Pelagos Sanctuary
Submission of Scientific Information to Describe Areas Meeting Scientific Criteria for Ecologically or Biologically Significant Marine Areas

Title/Name of the area: Pelagos Sanctuary

Presented by: (*names, affiliations, title, contact details)*

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Abstract (*in less than 150 words)*

The Pelagos Agreement establishing the Sanctuary for marine mammals in the Mediterranean Sea, is an international governmental agreement between France, Italy and the Principality of Monaco signed in 1999 and entered into force in 2002, to insure a favourable conservation status of marine mammals by protecting them and their habitat from direct and indirect negative impacts of human activities, in compliance with a management plan. With about 87,500 sq. km, most of which lie in high Seas, the Pelagos Sanctuary is registered as a Specially Protected Area of Mediterranean Importance (SPAMI).

Introduction *(To include: feature type(s) presented, geographic description, depth range, oceanography, general information data reported, availability of models)*

1. Geology/geomorphology

The western Mediterranean developed as a result of the convergence of tectonic plates. The Liguro-Provençal Basin opened up as a result of the rotation of the Corso-Sardinian Block. The morphology of the Sanctuary thus includes island areas.
The seabed of the Sanctuary was formed gradually as a result of large-scale folds and thrust faults in the Alpine orogeny, subsidence phenomena that occurred because of extensions in the Neogene period, the morphogenesis of sea-level oscillations in the Quaternary period, atmospheric, marine and fluvial erosion and recent and on-going sedimentation.
These different geomorphological phenomena explain the existence of mountainous areas, plains that extend into rocky coastlines of varying steepness and low coastal sections, often accompanied by lagoons and wetlands. Apart from the plains on the eastern side of Corsica and the Tuscan coast, the coastlines that run along the perimeter of the Sanctuary are rocky and often very steep. Most of the water regimes are torrential, consisting of steep and often interdependent catchment areas. The mouths of the rivers are generally small, with stony sediments.

2. Underwater topography

The Sanctuary area is characterized by markedly heterogeneous topography and hydrodynamic diversity.
The Liguro-Provençal Basin and the area adjacent to it alongside Corsica and across the Sea of Sardinia lie on a continental platform with a very small border that lies between 2.5 and 10 nautical miles from the coast.
Deep underwater canyons run along paleofluvial channels and tectonic fractures at a depth of over 2000 m in places.
The continental shelf broadens from west to east and is very steep in the Provence region and along Corsica's western coast, becoming wider in the eastern section and extending as far as 25 km from the Tuscany coasts.
The deepest seabeds are located to the east of the meridian, 5°30' E, and can reach 2,700 m. The northern Tyrrhenian Sea is less deep (reaching a maximum depth of around 1,700 m). It is separated from the Ligurian Sea by the Strait of Bonifacio and the Gulf of Follonica - island of Elba. Its large continental shelf, from which isolated underwater elevations arise, links the two parts.

See figure 1

3. Climate

The area of the Pelagos Sanctuary is subject to the Mediterranean climate: hot and dry summers under the influence of the Azores High, and winters mild and relatively rainy. Local winds are variable, with maxima observed in winter. The Liguria-Provencal basin suffers from high winds from the N-NW sector (Mistral and Tramontana) blowing in average at 50 km / h, and often more, with gusts regularly exceeding 100 km / h, up to 170 km / h; these are the winds which create, in the western Mediterranean, the most violent storms, but the coastline between St. Raphael and Genoa is relatively protected. The Gulf of Genoa and the northern Tyrrhenian Sea are often swept by winds from N-NE and S-SE (Sirocco), and the western coast of Corsica suffers less frequently from the Libeccio of S-SW.

See figure 2

4. Hydrology and currentology

The water balance of the Mediterranean is negative: high levels of evaporation are not offset by precipitation and water supplied by catchment areas. This negative balance is therefore partly offset by the inflow of Atlantic waters that is higher than the outflow of Mediterranean waters.
The Mediterranean's northwestern water masses circulate along the continental slope in a cyclonic circuit induced by the density gradients of three different water zones:

- a surface zone up to 300-400 m deep, composed of Atlantic waters and additional freshwater from rain and rivers,
- an intermediate zone between 200 and 500 m deep, which is denser, richer in nutrients and relatively warm,
- more homogenous deep water, with a near-constant annual temperature of 12.7°C. Wind-induced water exchanges are more intense in winter when subsurface waters rise to the surface in upwellings.

The intermediate waters also form part of this current. They flow into the Tyrrhenian Sea and divide in order to cross the Canal of Corsica, passing west beyond Sardinia and Corsica. By the Cap Corse, there is a second current from the eastern Mediterranean. The two currents meet to the north of Corsica, forming the Liguro-Provençal current that flows up to the north towards the Gulf of Genoa before turning to the west along the coast towards Spain. As a result of cyclonic flow, the current gives the Liguro-Provençal Basin its dome-shaped point of divergence and frontal zone structures, which are both significant in terms of their biological productivity. The intermediate waters also

form part of this current. They flow into the Tyrrhenian Sea and divide in order to cross the Canal of Corsica, passing west beyond Sardinia and Corsica. By the Cap Corse, there is a second current from the eastern Mediterranean. The two currents meet to the north of Corsica, forming the Liguro-Provençal current that flows up to the north towards the Gulf of Genoa before turning to the west along the coast towards Spain. As a result of cyclonic flow, the current gives the Liguro-Provençal Basin its dome-shaped point of divergence and frontal zone structures, which are both significant in terms of their biological productivity.

See figure 3

5. Oceanographic Processes and Structures

The northern part of the western Mediterranean is subject to a flow in an anti-clockwise direction. A fairly powerful current (25 to 50 cm/s) drives the less salty Atlantic surface waters (entered by the Strait of Gibraltar) from the coasts of Corsica to Spain, along the coastline of the Côte d'Azur and Provence. This current, known as the Liguro-Provençal current, or current Liguria, or North Mediterranean current, is present throughout the year. Under the effect of wind, evaporation, mouths of rivers, cooling or warming of the sea, this average flow may be disrupted.
Regarding swells, three main areas can be considered within the Pelagos Sanctuary:

- From the islands of Hyères to Saint Raphael, except in singular cases, the general direction of the coast gives it some protection against the swells from the South-West, corresponding to the largest fetch. The extreme swells reaching these coasts are generally from the South, their orientation turning gradually from south to South-East when approaching St. Raphael. In February 1989, during a severe storm from SW, the maximum significant height recorded south of the Island of Levant has been 4.06 m and the maximum height 7.33 m. During this storm, the average period, at the worst moment, was 7 to 8 seconds.
- From St. Raphael to Savona, swells come usually from the East. Maximum offshore swells come usually from the South-West, but, except in exceptional circumstances, the coast is relatively protected due to the general orientation of the shore and the importance of mountains bordering the coast. Swell measurements, off Nice, Cannes and Antibes, in the period 1954-1970, has led to estimate of annual and decadal significant heights of 1.8 m and 2.8 m in Antibes (a site opened only to the east) and of 2.4 m and 3.3 m in Nice. During the Christmas 1973 storm from the East, one of the most severe hitting this part of the coast, the buoy operating off Nice had recorded a maximum height of 5.3 m. In Monaco, the definition of the swells has been the subject of several studies since 1966, especially for the development of the quay of Fontvieille, facing southeast. The swell taken into consideration, assumed to be millennial, had a maximum height of 6 m, finally upgraded to 7 m.
- From Savona to La Spezia, the orientation of the coastline is exposed to the full force of the waves from Southwest generated by the largest fetch of the western Mediterranean. From the recordings made by the buoy off La Spezia in the Italian Network for directional measurement of waves, the significant waves in this location have been estimated as follows:
    - significant annual height: 4.94 m
    - significant decadal height: 6.61 m
    - significant centennial height: 8.26 m. For its own part, the Port of Genoa, using measurements taken during 5 years from a non-directional buoy, estimated the significant heights, annual, decadal and centennial, respectively to 3.55 m, 4.79 m and 6.02 m.

Location

The Pelagos Sanctuary includes the coastal waters and pelagic area comprised between the headlands of the Giens peninsula to the Burano Lagoon in southern Tuscany. It extends across the waters of a number of islands, including Corsica and northern Sardinia as well as smaller islands such as the islands of Hyères, Liguria, the Tuscan Archipelago and the Strait of Bonifacio.

The Sanctuary covers 2,022 km of coast and an area of 87,500 sq. km as follow:

- Inland waters: 14,7 %
- Territorial waters: 32,3 %
- Beyond 21 miles: 53 %

See figure 4

Feature description of the proposed area

(This should include information about the characteristics of the feature to be proposed, e.g. in terms of physical description (water column feature, benthic feature, or both), biological communities, role in ecosystem function, and then refer to the data/information that is available to support the proposal and whether models are available in the absence of data. This needs to be supported where possible with maps, models, reference to analysis, or the level of research in the area)

1. Cetaceans

The Pelagos Sanctuary is extremely important, for cetacean populations, due to the abundance of food and to the diversity of the habitats, with characteristics most favourable for the feeding and reproduction of marine mammals. Seven species are considered common or frequently sighted in the Corso-Liguro-Provencal basin:

- The **striped dolphin** (*Stenella coeruleoalba*) is the most abundant species in the Sanctuary.
  IUCN status in the Mediterranean: **vulnerable**.
  Population estimate in the Pelagos Sanctuary: **27.457-53.968 specimens in summer** (Panigada S, Lauriano G, Burt L, Pierantonio N, Donovan G (2011) Monitoring Winter and Summer Abundance of Cetaceans in the Pelagos Sanctuary (Northwestern Mediterranean Sea) Through Aerial Surveys. PLoS ONE 6(7): e22878. doi:10.1371/journal.pone.0022878)

- The **common bottlenose dolphin** (*Tursiops truncatus*) is the only species present in coastal areas of Pelagos Sanctuary and therefore, it is sensitive to disturbance caused by human maritime activities.
  IUCN status in the Mediterranean: **vulnerable**.
  Population estimate in the Pelagos Sanctuary: **884-1023 specimens (**Gnone, G., Bellingeri, M., Dhermain, F., Dupraz, F., Nuti, S., Bedocchi, D., Moulins, A., Rosso, M., Alessi, J., McCrea, R.S., Azzellino, A., Airoldi, S., Portunato, N., Laran, S., David, L., Di Meglio, N., Bonelli, P., Montesi, G., Trucchi, R., Fossa, F., Wurtz, M., 2011. Distribution, abundance, and movements of the

bottlenose dolphin (*Tursiops truncatus*) in the Pelagos Sanctuary MPA (north -west Mediterranean Sea). Aquatic Conservation: Marine and Freshwater Ecosystems 21, 372 -388)

- The **fin whale** (*Balaenoptera physalus*), the only whale frequent in the Mediterranean, particularly sensitive to collisions with large ships.
  IUCN status in the Mediterranean: **vulnerable**.
  Population estimate in the Pelagos Sanctuary: **879-923 specimens** (Forcada J., Aguilar A., Hammond P., Pastor X. & Aguilar R., 1996. Distribution and abundance of fin whales (*Balaenoptera physalus*) in the Western Mediterranean during summer. Jour. of Zool. London 238 : 23- 31)

- The **Cuvier's beaked whale** (*Ziphius cavirostris*), localized populations, species particularly sensitive to disturbances of acoustic origin.
  IUCN status in the Mediterranean: **data deficient**.
  Population estimate in the Pelagos Sanctuary: **95-98 specimens** (Rosso, M., 2010. Population size, Residency patterns and energy demand of Cuvier's beaked whale (*Ziphius cavirostris*) in the North Western Mediterranean Sea. PhD thesis, University of Basilicata, Potenza, Italy.)

- The **sperm whale** (*Physeter macrocephalus*), the largest of the toothed whales
  IUCN status in the Mediterranean: **endangered**.
  Population estimate in the Pelagos Sanctuary: **data deficient**

- The **pilot whale** (*Globicephala melas*), a species involved in collisions in the Mediterranean.
  IUCN status in the Mediterranean: **data deficient**.
  Population estimate in the Pelagos Sanctuary: **data deficient**

- The **Risso's dolphin** (*Grampus griseus*), a species sensitive to noise pollution and contaminants.
  IUCN status in the Mediterranean: **data deficient**.
  Population estimate in the Pelagos Sanctuary: **data deficient**

One other species, although rare, is present from time to time in the Pelagos Sanctuary:

- The **short-beaked common dolphin** (*Delphinus delphis*), a coastal species rare in the Northern Mediterranean basin.
  IUCN status in the Mediterranean: **endangered**.
  Population estimate in the Pelagos Sanctuary**: insufficient data**

Although only eight of these species are regularly observed in this area, 22 species of cetaceans have been recorded in the Mediterranean and Black Seas, many of which have been seen already in the waters of the Pelagos Sanctuary (eg Orca killer whale, *Orcinus orca*), approximately amounting to a quarter of the species of cetaceans listed worldwide.
The above paragraphs shows that out of the 8 species of cetaceans most present in the area, 5 of them have been classified by the IUCN as at risk, vulnerable or endangered, with data lacking for the other 3 species.
The following table describes the scientific studies conducted in the framework of the Pelagos Sanctuary and related to the cetaceans population (abundance, distribution, seasonality, demography, diet and genetic).

