United Nations Environment Programme

MEDITERRANEAN ACTION PLAN

Regional Activity Centre for Specially Protected Areas

STATUS AND CONSERVATION OF CETACEANS IN THE ADRIATIC SEA

Draft internal report

Draft to be used only to support the preparation of documents for the *"Mediterranean Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas. Malaga, Spain, 7-11 April 2014"*

March 2014

Draft internal report not for distribution

This report should be quoted as:

UNEP-MAP-RAC/SPA. 2014. Status and Conservation of Cetaceans in the Adriatic Sea. By D. Holcer, C.M. Fortuna & P. C. Mackelworth. Draft internal report for the purposes of the Mediterranean Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas, Malaga, Spain, 7-11 April 2014.

Contents

List of Figures

List of Tables

1 Context

Since 2008, the Regional Activity Centre for Specially Protected Areas (RAC-SPA) under the framework of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP) has been implementing the "MedOpenSeas" project to identify and establish Marine Protected Areas (MPAs) in the open seas, including the deep seas. The primary objective of this project is to promote the establishment of a representative ecological network of MPAs in the Mediterranean within the framework of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) on the establishment of Specially Protected Areas of Mediterranean Importance (SPAMIs). This project is financially supported by the European Commission, and is now in its third phase.

The first phase of the project, completed in late 2009, led to the identification of twelve priority conservation areas in the open seas, including the deep seas. These priority areas could become candidates for SPAMI listing and/or be recommended for inclusion in other frameworks, such as Ecologically or Biologically Significant Areas (EBSAs) developed under the Convention on Biological Diversity (CBD).

The aim of the project's second phase, completed in early 2012, was to support neighbouring Parties of the above-mentioned priority areas in evaluating and potentially presenting these sites as candidate(s) for inclusion in the SPAMI List, in accordance with the provisions of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean. The RAC/SPA in Tunis has been facilitating this preparatory work, including oceanographic surveys and stakeholder negotiations. The programme of work of the second phase included the establishment of *ad hoc* working groups, composed of representatives from the countries bordering the Alboran Sea (Algeria, Morocco, Spain) and Gulf of Lions (France, Spain) priority areas.

Table 1. List of neighbouring countries for the priority areas addressed by the third phase of the "MedOpenSeas" project.

Priority areas addressed during 3rd phase	**Neighbouring countries**
Adriatic Sea	Albania, Bosnia-Herzegovina, Croatia, Italy, Montenegro and Slovenia
Alboran Sea	Algeria, Morocco and Spain
Sicily Channel/Tunisian Plateau	Italy, Libya, Malta and Tunisia

The current third phase focuses on the spatial planning and evaluation of three priority areas (see Table 1 and Figure 1): Adriatic Sea, Alboran Sea and the Sicily Channel/Tunisian Plateau areas. The two adjacent sites within the Sicily channel/Tunisian plateau will be dealt with in joint meetings and working groups to maximize the effectiveness in the broader area. The process in the Alboran Sea benefits from initial preparatory work and a stakeholder meeting in 2011 conducted during the second project phase. The

RAC/SPA is currently starting to prepare meetings with the representatives of the neighbouring countries to these three sites, in order to present the proposed process and to discuss the feasibility of setting up multilateral working groups.

A wealth of biological and environmental data is available for the above-mentioned areas, based on long-term research and exploration efforts made by several countries. Ongoing programmes, for example on seabirds and marine mammals, continue to improve our understanding of the biodiversity in these regions.

Much of these data are however scattered across different national research institutes and are not necessarily formally published. A summary report and review of our current understanding of the biodiversity for each of the four priority areas will be essential to develop MPAs in these key open sea regions. Therefore expertise will be recruited i) to compile and review available data on the ecology for each of the priority areas and ii) to produce a report illustrating the state of ecological knowledge for the respective areas. Ultimately these outputs will provide the foundation for assessing the suitability of each of the sites for SPAMI listing.

In parallel to the preparation of an overall marine ecology report, there will be an initial and a follow-up project meeting for each priority area. This will assist stakeholder communication throughout the process, as well as the collection of data for the overall marine ecology report.

Figure 1. Priority conservation areas in the Mediterranean (UNEP/MAP).

2 The Adriatic Sea

The Adriatic Sea is the northernmost arm of the Mediterranean basin. It is a semi-enclosed sea with a surface area of around 138,000 km², connected to the Mediterranean through the narrow (72 km wide) but deep (780 m) Strait of Otranto (Cushman-Rosin *et al.* 2001). The bathymetry of the Adriatic Sea is characterized by strong latitudinal and longitudinal asymmetries (Figure 2).

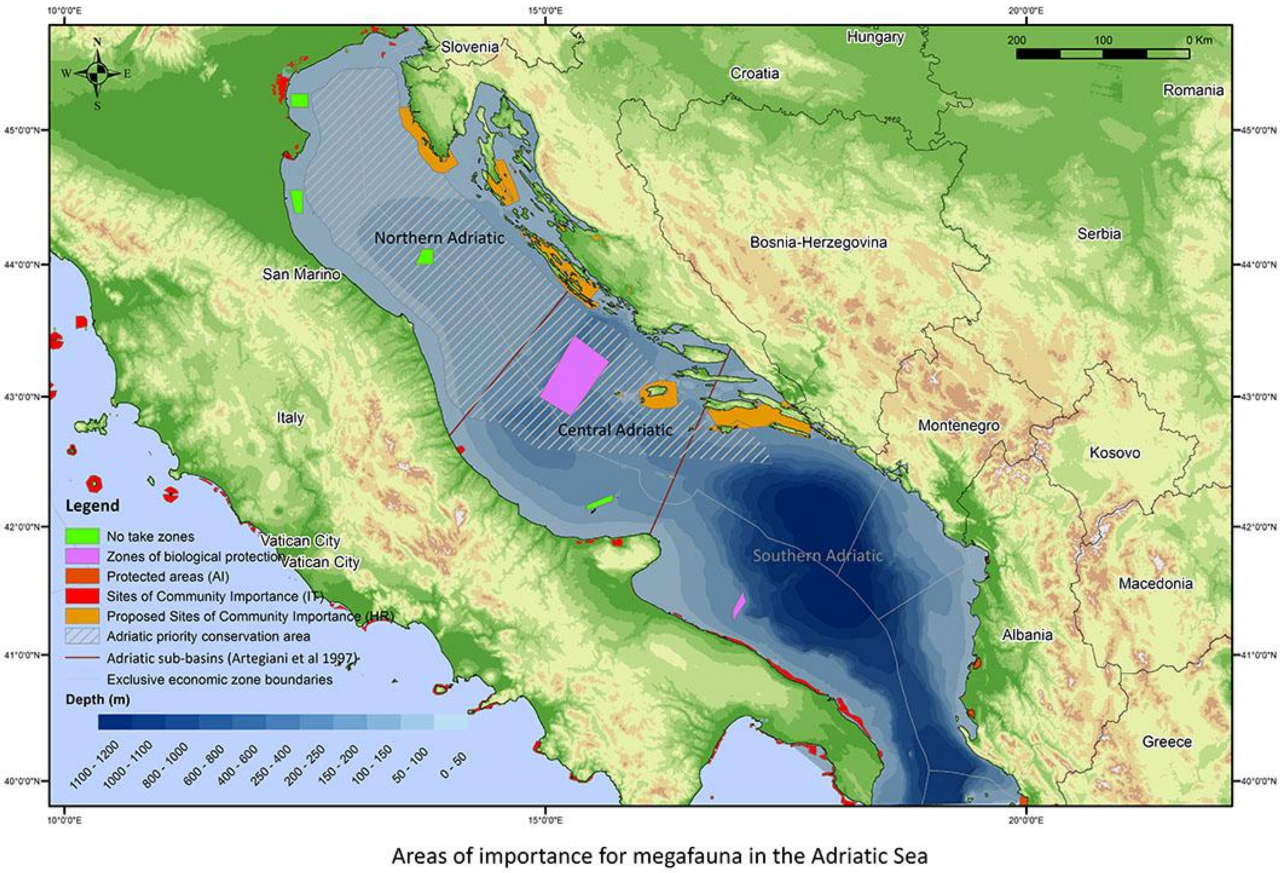


Figure 2. Map of Adriatic Sea with bathymetry and protected areas.

The northern sub-basin is shallow, with an average depth of 35 m and is strongly influenced by the Po river plumes, with low salinity, low water temperature and high productivity. The 100 m bathymetric contour line roughly separates the northern basin from the central Adriatic (Artegiani *et al.* 1997).

The central Adriatic is a transition zone with some open sea characteristics and the 270 m deep Jabuka (Pomo) pit (Russo & Artegiani 1996) influenced by the inflow of Levantine Intermediate Water (LIW).

Finally, the 170 m deep Palagruža (Pelagosa) sill separates the central sub-basin from the much deeper southern Adriatic. This sub-basin, with steep slopes, higher salinity and maximum depth of 1200 m, consists of around 55% of the surface area but about 80% of the total volume of the Adriatic Sea (Cushman-Rosin *et al.* 2001) and as such it can be considered as a pelagic oceanic habitat (Fonda-Umani 1996).

These three sub-regions have also noticeable differences in sea current gyres (Artegiani *et al.* 1997).

3 Cetacean species in the Adriatic Sea

Eleven Cetacean species are present with regular populations in the Mediterranean Sea and contiguous area (Notarbartolo di Sciara & Birkun 2010). Three of this species have limited ranges; the killer whale (*Orcinus orca*) is present in the Strait of Gibraltar, the rough-toothed dolphin (*Steno bredanensis*) in the Levantine basin and the harbour porpoises (*Phocoena phocoena relicta*) in the Aegean Sea (Notarbartolo di Sciara & Birkun 2010). The other eight species are present throughout the Mediterranean and are recorded in the Adriatic Sea with different densities. These include the common bottlenose dolphin, *Tursiops truncatus*, the short-beaked common dolphin, *Delphinus delphis,* the striped dolphin, *Stenella coeruleoalba*, the fin whale (*Balaenoptera physalus*), the sperm whale (*Physeter macrocephalus*), the long-finned pilot whale (*Globicephala melas*), the Risso's dolphin (*Grampus griseus*) and the Cuvier's beaked whale (*Ziphius cavirostris*) (Holcer 1994; Holcer *et al.* 2002). Additionally, two more species (considered visitors to the Mediterranean Sea), the false killer whale (*Pseudorca crassidens*) and the humpback whale (*Megaptera novaeangliae*), have been recorded with solitary individuals in the Adriatic Sea (Holcer *et al.* 2002; Genov *et al.* 2009a).

Current knowledge of the status of Cetacean species in the Adriatic Sea indicate that only the common bottlenose dolphin is regularly present in the entire Adriatic Sea. The striped dolphin, the Risso's dolphin and the Cuvier's beaked whale are present in different densities only in the southern Adriatic, while sperm whales occasionally visit the area. Fin whales are present seasonally in the central and southern Adriatic. The long-finned pilot whale, false killer whale and humpback whale present rare visitors to the Adriatic Sea. Finally, the short-beaked common dolphin, once present in the entire Adriatic Sea should be considered regionally extinct, as it is present only through either remnant or stray animals.

3.1 The common bottlenose dolphin (*Tursiops truncatus*)

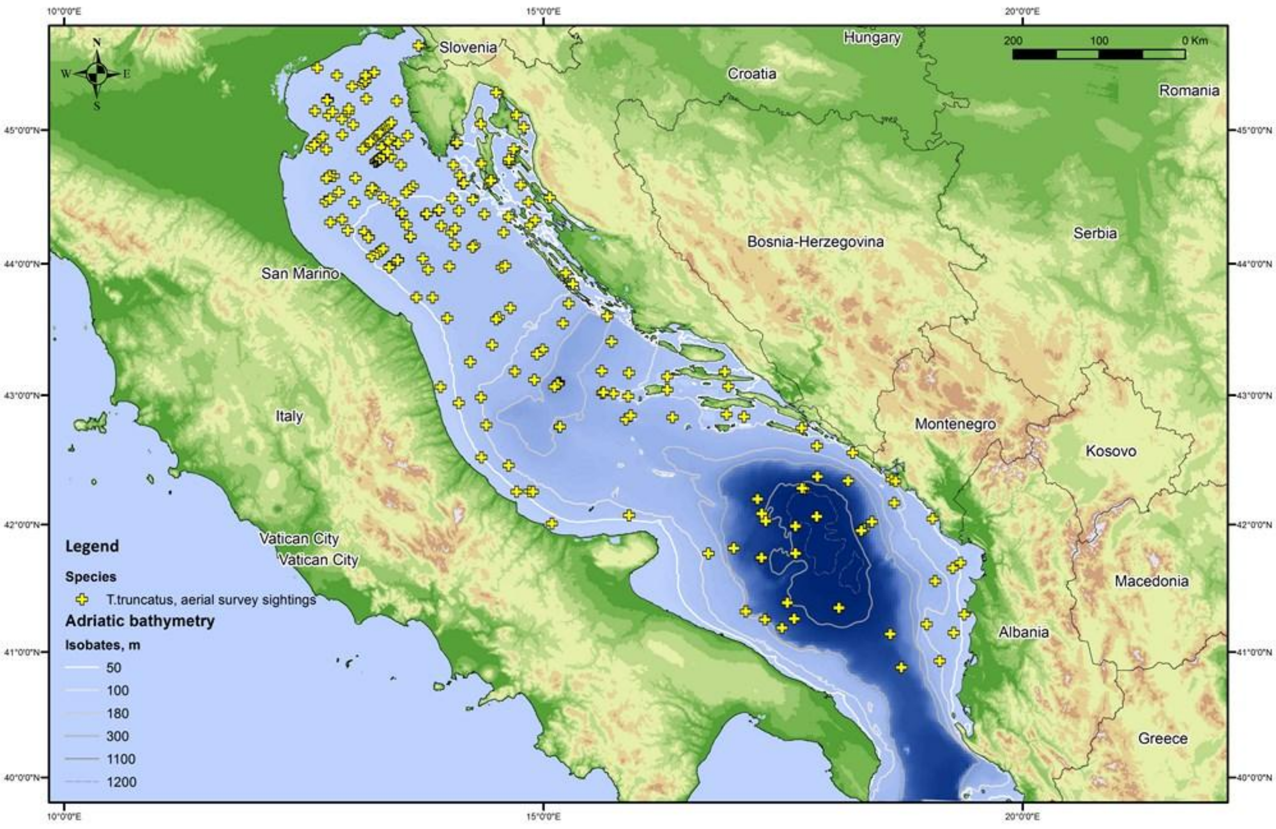
3.1.1 Distribution and abundance

The common bottlenose dolphin (*Tursiops truncatus*) is one of the most widely distributed species in the Mediterranean (Bearzi *et al.* 2008b). This species is believed to be most abundant in regions where neritic waters are predominant (e.g. the northern Adriatic Sea) or important (Notarbartolo Di Sciara *et al.* 1993). Nevertheless common bottlenose dolphins are found in a wide variety of other habitats, ranging from lagoons and river deltas to the oceanic waters (see Bearzi *et al.* (2008b) for a review).

