisions	Physique Physiologique	Blessure légère Blessure grave Mort Stress	Diminution de la résistance aux maladies et parasites Stress chronique	Mortalités en général Mortalités des femelles reproductives et des nouveau-nés	Réduction de la taille de la population Baisse du taux de reproduction Extinction (populations affaiblies / isolées)
Autres – l'habitat	Physique Chimique Biologique Emissions GES	Mouvement Ancrage Abrasion coque / hélice Macrodéchets Pétrole SNPD / biocides / métaux en traces Introduction d'espèces invasives	Soulèvement de sédiments Dommages aux habitats benthiques situés à faible profondeur Enchevêtrement / ingestion -> mort / baisse de condition physique Mort / revêtement corporel Bioaccumulation – condition physique réduite / dommages aux organes / os Perte de biodiversité Contribution au réchauffement climatique	Réduction de ressources alimentaires Diminution de la résistance aux maladies et parasites Nourrissage devient difficile Transfert à la progéniture Réduction de ressources alimentaires Perte d'habitat physique et sonore	Augmentation du taux de mortalité Baisse du taux de reproduction Extinction (populations affaiblies / isolées)

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