Marine mammals present in the Pelagos Sanctuary	**Population description**					
	Abundance	**Distribution**	**Seasonality**	**Demography**	**Diet**	**Genetic**
Balaenoptera physalus	A, B 6	A, D, E 6, 8, 10, 11, 20, 25, 26, 27, 44	A 6, 8, 10, 11, 12, 16, 20, 25, 26, 27, 40, 43	H 38, 39	7, 20, 44	
Physeter macrocephalus	6	D 6, 10, 11, 17, 25, 26, 27, 44	6, 9, 10, 11, 12, 16, 17, 25, 26, 27, 40, 43		5, 7, 9, 17	
Stenella coeruleoalba	A, B 6	A, D 6, 11, 15, 25, 26, 27	A 6, 11, 12, 15, 16, 25, 26, 27, 40, 43			
Tursiop truncatus	C 2, 35	C, D 1, 11, 18, 25, 26, 28, 35	1, 11, 12, 16, 18, 25, 26, 28, 35, 40, 43	1, 18, 35		
Delphinus delphis			11, 25, 26, 40			
Grampus griseus	3, 6, 3	D 3, 11, 25, 26, 28, 37	6, 11, 12, 16, 25, 26, 28, 31, 37, 40	3,37		
Globicephala melas		D 11, 25, 26	11, 12, 16, 25, 26, 40			
Ziphius cavirostris		D 34	34, 40			
Cetaceans in general	23					

Legend:

High priority research
Medium priority research
Low priority research

A, B, 1, 2 *Scientific studies (see references in the chapter "reference" at the end of this document)*

2. Other ecological criteria

a. Scarcity

The Mediterranean is a semi-enclosed sea, which, although it represents only 0.82% of the ocean surface, is one of the major reservoirs of global biodiversity, marine and coastal, with 28% of endemic species, 7.5% of fauna and 18% of marine flora. The vast majority of its populations has specific sub-Mediterranean characteristics, genetically isolated from other Atlantic populations. This has especially been demonstrated for a majority of species of fish – tropical, subtropical or boreal – or coastal invertebrates, but also for top predators such as bottlenose dolphins, fin whales or sperm whales present in the Pelagos Sanctuary. The Mediterranean Sea is characterized by a generally low productivity (oligotrophic sea), but the area of the Sanctuary is a separate sub-unit biogeographically marked by a relatively high productivity, including offshore. This phenomenon makes it an area of major importance for food, but also for the reproduction of several populations of Mediterranean cetaceans.

The importance of biodiversity within the Sanctuary and the genetic specificity of some Mediterranean cetacean species make it a rare zone, the deterioration of which could result in the disappearance of entire subpopulations.

b. Habitat

The Sanctuary includes different types of habitats used by cetaceans and represents a crucial feeding area for many species, especially in summer. All the cetacean species occurring in the area are listed in the Annex IV of the Habitats Directive 92/43/EEC Flora Fauna (this annex deals with the animals and plants of European Community interest in need of strict protection). The continental shelf is the habitat of the common bottlenose dolphin, of which the Mediterranean subpopulation is described as "vulnerable" according to IUCN criteria. This species is listed in Appendix II of the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), and is the only Mediterranean cetacean specie classified in Annex II of the Habitats Directive (animal and plant species of Community interest, endangered, vulnerable, rare or endemic species, whose conservation requires the designation of Special Areas of Conservation). The vast majority of observations of this specie in the north-western basin is carried out within the Sanctuary, mostly in the coastal domain. Thus, the French coast of the Sanctuary includes nine Special Areas of Conservation designated for this species.

Although rarely seen in the Sanctuary, another species is present in the same habitat: the common dolphin, the sub-Mediterranean population of which is endangered according to the IUCN criteria. The continental slope is the preferred habitat of large species: sperm whales, whose sub-Mediterranean population is at risk according to the IUCN criteria, but also pilot whales and Risso's dolphins. The vast abyssal plain in the western part of the Sanctuary is, in turn, the preferred habitat of fin whales. This species is frequent throughout the year with a peak abundance during the summer. The striped dolphin, considered vulnerable by IUCN, is also preferentially present in this habitat, while also regularly attending other pelagic areas.

Finally, the numerous submarine canyons, through their particular bio-geographical characteristics, induce a high productivity, which regularly attracts several species, including strict or preferential teutophagic species, such as Cuvier's beaked whales, sperm whales or Risso's dolphins.

See figure 5

c. Dependence

As already stated, the Sanctuary area is essential to the diet of many cetacean species in the western Mediterranean. During the winter, hydrological events produce a significant mixing of waters allowing the migration of nitrates, phosphates and silicates of lower strata to the euphotic layer. In the spring, an increase of water temperatures and a stabilization of the surface of the water masses happens. These phenomena give to the offshore area a spring and summer primary productivity higher than the coastal area, particularly within the frontal zone where the observed production is relatively high throughout the year.

The phytoplankton bloom begins in mid-April, lasts about six weeks and culminates in early May. Faced with the consumption of nutrients, the phytoplankton biomass regresses gradually, except in the centre of the Ligurian Sea, which is more productive than the rest of the basin. While lower temperatures and mineral resources result in a phasing-out of the primary production, this zone is distinguished by a secondary phytoplankton bloom in autumn, from mid-October to early November. This phenomenon is linked to frequent windy episodes in this season and responsible for an intrusion of intermediate waters, rich in nutrients, in the central and frontal zones.

The wealth of primary production is critical to the organization of the upper levels of the food chain, particularly for tertiary consumers such as cetaceans, especially abundant in summer. A primary example is the case of the Euphausiacea that find in this production the necessary elements they need to grow. Abundantly present and of a high-energy value, they are important in food chains for cetaceans. Thus, Meganyctiphanes norvegica, a boreal species, offers an exceptional abundance in summer but also in autumn within the Sanctuary. This bathypelagic crustacean, which constitutes very large swarms (up to 900 ind./100m^3), is the only source of supply identified for fin whales during the summer in the Liguria-Provencal basin. Therefore, every summer, many fin whales occur in the waters of the Sanctuary to feed.

Through the cephalopods, teutophagic cetaceans (pilot whale, sperm whale and Risso's dolphin) also benefit from the high productivity of the area, especially around the slopes and canyons, but later than whales, as peaks of abundance are recorded later in the season. The dolphins such as the bottlenose dolphin or the striped dolphin are continuously present, even if with some seasonal variation, thanks to less specific diets, consisting of cephalopods and fish.

d. Representative character and diversity

The area of the Sanctuary is inhabited, more or less regularly, by all species encountered in the Mediterranean. For eight of these species, the area hosts sedentary subpopulations for which these waters are a crucial area for food and / or reproduction.

e. Productivity

More than 8.500 macroscopic species are recorded in the Pelagos Sanctuary, which represent 4 to 18% of marine species compared to 0.024% of global sea surface. Biodiversity is especially noteworthy for marine megafauna, that is to say cetaceans. Although the Mediterranean is generally considered an oligotrophic sea, the Sanctuary area is marked by a relatively high productivity of mesotrophic type with primary production peaks reaching up to 500 gC/m^2/year and above in summer, in the frontal area. This productivity is caused by a variety of mechanisms of fertilization: the enrichment by coastal waters and submarine hydro contributions, doming, delayed effect of winter mixing bringing salt nutrients on the surface, frontal zone between coastal waters driven in the cyclonic flow and offshore waters, local upwelling phenomena associated with meso-scale vortices (100 km diameter), presence of the Liguria-Provencal current and existence of complex flowing structures involving divergences and convergences.

We can observe an optimum utilization of the productive potential by the existence of many links between the 'classic' food web (of the diatomaceous carnivorous copepods type) and the “microbial loop” using the full spectrum of particles sizes. This strong ramification of the trophic food web compensates the period of the annual cycle where primary production is minimal.

In this area, the bio-geographical parameters provide a higher offshore productivity than inshore, which is unusual.

f. Breeding area

Apart from being a very important feeding area for cetaceans, the sector also accounts for a breeding or calving zone for most species.

Newborn bottlenose dolphins, Risso's dolphins, pilot whales, sperm whales or striped dolphins were observed within the Sanctuary. Though no newborn fin whale has to date been documented in the area, calves, juveniles are seldom observed during the summer months, reproductive behaviours have been observed and strandings of newborns have been observed.

g. Biogeographical significance

In bio-geographical terms, the area has a special interest. Indeed, in addition to physical and chemical characteristics described in the previous paragraphs, the presence of the Liguria-Provencal front gives it special properties. The Ligurian Sea has, in both summer and winter, a cyclonic circulation with an isopycnal dome structure. The horizontal movement at the periphery of the basin is more intense than in the central part and constitutes the Ligurian Current, of Atlantic origin, characterized by the presence of light and oligotrophic waters. Across the Liguria-Provencal basin, the left side of the Liguria Current is surrounded by a permanent front, the Liguria-Provencal front. This front of geostrophic type is related to the general cyclonic circulation of the basin's coastal regions.

Shaped like a horseshoe, this front is a region of rapid transition between the light waters of the Liguria Current in the periphery and the denser waters in the centre of the basin. On a biological point of view, the Liguria- Provencal front is a transition region between the Current eco-system and that of the Liguria Sea. Moreover, it creates divergence and convergence mechanisms that ensure permanent fertilization of surface or subsurface waters and the export of the produced biomass.

Feature condition and future outlook of the proposed area

(Description of the current condition of the area – is this static, declining, improving, what are the particular vulnerabilities? Any planned research/programmes/investigations?)

1. Fragility and main threats overview

Corse-Ligurian-Provencal basin undergoes the combined pressure of natural environmental fluctuations and the impacts of human activities. It also faces the same constraints as the rest of the Mediterranean Sea, which is particularly sensitive to any change because it is small, semi-closed and with almost no tide. The profound changes of the Mediterranean ecosystem caused by the combination of increasing human impacts and natural factors are increasingly worrying especially since it is a very important sea of endemism. The monk seal, an emblematic species of the Mediterranean, present in the Corse-Ligurian-Provencal basin since the second half of the twentieth century, has today virtually disappeared, with some occasional sighting in the Tuscany Archipelago. The isolation of Mediterranean species makes their sub-populations more vulnerable.

The Pelagos Sanctuary is surrounded by 2,022 km of coastline including 238 municipalities. This area is very densely populated and highly touristic. Growing human activities, both at the watershed level or sea area generate increasing risks to cetaceans present in the area.

Thus, the Sanctuary is an area of intensive economic activities, in particular of maritime traffic. An analysis of the vessel traffic in the western Mediterranean conducted in 2004 reported for the period of 1998-2002, an annual average of 140,000 voyages, with 61% concentrated in the northern basin. In the area of the Sanctuary, in 2002 15,668 large ships were counted. This intensity creates impacts on cetaceans, either directly (disturbance, noise pollution and collisions) or indirectly (biological pollution by ballast water and biofouling, chemical pollution induced by the response to discharges or accidents, seaborne marine litter).

Fishing and aquaculture represent three types of threats for cetaceans: by-catch (which still exists despite the ban on driftnets), the localized deliberate kill of cetaceans (now almost non-existent but which in the past caused significant losses in dolphin populations), and the increased pressure on fish stocks.

Tourism development, increased recreational activities and development of whale watching are also sources of concern. All can cause serious disruption to the vital activities of different species of cetaceans, including the bottlenose dolphin, the only regular coastal species in the Sanctuary, whose preferred habitat is the place of many developing human activities.

On the other hand, the strong human presence on the Mediterranean coast causes a high level of pollution to the aquatic environment. Cetaceans, as upper level predators, accumulate the pollution present in the food chain, especially lipophilic Persistent Organic Pollutants such as organochlorine pesticides and PCB8. This accumulation of toxic substances in their body generates increased sensitivities to different pathogens, a general deterioration of their health status and decreases their reproductive rate.

Finally, specific climate events may favour episodes outlining the catastrophic impacts of long-term changes on environmental conditions on which depend marine mammals' populations and associated species. Thus, it is now recognized that the deep waters of the western Mediterranean have a tendency to increase their temperature and salinity. Series of measurements have shown a warming of coastal waters in north-western Mediterranean of about 1°C over the last 30 years; we are also witnessing a trend of increasing thermal anomalies. These climate changes have an impact on Mediterranean ecosystems and may involve changes in the geographical distribution of species, changes in the life cycle, significant epizootic mortalities or colonization by more southerly and exotic species. Marine Mammals may be directly affected by the impact on habitats and prey that they are dependent on, or indirectly by the accumulation of factors increasing their vulnerability. As a consequence, their migration patterns may change as well as their biological cycles and relationships among the various biocenosis.

The following table describes the scientific studies conducted for each species in the framework of the Pelagos Sanctuary and related to the threats to the marine mammals (pollution, ship strikes, bycatch, noise, disturbance, etc.). Research priorities have been established by the 6th Technical and Scientific Committee of the Pelagos Sanctuary (Monaco, October 2013). A call of proposal on such priorities has been launched by Pelagos Sanctuary, in addition to the working program of the Agreement and the annual national program research.