Prior to the 2010 aerial survey (Fortuna *et al.* 2011b), anecdotal accounts of common bottlenose dolphins were reported from many corners of the Adriatic basin, although reliable systematic data were limited to a few research studies. Since the late 1980s a long-term project on ecology of common bottlenose dolphins has been operating in the Lošinj-Cres archipelago and its adjacent areas (Notarbartolo Di Sciara *et al.* 1993;

Bearzi & Notarbartolo di Sciara 1995; Bearzi *et al.* 1997; Bearzi *et al.* 1999; Bearzi *et al.* 2008b; Bearzi *et al.* 2009). This study uses photo-identification as the main tool for looking at many aspects of the ecology of this population. It is the first project to provide quantitative information on population dynamics of the local population of common bottlenose dolphins (Bearzi *et al.* 1997; Fortuna *et al.* 2000; Fortuna 2006; Pleslić *et al.* 2014). Other long-term studies were started in Slovenia (Genov *et al.* 2008; Genov *et al.* 2009b) and central Croatia in 2002 (Impetuoso *et al.* 2003), and south Croatia in 2007 (Holcer *et al.* 2008c; Holcer *et al.* 2009; Holcer 2012). Additional data from short and medium-term projects on distribution, relative abundance and social structure was collected from Italian and Croatian waters (Bearzi *et al.* 2008a; Kammigan *et al.* 2008; Triossi *et al.* 2013).

Bearzi *et al.* (2008a) using data collected during oceanographic cruises in the north-western part of the northern Adriatic observed that common bottlenose dolphins' distribution changed depending on seasonal forcing. Given that their study area was relatively uniform in terms of bottom topography, they concluded that habitat use by the animals seems to depend on complex interactions among hydrological variables, caused primarily by seasonal change and likely to determine shifts in prey distribution.



Sightings of common bottlenose dolphin the Adriatic Sea (2010 & 2013)

Figure 3. Map of sighting of common bottlenose dolphins during aerial surveys in 2010 and 2013.

In 2010 and 2013 aerial surveys were carried out to provide snapshots of the summer distribution and abundance of common bottlenose dolphins in the entire Adriatic Sea. Figure 3 shows the common bottlenose dolphins distribution recorded during these surveys. These surveys confirmed that the common bottlenose dolphin is the only cetacean species regularly observed in the Adriatic Sea (Notarbartolo Di

Sciara *et al.* 1993; Bearzi & Notarbartolo di Sciara 1995; Bearzi *et al.* 2008b). In terms of distribution it is clear that this species prefers (five more times) the neritic province (<200m) to the oceanic one (see also Table 2), with a higher prevalence for areas with depths <100m.

Table 2. Minimum abundance estimates of common bottlenose dolphins in the Adriatic Sea from the aerial survey 2010.

Stratum	Sample size	Model	Group density per km2 (CV)	Animal density per km2 (CV)	Uncorrected estimate (CV; 95% CIs)	Estimated mean group size (CV)
All Adriatic (survey transect spacing: 20 km; area: about 133,400 km2)	61	Half-normal/Cosine	0.014 (21.6%)	0.043 (25.7%)	5,772 (25.7%; 3,467-9,444)	3.87 (20.7%)
Northern Adriatic only (survey transect spacing: 20 km)	35	Uniform/Cosine	0.025 (26.0%)	0.074 (30.2%)	3,608 (30.2%; 1,971-6,604)	2.80 (14.9%)
Central and southern Adriatic only (survey transect spacing: 20 km; area: about 73,900 km2)	23	Uniform/Cosine	0.010 (28.9%)	0.024 (34.8%)	1,786 (34.8%; 903-3,534)	2.87 (18.5%)

In the past the Adriatic common bottlenose dolphin was described as mostly scattered into relatively small inshore 'local populations'. After two aerial surveys it seems that this determination must have been largely affected by a perception bias connected the fact that the existing studies were mainly coastal. A biased view-point gained working in relatively small study areas (100 - 3,000 km^2). Wider surveys have revealed a different overall picture both in terms of general extension of this species distribution and its total numbers.

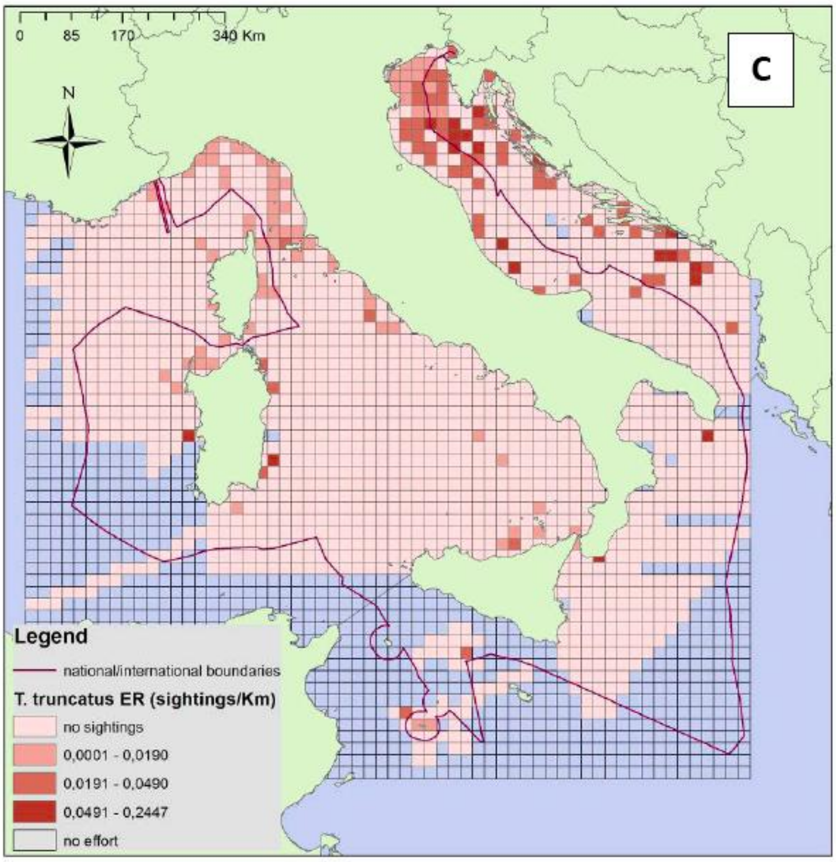


Figure 4. Common bottlenose dolphin distribution based on encounter rates (sightings/km) within cells of size 20x20km (Fortuna et al. 2013).

For the Initial Assessment (IA) of this species under the Marine Strategy Framework Directive (MSFD), Italy provided an overview on the sub-region "Adriatic Sea" (ISPRA 2013). This was based on most of the above mentioned data (including the 2010 aerial survey). Figure 4 shows the common bottlenose dolphin distribution obtained in this IA based on their encounter rates (sightings/km) obtained pooling all data available between 1986 and 2010. The cell size was 400km^2 (20x20) (Fortuna *et al.* 2013).

The information on the abundance of common bottlenose dolphins, through preliminary estimates obtained for the entire Adriatic Sea from the 2010 aerial survey (not corrected for perception nor availability bias) are shown in Table 2 (Fortuna *et al.* 2011b).

Densities are not particularly high, however, they are comparable to those of other areas of the Mediterranean Sea (i.e. Alboran Sea, Balearic Islands, see Bearzi *et al.* (2008b)). Both, densities and abundance estimates, when corrected for availability bias (diving behaviour) increase over 20%; whereas when accounting for the group size increase by about 50%. New abundance estimates accounting for availability and perception bias are due in 2014 (ISPRA & BWI, *unpublished data*).

Data on abundance obtained with mark-recapture methods in local studies is summarised in Table 3.

Table 3. Selected mark-recapture abundance estimates of common bottlenose dolphins in the Adriatic Sea.

Location (Sampling year)	Model	Total estimate (CV; 95% CIs)	Source
North-western Adriatic Sea, Slovenia & Croatia (2005)	M_{th} of Chao estimator	68 (0.18; 62-81)	Genov *et al.* 2008
North-western Adriatic Sea, Slovenia & Croatia (2008)	M_t	69 (0.08; 68-70)	Genov *et al.* 2008
Lošinj-Cres archipelago, Croatia (1995)	M_{th} of Chao estimator	168 (0.14; 132-229)	Fortuna 2006
Lošinj-Cres archipelago, Croatia (1998)	M_{th} of Chao estimator	130 (0.11; 108-152)	Fortuna 2006
Lošinj-Cres archipelago, Croatia (2001)	M_{th} of Chao estimator	105 (0.20; 76-160)	Fortuna 2006
Lošinj-Cres archipelago, Croatia (2004)	M_{th} of Chao estimator	197 (0.16; 162-272)	Pleslić *et al.* 2013
Lošinj-Cres archipelago, Croatia (2007)	M_{th} of Chao estimator	200 (0.13; 172-252)	Pleslić *et al.* 2013
Lošinj-Cres archipelago, Croatia (2010)	M_{th} of Chao estimator	186 (0.11; 164-230)	Pleslić *et al.* 2013
Vis-Lastovo archipelago, Croatia (2008)	M_h jacknife	396 (0.09; 350-456)	Holcer 2012
Vis-Lastovo archipelago, Croatia (2010)	M_{th} of Chao estimator	474 (0.22; 352-638)	Holcer 2012

3.1.1.1 Trends in distribution & abundance

There is no quantitative historical information that can be used to infer population trends in the Adriatic Sea. However, local experts believe that the common bottlenose dolphin numbers probably declined by at least 50% in the second half of the 20th century, largely as a consequence of deliberate killing initially (see paragraph 6.1.1.1), possibly followed by habitat degradation and overfishing of prey species (Bearzi *et al.* 2004; Bearzi *et al.* 2008b; Bearzi & Fortuna 2012). The aerial survey data collected in 2010 and 2013 will allow the first quantitative comparison for the entire basin and for its sub-regions.

3.1.2 Population structure

Looking at the population structure of common bottlenose dolphins in the Adriatic Sea, the meta-population concept is a useful context. A '*meta-population*' comprises '*local populations*' that are discrete or relatively discrete entities in space, which interact via migration and gene flow (Hanski & Gaggiotti 2004). The concept of meta-population also implies that the processes of ‘geographical extinction’ and ‘recolonisation’ occur ‘regularly’. It is widely accepted that the fragmentation of a landscape represents the most visible anthropogenic threat to the survival of natural populations (e.g. (Hanski 2005)). Such fragmentation can occur within the range of a local population, particularly for highly mobile species. In extreme cases, this might ultimately lead to both genetic and geographical isolation (Freedman *et al.* 2003; Hanski & Gaggiotti 2004). In the marine ecosystem landscape fragmentation is difficult to detect and explain, but there is increasing evidence that both oceanographic and anthropogenic factors can actually induce a fragmented genetic landscape in cetaceans too (e.g. Natoli *et al.* (2005)).

Figure 5. Common bottlenose dolphins, central Adriatic. Photo: D.Holcer, BWI.

Based on mitochondrial (mtDNA) and nuclear DNA from skin samples of 63 Adriatic common bottlenose dolphins, Gaspari *et al.* (2013) found that the Adriatic population cannot be considered as a single 'unit-to-conserve'. In particular the Adriatic common bottlenose dolphins reveal a fine-scale genetic structure showing a differentiation between north and central-south sub-basins (mtDNA), as well as between the western and eastern coasts (nuclear DNA). This subdivision seems to reflect the existing physiographic differences along both latitudinal and longitudinal axes of the Basin. In this fine-scale genetic structure females appear to be the principal gene flow mediators. The assessment of recent migration rates also indicates a relatively high level of gene flow from the northern Adriatic to adjacent areas. Finally, the mtDNA and nuclear DNA analysis revealed diverse levels of genetic differentiation between the Adriatic putative local populations and those from the Tyrrhenian Sea and the Aegean Sea. This reinforces the MSFD sub-region 'Adriatic Sea' as an ecologically meaningful management area for this species. According to these results (Gaspari *et al.* 2013), despite potential sample size limitations, it seems appropriate to address the conservation issues of the common bottlenose dolphin in the Adriatic Sea at the ‘sub-regional’ if not the ‘local’ population level, rather than focussing on the entire basin. Potential threats should be evaluated accordingly.

Photo-identification data have also suggested that common bottlenose dolphins of the Adriatic Sea are structured in putative local populations (Fortuna 2006; Genov *et al.* 2008; Genov *et al.* 2009b; Holcer 2012; Pleslić *et al.* 2013). Social characteristics can also play an important role in structuring a meta-population and should be investigated to inform managers on *inter alia* average home ranges of populations.

3.1.3 Feeding ecology and behaviour

As in other parts of the world, the common bottlenose dolphins of the Adriatic Sea appear to have highly adaptive feeding habits (Stewart 2004) with a possible preference for demersal prey (Mioković *et al.* 1999), Fortuna, *unpublished data*). Results of the analysis of stomach contents of the common bottlenose dolphins in the Kvarnerić region (northern Adriatic) indicates that prey species are very diverse and include large number of species of bony fish and cephalopods.

In the Cres-Lošinj area (Croatia) Mioković *et al.* (1999) suggested the existence of qualitative overlap between local fisheries target species and dolphin prey. They found that commercially important species, such as the European hake (*Merluccius merluccius*) and conger eel (*Conger conger)* were a significant component of the diet of this species (N=1). Stewart (2004) found that *Sparidae* made up to 45% of the stomach content of common bottlenose dolphins (n=3), with horse mackerel (*Trachurus* sp.) 25%, hake 2% and European conger only 1%.

Sprčić (2011) analysed the stomach contents of four common bottlenose dolphins found in the same area (2006-2007). Horse mackerel represented the 8.5% of the identified fish species, European hake 11%, Sparidae 16%, Gobidae 7,7%, Octopoda 10,3% and Teuthoidea 7.7%. Interestingly, no remains of small pelagic fish were not found in any of the stomach contents analysed and, the percentage of mullets (*Mullus* sp) was quite small (1-2%). These results are in contrast with observations of dolphins regularly following both bottom trawlers (Fortuna *et al.* 1996; Bearzi *et al.* 1999; Casale & Giovanardi 2001; Stewart 2004; Prihoda 2005; Fortuna 2006) and mid-water trawlers (Fortuna *et al.* 2010b; Holcer 2012) for feeding purposes and fishermen claim substantial damage to caught red mullet (*Mullus barbatus*).

Results from stable isotopes analyses (C, N) on samples from common bottlenose dolphins biopsied in the central Adriatic Sea show a partially different story (Holcer 2012). For these dolphins there is a seasonal shift in prey species. At the end of the winter over the 87% of biopsied dolphins feed almost exclusively on small pelagic fish, mostly sardines. These findings could indicate that other fish species are either less available or pelagic fish is very abundant. According to a number of authors, the end of winter is time when sardines migrate from the open sea towards the coastal areas for spawning, they are present in the central

Adriatic in large numbers. In spring red mullet become available in large quantities along the eastern Adriatic coast. This is the period when, according to interviews with local fisherman, most dolphin-fisheries interactions occur. Biopsy samples taken in spring and summer show prey species similar to those found in the north-eastern stomach contents. In addition, individual diet differences were also recorded, either indicating individual preferences and/or different prey availability.

Bearzi *et al.* (1999) looked at the diurnal behaviour of a common bottlenose dolphin community in the north-eastern Adriatic. The behavioural budget showed a predominance (about 80%) of activities characterized by long dives (>30 sec), which these Authors considered to be largely related to prey search or feeding. Foraging near the surface was observed rarely. The frequent following of trawlers (accounting for 4.5% of the behavioural budget) was indicative of the presence of alternative strategies for finding food and overlaps between dolphins distribution and fishing activities, confirmed also in other studies (Prihoda 2005; Fortuna 2006).

Triossi *et al.* (2013) analysed the behaviour of the common bottlenose dolphins around and within the offshore gas fields off Ravenna (Italy). Their analyses showed that dolphin density was approximately 80% higher within 750m of gas platforms (compare to densities >750 m from platforms). In addition they noticed that slightly higher frequencies of feeding and milling behaviour were observed closer to gas platforms, whereas dolphins observed further away exhibited higher frequencies of socialising and travelling. As gas platforms are known to provide a refuge habitat for demersal fish and act as aggregation points for pelagic fish, they concluded that common bottlenose dolphins may utilise gas platforms opportunistically as feeding sites. It should be noted that under the Italian law, it is forbidden to anchor, fish or navigate within 500 m of these 130 platforms scattered over the Adriatic Sea. Oil and gas platforms in this region essentially act as a highly dense network of small marine protected areas.

3.1.4 Conservation status

The Mediterranean subpopulation of the common bottlenose dolphin is listed as "Vulnerable" under IUCN (World Conservation Union) criterion A2dce (Bearzi & Fortuna 2012).

In its MSFD report to the European Commission (Fortuna *et al.* 2013) Italy provided an initial assessment (IA) for this species considering all waters (not only the Italian territorial waters). It argued that any assessment at the sub-region level - of both cetacean species and potential threats to these species - can only be meaningful if carried out cooperatively with all bordering countries (not only the European Member States (EU MS)). Given the time limitation for setting up effective cooperation on this matter, even within the EU MS, the first round reporting for the MSFD reporting for the Italian IA for common bottlenose dolphin in the Adriatic sub-region is presented in Table 4.

According to UNEP (2011) the Cres-Lošinj Archipelago (Kvarnerić area) represents the habitat of a resident population of common bottlenose dolphin researched since 1987. Based on this research this area was proclaimed as the part of Croatian National Ecological Network and a potential NATURA 2000 site, as well as proposed marine protected area.

The Cres-Lošinj Special Marine Reserve (CLSMR) was designated in 2006 with the specific aim to conserve this local dolphin population and sustainably manage the use of the natural resources of the Cres-Lošinj archipelago (Ministarstvo kulture RH 2006). The archipelago is a nationally important region for tourism. Between July 2006 and July 2009 the CLSMR was the largest marine protected area (MPA) in the Adriatic Sea (approximately 525 km^2).

Table 4. Italian initial assessment (2012) on the common bottlenose dolphin status under the MSFD (based on Fortuna et al. (2013)).

MSFD topic	Criterion	Evaluation	Reliability of data
Initial Assessment	**Distribution (1.1.)**	Within the norm for the entire Adriatic Sea (see Figure 4)	High
	Abundance (1.2.1)	Minimum estimate for the entire Adriatic Sea: over 5000 specimens	High
	Genetic population structure (1.3.2)	At least two general subdivisions (north and central-south Adriatic) and an additional differentiation east/west for males*.	High
Potential threats	**Fishery accidental captures (bycatch)**	Unknown cumulative impact of all fisheries. Bycatch rate in Italian mid-water trawlers (GSA 17) = 0.001 animal/haul, for a total of 19 specimens (CV=59%; 95%CIs 10-29) per year in this fishery alone (Fortuna & Filidei 2012).	High
	Chemical pollution	Unknown	Medium
	Overfishing of demersal resources	Unknown	Low

Key: MSFD=Marine Strategy Framework Directive; High=based on reanalyses of robust data collected of the subregion; Medium=based on published data collected from some part f the region; Low=based on expert opinion; *conclusions revised after Gaspari *et al*. 2013.

The CLSMR represented Croatian commitments to many of the international environmental agreements signed by the government. However local development commitments were in direct conflict with the objectives of the MPA. As a result support for the concept was undermined and, coupled with State paralysis, the imbalance between local development and international commitments led to a proposed downgrading of the MPA and subsequent degazettement (Mackelworth & Holcer 2011; Becker *et al.* 2013; Mackelworth *et al.* 2013a).

3.2 The striped dolphin (*Stenella coeruleoalba*)

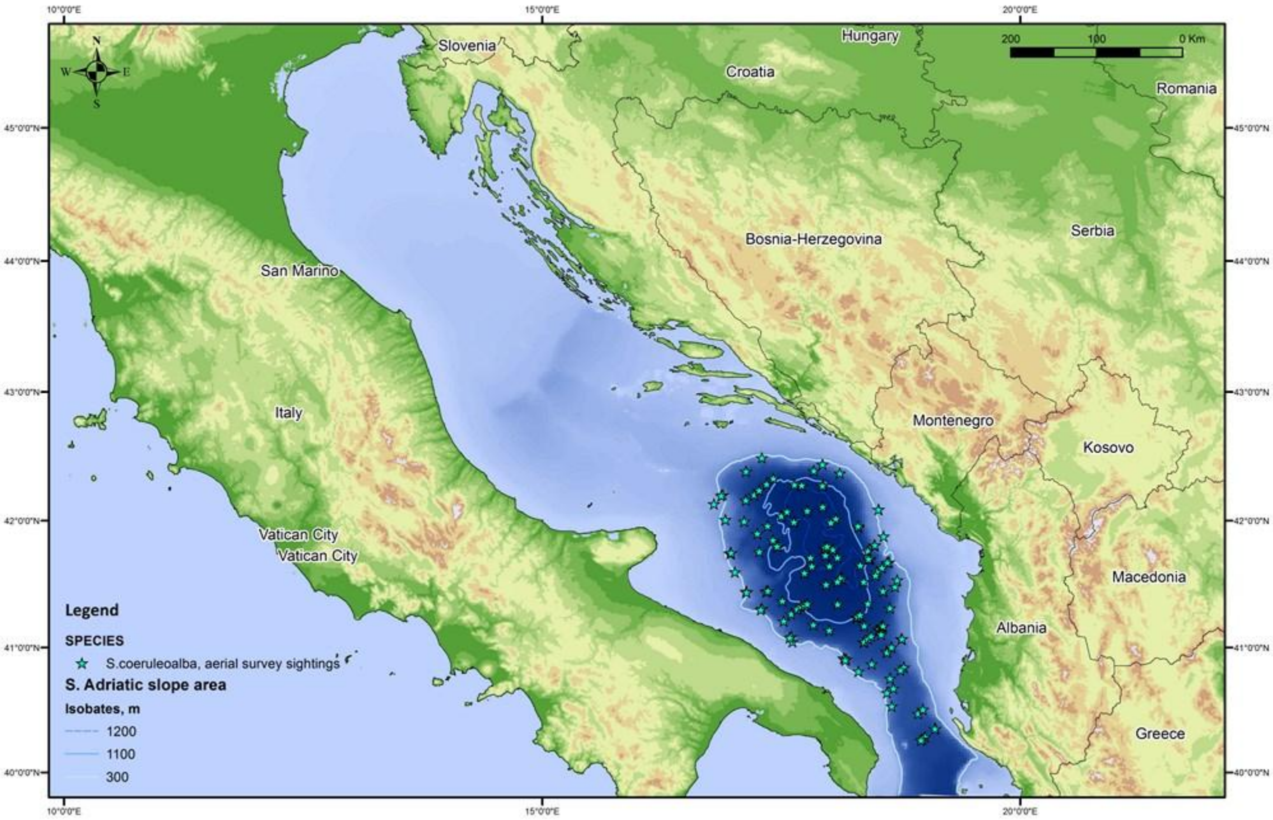
3.2.1 Distribution and abundance

The striped dolphin (*Stenella coeruleoalba*) is considered the most abundant cetacean species in the Mediterranean Sea (Aguilar 2000). This also appear to be the case in the Adriatic Sea (Fortuna *et al.* 2011b), although its presence is only regular in the southern part of the basin (Figure 7). This distribution reflects the oceanographic characteristics of that sub-basins (Notarbartolo Di Sciara *et al.* 1993; Fortuna *et al.* 2011b). The striped dolphin tends to occur in sea depths greater than 600 m, where it feeds mostly on cephalopods and epipelagic fish (Aguilar 2000). It is only exceptionally found in areas less than 200 m (Notarbartolo Di Sciara *et al.* 1993; Fortuna *et al.* 2007). This happens in the Adriatic with stray solitary dolphins and small groups in the northern portion of the basin (Bearzi *et al.* 1998; Francese *et al.* 2007; Rako *et al.* 2009; Nimak-Wood *et al.* 2011).

The striped dolphin is a gregarious species found in the south Adriatic Sea in large herds of some hundreds of individuals (Fortuna *et al.* 2011b), whereas in the northern Adriatic the group size range from one to three specimens (Bearzi *et al.* 1998; Francese *et al.* 2007; Rako *et al.* 2009; Nimak-Wood *et al.* 2011).

Figure 6. Striped dolphins, southern Adriatic. Photo: E.Filidei jr., ISPRA.

Some authors argue that the more frequent reports of striped dolphins along the northern Adriatic coastline is possibly an expansion of the distribution range as has been reported for other Mediterranean areas (Bearzi *et al.* 1998). Others suggest that an increased interested and ease of documentation of cetacean sightings may explain this increased number of reports even on single individuals (Francese *et al.* 2007; Rako *et al.* 2009).



Sightings of striped dolphin in the Adriatic Sea (2010 & 2013)

Figure 7. Map of sighting of striped dolphins during aerial surveys in 2010 and 2013.

Data on the abundance of this species in the Adriatic Sea is summarised in Table 5. Please note that this is to be considered as minimum estimate (uncorrected for availability and perception bias).

Table 5. Abundance estimates of striped dolphins in the Adriatic Sea (aerial survey 2010).