Marine mammals present in the Pelagos Sanctuary	Main threats to marine mammals				
	Pollution	**Maritime traffic (ship strikes)**	**Fisheries (bycatch)**	**Anthropogenic activities (noise)**	**Whale watching (disturbance)**
Balaenoptera physalus	L, M, N 31	G 1, 10, 11, 19, 29, 30, 40, 44		F	14, 32, 41
Physeter macrocephalus	O 31, 36	10, 11, 29, 30, 40, 44			14, 32, 41
Stenella coeruleoalba	P, Q, R, S, T, U, V, W		21		14, 32, 41
Tursiop truncatus	X, Y		I, J 22	22	14, 32, 41
Delphinus delphis	Z				14, 32, 41
Grampus griseus	α				14, 32, 41
Globicephala melas	α 31, 36				14, 32, 41
Ziphius cavirostris					14, 32, 41
Cetaceans in general	23 + **Stranding**: 4, 13, 24, 33				

Legend:

	High priority research
	Medium priority research
	Low priority research
A, B, 1, 2	*Scientific studies (see references in the chapter "reference" at the end of this document)*

2. Pollution

a. Chemical pollution from land-based sources

With a population growth of 50% between the 1970's and 2000, including 14% for the countries of the northern shore of the Mediterranean, and 31% of world tourism, the Mediterranean basin is subject to a particularly strong land-based pollution.

Aquaculture, in full development, and agriculture generate effluents, nitrates and antibiotics. But in general, an improvement is observed in the North, where waste spread on land is reduced nowadays. The main source of contamination by nitrates and phosphates remains the inadequate treatment of domestic wastewater in the Mediterranean basin, although here too, the northern shore is less touched since only 11% of the cities with over 10,000 inhabitants have no sewage networks, against 31% across the whole basin. On the whole, wastewater discharges from industry and households have been stabilized or even reduced in the North, although they still remain a very important polluting factor (due to the concentration and more complex nature of the products), especially in some sites. The particular case of heavy metals remains worrying since the quantity discharged by industry rose by 300% between 1950 and 1990, and this trend has reversed only recently; they reach the sea through road runoff and atmospheric transport, and come in majority from the four countries in the North-West (Spain, France, Italy and Greece). In summary, despite the overall progress in the north of the Mediterranean basin, chemical pollution comes much more from land-based sources than from commercial shipping. Over the past decades, there has been a growing concern regarding the potential threat to Mediterranean cetaceans from persistent organic pollutants such as organochlorine compounds (OCs) (Fossi et al., 2006), polybrominated diphenyl ethers (PBDEs) and PAHs. Fossi et al. (2010) applied a set of sensitive non-lethal biomarkers in skin biopsies of fin whales (*Balaenoptera physalus*) to evaluate the toxicological status of this mysticete in the Pelagos Sanctuary (Mediterranean Sea) and in the Gulf of California (Sea of Cortez-Mexico). They developed a "multi-trial diagnostic tool" (based on field and in vitro studies), combining molecular biomarkers (western blot of CYP1A1, CYP2B) and gene expression (qRT-PCR of HSP70, ERa, AHR, E2F-1) with the analysis of OCs, PAHs and PBDEs. The study revealed a higher level of toxicological stress in the Mediterranean fin whales. Higher levels of PCBs, DDTs and PAHs were found in both male and female (PAHs $p < 0.1$) Mediterranean fin whales in comparison to the Cortez specimens confirming the high toxicological stress to which the fin whale population in the Pelagos Sanctuary is exposed.

b. Exploitation of oil fields

To this day, no exploitation of oil fields takes place in the Pelagos Sanctuary and its adjacent waters. However, some seismic surveys conducted recently in the north-western Mediterranean have shown that rich underground deposits of liquid or gaseous hydrocarbons are likely. Given the worldwide depletion of fossil fuel, the interest for their exploitation has become a reality that should not be underestimated.

c. Hydrocarbons

Thirty per cent of the international maritime traffic of goods and 20% of transport of oil by ships circulate in the Mediterranean, making shipping one of the major potential pollution sources by crude oil and polycyclic aromatic hydrocarbons (PAHs) in this Sea. Although any deliberate dumping of oil from ships, as well as any discharge of "operational" oily waste are prohibited in the Mediterranean (MARPOL Annex I and Barcelona Convention of 1976), during the year 2000 no fewer than 2,350 oil spills of unknown origin have been detected in the Mediterranean by the Joint Research Centre (JRC) of the European Commission, using satellite-based sensors. Although the public opinion continues to bring attention to accidental marine pollution, operational pollution resulting in illicit discharges is the main source of marine pollution by ships. This kind of pollution results from the intentional discharge of wastewater sometimes mixed with hydrocarbons, and detergents during routine operations such as cleaning of ballast tanks and cleaning of bilges. This problem is of particular concern in the Mediterranean, a region highly sensitive and vulnerable to chronic pollution due to its geographical, oceanographic and ecological specificities.

Beyond these pollutions, accidental pollution must not be neglected because, although occasional, their impact in the short and long term can be dramatic. Between 1977 and 2003, about 155,585 tons of oil have been discharged in the Pelagos Sanctuary following accidents, including the explosion off Genoa on 11 April 1991, of the oil tanker Haven loaded with 144 000 tons of crude oil. Despite major control operations at sea, oil slicks have drifted west, affecting many sites of the Ligurian coast and the French Riviera down to Hyères, causing a 43% reduction in fish populations in certain fishing areas. Significant concentrations of PAHs, correlated with those in the environment due to spills, were found in the tissues of stripped dolphins and fin whales in the Mediterranean. Finally, due to its viscosity, the crude oil spilled

in an accident can cover during a long period the body surface of cetaceans, leading, for example, to a reduction in the filtering capacity of mysticetes.

d. Antifouling paints

Waters and ports of the Pelagos Sanctuary (eg Saint-Laurent-du-Var, Antibes, Golfe Juan, Cannes, Nice, Beaulieu, Monaco, San Remo, Bastia, Porto Vecchio, Ajaccio, Propriano) are particularly affected by the persistence of heavy metals and biocides, such as dibutyltin (DBT) and tributyltin (TBT) (banned since 2008), or Irgarol 1051, all contained in antifouling paints for ships.

Because of their status as super-predators, cetaceans are highly vulnerable to the bioaccumulation of immune-toxic substances, which can disrupt their immune system to the point where it can sometimes result in death. Cetaceans of the Pelagos Sanctuary are no exception to this rule because high concentrations of TBT have been found in the liver of dolphins in the north-western Mediterranean. High concentrations of heavy metals have been detected also in tissues of Cuvier beaked whale, pilot whales, bottlenose dolphins, striped dolphins, Risso's dolphins, as well as common dolphins stranded in Corsica. It should be noted here that the contaminants such as mercury, lead, copper and zinc, accumulated by females, are transferred (up to 85%) to their offspring through breast milk.

The use of anti-fouling paints containing TBT was banned on 1st January 2003 by IMO Resolution A.895(21) of 5th October 2001. Their use on a ship's hull is prohibited since 1st January 2008. These bans are also mentioned in the International Convention on the Control of Harmful Anti-fouling Systems on Ships.

e. Other toxics

Besides oil, the Hazardous and Noxious Substances (HNS) accidentally spilled into the marine environment can threaten species such as marine cetaceans. HNS include bulk liquid cargoes (e.g. petrochemicals, solvents and liquefied gas), solid bulk cargoes (e.g. fertilizers) and chemicals in packaging. Between 1988 and 2003, three accidents involving HNS took place in the area of the Pelagos Sanctuary and released about 19,203 tons of Hazardous and Noxious Substances.

f. Macro waste

Each year, 6.4 million tons of macro-waste are released into the oceans and seas by ships. In the Mediterranean, the majority of floating debris or sunken waste comes from ships. Macro-waste represents a serious and growing threat to the marine environment and harms the cetaceans living in the Pelagos Sanctuary by entanglement or ingestion, often leading to death. Several cases are well documented in the Pelagos Sanctuary and its adjacent waters, including for Stripped dolphins, Risso dolphins and Cuvier's beaked whales.

Studies have shown that 80% of marine debris comes from land-based activities and 20% from marine activities, apart in a few well-defined areas. According to a study by MEDPOL57, contribution come from households, followed by tourist facilities, waste discharges, discharges to rivers, recreational craft, villages, with commercial shipping coming last and being a minor contributor to macrowaste. The emerging issue of microplastics (plastic fragments smaller than 5 mm) in marine environment is recently raising increasing attention (Hidalgo-Ruz et al., 2012). These ubiquitous, persistent micro-debris require centuries to completely degrade and they are mainly the result of the degradation of plastics released in the environment since the plastic age begun. Micro-debris floating on the Mediterranean Sea have reached a maximum of 892,000 per sq. km particles. Recently, Collignon et al. (2012) and Fossi et al. (2012) determined neustonic microplastic and zooplankton abundance in the North Western Mediterranean Sea revealing that the mean abundance of microplastics estimated was of the same order of magnitude as that found for the North Pacific Gyre (0.334 particles/m^2, Moore et al., 2001), underlining the high occurrence of this emerging threat in the Mediterranean environment. The impacts of microplastics on baleen whales, which potentially undergo to the ingestion of micro-litter by filtrating feeding activity, are largely unknown. Fossi et al. (2012) present the study of the Mediterranean fin whale (*Balaenoptera physalus*), exploring the toxicological effects of microplastics on mysticetes. The work is implemented through three steps:

1) collection/count of microplastics in Pelagos Sanctuary (Mediterranean Sea);
2) detection of phthalates in superficial neustonic/planktonic samples;
3) detection of phthalates in stranded fin whales.

Among the superficial neustonic/planktonic samples, 56% have shown the presence of microplastic particles. The highest microplastic abundance (9.63 items/m^3) was found in the Portofino MPA (Ligurian Sea). High concentration of phthalates (DEHP and MEHP), have been detected in neustonic/planktonic samples. Relevant concentrations of MEHP in the blubber of stranded fin whales suggest the use of phthalates as a tracer of microplastics assumption and represent the first warning on this emerging threat in baleen whales.

3. Maritime traffic (ship strikes)

The Pelagos Sanctuary and its adjacent waters are home to a high density of vessels and large whales in the same space, mostly between May and September. This configuration is the primary source of risk in this area, considered as one of the "high-risk areas for cetaceans collisions" in the world (Summer distribution of areas at risk of collisions between large commercial vessels and fin whales and sperm whales - Source: David and Di-Méglio, 2010).

For fin whales, the available literature on the subject show an average of 1.5 known case of lethal collision each year in the western Mediterranean, with over 80% of cases being reported in the Pelagos Sanctuary or its adjacent waters. To these known cases, we must of course add all those who are not reported to scientists. Extrapolations have enabled to estimate that the actual number of lethal collisions for fin whales in the basin, might be between 8.4 and 40 animals each year, increasing the natural mortality by a factor of 4% to 19%. Concerns have also been raised for Sperm whales, which represent 6% of the known cases of lethal collisions reported in the Pelagos Sanctuary and adjacent waters (in the database of the National Stranding Network). Although this value is smaller than that of the fin whales, it must be compared to the much lower and probably sensitive population of Sperm whales (the only abundance estimates is from the Ionian sea and refer 62 individuals) Moreover, photo-identification shows that many individuals of both species have undergone non-lethal collisions, which have left severe scars - up to the loss of one half of the caudal fin.

Ultimately, in this sector, the entire scientific community recognizes these accidents as constituting one of the leading causes of death for fin whales and Sperm whales. Although the quantification of these impacts on the dynamics of the populations is not yet precisely determined, researchers and managers agree on the fact that these accidents pose a major risk for these two populations, particularly with regard to their ecological fragility. Moreover, it is known worldwide that collisions between ships and whales have resulted in serious injuries, sometimes fatal, to the passengers of high-speed craft. Within the Pelagos Sanctuary, no injury happened up to now. However, the safety of high-speed craft has already been severely test during collisions with fin whales, particularly in 1998 and 1999, where fin-stabilisers have been damaged or lost, resulting in an ingress of water and a diversion to the nearest port. Worldwide, for some cases severe damage also to the vessel has been reported; serious or even fatal injuries to passengers have occurred involving hydrofoil ferries, whale-watching vessels and recreational craft. In terms of geographic distribution of these collisions, the pelagic area is mainly concerned, but the slope and the coastal area are not spared due to the distribution of the different species and a different but intense traffic in all sectors. Although all types of vessels may be affected, the ships most often quoted in cases of collisions in the area are roro ferries (62%), cargo (16%), fast ships (12%) and yachts (8%).

If the main risk factor for collisions is the overlap between the habitats of cetaceans and sea-lanes, other parameters have an effect. It appears that the mortality rate increases significantly with larger size units (more important shock, gaps in visibility from the bridge when the bridge is placed in the rear section of the ship, reduced manoeuvrability). Just as the vessel size, speed is a determining factor in the frequency and

severity of collisions between ships and whales. All accidents that resulted in damage to the ship happened at speeds of 10 knots at least. At 10.5 knots, a great cetacean hit has a 50% risk of being killed or seriously injured. The speed of 13 knots appears to be the speed above which the risk increases dramatically and, beyond 15 knots, any collision is practically lethal. Furthermore, the hydrodynamic forces created by the movement of ships are increased with speed and they can attract whales towards the hull, causing serious injury or death of the animal. Furthermore, lower speeds give the ship and the whale more time to react and avoid an impact.
The evolution of maritime traffic, hints at a potential increased risk of collisions with the populations of whales present within the Pelagos Sanctuary.

Commercial navigation is not the only activity, which generates collisions with cetaceans, as several cases involving whale-watching boats, pleasure craft, have shown. More than 760 collisions have been reported in the database of the International Whaling Commission (IWC). About half of these involve vessels above 50 meters in length, and the proportion of lethal accidents increases with the size of ships. For France, the known cases of collisions with pleasure craft are less frequent than with merchant ships. Between 2004 and 2012, only two such cases are known: in 2004 a speedboat tore off half of the tail of a striped dolphin (*Stenela coeruleoalba*) in the Bay of Marseilles and in 2005 a big game fishing boat collided with a fin whale (*Balaenoptera physalus*). In the whole western Mediterranean, a study published in 2006 showed that pleasure craft are involved in a minority of the known cases of fin whales killed by collision: amongst 34 cases in which the vessel involved in the collision is known, only three involve pleasure craft. In view of these elements, the priority must be focused on commercial shipping compared to other sources of collisions.