Location (Sampling year)	**Total estimate (CV; 95% CIs)**	**Source**
Central-southern Adriatic Sea (2010)	15,343 (0.28; 8,545-27,550)	Fortuna *et al*. (2011)

3.2.2 Population structure

Little is known on the genetic population structure of the striped dolphin in the Adriatic Sea. However, from a very preliminary study (n=15) it seems that specimens using the Adriatic Sea are not strongly differentiated from those of other parts of the Mediterranean Sea (Galov *et al.* 2009).

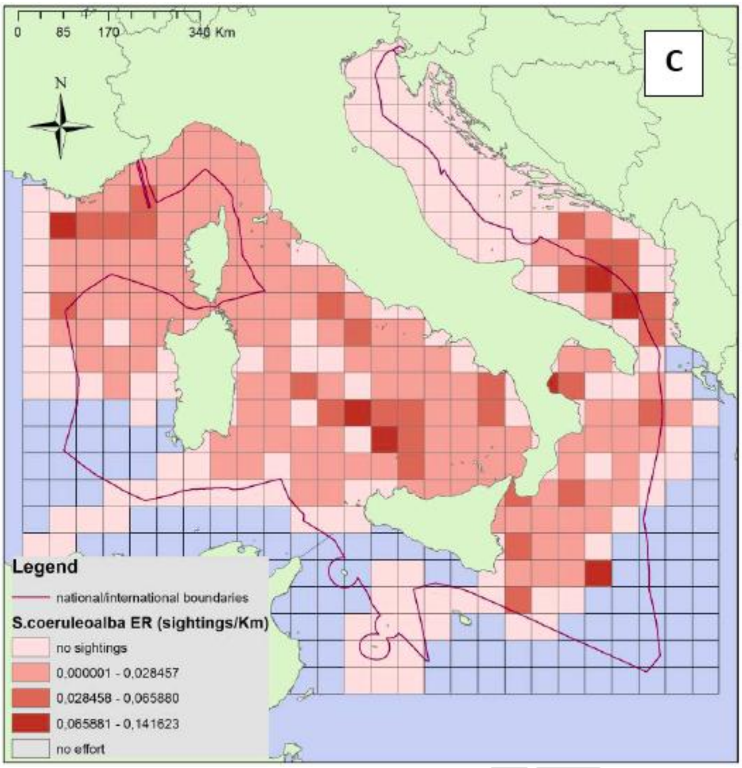


Figure 8. Striped dolphin distribution based on encounter rates (sightings/km) within cells of size 50x50km (Fortuna et al. 2013).

3.2.3 Conservation status

The Mediterranean subpopulation of the striped dolphin is listed as "Vulnerable" under IUCN (World Conservation Union) criterion A2bcde (Aguilar & Gaspari 2012).

3.3 The Cuvier's beaked whale (*Ziphius cavirostris*)

3.3.1 Distribution and abundance

Cuvier’s beaked whale (Figure 9) is a mid-sized Cetacean with adults reaching between 5,5 and 7m in length (MacLeod 2006). Of all the beaked whales it has the widest distribution range. Its distribution is global while it is absent only from polar waters (Heyning 1989).

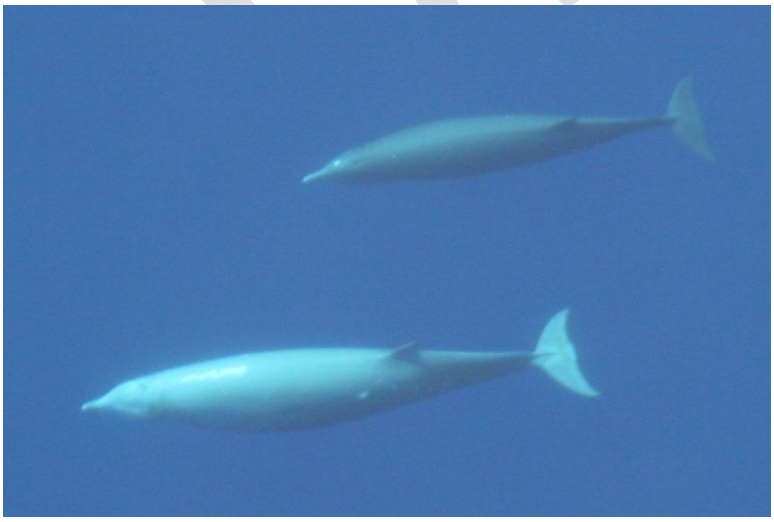


Figure 9. Cuvier's beaked whales, southern Adriatic. Photo: C.M.Fortuna, ISPRA.

Of the beaked whale family, Cuvier’s beaked whale is the only species known to regularly occur throughout the entire Mediterranean Sea, with no notable difference in distribution between the western and the eastern basins (Notarbartolo di Sciara & Demma 1997, Notarbartolo di Sciara 2002). Research of the species in the

Mediterranean Sea revealed relatively higher abundance in the areas of Alboran Sea (Cañadas 2011), along the Hellenic trench, from Rhodos to NW Corfu (Frantzis *et al.* 2003) and in the Ligurian Sea where a long-term site fidelity has been established through photo-identification (Revelli *et al.* 2008; Rosso *et al.* 2011). Population size estimates exist only for areas of the Alboran sea & Gulf of Vera (Cañadas 2011) where availability bias corrected estimate of abundance for 2008-2009 was 1994 (CV=39,7%) and the northern Ligurian Sea where mark-recapture analysis in the period of 2004-2005 yielded total estimate of 85 (CV=0,24)/ 94 (CV=0,21) animals (left/right side) (Rosso *et al.* 2007).

Species has been recorded through sightings and strandings in a number of other locations in the Mediterranean Sea (D'Amico *et al.* 2003; Frantzis *et al.* 2003; Podestà *et al.* 2006; Holcer *et al.* 2007; Gannier & Epinat 2008; Notarbartolo di Sciara & Birkun 2010; Gannier 2011).

Cuvier's beaked whale is often associated with deep slope habitat and a preference for submarine canyons, steep slopes, scarps or submarine mounts (D'Amico *et al.* 2003; MacLeod 2005; Gannier & Epinat 2008). In the area of Pelagos Sanctuary Moulins *et al.* (2007) found out that sightings of Cuvier's beaked whales were most often where the depth was between 756 and 1389 m (and slope was steeper) but the encounter rate was higher between depths of 1389 and 2021 m (where slope was more flat). In Greece animals were observed in depths from 500 – 1500 m along slopes (Frantzis *et al.* 2003).

Based on the data collected by different organisations in the period of 1990 to 2010, habitat modelling of Cuvier´s beaked whales in the Mediterranean Sea (Figure 10) identified previously mentioned areas of the Alboran Sea, the central Ligurian Sea, the Hellenic Trench and the south Aegean Sea (north Cretan Sea) as the areas of highest predicted density. The areas of the Tyrrhenian Sea, the southern Adriatic Sea, some areas to the north of the Balearic islands, and south of Sicily had relatively high predicted densities compared to the rest of the Mediterranean (Cañadas *et al.* 2011). The modelling exercise did not include all of the records from the Adriatic Sea presented here.

Cuvier's beaked whale is mainly teuthophagic although fish may also be an important component of their diet (MacLeod 2005). The most common prey in the Mediterranean are oceanic and pelagic (meso- or bathy-) cephalopods of the families Histioteuthidae, Cranchiidae and/or Octopoteuthidae (Podestà & Meotti 1991; Carlini *et al.* 1992; Lefkaditou & Poulopoulos 1998; Blanco & Raga 2000; MacLeod 2005).

Special concern over species status and impact of anthropogenic sound has been expressed due to several atypical mass strandings coinciding with use of naval mid-frequency sonars (Frantzis 1998; Arbelo *et al.* 2008; ACCOBAMS SC 2012). Additionally, seismic surveys for hydrocarbons and the general increase of sea ambient noise, and its cumulative effects, present additional cause for concern (Gordon *et al.* 2003)

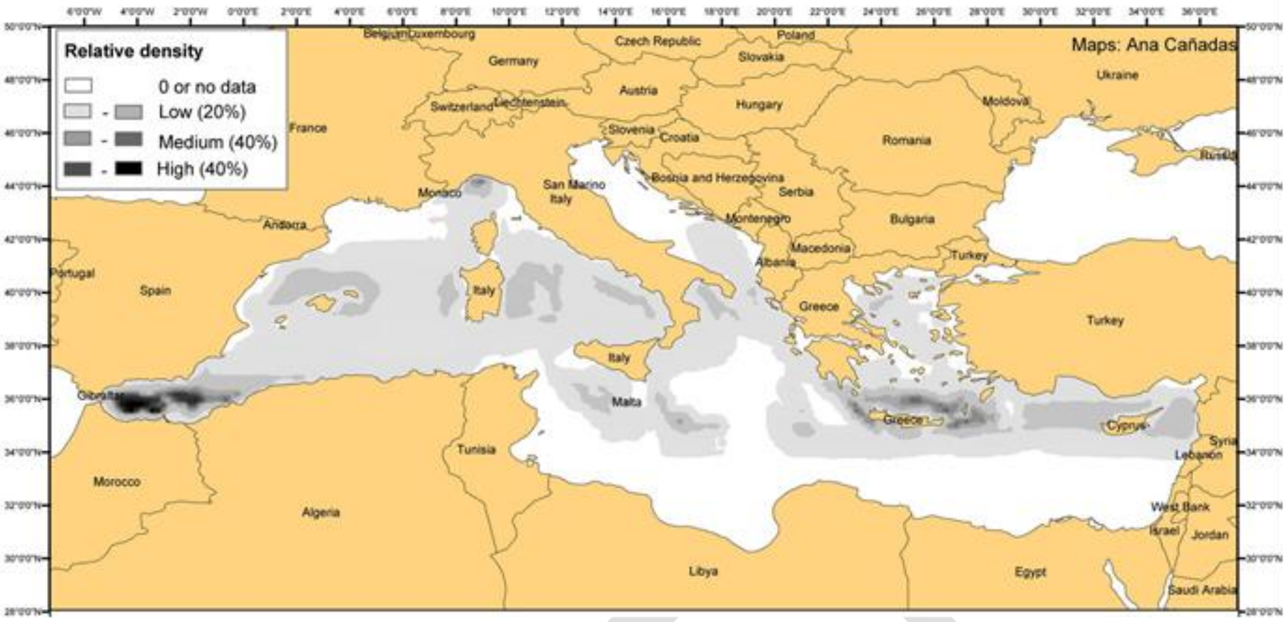
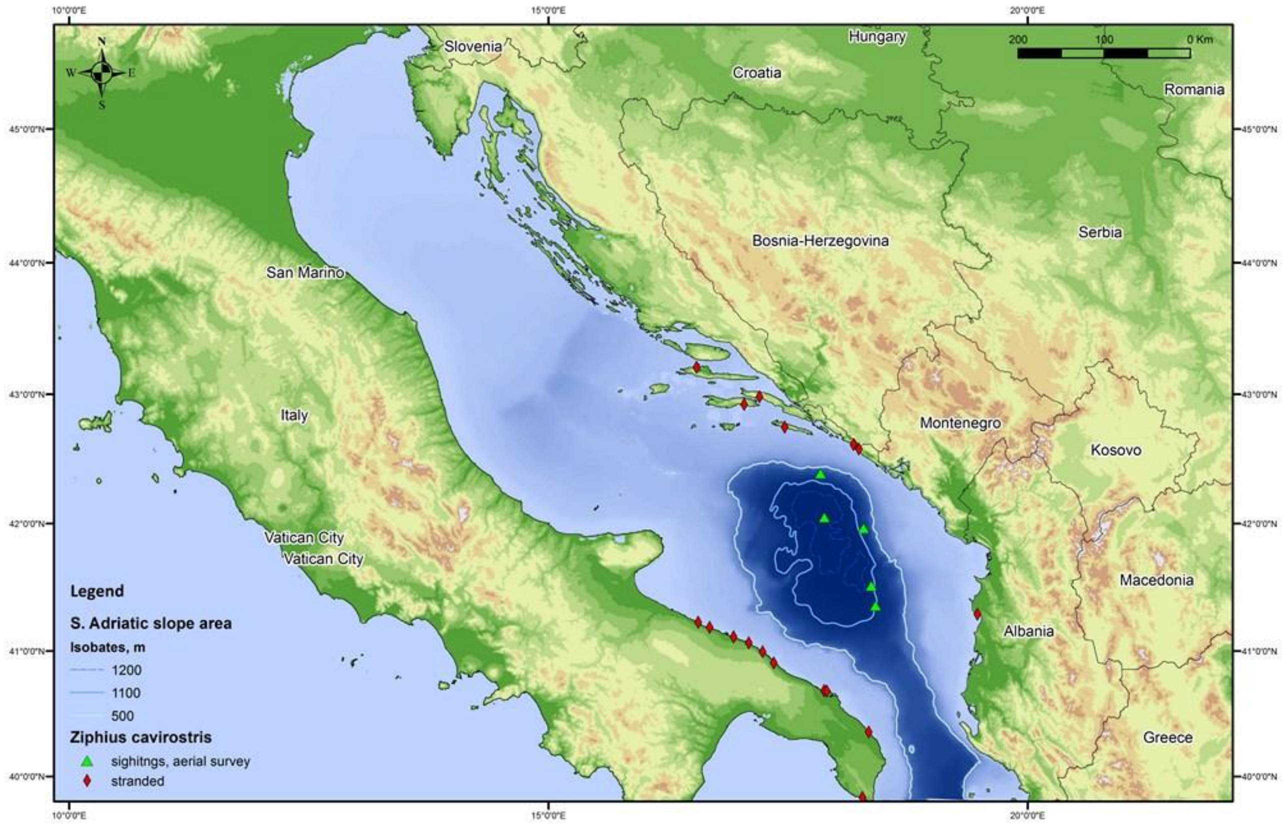


Figure 10. Relative density of beaked whales **predicted through habitat modelling of 1990-2010 data (Cañadas *et al.* 2011). (Authors marked that in the south-eastern region of the basin the lack of survey effort did not allow making of predictions of presence/absence or relative density of this species).**

3.3.1.1 Adriatic Sea

Historic information regarding the species' distribution and occurrence in the Adriatic Sea is scarce and species was considered occasional in the deeper southern basin, where stranded specimens have been found (Lamani *et al.* 1976; Centro Studi Cetacei 1987; Notarbartolo di Sciara *et al.* 1994; Centro Studi Cetacei 1995; Storelli *et al.* 1999; Holcer *et al.* 2002; Holcer *et al.* 2003; Gomerčić *et al.* 2006a; Podestà *et al.* 2006). In the review paper by Holcer *et al.* (2007), the authors presented detailed overview on the occurrence of the species in the Adriatic concluding, based on the relative number of strandings, that the southern Adriatic Sea could be an important habitat for Cuvier's beaked whale. In total eleven stranded specimens of Cuvier's beaked whales have been documented in the Adriatic Sea until 2004 (Holcer *et al.* 2007). Five of these were recorded along the Apulian coast in Italy, one recorded in Albania and five strandings have occurred along the Croatian Adriatic shores (Figure 11). Additionally, in 2008 a newborn Cuvier's beaked whale was found in Trstenica bay on Pelješac in Croatia (Kovačić *et al.* 2010). Previously unreported two stranded animals in the Brindisi area were reported by Pino d'Astore *et al.* (2008). Finally, an additional two stranded animals were reported by Museo Civico in Gallipoli and Dept. of pathology University of Bari to the Italian stranding database (http://mammiferimarini.unipv.it).