4. Fisheries (bycatch)

Bycatch events are a significant cause of death among cetaceans, particularly dolphins. Estimates indicate that every summer between 2000 and 2005, from 80 to 250 striped dolphins were accidentally captured in fishing nets. Findings suggest that young dolphins are more vulnerable to capture in August, while the highest number of dolphins is captured in September. The impact of bycatch events on the survival of the striped dolphins population is difficult to estimate, depending on whether the issue is addressed in terms of the local population or on the broader scale of part of the western Mediterranean Basin.
It is also worth remembering that striped dolphins are not the only species that are bycaught. Sperm whales, pilot whales, common bottlenose dolphins and Risso's dolphins are species that are low in number and bycaught by fishing nets. These bycatch events are a major concern.
Fishing with thonaille nets technique is reputedly very selective, targeting two species that account for 96% of all those captured:

- bluefin tuna (77%)
- swordfish (19%)
- the remaining 4% are species captured accidentally, mainly striped dolphins but also sperm whales, pilot whales, Risso's dolphins and loggerhead sea turtles.

Assessing the impact of this kind of fishing on cetacean populations is not easy, however. The data are difficult to quantify and we can only make estimations regarding the real impact on cetacean populations. We thus need to make a relative comparison of the number of bycatch events for each species versus the size of the population, and also as a function of the technical means deployed for fishing trips.
Here are the results of some studies conducted on bycatch events by French Part of the Sanctuary.

2000	- Conducted by the Marseille Oceanographic Centre - Estimated number of dolphins bycaught: 346 +/- 146
2004	- Conducted by GECEM - 4 boats with observers / 25 monitoring trips between July and September - 10 dolphins bycaught - NB: Sample deemed non-representative, limited by the study's delayed start
2005	- Conducted by GECEM - 79 trips between June and September - 8 striped dolphins bycaught, with an estimated 81 bycaught by the group of boats every year

5. Sound pollution

a. Noise pollution from ships

The specific characteristics of the aquatic environment in which cetaceans live have resulted in specific physiological adaptations. The transmission and reception of sounds represent the primary means of communication of these animals; their noise emissions cover a very wide frequency band, between 10 Hz and 150 kHz. The contribution of shipping to the low-frequency ambient noise reduces the low frequency space for cetacean communication, essential to find partners or to build social and territorial relationship; it also reduces their capacity of echolocation, used to find food and for the orientation of the animal (observed for example on the Cuvier beaked whale). Noise exposure may result for cetaceans in temporary hearing loss and, in extreme cases, cause permanent acoustic damage, or even harm other organs and body tissues. In addition, shallow repeated dives to deal with frequent acoustic disturbances are likely to increase the risks of decompression accidents in these animals. It has even been shown by necropsies that sounds of high intensity are responsible for injuries resulting in the death of Cuvier beaked whales. Finally, knowing that fish show a wide range of reactions to vessel noise (behavioural changes, stress, migration, increased energy expenditure, disruptions in feeding and reproduction, weakened immune system) and that the krill uses passive acoustic techniques to detect their predators and find food, noise pollution may have effects on the preys of cetaceans and, as such, affect the cetaceans themselves. The main contributor to the noise generated by a ship is the movement of the propeller, which generates a phenomenon of cavitation, which dominates the sound spectrum of a large vessel (83% of its acoustic field). The noise level may increase according to the shape of the propeller, the state of wear of the ship, its size, speed and load. Over the last forty years, marine environmental noise has increased by 12 dB (3 dB per decade on average), especially in the low frequency range. The development of the world fleet in terms of number, size and speed of vessels is recognized as the most likely cause of this increase. In the Mediterranean and in the Ligurian Sea in particular, the levels of anthropogenic noise are extremely worrying. Experts believe that, due to the intensity of the maritime traffic, there is no more quiet areas in the basin. In some places, the levels are so high they are likely to literally prevent any communication between fin whales in the Mediterranean, despite being relatively old (i.e. 16.5 years on average in 1998 and 16.0 in 2002), the fleet follows the global trends of growth in size and volume. The shipping activity has increased steadily in this region during the last 10 years and is projected to increase by 18% in the next 10 years, some analysts even envisaging a doubling by 2025. An increase of 23% in the transit of vessels is expected, with greater ships. Such elements cannot, for the time being, alleviate greater concerns regarding acoustic disturbances of cetaceans in the Pelagos Sanctuary.

b. Continuous noise produced by pleasure

Generally, smaller boats produce higher frequencies than larger boats (from 1 kHz to 50 kHz). These frequencies are likely to disturb odontocetes in particular. Several studies involving boats have indeed demonstrated these impacts (change of diving time, escape, etc.), especially when boats sail at high speed. Given the heavy use of pleasure boats in the coastal zone of the Pelagos Sanctuary, these acoustic impacts must be considered seriously.
However, the frequencies emitted by smaller boats are transmitted less far than the emissions of larger vessels and thus they concern

localized areas. Thus, it is recognized that smaller boats contribute in a limited way to the overall increase of marine noise compared to larger vessels, especially at low frequencies, because larger vessels remain primarily responsible for the increase in the background noise of the oceans. For these reasons, on the whole, commercial traffic must be considered as a source of acoustic impacts greater than the pleasure boat activity even if locally and at certain times, the latter remains a source of considerable acoustic nuisance.

c. Occasional noises: seismic surveys

Seismic surveys, especially used for oilfields exploration, are sources of particularly worrying noise pollution for cetaceans. In most cases, they use air guns, towed at the rear of a special ship. The source level of their low frequency pulses (240-260 dB re 1µPa) and their repeatability (several pulses each minute, 24/7 for several days) make them particularly dangerous for cetaceans, with several examples demonstrating serious impacts. Despite the low speed (5 knots) of the specialized ships it turns out that cetaceans cannot escape the noise generated by these units, insofar as studies mention several fatal accidents. Measures to limit the impact of this activity exist (visual and acoustic watch for cetaceans, progressive emission) but it remains difficult to assess their actual implementation and effectiveness. Although the north-western Mediterranean is particularly affected by this activity since the years 2000, seismic surveys remains localized in time and space, and relatively regulated; however, the detrimental effects on cetacean population should not be underestimated and considered carefully. For this reason, the noise generated by the commercial navigation in the Pelagos Sanctuary is considered a greater threat to the conservation of Mediterranean cetaceans, because of its diffuse nature, its continuity, its accumulation and its increase.

d. Military explosions

Military activities are also a source of acoustic noise, short but potentially lethal. The explosion of munitions at sea, but also the explosive cutting of whale carcasses may cause stress, temporary or permanent deafness or even death of cetaceans within the effect radius of the explosives. In one case, bottlenose dolphins appear to have deserted for several days one of their preferred habitat following an explosive cutting of a whale carcass. However, it is relatively easy to implement measures to prevent or limit such excessive use. For these reasons, the noise generated by the commercial navigation in the Pelagos Sanctuary is considered a nuisance of much greater magnitude on Mediterranean cetaceans.

e. Offshore powerboat races

During offshore races powerboats reach speeds of 250 km/h and constitute a major threat to cetaceans, both in terms of increased risk of collisions and in terms of noise. Although relatively frequent in the past, this activity has become a very rare nuisance in the Pelagos Sanctuary: Italy has passed a law banning these races within the Pelagos Sanctuary and France and Italy are engaged in a process encouraging coastal municipalities to give up organizing such events (27 signatories of the relevant charter in France and 33 in Italy). For these reasons, the noise generated by the commercial navigation is considered a nuisance of much greater magnitude on Mediterranean cetaceans than offshore powerboats races in the Pelagos Sanctuary.

f. Military sonars

Certain frequencies of military sonars might explain some behavioural changes of marine mammals. Mid frequency sonars may have had lethal effect of beaked whales, causing mass stranding events in the Mediterranean Sea; but according to the current knowledge, accurate conclusions could not properly be drawn. It should be noted that these emissions are intermittent, timely and localized (about 1 to 5% of emission time over a training period). Crews on board warships are also trained to detect the presence of marine mammals (the crew is constantly on watch during sonar transmission sessions) and, if necessary, they have the capability and the instructions to reduce the transmitted signals' intensity in case where animals are present in the vicinity. Areas of practice and training are also chosen to avoid known areas of high concentration of marine mammals.

Compared to the noise transmitted by a merchant ship during its navigation, the noise generated by sonars is more localized in time and in spectrum. The military navies active in the area are conscious of possible detrimental effects on cetaceans, and do their utmost to use the best information available to them to minimize this impact.

6. Physical disturbance

a. Physical disturbance of cetaceans from ships

The number of vessels present, their proximity and speed are all factors that can influence the reactions of cetaceans. Disturbances generated by shipping activities cause changes of activity (observed for instance during the passage of HSC within 0.3 nautical mile of fin whales) and behaviour (e.g. increased energy expenditure associated with escape or stress, interruption of periods of feeding and resting); they are likely to reduce their long-term physical condition and the success of their reproduction. When an individual faces repeated disturbances, and if the strategies to change activity in the short term become ineffective, it may opt for a long-term avoidance of a more impacted habitat in favour of other sites which may be less favourable (observed on the bottlenose Dolphin). Therefore traffic may become a factor, which changes the trends of cetacean residence more quickly than the oceanographic phenomena. These findings show clearly that the disturbances generated by vessels, if repeated frequently, impair seriously the populations of cetaceans resident in the Pelagos Sanctuary, which are threatened already by other disturbances.

b. Pleasure boats and opportunistic whale watching

The north-western Mediterranean has such a touristic attraction that it generates a particularly intense summer use, which results in an intense recreational boating activity. Yachtsmen who come across cetaceans are likely to want to approach and practice an "opportunistic whale watching". Because it is random, scattered and unorganized, it is difficult to accurately assess the impacts of this activity. However, a study published in Corsica in 2007 (program Life Linda) provides an example of the situation for the French part of the Pelagos area: on average, each summer, more than 44,000 vessels in transit sail through the Bonifacio area. In coastal navigation, when boats come across Bottlenose dolphins (*Tursiops truncatus*), it often happens that the boats divert from their route to observe the animals, often under very intrusive conditions. As a result, in 71% of cases, this kind of interaction causes the dispersal of groups, then their escape in 85% of cases and/or dive in 68% of cases. Recreational boating is therefore a source of significant physical disturbance, the impact of which may be considered as superior to commercial traffic in the coastal area, because merchant ships do not generally divert from their routes to approach a cetacean.

c. Direct commercial whale watching

Organized whale watching (the "direct trade") is also growing in north-western Mediterranean. To date, there are 27 operators based in France, including 3 offering a swim with cetaceans. A study conducted in 2005 on commercial whale-watching in the French Mediterranean showed that its development grew in total opposition to the basic rule of minimising disturbance to the animals. Since then, efforts have been led by the Pelagos Agreement, in partnership with the ACCOBAMS Agreement, with the objective to regulate this activity: development of a regularly updated database of operators, regular monitoring of a series of indicators on whale-watching, awareness campaigns for operators and the general public, mass-mailing of a code of conduct, etc. In France, the law supports this work since the first Ministerial Decree of July 2011 prohibits the deliberate disturbance of all cetacean species, including stalking or harassing animals in the natural environment. Additionally, the first training course associated with a future ACCOBAMS-Pelagos Sanctuary label took place in 2012. Although these

measures should be continued and assessed, they are likely to reduce seriously the global physical impacts of the whale-watching business. These actions contribute to reducing the impacts of commercial whale-watching below those of the merchant shipping traffic.

Assessment of the area against CBD EBSA Criteria

(Discuss the area in relation to each of the CBD criteria and relate the best available science. Note that a proposed area for EBSA description may qualify on the basis of one or more of the criteria, and that the polygons of the EBSA need not be defined with exact precision. And modeling may be used to estimate the presence of EBSA attributes. Please note where there are significant information gaps)

CBD EBSA Criteria (Annex I to decision IX/20)	**Description** (Annex I to decision IX/20)	**Ranking of criterion relevance** (please mark one column with an X)			
		No information	**Low**	**Medium**	**High**
Uniqueness or rarity	Area contains either (i) unique ("the only one of its kind"), rare (occurs only in few locations) or endemic species, populations or communities, and/or (ii) unique, rare or distinct, habitats or ecosystems; and/or (iii) unique or unusual geomorphological or oceanographic features.				X
Explanation for ranking					
Special importance for life-history stages of species	Areas that are required for a population to survive and thrive.				X
Explanation for ranking					
Importance for threatened, endangered or declining species and/or habitats	Area containing habitat for the survival and recovery of endangered, threatened, declining species or area with significant assemblages of such species.				X
Explanation for ranking					
Vulnerability, fragility, sensitivity, or slow recovery	Areas that contain a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery.			X	
Explanation for ranking					
Biological productivity	Area containing species, populations or communities with comparatively higher natural biological productivity.				X
Explanation for ranking					
Biological diversity	Area contains comparatively higher diversity of ecosystems, habitats, communities, or species, or has higher genetic diversity.				X
Explanation for ranking					

Naturalness	Area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.		X		
Explanation for ranking					

Sharing experiences and information applying other criteria (Optional)

Other Criteria	**Description**	**Ranking of criterion relevance** (please mark one column with an X)			
		Don't Know	**Low**	**Medium**	**High**
Add relevant criteria					
Explanation for ranking					

References

(e.g. relevant documents and publications, including URL where available; relevant data sets, including where these are located; information pertaining to relevant audio/visual material, video, models, etc.)