The map of the strandings of Cuvier's beaked whale in the Adriatic shows that stranded animals have been found around the entire southern Adriatic basin. In addition, there have been no reports in the northern Adriatic Sea and the occurrence in the central Adriatic is marginal (as stranded specimens were most probably taken by the sea currents to the stranding locations). Considering that Cuvier's beaked whale is a deep diving animal with most notable preference for deep slope habitats, the lack of occurrence in the rather shallow continental shelf of the northern Adriatic should not be surprising.



Sightings and strandings of Cuvier's beaked whale in the Adriatic Sea (1939 - 2013)

Figure 11. Map of strandings and sighting of Cuvier's beaked whale during aerial surveys in 2010 and 2013.

The analysis of the stomach content of the Cuvier’s beaked whale from the Adriatic Sea revealed similar type of prey as found in other stranded specimens in the Mediterranean. Prey included species of Histioteuthidae (34,7%), Octopoteuthidae (39,1%; not found in the Adriatic), Chiroteuthidae (17,7%), Cranchiidae (8,2%%; not found in the Adriatic) and Sepiolidae (0,2%) (Kovačić *et al.* 2010) occurring in the deep southern Adriatic. Furthermore, some of the prey species found in the analysed stomach content were not recorded in the Adriatic Sea indicating either some form of migration between Adriatic and Mediterranean or lack of knowledge of the deep living cephalopods of the Adriatic Sea.

In addition to the strandings, the presence of Cuvier´s beaked whales in the Adriatic Sea has been confirmed through aerial surveys of cetacean abundance in 2010 and 2013 (Figure 11). In total, five sightings of Cuvier´s beaked whales were made in 2010 and 2013. Sightings occurred in waters with depths between 700 - 1200m in the areas of steep bathymetry. It is notable that sightings are grouped along the northern and eastern part of the south Adriatic basin where there is almost direct drop to the depth of 1000m. Within the sighing areas known prey species are found. Sightings included females with juvenile animals indicating southern Adriatic as nursery area.

3.3.2 Population structure

No information exists on population structure of *Ziphius* throughout its Mediterranean range.
The mean group size in the Mediterranean ranges between 2,2 to 2,3 individuals (Canadas *et al.* 2005; Moulins *et al.* 2007; Gannier 2011). The indication of group size based on five sightings during aerial surveys in the Adriatic is 2,6 (authors data).

Analysis of genetic diversity between 87 samples obtained worldwide (10 Mediterranean, 2 Adriatic) found that mtDNA haplotypes from the Mediterranean Sea were not found elsewhere and were highly distinct from the neighbouring Eastern North Atlantic (Dalebout *et al.* 2005). Low diversity could indicate low level of exchange between two basins. Of the two found haplotypes (T3 and T4) only one (T3) was found on two specimens stranded on the Croatian coast (Dalebout *et al.* 2005).

3.3.3 Conservation status

The Mediterranean subpopulation of the beaked whale is listed as "Data Deficient" (Cañadas 2012)

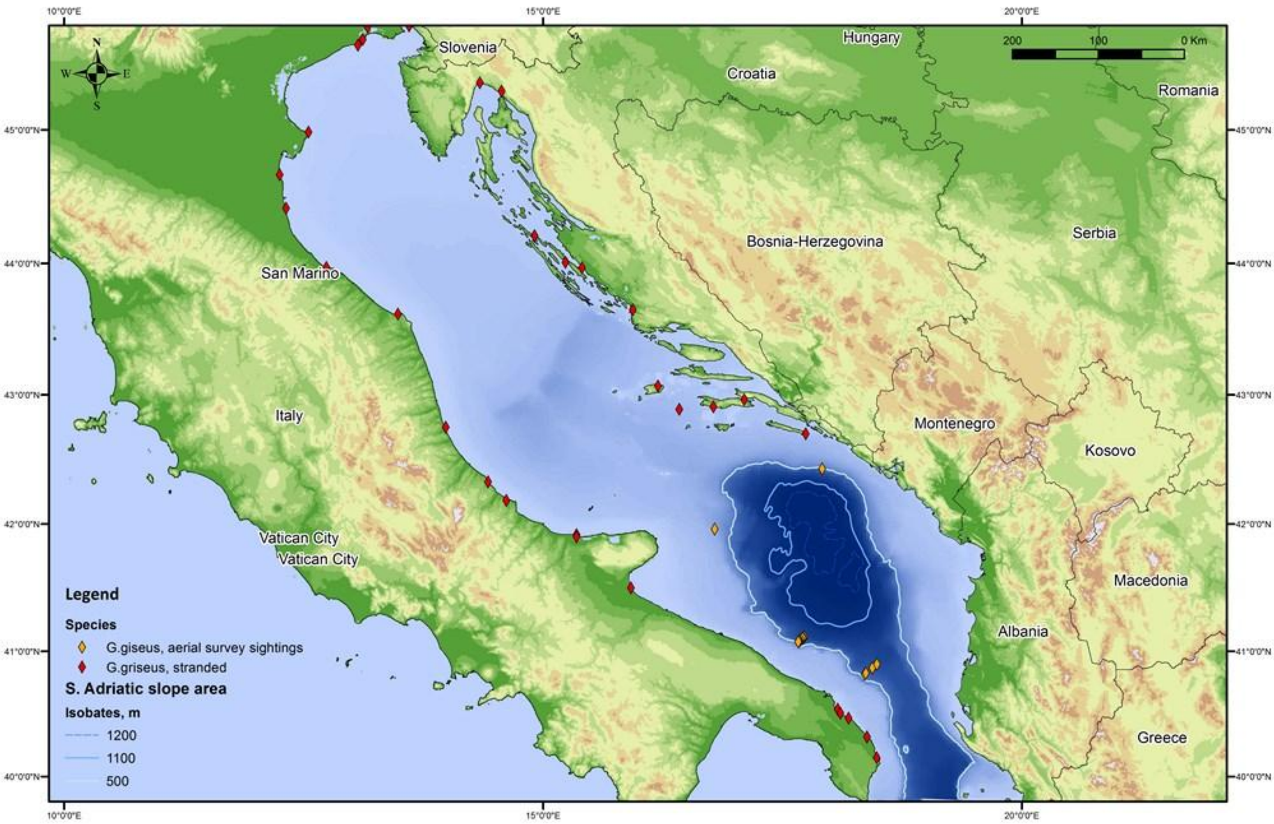
3.4 The Risso's dolphin (*Grampus griseus*)

3.4.1 Distribution and abundance

Risso's dolphins (Figure 12) are relatively large dolphins measuring up to 4m in length (Kruse *et al.* 1999). Most distinctive is blunt head without beak and dark coloration dominated by whitish scars which they accumulate throughout life, making older animals appear almost white. Risso's dolphins are distributed worldwide in tropical and temperate seas with preference for deep offshore waters and coastal areas with narrow continental shelves (Leatherwood *et al.* 1980).

Figure 12. Risso's dolphins, southern Adriatic. Photo: BWI.

The Risso's dolphin is present in the entire Mediterranean Sea and is considered a regular inhabitant, although abundance is unknown (Notarbartolo di Sciara & Birkun 2010). In the Mediterranean Sea Risso's dolphin is mostly encountered in deep pelagic waters, in particular over steep shelf slopes and submarine canyons (Gaspari 2004; Azzellino *et al.* 2008; Gómez de Segura *et al.* 2008). Furthermore, Gaspari (2004) found out that distribution of Risso's dolphin is not a function of depth but rather of the habitat. She showed that Risso's dolphins have preferences for areas with higher depth and slope gradient where the continental slope was deeper and steeper suggesting a feeding specialization. Analysis of stomach contents of stranded Risso’s dolphins indicate that species is feeding mostly with cephalopods inhabiting oceanic waters over the steep continental slope (Podestà & Meotti 1991; Wurtz *et al.* 1992). Analysis of Blanco *et al.* (2006) shows that Risso’s dolphins feed on cephalopods on the middle slope (600-800m depth).



Sightings and strandings of Risso's dolphin in the Adriatic Sea (1905 - 2013)

Figure 13. Map of strandings and sighting of Risso's dolphins during aerial surveys in 2010 and 2013.

Within the Mediterranean Sea Risso's dolphins are regularly observed and found stranded in most areas of the Mediterranean Sea (Bearzi *et al.* 2011b) although no data exists for the southern Mediterranean part of the basin (Notarbartolo di Sciara & Birkun 2010). The Ligurian-Corso-Provençal basin is identified as an area of greater importance for Risso’s dolphins.

Basin wide data on the distribution and abundance is lacking. Abundance estimates exist for a few areas such as the Spanish central Mediterranean, where aerial surveys from 2001–2003 resulted in an uncorrected estimate of 493 Risso’s Dolphins (95% C.I. 162–1,498) in an area of 32,270 km² (Gómez de Segura *et al.* 2006). Other aerial and ship based surveys carried out within the western Mediterranean did not yield a sufficient number of observations to obtain an abundance estimate (Fortuna *et al.* 2007; Panigada *et al.* 2011). In the Ligurian basin densities are low i.e. 0,035 individuals/km2 during winter and 0,011 individuals/km2 during summer (Laran *et al.* 2010).

3.4.1.1 Adriatic Sea

Risso's dolphins have been recorded on numerous occasions in the Adriatic Sea (Figure 13). First records originate from 19th century (Giglioli 1880; Faber 1883; Brusina 1889; Kolombatović 1894). Most records are from stranded animals found along the Italian (Trois 1894; Valle 1900; Francese *et al.* 1999; Storelli *et al.* 1999; Zucca *et al.* 2005) and Croatian coasts (Hirtz 1938; Notarbartolo di Sciara *et al.* 1994; Holcer *et al.* 2002; Gomerčić *et al.* 2006b; Bilandžić *et al.* 2012), while according to the available information animals have not been observed or found stranded on the coasts of Slovenia, Montenegro and Albania. Stranded animals have been found along the entire Adriatic Sea basin and including even the shallow areas of the northern Adriatic (Figure 13). On a number of occasions animals stranded live, while some have died other have been successfully returned to the sea (Zucca *et al.* 2005). On most occasions records relate to single animals, while only in two cases more animals were observed; three animals were observed near the Gulf of Trieste (Francese *et al.* 1999) and two animals were found stranded on the island of Molat (Gomerčić *et al.* 2006b). Regardless of the relatively high numbers of strandings and their presence throughout the Adriatic basin, most authors concluded that Risso's dolphin is only occasionally present in the Adriatic Sea (Bearzi *et al.* 2004).

Dedicated and opportunistic surveys with relatively high effort carried out in the northern Adriatic Sea in the period of 1988 to 2013 (Bearzi *et al.* 1997; Fortuna 2006; Bearzi *et al.* 2008a; Bearzi *et al.* 2009; Pleslić *et al.* 2013) did not record any sightings of Risso's dolphin. In addition localised surveys in the central Adriatic (Holcer *et al.* 2008a; Holcer *et al.* 2008b; Holcer *et al.* 2008c; Fortuna *et al.* 2010b; Holcer *et al.* 2010; Holcer & Fortuna 2011; Holcer 2012) did not find any sighting of the Risso's dolphins. It is worth noting that all of this research effort was in areas which would not normally represent usual habitat for Risso's dolphins and thus their absence should be expected.

The results of two aerial surveys carried out on the basin-wide scale confirm such conclusions (Fortuna *et al.* 2011b; Lauriano *et al.* 2011) as Risso's dolphins were only observed only in the southern Adriatic along the steep slope areas with depths between 600-900m (Figure 13). Several additional opportunistic observations were made from the ferries traversing southern Adriatic Sea (Giovagnoli 2013). Such results are in line with known habitat preferences and feeding specialisation of Risso's dolphins that prefer deep slope habitats between depths 500-1000 (Azzellino *et al.* 2008), only present in the southern Adriatic. A preliminary abundance estimate was obtained in 2010 (510 individuals; CV=78.1%; 95% CI=124-2,089), indicating that the southern Adriatic could host several hundred Risso's dolphins (Fortuna *et al.* 2011a).

As deep diving cetaceans may be prone to the impact of anthropogenic sound concern for the species has been expressed by several international panels (ACCOBAMS SC 2012).

3.4.2 Population structure

The overview of the current details on the status and ecology of Risso's dolphin in the Mediterranean are given by Bearzi *et al.* (2011b) and Gaspari and Natoli (2012). Generally, little is known of the social structure and behaviour of Risso's dolphins.

Group size in the Ligurian basin ranges from 2 to 70 individual with average size of 14,5 animals and most frequent groups of four and five animals as found by Gaspari (2004) and average group size of 9,8 during summer and 11,3 during winter as found by Laran *et al.* (2010). In the area of Alboran sea average group size was 12,5 (Canadas *et al.* 2005) and off south-eastern coast of Spain 21,7 (Gómez de Segura *et al.* 2008). Group sizes observed in the Adriatic Sea during aerial surveys ranged from 1 to 12 animals with most frequent group size of four and six animals (authors data).

Groups of Risso's dolphins in the Ligurian Sea present weak inter-individual associations, but there are some consistent longer term relationships between individuals over periods of years (Gaspari 2004).

Available data based on the microsatellite and mitochondrial DNA analysis show that Mediterranean Risso's dolphins are genetically differentiated from the nearest eastern Atlantic population and the gene flow is limited (Gaspari *et al.* 2007). No data on DNA analysis on Adriatic samples exist, although research of Gaspari *et al.* (2007) indicates potential Mediterranean regional population structuring.

Research in the Ligurian basin based on the photoidentification indicate that animals show site fidelity (Airoldi *et al.* 2005), but seasonal (summer/winter) difference in density (Laran *et al.* 2010) indicate possible seasonal migration within the Mediterranean.

3.4.3 Conservation status

The Mediterranean subpopulation of the Risso's dolphin is listed as "Data Deficient" (Gaspari & Natoli 2012)

3.5 The fin whale (*Balaenoptera physalus*)

3.5.1 Distribution and abundance

Fin whales (Figure 14) in the Mediterranean are most commonly found in deep waters (400 to 2,500 m), but they can occur in slope and shelf waters, depending on the distribution of their prey (e.g. Canese *et al.* (2006)). They favour upwelling and frontal zones (Notarbartolo-Di-Sciara *et al.* 2003) and coastal areas (Canese *et al.* 2006) with high zooplankton concentrations, their main prey in the region.

Within the Adriatic Sea most of the records on this species rely on stranding and sightings of stray individuals scattered all around the northern and central Adriatic (Lipej *et al.* 2004); BWI *unpublished data*) and some regular sighting in the central Adriatic likely related to the seasonal presence of prey (Holcer, *unpublished data*, (Fortuna *et al.* 2011b)).

Figure 14. Fin whale, central Adriatic. Photo: C.M.Fortuna, ISPRA.

Recent research indicates that fin whales regularly enter the southern and central Adriatic Sea and their abundance depends probably on the abundance of krill. Large biomass of krill has been recorded in the central Adriatic, particularly in the area of Jabuka pit but the seasonality of presence and abundance is not yet known. However, observation of fin whales feeding in the vicinity of Vis island and collected faeces indicate that there is a causal connection between fin whales and krill such that the area might have some seasonal importance (Holcer, *unpublished data*).

There are not abundance estimates for the fin whale in either the Adriatic Sea or for the eastern Mediterranean.

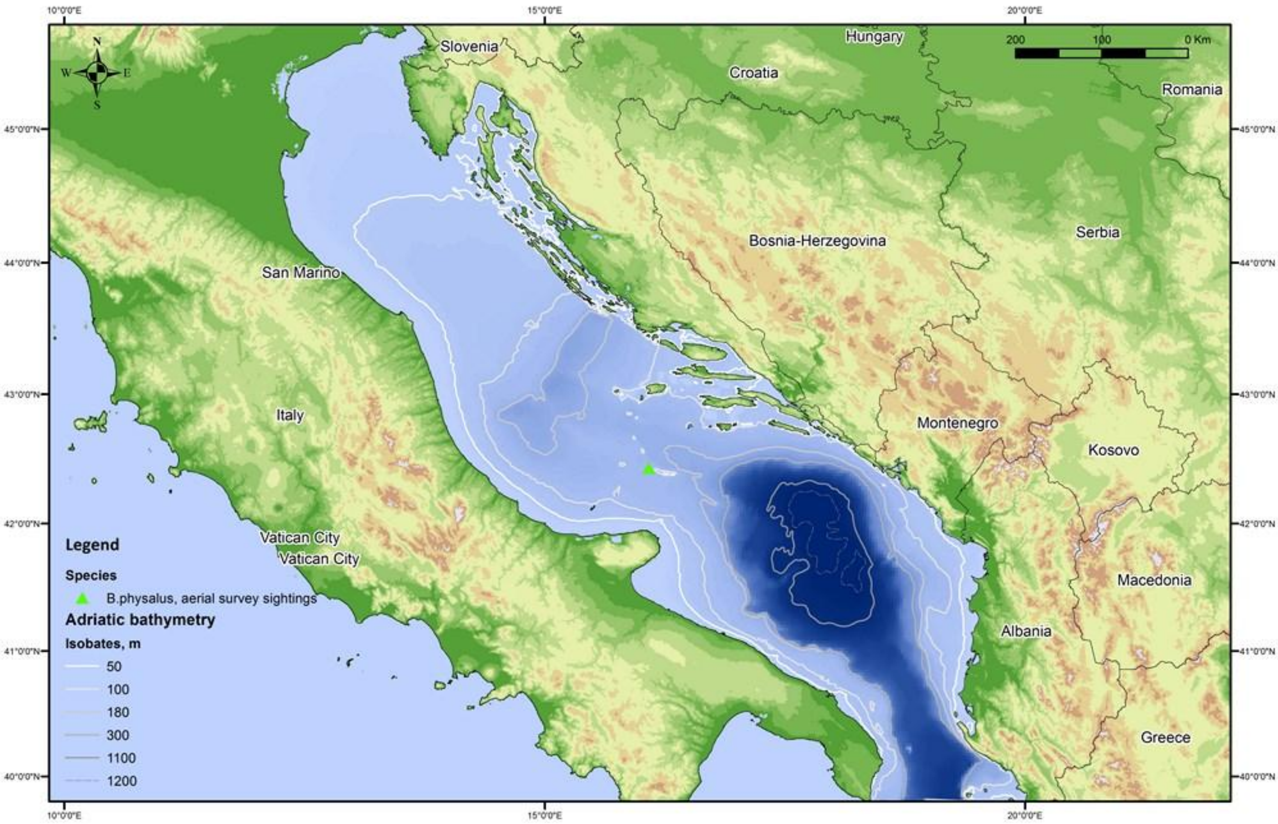
3.5.2 Population structure

Genetic analyses indicate that the Mediterranean fin whales are largely resident in the basin, although limited but recurrent gene flow was detected in the samples (Palsboll *et al.* 2004). According to the IUCN definition for subpopulation (i.e., less than about one migrant/year), the Mediterranean fin whale are considered as sub-population (Palsboll *et al.* 2004).

The only genetic information available for fin whales frequenting in the Adriatic Sea comes from the analysis of a single specimen that showed an allotype typical from the Ligurian Sea (Caputo & Giovannotti 2009).

3.5.3 Conservation status

The Mediterranean subpopulation of the fin whale is listed as "Vulnerable" under IUCN (World Conservation Union) criterion C2a(ii) (Panigada & Notarbartolo di Sciara 2012).



Sightings of fin whale in the Adriatic Sea (2010 & 2013)

Figure 15. Map of sighting of fin whales during aerial surveys in 2010 and 2013.

3.6 Other non-regular species

3.6.1 The short-beaked common dolphin (*Delphinus delphis*)

The short-beaked common dolphin is a small cetacean species with a world-wide distribution. It was distributed throughout the Mediterranean Sea and was considered the most abundant Cetacean species. Currently the abundance is in steep decline throughout the central and eastern Mediterranean (Bearzi *et al.* 2003) with the only notable population remaining in the Alboran sea (Canadas & Hammond 2008). The overview of species status and ecology is reviewed in Bearzi *et al.* (2003).

Mediterranean short-beaked common dolphins can be found in pelagic and neritic habitat (Notarbartolo di Sciara & Birkun 2010) where they feed mainly on epipelagic and mesopelagic shoaling fish and cephalopods (Bearzi *et al.* 2003).

The short-beaked common dolphin was widely present in the Adriatic Sea until the mid-19th century. Numerous records by respected researchers of the time noted the species as the most common in the Adriatic Sea (Faber 1883; Brusina 1889; Trois 1894). During the late 1970s a decrease in the numbers and group sizes of short-beaked common dolphins in the Adriatic was noted (Pilleri & Gihr 1977). During the following years researchers followed the disappearance of the species throughout the northern Adriatic

(Bearzi 1989; Notarbartolo di Sciara & Bearzi 1992; Bearzi & Notarbartolo di Sciara 1995; Bearzi *et al.* 2000) with documented presence of only solitary individuals or small groups since the late 1990s (Bearzi 2000; Rako *et al.* 2009; Boisseau *et al.* 2010; Genov *et al.* 2012; Lazar *et al.* 2012). The role of overfishing, organised culling and habitat degradation are the main reasons for the decline and disappearance from the Adriatic Sea reviewed by Bearzi *et al.* (2004). Due to the lack of information from the central and southern Adriatic the species was listed as data deficient in the Croatian red list, although it was indicated that species could be critically endangered (Holcer 2006).

The recent aerial surveys of the entire Adriatic Sea in 2001 and 2013 (Fortuna *et al.* 2011b) and ISPRA and BWI *unpublished data*) did not yield any sightings of the short-beaked common dolphin leading to a conclusion that species is regionally extinct in the Adriatic Sea.

The Mediterranean subpopulation of the short-beaked common dolphin is listed as "Endangered" under IUCN (World Conservation Union) criterion A2abc (Bearzi 2003).

3.6.2 The sperm whale (*Physeter macrocephalus*)

The sperm whale is a largest Odontocete inhabiting Mediterranean Sea. The population of the Mediterranean is genetically distinct (Drouot *et al.* 2004). No estimate of population size exists for the region. Preferred habitats in the Mediterranean are areas of deep continental slope waters where mesopelagic cephalopods are abundant (Azzellino *et al.* 2008; Praca & Gannier 2008).

The occasional occurrence of sperm whales in the Adriatic Sea including 36 strandings documented on a number of occasions from as early as 1555 (Bearzi *et al.* 2011a). Furthermore, this is the only Cetacean species that had a mass strandings on the Adriatic Sea coast with the latest occurring in December 2009 when a pod of seven male sperm whales stranded on northern side of Gargano promontory (Mazzariol *et al.* 2011). As deep diving Cetaceans, sperm whales do not have a suitable habitat in the central and northern Adriatic. The southern Adriatic, although deeper, may host vagrant animals coming from the Ionian Sea or animals arriving during seasonal migration. But given its physiography and size most probably it is not of greater importance for Mediterranean sperm whales. This conclusion is confirmed through the results of the aerial surveys which did not produce any sightings of sperm whales (Fortuna *et al.* 2011b) and ISPRA and BWI *unpublished data*) and towed hydrophone survey (Boisseau *et al.* 2010)

3.6.3 Visitor species

3.6.3.1 Long-finned pilot whale (*Globicephala melas*)

The only occurrence of a long-finned pilot whale in the Adriatic Sea was reported in 1922 when two individuals were caught in a tuna trap on the island of Rab (Hirtz 1922). The larger of the two animals managed to escape, while other was killed by local fishermen. The animal that was caught was a male approximately 5.5 m long and is well described by Hirtz (1922).

3.6.3.2 The false killer whale (*Pseudorca crassidens*)

A well recorded instance of the capture of a false killer whale in central Adriatic on the island of Korčula was recorded by Hirtz (1938). Three individuals from a pod of 30-40 false killer whales were reportedly captured in northern Adriatic waters off Ravenna, Italy, in a fishing episode occurred between 1959 and 1961 (Stanzani & Piermarocchi 1992).

3.6.3.3 The humpback whale (*Megaptera novaeangliae*)

Occurrences of humpback whales are rare in the Mediterranean (Notarbartolo di Sciara & Birkun 2010), and on two occasions they have been reported in the Adriatic Sea. The first occurrence was of a 10 m long humpback whale reported off Senigallia, Italy, in August 2002 (Affronte *et al.* 2003). Approximately two weeks before one individual was spotted in the Ionian sea so there was a possibility it was the same animal (Frantzis *et al.* 2003). The second sighting occurred in the Piran bay in 2009 (Genov *et al.* 2009a) where the animal remained for almost three months.