A) Panigada S., Lauriano G., Burt L., Pierantonio N. and G Donovan. 2011. Monitoring winter and summer abundance of cetaceans in the Pelagos Sanctuary (Northwestern Mediterranean Sea) through aerial surveys. Plos one 6(7): e22878. Doi:10.1371/journalpone.0022878

Systematic long-term monitoring of abundance is essential to inform conservation measures and evaluate their effectiveness. To instigate such work in the Pelagos Sanctuary in the Mediterranean, two aerial surveys were conducted in winter and summer 2009. A total of 467 (131 in winter, 336 in summer) sightings of 7 species was made. Sample sizes were sufficient to estimate abundance of fin whales in summer (148; 95% CI = 87–254) and striped dolphins in winter (19,462; 95% CI = 12 939–29 273) and in summer (38 488; 95% CI = 27 447–53 968). Numbers of animals within the Sanctuary are significantly higher in summer, when human activities and thus potential population level impacts are highest. Comparisons with data from past shipboard surveys suggest an appreciable decrease in fin whales within the Sanctuary area and an appreciable increase in striped dolphins. Aerial surveys proved to be more efficient than ship surveys, allowing more robust estimates, with smaller CIs and CVs. These results provide essential baseline data for this marine protected area and continued regular surveys will allow the effectiveness of the MPA in terms of cetacean conservation to be evaluated and inform future management measures. The collected data may also be crucial in assessing whether ship strikes, one of the main causes of death for fin whales in the Mediterranean, are affecting the Mediterranean population.

B) Lauriano, G., Panigada, S., Canneri, R., Manca Zeichen, M and G. Notarbartolo di Sciara. 2010. Abundance estimate of striped dolphins (*Stenella coeruleoalba*) in the Pelagos Sanctuary (NW Mediterranean Sea) by means of line transect survey. *J. Cetacean Res. Manage*. 11(3): 279–283

To assess cetacean densities in the Pelagos Sanctuary for Mediterranean Marine Mammals, a Marine Protected Area (MPA) specifically designated to protect cetaceans, a survey was carried out in the Ligurian-Provencal Basin (NW Mediterranean) in August 2008. An area of 58,000 km2 was surveyed in eight days with equally spaced zigzag transects, covering 1,255 km in favourable conditions. Tracklines were designed using Distance 5.0 to allow for homogeneous coverage probability over the selected area. Fifty-three sightings of four cetacean species were made: striped dolphins (n = 37), fin whales (n = 12), sperm whales (n = 3) and Cuvier's beaked whales (n = 1). Estimates of abundance were obtained using Distance 5.0. The estimated dolphin abundance was 13,232 (CV = 35.55; 95% CI = 6,640–26,368), with a density of 0.23 individuals km–1 (CV = 35.55; 95% CI = 0.11–0.45). No fin whale abundance estimate was possible due to the small sample size. The point estimate of the 2008 striped dolphin abundance estimate was almost half of that of a survey conducted in 1992 by Forcada and colleagues (1995) in the same area with comparable effort, platform and methodology (25,614; CV = 25.3; 95% CI = 15,377–42,658); nevertheless, the difference was not statistically significant. These results strongly support the need for further systematic monitoring in the Sanctuary and in the surrounding areas, in order to assess striped dolphin abundance, spatial and temporal trends.

C) Gnone et al., 2011. Distribution, abundance, and movements of the bottlenose dolphin (Tursiops truncatus) in the Pelagos Sanctuary MPA (north‐west Mediterranean Sea) Aquatic Conserv: Mar. Freshw. Ecosyst.

1. The Pelagos Sanctuary is the largest marine protected area of the Mediterranean Sea (87 500 km^2), and is located in the northwest part of the basin. The presence of the bottlenose dolphin in this area is well documented but its distribution and abundance are not well known.
2. The present study collected and analysed data from 10 different research groups operating in the Pelagos Sanctuary from 1994 to 2007. Photo identification data were used to analyse the displacement behaviour of the dolphins and to estimate their abundance through mark–recapture modelling.
3. Results show that the distribution of bottlenose dolphin is confined to the continental shelf within the 200m isobath, with a preference for shallow waters of less than 100 m depth.
4. Bottlenose dolphins seem to be more densely present in the eastern part of the sanctuary and along the north‐west coast of Corsica.
5. Bottlenose dolphins show a residential attitude with excursions usually within a distance of 80 km (50 km on average). A few dolphins exhibit more wide-ranging journeys, travelling up to 427 km between sub areas.

6. The displacement analysis identified two (sub)populations of bottlenose dolphins, one centred on the eastern part of the sanctuary and the other one around the west coast of Corsica.
7. In 2006, the eastern (sub)population was estimated to comprise 510–552 individuals, while 368–429 individuals were estimated in the Corsican (sub)population. It was estimated that in total, 884–1023 bottlenose dolphins were living in the Pelagos Sanctuary MPA in the same year.
8. The designation of a number of Special Areas of Conservation (SACs) under the Habitats Directive is discussed as a possible tool to protect the bottlenose dolphin in the Pelagos Sanctuary and in the whole of the Mediterranean Sea.

D) A. Azzellino, S. Panigada, Lanfredi, M. Zanardelli, S. Airoldi, G. Notarbartolo di Sciara. 2012. Predictive habitat models for managing marine areas: Spatial and temporal distribution of marine mammals within the Pelagos Sanctuary (North-western Mediterranean sea)
Habitat use of seven different species of cetaceans inhabiting the Pelagos Sanctuary was studied using 18-year summer shipboard surveys data, in an area of approximately 25,000 km2. 2940 sightings were collected: 1996 striped dolphins, 626 fin whales, 120 Risso's dolphins, 114 sperm whales, 27 common bottlenose dolphins, 25 long-finned pilot whales, 23 Cuvier's beaked whales. Stepwise Logistic Regression Analysis was used to develop presence/absence predictive models. Statistics of depth and slope were used as covariates. Significant correlations were outlined ($P < 0.05$) supporting the hypothesis that physiographic factors may be employed as predictors of the species presence. The temporal variability of the species habitat use was also analysed, confirming the reliability of the physiographic predictors. Temporal trends and variability in the species distribution were also assessed through a GLM analysis. The understanding offered by this long-term study is essential for managing the conservation status of these wide-ranging species.

E) Jean-Noël Druon, Simone Panigada, Léa David, Alexandre Gannier, Pascal Mayol, Antonella Arcangeli, Ana Cañadas, Sophie Laran, Nathalie Di Méglio, Pauline Gauffier. 2012 Potential feeding habitat of fin whales in the western Mediterranean Sea: an environmental niche model. Mar Ecol Prog Ser 464: 289–306, 2012
The development of synoptic tools is required to derive the potential habitat of fin whales *Balaenoptera physalus* on a large-scale basis in the Mediterranean Sea, as the species has a largely unknown distribution and is at high risk of ship strike. We propose a foraging habitat model for fin whales in the western Mediterranean Sea relying on species ecology for the choice of predictors. The selected environmental variables are direct predictors and resource predictors available at daily and basin scales. Feeding habitat was determined mainly from the simultaneous occurrence of large oceanic fronts of satellite-derived sea-surface chlorophyll content (chl *a)* and temperature (SST). A specific range of surface chl *a* content (0.11 to 0.39 mg m−3) and a minimum water depth (92 m) were also identified to be important regional criteria. Daily maps were calibrated and evaluated against independent sets of fin whale sightings (presence data only). Specific chl *a* fronts represented the main predictor of feeding environment; therefore, derived habitat is a potential, rather than effective, habitat, but is functionally linked to a proxy of its resource (chl *a* production of fronts). The model performs well, with 80% of the presence data <9.7 km from the predicted potential habitat. The computed monthly, seasonal and annual maps of potential feeding habitat from 2000 to 2010 correlate, for the most part, with current knowledge on fin whale ecology. Overall, fin whale potential habitat occurs frequently during summer in dynamic areas of the general circulation, and is substantially more spread over the basin in winter. However, the results also displayed high year-to-year variations (40 to 50%), which are essential to consider when assessing migration patterns and recommending protection and conservation measures.

F) Manuel Castellote, Christopher W. Clark, Marc O. Lammers 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. Biological Conservation 147 115–122
Non-lethal behavioural effects of underwater noise in marine mammals are difficult to measure. Here we report acoustic and behavioural changes by fin whales in response to two different types of anthropogenic noise: shipping and airgun noise. Acoustic features of fin whale 20-Hz song notes recorded in the Mediterranean Sea and Northeast Atlantic Ocean were compared for areas with different shipping noise levels, different traffic intensities in the Strait of Gibraltar and during a seismic airgun array survey. In high noise conditions 20-Hz note duration shortened, bandwidth decreased, centre frequency decreased and peak frequency decreased. Similar results were obtained in 20-Hz song notes recorded during a 10-day seismic survey.
During the first 72 h of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the airgun array source and out of our detection area, and this displacement persisted for a time period well beyond the 10-day duration of seismic airgun activity. This study provides evidence that male fin whales from two different subpopulations modify song characteristics under increased background noise conditions, and that under seismic airgun activity conditions they leave an area for an extended period. We hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement. The observed acoustic and behavioural changes of this endangered species are discussed in the context of reproduction success and population survival.

G) Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. and Weinrich, M. 2006. Medditerranean fin whales at risk from fatal ship strikes. Mar. Poll. Bull. 52: 1287–98.
This paper reviews and analyses ship collision records for the relatively isolated population of fin whales in the Mediterranean Sea from 1972 to 2001. Out of 287 carcasses, 46 individuals (16.0%) were certainly killed by boats. The minimum mean annual fatal collision rate increased from 1 to 1.7 whales/year from the 1970s to the 1990s. Fatal strike events (82.2%) were reported in or adjacent to the Pelagos Sanctuary, characterized by high levels of traffic and whale concentrations. Among 383 photo-identified whales, 9 (2.4%) had marks that were attributed to a ship impact. The reported rates are unusually high for baleen whales. The high likelihood of unreported fatal strikes combined with other anthropogenic threats suggests an urgent need for a comprehensive, basin-wide conservation strategy, including ship strike mitigation requirements, like real-time monitoring of whale presence and distribution to re-locate ferry routes to areas of lower cetacean density, and reducing ship speed in high cetacean density areas.

H) Massimo Arrigoni, Piero Manfredi, Simone Panigada, Lorenzo Bramanti & Giovanni Santangelo 2011. Life-history tables of the Mediterranean fin whale from stranding data Marine Ecology 32 (Suppl. 1) 1–9
The conservation of long-lived species requires extensive, in-depth knowledge of their population structure and vital rates. In this paper we examine the structure of the Mediterranean fin whale (Balaenoptera physalus) population based on the available mortality figures from European stranding network databases compiled over the past 22 years. Such data has enabled us to lay out a first life-history (mortality) table of the population using a simple age-structured demographic model with three life-tables: calf, immature and mature. Our results reveal a high mortality rate in the first stage of life (77% per year), which decreases during the immature stage and falls further during the mature adult stage. In addition, we have calculated the corresponding life expectancies at birth (e0), at entry in the immature stage (e1) and at maturity (e2) under different hypotheses on survival at the maximum age of 90 years (s90) ranging between 0.1 and 3% of newborns still alive. The life expectancy at birth (e0) at the lower bound of the chosen range (s90 = 0.001) is about 6 years, entry in the immature stage (e1) is 8.2 years, and entry in the mature stage (e2) is about 15.6 years. This large increase is the consequence of the higher mortality in the first two stages compared with the mature one. The life expectancies are 10.1, 14.3, and 37.8 years for s90 at the upper bound of the chosen range (s90 = 0.03). The resulting population intrinsic growth rates (r) ranged between)1.3. and +1.7 per year. High juvenile mortality patterns

imply that the stationary reproductive value (the number of female offspring produced by each female after a given age x) at the start of maturity reaches a value about seven times higher than at birth. Only optimistically high survival patterns of older individuals would allow positive intrinsic growth rates, thereby enhancing the chances of the population survival.

I) Lauriano, G., Fortuna, C.M., Moltedo, G., Notarbartolo di Sciara, G. 2004. Interaction between common bottlenose dolphin (Tursiops truncatus) and the artisanal fishery in Asinara island National Park (Sardinia): assessments of catch damage and economic loss. J. Cetacean Res. Manage. 6(2): 165–173, 2004

In 1999, the Italian Central Institute for Applied Marine Research (ICRAM), in response to reports made by local fisheries, began a study into the interactions between common bottlenose dolphins (*Tursiops truncatus*) and the artisanal fishery in the Asinara Island National Park (Sardinia). Using on board observers, fishing boat surveys were carried out to determine the frequency of interactions, variations in the catch of target species and damage to two different types of trammel net caused by dolphins. Interactions occurred primarily with trammel nets targetting striped red mullet (*Mullus surmuletus*; the less valuable peacock wrasse, *Simphodus tinca*, was also caught). Interactions also occurred with trammel nets set for lobster (*Palinurus elephas*), cuttlefish (Sepia spp.) and scorpionfish (*Scorpaena spp.*), but these were considered negligible. The target species, catch and damage inflicted on the catch were recorded, both in the presence and absence of dolphins, in an effort to ascertain associated damage and economic cost. Loss of catch was found to be significant only in the case of nets deployed during the red striped mullet fishing season. Although the level of interaction was high relative to the narrow red striped mullet fishery season, the overall economic impact on the fishing community was found to be modest. The presence and regulations of the national park area may provide an opportunity for investigating mitigation activities compatible with both cetacean conservation and the maintenance of the traditional fisheries.