4 Sea turtles species in the Adriatic Sea

4.1 The loggerhead turtle (*Caretta caretta*)

Loggerhead turtle is the most abundant sea turtle in the Mediterranean Sea (Broderick *et al.* 2002). Reproductive isolation from the Atlantic populations and reproductive habitat philopatry of the animals has led to genetic divergence of the Mediterranean Sea turtles into several distinct populations (Laurent *et al.* 1998; Carreras *et al.* 2007) and the formation of reproductive subpopulations (Schroth *et al.* 1996; Carreras *et al.* 2007). The main nesting beaches of the loggerhead turtles are in the eastern Mediterranean in Greece, Turkey, Cyprus and Libya (Margaritoulis *et al.* 2003). Smaller reproductive populations exist in Israel, Lebanon and Tunis while occasional nesting events have been documented in Italy, Spain, France and Albania (Lazar 2010). Total abundance of the loggerhead turtles in the Mediterranean is unknown particularly due to the lack of information on the actual size of the Libyan population that has been estimated based on a partial survey of the coastline (Laurent *et al.* 1999). Without considering Libya, it is estimated that there are around 5000 nests along the Mediterranean coasts and the entire breeding population consists of 2280-2787 nesting females with average re-migration period of two years (Broderick *et al.* 2002).

Figure 16. Loggerhead turtle, central Adriatic. Photo: A.Žuljević, IOR.

Before reaching sexual maturity sea turtles inhabit different habitats in the oceans going through ontogenetic developmental shift between habitats. Pelagic habitats for loggerhead turtles are present in parts of eastern and western

Mediterranean and waters of Ionian and southern Adriatic Sea (Margaritoulis *et al.* 2003; Casale *et al.* 2005; Casale *et al.* 2007a). Neritic habitats are mostly limited to eastern Mediterranean where Gulf of Gabès and central and northern Adriatic represent two of the largest neritic areas of the Mediterranean (Lazar & Tvrtković 2003a; Margaritoulis *et al.* 2003). The importance is further confirmed through numbers of recoveries of tagged individuals (Margaritoulis 1988; Margaritoulis *et al.* 2003; Lazar *et al.* 2004b) and the high numbers of incidental catches in bottom trawling nets (Lazar & Tvrtković 1995; Casale *et al.* 2004; Jribi *et al.* 2007).

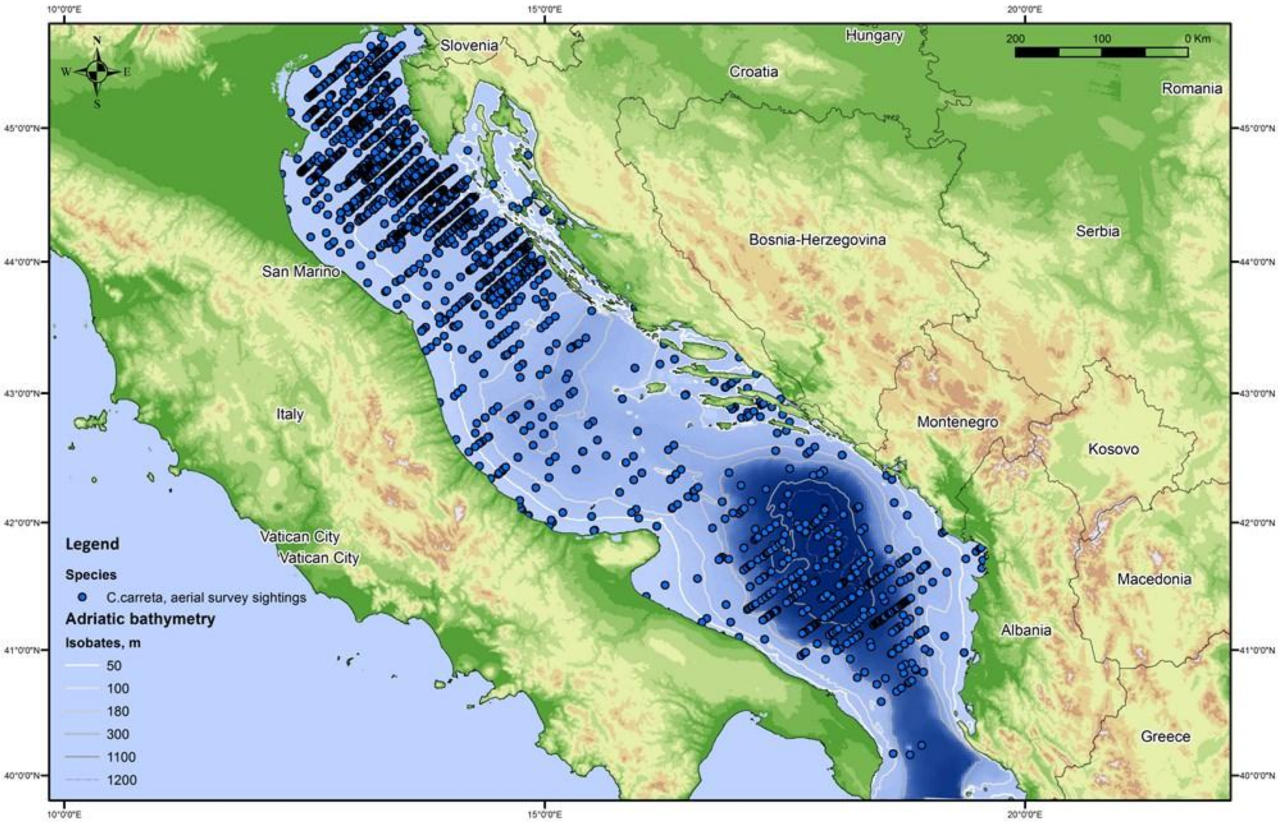
Loggerhead turtles of the Mediterranean Sea express high level of philopatry for nesting places (Carreras *et al.* 2007) and for marine habitats (Lazar *et al.* 2004b; Broderick *et al.* 2007; Casale *et al.* 2007a; Revelles *et al.* 2008). Although neritic habitats are shared by animals from several reproductive populations (Lazar *et al.* 2004b; Maffucci *et al.* 2006; Casale *et al.* 2008), after recruitment of particular neritic habitat there is only a small probability that animals will change that habitat during lifetime (Casale *et al.* 2007a).

Data on the demography of the loggerhead turtles in the Mediterranean Sea are scarce. Estimated average survival rate of the animals with 22-88 cm CCL is 0,73 (98% CV 0,67 – 0,78, (Casale *et al.* 2007b)) with age of maturity at 16 to 28 years (Casale *et al.* 2009). Loggerhead turtles are under heavy pressure of anthropogenic activities (Margaritoulis *et al.* 2003). Most of the nesting beaches in the Mediterranean are under some form of protection (Margaritoulis *et al.* 2003). Presently, incidental capture through fishery is estimated to be between 152723 to 209717 captures per year which is the most dangerous human activity for sea turtles (Casale 2008). Focal areas for by-catch on pelagic longlines are developmental habitats in the pelagic areas of western Mediterranean and Ionian Sea with estimated 60000-80000 by-catch incidents per year (Lewison *et al.* 2004). Neritic habitats of the Adriatic Sea (Lazar & Tvrtković 1995; Lazar & Tvrtković 2003b; Casale *et al.* 2004; Lazar *et al.* 2006), Tunisia (Jribi *et al.* 2007) and Egypt (Nada & Casale 2008) are focal areas of trawling and trammel net bycatch. Estimated yearly impact of bottom trawlers in the Mediterranean is between 36.700 – 90.300 captures with direct mortality of 0,6 to 12,5% (Lazar *et al.* 2003; Casale 2008) and total mortality up to 34% (Casale *et al.* 2004).

4.1.1.1 Adriatic Sea

A study carried out on 264 loggerhead turtles from northern Adriatic between 1995 and 2007 confirmed the northern and central Adriatic as a neritic habitat of loggerhead turtles. The area is shared by juvenile and adult animals originating from Greece (75,3%) and Turkey (19,5%) and to lesser extent Cyprus, Israel and Libya (Lazar 2010). Recruitment of small juvenile animals (CCL 25-30 cm) into northern Adriatic indicates ontogenetic habitat shift from oceanic to neritic stage and primarily benthic feeding. Of particular importance is gillnet mortality of 74% and bottom trawling by-catch with direct mortality of 7,5% and potential mortality of 26,9% (Lazar 2010).

Preliminary abundance estimate based on the aerial survey results from 2010 yielded total estimate of 25.692 (CV 21,6%) loggerhead turtles in the entire Adriatic Sea and 18.008 (CV 15,1%) loggerhead turtles in the northern Adriatic (Fortuna *et al.* 2010a). This numbers grow dramatically when corrected for dive time (73.406 and 51.451 loggerhead turtles in whole and northern Adriatic) (Fortuna *et al.* 2010a). Estimated numbers have some limitations as for example smaller turtles could not be seen from the air. Therefore, estimated numbers are only indication of the scale of loggerhead turtle abundance in the Adriatic Sea.



Sightings of loggerhead turtle in the Adriatic Sea (2010 & 2013)

Figure 17. Map of sighting of (mostly) loggerhead turtles during aerial surveys in 2010 and 2013.

Due to such a large number of loggerhead turtles, interaction with human activities is substantial. Estimated number of incidental capture by only bottom trawlers is over 11.000 specimens (Casale 2011). Such a large impact has implications on the entire Mediterranean population.

4.2 Other species of sea turtles in the Adriatic Sea

Two other sea turtle species are present in the Mediterranean Sea, the leatherback turtle (*Dermochelys coriacea*) and the green turtle (*Chelonia mydas*). The leatherback turtle is the only species that is regularly present in the Mediterranean Sea but does not nest in the area. Their immigration from the Atlantic is connected with feeding (Casale *et al.* 2003). Their presence in the Mediterranean is year round while their appearance in the Adriatic indicates seasonality with higher number of records during the summer (Lazar *et al.* 2008)

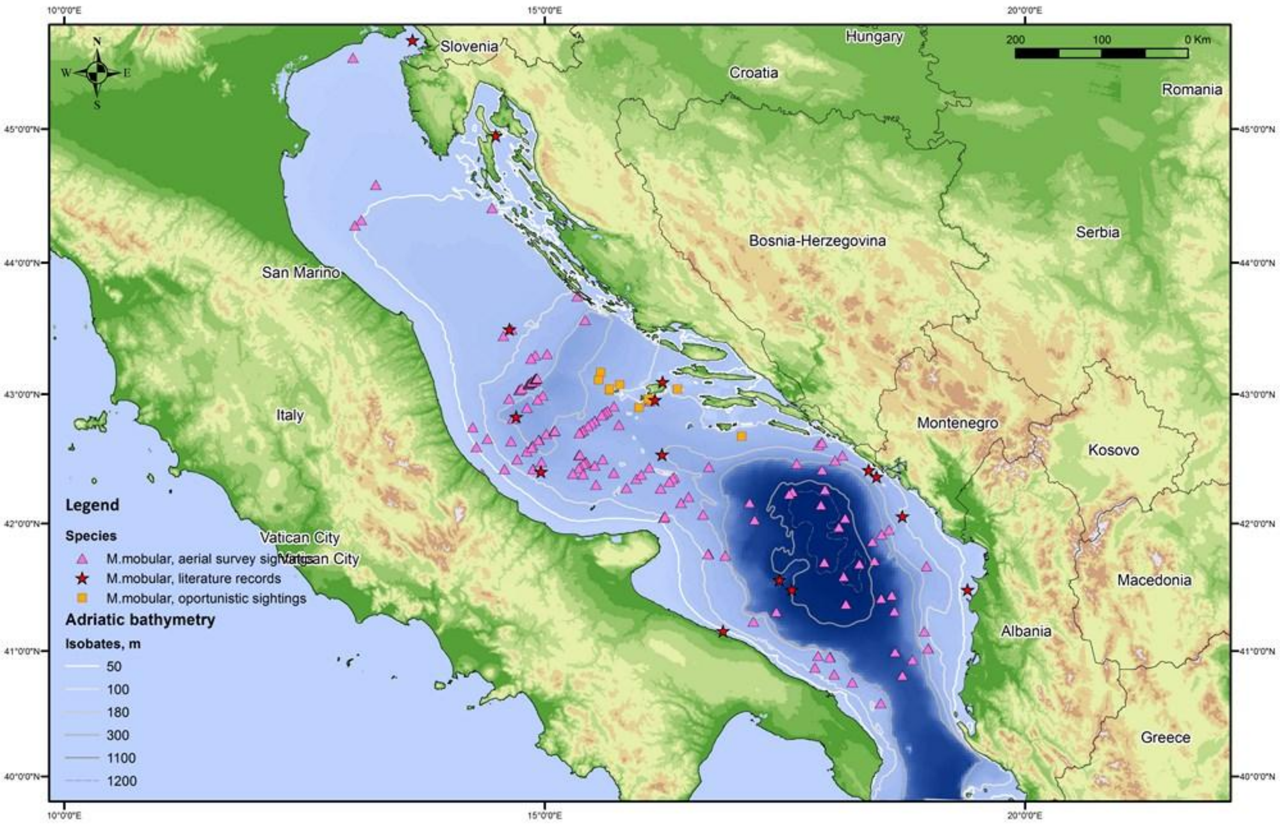
The Mediterranean population of the green turtle is one of the smallest and most endangered populations of this species in the world and is a remnant of once thriving population whose decline was caused by anthropogenic influence (Sella 1995). Most nesting is concentrated on a few beaches in Turkey, Syria and Cyprus while a small number of animals also nests in Lebanon, Israel and Egypt (Kasparek *et al.* 2001; Rees *et al.* 2008). Estimated number of nesting females is only between 339-360 females with a triennial re-migration period (Broderick *et al.* 2002). Main neritic habitats of the species are along the coasts of northern Africa (Broderick *et al.* 2007) while developmental habitats of juvenile individuals are present in the Ionian and southern Adriatic Sea (Margaritoulis & Teneketzis 2001; Lazar *et al.* 2004a)

5 The giant devil ray (*Mobula mobular*)

Figure 18. Giant devil ray, central Adriatic. Photo: D.Holcer, BWI.