J) Diaz Lopez B. (2006) Interactions between Mediterranean bottlenose dolphins (Tursiops truncatus) and gillnets off Sardinia, Italy. ICES Journal of Marine Science 63, 946–951.

K) Gomez-Campos E, Borrell A, Cardona L, Forcada J, Aguilar A (2011) Overfishing of Small Pelagic Fishes Increases Trophic Overlap between Immature and Mature Striped Dolphins in the Mediterranean Sea. PLoS ONE 6(9): e24554. The interactions among diet, ecology, physiology, and biochemistry affect N and C stable isotope signatures in animal tissues. Here, we examined if ecological segregation among animals in relation to sex and age existed by analysing the signatures of d15N and d13C in the muscle of Western Mediterranean striped dolphins. Moreover, we used a Bayesian mixing model to study diet composition and investigated potential dietary changes over the last two decades in this population. For this, we compared isotope signatures in samples of stranded dolphins obtained during two epizootic events occurring in 1990 and 2007–2008. Mean d13C values for females and males were not significantly different, but age-related variation indicated d13C enrichment in both sexes, suggesting that females and males most likely fed in the same general areas, increasing their consumption of benthic prey with age. Enrichment of d15N was only observed in females, suggesting a preference for larger or higher trophic level prey than males, which could reflect different nutritional requirements. d13C values showed no temporal variation, although the mean d15N signature decreased from 1990 to 2007–2008, which could indicate a dietary shift in the striped dolphin over the last two decades. The results of SIAR indicated that in 1990, hake and sardine together contributed to 60% on the diet of immature striped dolphins, and close to 90% for mature striped dolphins. Conversely, the diet of both groups in 2007–2008 was more diverse, as hake and sardine contributed to less than 40% of the entire diet. These results suggest a dietary change that was possibly related to changes in food availability, which is consistent with the depletion of sardine stocks by fishing.

L) Marsili L, Caruso A, Fossi MC, Zanardelli M, Politi E, Focardi S. 2001 - Polycyclic aromatic hydrocarbons (PAHs) in subcutaneous biopsies of Mediterranean cetaceans. Chemosphere. 44(2): 147-154.

The aim of the present study was to measure polycyclic aromatic hydrocarbon (PAH) levels in free-ranging Mediterranean cetaceans, as they are likely to cause chemical stress in the organisms of this basin. Blubber samples were collected from live specimens of fin whales (Balaenoptera physalus) and striped dolphins (Stenella coeruleoalba) by means of biopsies, a non-destructive biological method. Fin whales were sampled in the Ligurian Sea, whereas striped dolphins were collected in the Ligurian and the Ionian Seas. A fingerprint of 14 PAHs was obtained for both species. In whales, the median value of total PAHs was 1970 ppb fresh weight (f.w.) while median carcinogenic PAH values were 89.80 ppb f.w.; in dolphins, the median values of total and carcinogenic PAHs were 29,500 and 676.00 ppb f.w., respectively. The different PAH values between the two species can be attributed to the different positions they take in the Mediterranean food web. The sampling period significantly influenced PAH concentrations of fin whales.

M) Fossi M. C., Urban J., Casini S., Maltese S., Spinsanti G., Panti C., Porcelloni S., Panigada S., Lauriano G., Nińo-Torres C., Rojas-Bracho L., Jimenez B., Muńoz-Arnanz J., Marsili L. 2010 - A Multi-Trial diagnostic tool in fin whale (Balaenoptera physalus) skin biopsies of the Pelagos Sanctuary (Mediterranean Sea) and the Gulf of California (Mexico). Marine Environmental Research, 69 (1): S17-S20.

The main objective of this study was to apply a set of sensitive non-lethal biomarkers in skin biopsies of fin whales (Balaenoptera physalus) to evaluate the toxicological status of this mysticete in the Pelagos Sanctuary (Mediterranean Sea) and in the Gulf of California (Sea of Cortez-Mexico). We developed a "multi-trial diagnostic tool" (based on field and in vitro studies), combining molecular biomarkers (western blot of CYP1A1, CYP2B) and gene expression (qRT-PCR of HSP70, ERα, AHR, E2F-1) with the analysis of OCs, PAHs and PBDEs. The study revealed a higher level of toxicological stress in the Mediterranean fin whales.

N) Fossi MC, Panti C, Guerranti C, Coppola D, Giannetti M, Marsili L, Minutoli R. 2012 - Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (Balaenoptera physalus). Mar Pollut Bull.64(11): 2374-2379.

Baleen whales are potentially exposed to micro-litter ingestion as a result of their filter-feeding activity. However, the impacts of microplastics on baleen whales are largely unknown. In this case study of the Mediterranean fin whale (Balaenoptera physalus), we explore the toxicological effects of microplastics on mysticetes. The study included the following three steps: (1) the collection/count of microplastics in the Pelagos Sanctuary (Mediterranean Sea), (2) the detection of phthalates in surface neustonic/planktonic samples, and (3) the detection of phthalates in stranded fin whales. A total of 56% of the surface neustonic/planktonic samples contained microplastic particles. The highest abundance of microplastics (9.63 items/m(3)) was found in the Portofino MPA (Ligurian Sea). High concentrations of phthalates (DEHP and MEHP) were detected in the neustonic/planktonic samples. The concentrations of MEHP found in the blubber of stranded fin whales suggested that phthalates could serve as a tracer of the intake of microplastics. The results of this study represent the first warning of this emerging threat to baleen whales.

O) Mazzariol S., Di Guardo G., Marsili L., Fossi M.C., Leonzio C., Petrella A., Ferrante M., Airoldi S., Frantzis A., De Beraldo Quiros Y.M., Pavan G., Podesta' M., Garibaldi F., Vizzini S., Gaspari S., Zizzo N., Traversa D., Marcer F., Cozzi B., Fernandez A. 2011 – Sometimes sperm whales (Physeter macrocephalus) cannot find their way back to the high seas: a multidisciplinary study on a mass stranding. Plos One, 6(5): 1-17.

BACKGROUND:

Mass strandings of sperm whales (Physeter macrocephalus) remain peculiar and rather unexplained events, which rarely occur in the Mediterranean Sea. Solar cycles and related changes in the geomagnetic field, variations in water temperature and weather conditions, coast

geographical features and human activities have been proposed as possible causes. In December 2009, a pod of seven male sperm whales stranded along the Adriatic coast of Southern Italy. This is the sixth instance from 1555 in this basin.
METHODOLOGY/PRINCIPAL FINDINGS:
Complete necropsies were performed on three whales whose bodies were in good condition, carrying out on sampled tissues histopathology, virology, bacteriology, parasitology, and screening of veins looking for gas emboli. Furthermore, samples for age determination, genetic studies, gastric content evaluation, stable isotopes and toxicology were taken from all the seven specimens. The animals were part of the same group and determined by genetic and photo-identification to be part of the Mediterranean population. Causes of death did not include biological agents, or the "gas and fat embolic syndrome", associated with direct sonar exposure. Environmental pollutant tissue concentrations were relatively high, in particular organochlorinated xenobiotics. Gastric content and morphologic tissue examinations showed a prolonged starvation, which likely caused, at its turn, the mobilization of lipophilic contaminants from the adipose tissue. Chemical compounds subsequently entered the blood circulation and may have impaired immune and nervous functions.
CONCLUSIONS/SIGNIFICANCE:
A multi-factorial cause underlying this sperm whales' mass stranding is proposed herein based upon the results of postmortem investigations as well as of the detailed analyses of the geographical and historical background. The seven sperm whales took the same "wrong way" into the Adriatic Sea, a potentially dangerous trap for Mediterranean sperm whales. Seismic surveys should be also regarded as potential co-factors, even if no evidence of direct impact has been detected.

P) Reich S., Jimenez B., Marsili L., Hernandez L.M., Shurig V., Gonzales M.J. 1999 - Enantiomeric ratios of chiral PCBs in striped dolphins (*Stenella coeruleoalba*) from the Mediterranean sea. Environmental Science and Technology, 33: 1787-1793.
Blubber and liver samples from six striped dolphins (Stenella coeruleoalba) found dead in the Mediterranean sea in 1989-1990 were tested for 37 coplanar and chiral polychlorinated biphenyls (PCBs), including the enantiomeric ratios of 9 chiral PCBs. The method includes a fractionation step using HPLC (PYE column) for separating the PCBs according to the number of chlorine atoms in the ortho positions. HRGC/ECD and HRGC/LRMS with an achiral column (DB-5) were used to determine the PCB congeners. The enantiomeric ratios of nine chiral PCBs were determined by HRGC/LRMS (SIM) with a chiral column (Chirasil-Dex) and by MDGC as the confirmatory technique. The total PCB concentration (sum of 37 congeners) ranged from 7.2 to 89.6 íg/g (wet weight) and from 0.52 to 29.2 íg/g (wet weight) for blubber and liver samples, respectively. PCB profiles were dominated by congeners 138, 153, 170, and 180. The toxic equivalent values (TEQ) ranged from 0.17 to 3.93 ng/g (wet weight) and from 0.02 to 0.73 ng/g (wet weight) for blubber and liver samples, respectively. PCBs 95, 132, 135, 149, and 176 revealed an enantiomeric excess of the second eluted enantiomer in almost all of the samples, whereas PCBs 136 and 174 were racemic or almost racemic. PCBs 88 and 91 were under the detection limits of the methodology used.

Q) Marsili L, Caruso A, Fossi MC, Zanardelli M, Politi E, Focardi S. 2001 - Polycyclic aromatic hydrocarbons (PAHs) in subcutaneous biopsies of Mediterranean cetaceans. Chemosphere. 44(2): 147-154.
The aim of the present study was to measure polycyclic aromatic hydrocarbon (PAH) levels in free-ranging Mediterranean cetaceans as they are likely to cause chemical stress in the organisms of this basin. Blubber samples were collected from live specimens of fin whales (Balaenoptera physalus) and striped dolphins (Stenella coeruleoalba) by means of biopsies, a non-destructive biological method. Fin whales were sampled in the Ligurian Sea, whereas striped dolphins were collected in the Ligurian and the Ionian Seas. A fingerprint of 14 PAHs was obtained for both species. In whales, the median value of total PAHs was 1970 ppb fresh weight (f.w.) while median carcinogenic PAH values were 89.80 ppb f.w.; in dolphins, the median values of total and carcinogenic PAHs were 29,500 and 676.00 ppb f.w., respectively. The different PAH values between the two species can be attributed to the different positions they take in the Mediterranean food web. The sampling period significantly influenced PAH concentrations of fin whales.

R) Merino R., Bordajandi L.R., Gonzales M.J. Abad E., Rivera J., Fossi M.C., Marsili L., Jimenez B. 2003 - First attempt to evacuate PCDDs, PCDFs and PCB enantiomeric ratios in striped dolphins (*Stenella coeruleoalba*) from the Mediterranean sea using skin biopsies. Organohalogen Compounds, 62: 165-168.
Several studies1,2 conducted in the Mediterranean basin have revealed that top predators, and particularly cetaceans, accumulate high concentrations of Organochlorine Contaminants (OCs). However it should be pointed that most of these studies are based on tissues obtained from dead specimens such as blubber or liver. Limited information exists on the ecotoxicological status of free ranging specimens of high interest, in particular of top predators. In this study, we used skin biopsy as a non-lethal approach to investigate the presence of OCs, in particular polychlorodibenzo-p-dioxins (PCDDs), polychlorodibenzofurans (PCDFs) and polychlorobiphenyls (PCBs) in striped dolphins (Stenella coeruleoalba). Skin biopsy has certain advantages in ecotoxicological studies: it enables a large number of samples to be obtained across a wide geographic range; it could be suitable for residue analysis and, biomarker analysis such as Cytochrome P4501A (CYP1A1) induction. Recently, increasing attention has also been paid on PCBs which display axial chirality in their non-planar conformations. Nineteen out of 78 chiral PCBs exist as stable atropisomers at ambient temperature and have been introduced into the environment as racemates. But it has been shown that their intake or metabolism by organisms may be enantioselective and that PCB atropisomers may have different activities, toxicities, or metabolic pathways. This makes their determination highly important and interesting in different research topics, especially in the environmental field. Moreover, few studies deal with their determination in marine mammals such as stripped dolphins, being this study the first one performed in skin biopsy. Among the objectives of this work, are to provide for the first time baseline data on PCDD and PCDF levels, as well as PCB enantiomeric ratios for an endangered population of South-West Mediterranean striped dolphins using skin biopsy as a non destructive sampling procedure.

S) Fossi MC, Marsili L, Lauriano G, Fortuna C, Canese S, Ancora S, Leonzio C, Romeo T, Merino R, Abad E, Jiménez B. 2004 - Assessment of toxicological status of a SW Mediterranean segment population of striped dolphin (*Stenella coeruleoalba*) using skin biopsy. Mar Environ Res. 58(2-5): 269-274.
Various studies have revealed high concentrations of contaminants such as organochlorines (OCs) and heavy metals in Mediterranean cetaceans. A geographical trend of contamination (PCBs and DDTs) has been found for striped dolphin (Stenella coeruleoalba). In this study we used a non-lethal approach (skin biopsy) to investigate bioaccumulation of OCs, including polychlorobiphenyls (PCBs), DDTs, polychlorodibenzo-p-dioxins (PCDDs), polychlorodibenzofurans (PCDFs), trace elements (Hg, Cd, Pb) and CYP1A activity (BPMO) in nine striped dolphins sampled in the Aeolian area (Sicily - Italy) in summer 2002. The arithmetic mean value of BPMO activity in this group was 43.46 AUF/g tissue/h. This value is approximately 3 times and 5 times lower, respectively, than the value found in the Ionian and in the Ligurian groups. Skin biopsies of striped dolphins emerged as a suitable material for assessing the toxicological status of the various Mediterranean groups.

T) Marsili L, D'Agostino A, Bucalossi D, Malatesta T, Fossi MC. 2004 - Theoretical models to evaluate hazard due to organochlorine compounds (OCs) in Mediterranean striped dolphin (*Stenella coeruleoalba*). Chemosphere.56(8): 791-801.
Many studies document the chemical stress related to organochlorine (OC) xenobiotics in Mediterranean cetaceans. The aim of this study was to establish a theoretical model to evaluate the hazard to Mediterranean striped dolphins (Stenella coeruleoalba) due to HCB, DDTs and PCB congeners. Differences in OC levels in blubber of stranded and free-ranging specimens enabled us to evaluate the hazard associated with different chlorinated xenobiotics, taking the live population as control sample, assumed to be in good health. For the most toxic

compounds, with teratogenic, mutagenic, carcinogenic and endocrine disrupting capacity, we indicate levels beyond which there can be toxicological hazard for the striped dolphin. Using a mathematical formula derived from knowledge of the length and age of 62 stranded specimens, the age of dolphins was estimated and sexual maturity was identified at nine years. This evaluation was important for understanding differences in contaminant burden between males and females.

U) Spinsanti G, Panti C, Lazzeri E, Marsili L, Casini S, Frati F, Fossi CM. 2006 - Selection of reference genes for quantitative RT-PCR studies in striped dolphin (*Stenella coeruleoalba*) skin biopsies. BMC Mol Biol. 19; 7:32.

BACKGROUND:

Odontocete cetaceans occupy the top position of the marine food-web and are particularly sensitive to the bioaccumulation of lipophilic contaminants. The effects of environmental pollution on these species are highly debated and various ecotoxicological studies have addressed the impact of xenobiotic compounds on marine mammals, raising conservational concerns. Despite its sensitivity, quantitative real-time PCR (qRT-PCR) has never been used to quantify gene induction caused by exposure of cetaceans to contaminants. A limitation for the application of qRT-PCR is the need for appropriate reference genes, which allow the correct quantification of gene expression. A systematic evaluation of potential reference genes in cetacean skin biopsies is presented, in order to validate future qRT-PCR studies aiming at using the expression of selected genes as non-lethal biomarkers.

RESULTS:

Ten commonly used housekeeping genes (HKGs) were partially sequenced in the striped dolphin (Stenella coeruleoalba) and, for each gene, PCR primer pairs were specifically designed and tested in qRT-PCR assays. The expression of these potential control genes was examined in 30 striped dolphin skin biopsy samples, obtained from specimens sampled in the north-western Mediterranean Sea. The stability of selected control genes was determined using three different specific VBA applets (geNorm, NormFinder and BestKeeper) which produce highly comparable results. Glyceraldehyde-3P-dehydrogenase (GAPDH) and tyrosine 3-monooxygenase (YWHAZ) always rank as the two most stably expressed HKGs according to the analysis with geNorm and Normfinder, and are defined as optimal control genes by BestKepeer. Ribosomal protein L4 (RPL4) and S18 (RPS18) also exhibit a remarkable stability of their expression levels. On the other hand, transferrin receptor (TFRC), phosphoglycerate kinase 1 (PGK1), hypoxanthine ribosyltransferase (HPRT1) and beta-2-microglobin (B2M) show variable expression among the studied samples and appear as less suitable reference genes for data normalization.

CONCLUSION:

In this work, we have provided essential background information for the selection of control genes in qRT-PCR studies of cetacean skin biopsies, as a molecular technique to investigate ecotoxicological hazard in marine mammals. Of 10 HKGs tested, those encoding for YWHAZ and GAPDH appear as the most reliable control genes for the normalization of qRT-PCR data in the analysis of striped dolphin skin biopsies. Potentially useful reference genes are also those encoding for ribosomal proteins L4 and S18.

V) Panti, C., Spinsanti G., Marsili L., Casini S., Fossi M.C. 2011- Ecotoxicological diagnosis of striped dolphin (*Stenella coeruleoalba*) from the Mediterranean basin by skin biopsy and gene expression approach. Ecotoxicology, 20(8): 1791-1800.

Mediterranean cetacean odontocetes are exposed to environmental stress, in particular to persistent organic pollutants, polycyclic aromatic hydrocarbons and trace elements. In the present study, the response of "gene-expression biomarkers" was evaluated in Mediterranean striped dolphin (Stenella coeruleoalba) skin biopsies collected in three sampling areas: Pelagos sanctuary (Ligurian sea), Ionian Sea, and Strait of Gibraltar. The mRNA levels of five putative biomarker genes (aryl hydrocarbon receptor, E2F-1 transcription factor, cytochrome P450 1A, estrogen receptor 1, and heat shock protein 70) were measured for the first time by quantitative real-time PCR in cetacean skin biopsies. The different responses of most of the genes reflected contamination levels in the three sampling areas. Pelagos sanctuary dolphins appeared to be the most exposed to toxicological stress, having the highest up-regulation of CYP1A and AHR. Moreover, a cluster analysis distinguished the populations on the basis of the gene expression biomarker used in our study, showing different pattern between Mediterranean sea and Strait of Gibraltar. Our results suggest that this molecular approach applied to non-destructive biopsy material is a powerful diagnostic tool for evaluating ecotoxicological impact on cetacean populations.

W) Fossi MC, Panti C, Marsili L, Maltese S, Spinsanti G, Casini S, Caliani I, Gaspari S, Muñoz-Arnanz J, Jimenez B, Finoia MG. 2013 - The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (Stenella coeruleoalba). Mar Pollut Bull. In press

The concurrence of man-made pressures on cetaceans in the Mediterranean Sea is potentially affecting population stability and marine biodiversity. This needs to be proven for the only pelagic marine protected area in the Mediterranean Sea: the Pelagos Sanctuary for Mediterranean Marine Mammals. Here we applied a multidisciplinary tool, using diagnostic markers elaborated in a statistical model to rank toxicological stress in Mediterranean cetaceans. As a case study we analysed persistent, bioaccumulative and toxic chemicals combined with a wide range of diagnostic markers of exposure to anthropogenic contaminants and genetic variation as marker of genetic erosion in striped dolphin (Stenella coeruleoalba) skin biopsies. Finally, a statistical model was applied to obtain a complete toxicological profile of the striped dolphin in the Pelagos Sanctuary and other Mediterranean areas (Ionian Sea and Strait of Gibraltar). Here we provide the first complete evidence of the toxicological stress in cetaceans living in Pelagos Sanctuary.

X) Kannan K, Corsolini S, Focardi S, Tanabe S, Tatsukawa R. 1996 - Accumulation pattern of butyltin compounds in dolphin, tuna, and shark collected from Italian coastal waters. Arch Environ Contam Toxicol. 31(1): 19-23.

Tributyltin (TBT) and its breakdown products, mono-(MBT) and dibutyltin (DBT) were determined in bottlenose dolphin (Tursiops truncatus), bluefin tuna (Thunnus thynnus thynnus) and blue shark (Prionace glauca) collected from the Italian coast of the Mediterranean Sea in 1992-1993. Concentrations of total butyltin (BTs) in the liver of dolphin (1,200-2,200 ng/g wet wt) were an order of magnitude higher than in the blubber (48-320 ng/g wet wt). TBT was the predominant butyltin species in the blubber while DBT accounted for an higher proportion in the liver of dolphins. Butyltin concentrations in bluefin tuna were lower than those in dolphins, with TBT highest in the muscle and DBT in the liver. Concentrations of BTs in blue sharks were lower than those in dolphin and tuna, with kidney having the highest concentrations. TBT was the predominant form of butyltin derivatives in all the tissues of shark. Accumulation of butyltin compounds in liver/kidney seems to be associated with the presence of proteins such as glutathione.

Y) Marsili L. 2000 - Lipophilic contaminants in marine mammals: review of the results of ten years work at the Department of Environmental Biology, Siena University (Italy). "The Control of Marine Pollution: Current Status and Future Trends", Special Issue International Journal of the Environment and Pollution, 13: 416-452.

Organochlorine contaminants (HCB, DDTs and PCBs) and polycyclic aromatic hydrocarbons (PAHs) were valuated in three Mediterranean cetaceans: the striped dolphin (Stenella coeruleoalba), the bottlenose dolphin (Tursiops truncatus) and the fin whale (Balaenoptera physalus), and in three Argentinean pinnipeds: the southern sea lion (Otaria flavescens), the South American fur seal (Arctocephalus australis) and the subantarctic fur seal (Arctocephalus tropicalis). Two kinds of sample were obtained from the different species of cetaceans and pinnipeds in order to evaluate the toxicological risk to which a species or population is exposed those from stranded specimens and those from free-ranging specimens. In this paper, the use of a non-destructive approach, biopsy sampling, for free ranging marine mammals is recommended.

Z) Fossi MC, Casini S, Marsili L. 2007 - Potential toxicological hazard due to endocrine-disrupting chemicals on Mediterranean top predators: state of art, gender differences and methodological tools. Environ Res. 104(1): 174-182.
Man-made endocrine-disrupting chemicals (EDCs) range across all continents and oceans. Some geographic areas are potentially more threatened than others: one of these is the Mediterranean Sea. Levels of some xenobiotics are much higher here than in other seas and oceans. In this paper we review the final results of a project supported by the Italian Ministry of the Environment, in which the hypothesis that Mediterranean top predator species (such as large pelagic fish and marine mammals) are potentially at risk due to EDCs was investigated. We illustrate the need to develop and apply sensitive methodological tools, such as biomarkers (Vitellogenin, Zona Radiata proteins and CYP1A activities) for evaluation of toxicological risk in large pelagic fish top predators (Swordfish, (Xiphias gladius), Bluefin Tuna (Thunnus thynnus thynnus)) and nondestructive biomarkers (CYP1A activities and fibroblast cell culture in skin biopsy), for the hazard assessment of threatened marine mammals species (Striped Dolphin, (Stenella coeruleoalba), Bottlenose Dolphin (Tursiops truncatus), Common Dolphin (Delphinus delphis) and Fin Whale (Balaenoptera physalus))exposed to EDCs. Differential gender susceptibility to EDCs is also explored both in large pelagic fish and in cetaceans. In cetaceans, male specimens showed higher cytochrome P450 induction (BPMO in skin biopsies, CYP2B in fibroblasts cell cultures) by xenobiotics with respect to females.

α) Marsili L. & Focardi S. 1997 - Chlorinated hydrocarbon (HCB, DDTs and PCBs) levels in cetaceans stranded along the Italian coasts: an overview. Environmental Monitoring and Assessment, 45: 129-180.
Concentrations of HCB, DDTs and PCBs in the tissues and organs of cetaceans (Stenella coeruleoalba, Tursiops truncatus, Balaenoptera physalus, Grampus griseus and Globicephala melaena) stranded along the Italian coasts in the period 1987–1993 are reported. The values are compared between species and between specimens of the same species. Chlorinated hydrocarbon (CH) levels were found to increase in relation to the quantity and type of lipids in each tissue and organ. Differences in accumulation encountered in the different species are principally due to different feeding habitats. Remarkable differences found between males and females of each species confirm that during gestation and lactation, females undergo disintoxication by passing much of their total burden of CHs to their young.

Number Reference	Title	Organization leading the project	Responsible
1	Fin whale and maritime transport: what are the challenges and solutions?	EPHE / CEBC-CNRS	L. DAVID - P. BEAUBRUN, Ch. GUINET
2	Winter monitoring of common bottlenose dolphins in Corsica and photo-identification catalogue	GECEM	F. DHERMAIN, J.-M. BOMPAR
3	Further monitoring of Risso's dolphin population and computerised version of the photo-identification file	GECEM	J.-M. BOMPAR
4	Stranding data operating protocol. Cetacean strandings in the Mediterranean from 1999 to 2002	GECEM	F. DHERMAIN
5	Assessing sperm whale feeding ecology in the north-western Mediterranean Sea	GREC	V. DROUOT, A. GANNIER
6	Assessing seasonal variations in the distribution and relative abundance of cetaceans in the Sanctuary for Mediterranean Marine Mammals	CRC	S. LARAN, A. GANNIER
7	Assessing cetacean feeding ecology in the Sanctuary for Mediterranean Marine Mammals	EPHE	G. ASTRUC, P. BEAUBRUN
8	Summer groupings of fin whales and environmental conditions observed by satellite remote sensing. Summer 1998 to 2002 in the north-western Mediterranean Sea	GREC	A. LITTAYE, A. GANNIER
9	Sperm whale nutrition survey in the Sanctuary for Mediterranean Marine Mammals	GREC	A. GANNIER
10	Cetacean detection protocol for liner vessels travelling from Corsica to the Continent	EPHE	M. O. BOURCOURD
11	"Vessel Tests" - Validation tests for existing protocols on cetacean population monitoring on liner vessels	EPHE, Océanides	P. BEAUBRUN, P. MAYOL, F. CAPOULADE, G. ASTRUC
12	"ULM-Monitoring" to validate the cetacean monitoring protocol of ferries	EPHE, Océanides	P. BEAUBRUN, F. CAPOULADE, G. ASTRUC
13	Cetacean stranding census on Mediterranean French coasts 2002-2004	GECEM	F. DHERMAIN
14	Whale-watching in the French Mediterranean Sea: state of the art and future prospects	Souffleurs d'écume	P. MAYOL, P. BEAUBRUN, F. DHERMAIN, J-M BOMPAR
15	Use of coastal areas by striped dolphins in the Pelagos Sanctuary	CRC	A. MEISSNER, A. GANNIER, S. LARAN, V. RIDOUX
16	Seasonal variations in the distribution and relative abundance of cetaceans in the Sanctuary	CRC	S. LARAN, A. GANNIER
17	Distribution and summer habitat of the sperm whale (*Physeter macrocephalus*) in the north-western Mediterranean Sea	GREC	A. GANNIER
18	Population monitoring of the common bottlenose dolphin (*Tursiops truncatus)* in Corsica	GECEM	F. DHERMAIN
19	Fin whale and maritime transport: what are the challenges and solutions?	CNRS CEBC , EcoOcéan	L. DAVID
20	Mediterranean fin whale ecology by isotope geochemistry	Université Montpellier II	I. BENTALEB
21	Thonaille fishing monitoring: what is the impact on striped dolphins?	GECEM	L. DAVID, M. CHENOZ
22	Dolphin vocalisation: sound beacon tests on fish and dolphin populations	Université de Cagliari	F. MAGGIANI

23	Summary and analysis of research projects carried out under the auspices of the French part of Pelagos Sanctuary since 2001	Klymene Recherche Marine	A. GANNIER
24	Monitoring strandings on the coast in the Pelagos Sanctuary (Action A4)	GIS 3M	GECEM
25	Spatio-temporal analysis of cetacean distribution in relation to environmental parameters (Action A2)	GIS 3M	CRC Marineland
26	Time series in the Pelagos Sanctuary in monthly transects off (Action A3-1)	GIS 3M	EcoOcéan Institut
27	Acoustic monitoring of cetacean populations north of the Pelagos Sanctuary (Action A3-3)	GIS 3M	CRC Marineland
28	Monitoring of bottlenose dolphins and Risso's dolphins in the area of Hyères islands (Action A3-2)	GIS 3M	GECEM
29	Summary of knowledge on the impact of maritime traffic (Action E1)	GIS 3M	EcoOcéan Institut
30	Preventing collisions between ships and whales (Action E2)	GIS 3M	EcoOcéan Institut
31	Evaluation of the level of contamination species toothed and baleen whales in the Pelagos Sanctuary	GIS 3M	
32	Whale watching in the French Mediterranean: Updating the database operators	Souffleurs d'écume	P. MAYOL, P-H WEBER
33	Monitoring and operation of strandings on French Mediterranean coast	GIS 3M	F.DHERMAIN
34	Behavior Ziphius (cycles probe and surface). Ziphius Distribution	GREC	
35	Study of the population of bottlenose dolphins Tursiops truncatus along the coast of Provence	GIS 3M	H.LABACH
36	Establishing a baseline contamination level for sperm and pilot whales in the Pelagos Sanctuary	GIS 3M	D.ODY, A.TASCIOTTI
37	Study of Risso's dolphins population in the Mediterranean North West	GIS 3M	H.LABACH
38	Genetic study of the structure of the population of fin whales in the Mediterranean North West and its conservation status	GIS 3M	D.ODY, A.TASCIOTTI
39	Indication of reproductive physiological status by hormonal analysis whales	GIS 3M	D.ODY, A.TASCIOTTI
40	Monitoring ferry: seasonal monitoring of cetacean populations and validation REPCET interest in terms of monitoring	GIS 3M	A.ARCANGELLI, S.COMINELLI,L.DAVID,N.DIMEGLIO,A.MOULINS, P.MAYOL, L.MARINI, M.ROSSO, P.TEPSICH
41	Whale-watching and pleasure: knowledge precision and management measures	GIS 3M	P.MAYOL, L.DAVID,N.DIMEGLIO,S.SERRE,F.DHERMAIN
42	Detection and classification of visual transect cetacean populations in northern Pelagos-Iles d'Or (DECAV)	USTV	R.ABEILLE, F.CHAMROUKHI,Y.DOH, O.DUFOUR, P.GIRAUDET, X.HALKIAS, H.GLOTIN,J-M.PREVOT, C.RABOUY, J.RAZIK
43	Monitoring ferry: winter data collection	GIS 3M	N.DIMEGLIO,L.DAVID, S.SERRE
44	Movements of whales in the aim of improving the areas of risk of the REPCET system	GIS 3M	J.COUVAT, P.MAYOL, D.GAMBAIANI

Maps and Figures

Figure 1: Underwater topography of the Pelagos Sanctuary

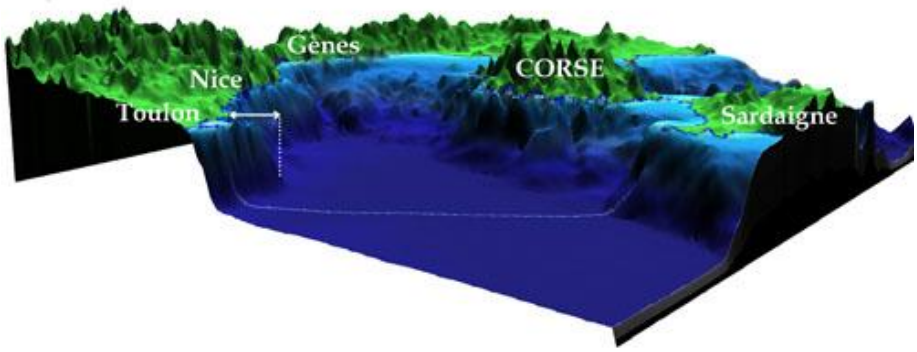


Figure 2: Climate of the Pelagos Sanctuary

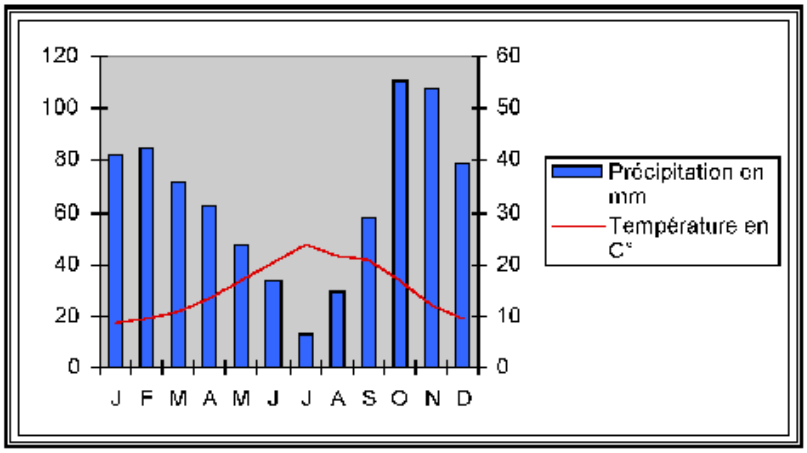


Figure 3: hydrology and currentology

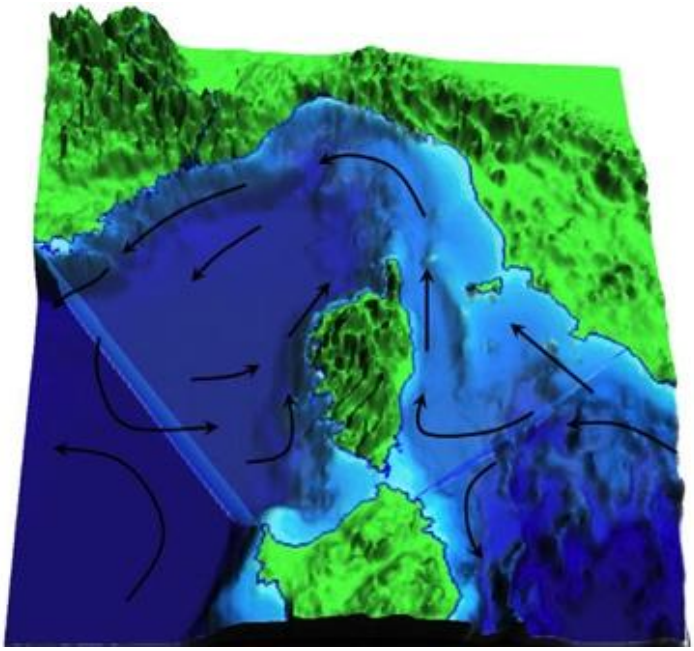
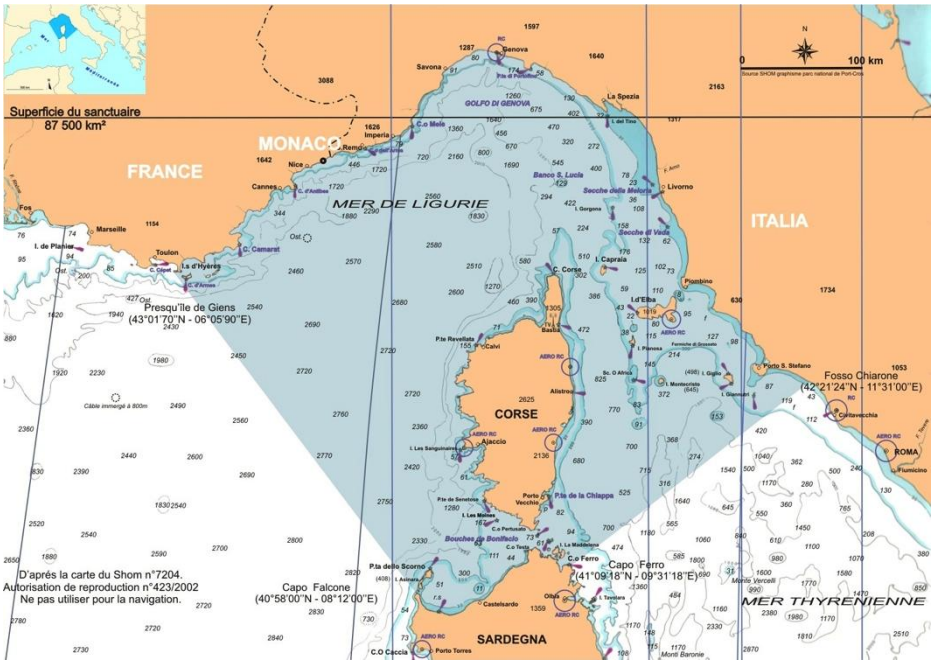
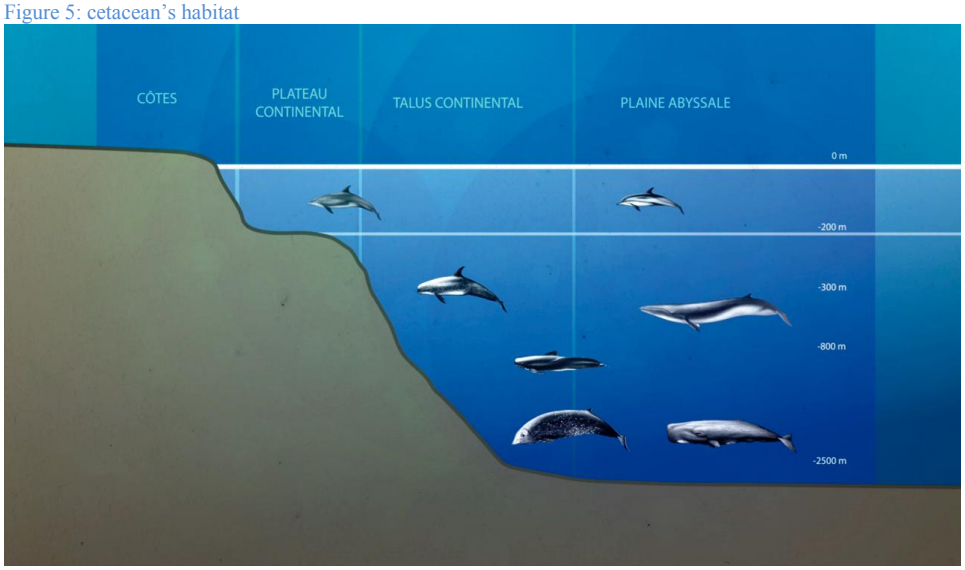


Figure 4: Map and boundaries of the Pelagos Sanctuary



Boundary	Description	Geographic coordinates
Western	A line extending from the Escampobariou Point (on the western edge of the Giens peninsula)	N 43°01'70 – E 06°05'90
	to the Falcone Cape (the westernmost part of the Gulf of Asinara)	N 40°58'00 – E 08°12'00
Eastern	A line extending from the Ferro Cape (on Sardinia's north-eastern coast)	N 41°09'18 – E 09°31'18
	to Fosso Chiarone (on the west coast of Italy)	N 42°21'24 – E 11°31'00

Figure 5: cetacean's habitat



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