The giant devil ray (Figure 18) is a large marine vertebrate and can reach up to 5.2 m in disc width (DW), although specimens of about 3 m DW are most common (Serena 2005). This large epipelagic batoid fish inhabits the entire Mediterranean Sea and possibly the adjacent Atlantic waters (Serena 2005). Due to its geographic distribution and rare records outside the Mediterranean it is considered as an endemic elasmobranch in the region (Notarbartolo di Sciara & Bianchi 1998). The giant devil ray has been recorded in a number of Mediterranean countries including Albania (Rakaj 1995), Algeria (Hemida *et al.* 2002) Croatia (Šoljan 1948; Jardas 1996), France (Capapé *et al.* 1990; Capapé *et al.* 2006), Greece (Bearzi *et al.* 2006), Italy (Notarbartolo di Sciara & Bianchi 1998), Israel (Golani & Levy 2005), Malta (Schembri *et al.* 2003; Burgess *et al.* 2010), Tunisia (Bradai & Capape 2001) and Turkey (Akyol *et al.* 2005), demonstrating its basin-wide distribution. Information on the biology of the giant devil ray is scarce (Couturier et al. 2012). The limited data have largely been obtained from opportunistic measurements of a few specimens caught in various locations in the last century (Couturier *et al.* 2012). It mostly inhabits deep pelagic waters where it feeds on plankton, predominantly krill and small schooling fish (Notarbartolo di Sciara 2005). However, there are also occasional records from the shallow waters of the northern Adriatic Sea, the Gulf of Gabès and the south-western coastal part of Sardinia (Bradai & Capape 2001; Storai *et al.* 2011; Holcer *et al.* 2013).Throughout its range the giant devil ray is believed to live in low numbers although population estimates are unavailable (Notarbartolo di Sciara *et al.* 2006).

While the giant devil ray is not considered to have been subjected to a directed fishery, ‘incidental’ catches in the otherwise highly selective Sicilian swordfish harpoon fishery were reported until the late 1990s (Bauchot 1987; Celona 2004); despite the absence of abundance data, the level of exploitation was considered ‘low’ by Bauchot (1987).



Sightings and records of the giant devil ray in the Adriatic Sea (1883 - 2013)

Figure 19. Map of literature records, opportunistic sightings and sighting of giant devil ray during aerial surveys in 2010 and 2013.

There have been numerous reports of incidental catches for purse-seines, longlines, trammel nets, mid-water/pelagic trawls and traditional tuna traps in addition to IUU (Illegal, Unregulated and Unreported) driftnet fisheries (Marano *et al.* 1983; Notarbartolo di Sciara & Serena 1988; Bradai & Capape 2001; Akyol *et al.* 2005; Scacco *et al.* 2009; Storai *et al.* 2011). Most recently unregulated fishery along the coast of the Gaza Strip (Palestine) taking advantage of winter aggregations caught 500 specimens (Couturier *et al.* 2013). Bycatch from the large pelagic driftnet fishery was reported up until two decades ago (Di Natale *et al.* 1995; Di Natale 1998a).

Due to its limited range, inferred low densities and presumed unsustainable interactions with fisheries, the giant devil ray is listed as Endangered (EN A4d) on the IUCN Red list (Notarbartolo di Sciara *et al.* 2006).

5.1.1.1 Adriatic Sea

The presence of the giant devil ray in the Adriatic was relatively unknown and the species was considered as rare (Jardas 1985; Jardas 1996; Jardas *et al.* 2008). The literature review from 19th century onward indicates that it is a species known to occur in the Adriatic (Bello *et al.* 2012; Holcer *et al.* 2013) (Figure 19). The first known records originate from the end of 19th century when the species was listed as *Dicerobates giornae,* Lac. (Stossich 1880), and a specimen was caught in the Gulf of Trieste and noted under same synonym by Faber (1883) (Figure 19).

The seasonal distribution of records, with a peak in the summer suggests the existence of a temporal pattern of occurrence (Holcer *et al.* 2013). The giant devil ray is generally considered to be a plankton feeder, feeding on pelagic crustaceans and small schooling fish (Celona 2004; Serena 2005). The earliest seasonal observations of the giant devil ray in the Adriatic are from the area of open waters in the central Adriatic in April and May while the majority of opportunistic sightings, however, are made in the areas closer to the coast late in the spring and throughout the summer (Holcer *et al.* 2013). This distribution coincides with appearance of large quantities of sardines and anchovies (Skrivanić & Zavodnik 1973; Benović *et al.* 1984; Regner 1996). The increase in the number of sightings closer to the central Adriatic islands and along the western coast is likely to be connected with the migration of sardines along the eastern coast (Skrivanić & Zavodnik 1973) and anchovies on the western coast of the Adriatic Sea (Regner 1996).

Most findings originate from the southern and the central Adriatic sub-basins (Figure 19). This conforms with the proposed local geographic range of this species (Notarbartolo di Sciara *et al.* 2006). The giant devil ray is an epipelagic species which spends most of its time (81.5%) in surface waters between 0 and 50 m, although it is capable of deep dives to 700 m (Canese *et al.* 2011).

The aerial surveys carried out in 2010 and 2013 provide the first overview of the summer distribution and abundance of the giant devil ray in the Adriatic Sea (Fortuna *et al.* 2011b; Fortuna *et al.* in press). The results of the survey between 31 July and 16 August 2010 with applied availability correction factor (0.49; SD=0.25) to the uncorrected estimate (N=1,595; CV=0.23) for confirmed adult giant devil rays, yielded the estimate of abundance to 3,255 individuals (CV=0.56) (Fortuna *et al.* in press).

Data from the aerial surveys in 2010 and 2013 survey (Figure 19) generally confirm information from earlier opportunistic data and inferred distribution, with more encounters in the central and southern parts of the Adriatic (Notarbartolo di Sciara *et al.* 2006; Fortuna *et al.* 2011b; Holcer *et al.* 2013; Fortuna *et al.* in press).

5.1.2 Population structure

No information exists on the population structure of *Mobula mobular* throughout its range.
Most sightings in the Adriatic Sea are of solitary animals. During aerial survey in the Adriatic Sea in 2010 the mean group size was 1,2 animals (SD=0.6; range=1-4) (Fortuna *et al.* in press)

6 Threats to species in the Adriatic Sea

The cumulative model of 22 anthropogenic drivers categorised as climate (i.e. the combined cumulative impact of temperature and UV increase, and acidification), fishing, sea-based drivers (commercial shipping, invasive species, oil spills and oil rigs) and land-based drivers (nutrient input, organic pollution, urban runoff, risk of hypoxia and coastal population density) show that Adriatic Sea is one of the areas with highest anthropogenic impacts (Micheli *et al.* 2013) (Figure 20). When climatic drivers (that cannot be directly controlled or managed) are not included, demersal fishing, hypoxia and pollution from land-based activities are major contributors to the high cumulative impacts to the Adriatic (Micheli *et al.* 2013). At the same time, within the Adriatic Sea it is visible that there is very high difference in the overall impact between eastern and western coast, latter being more impacted (Figure 20).

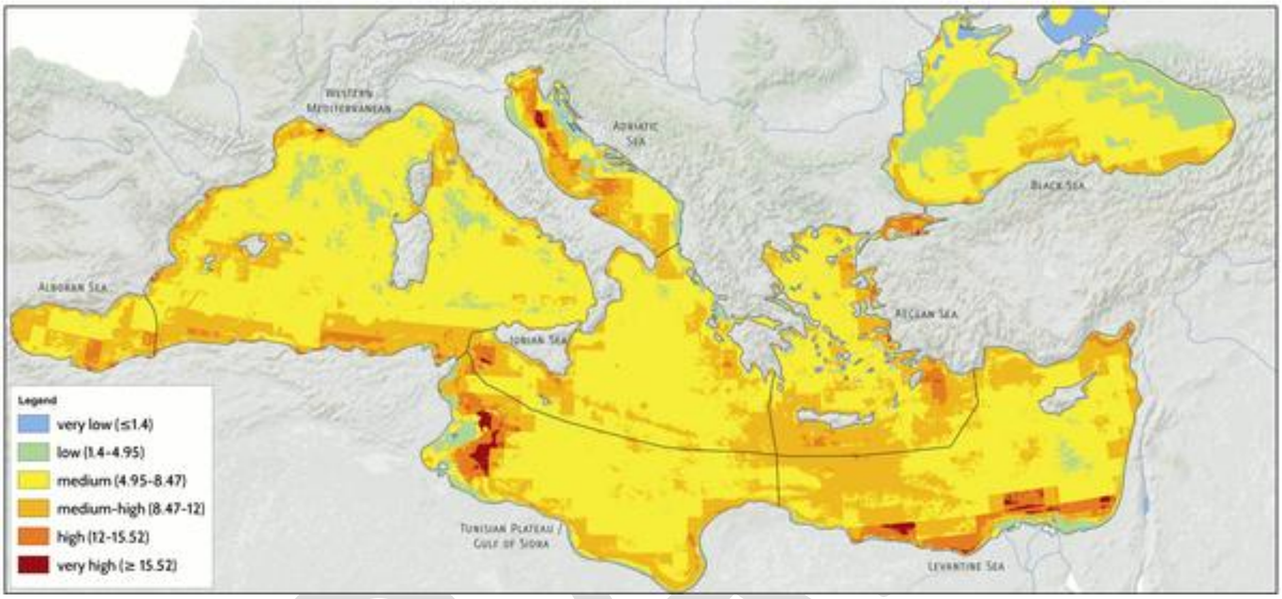


Figure 20. Map of cumulative anthropogenic impact on the Mediterranean and Black Sea (Micheli et al. 2013).

6.1 Fishery

As one of two largest areas of continental shelf in the Mediterranean, the Adriatic Sea (and Gulf of Gabès) is the most heavily bottom trawled area in the Mediterranean Sea (Figure 21) of great value for fisheries (Mannini & Massa 2000). Bottom trawling together with purse-seining and pelagic pair-trawling has the largest impact on the Adriatic ecosystem (Mannini *et al.* 2005). Additionally, bottom and pelagic long-lines, trammel nets and other forms of artisanal fisheries reduce the overall fish biomass (Matić-Skoko *et al.* 2011).

Impact of reduced prey availability due to overfishing, habitat degradation and by catch are the main sources of concern for large marine vertebrates including Cetaceans, marine turtles and cartilaginous fish.

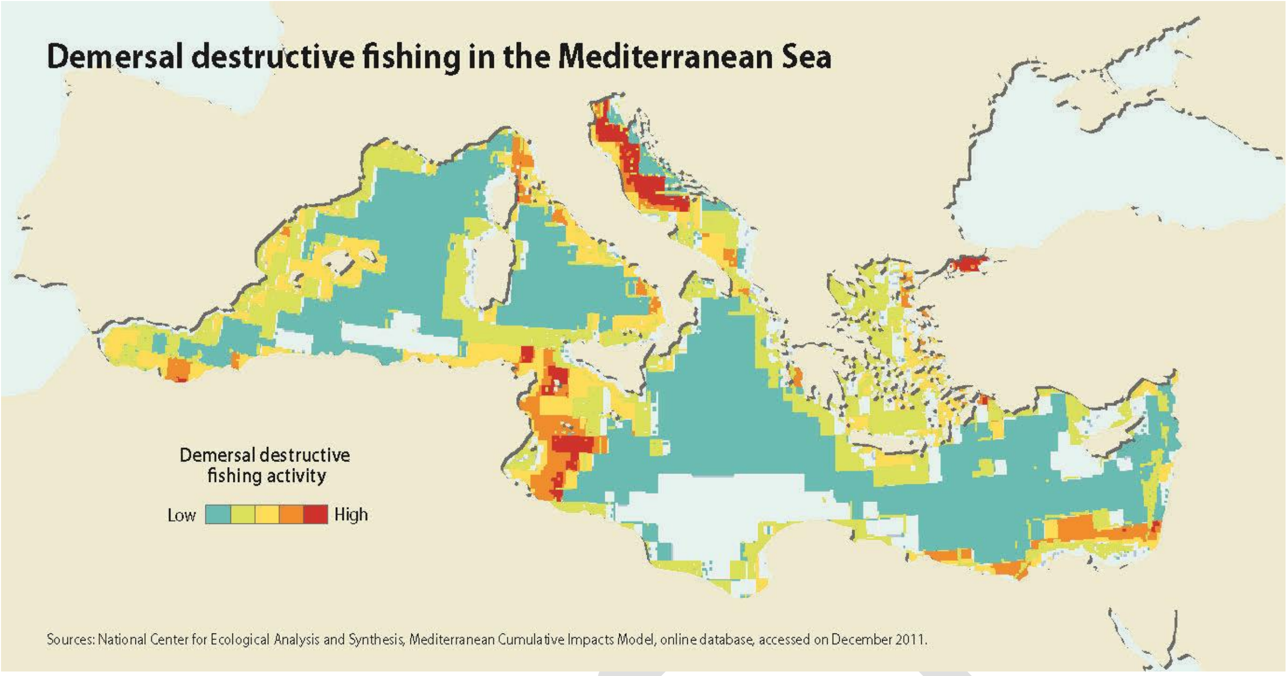


Figure 21. Map of cumulative demersal fishing impact on the Mediterranean Sea (Author: GRID-Arendal, http://www.grida.no/).

6.1.1 Cetacean-fishery interactions

Historically, the interaction between dolphins and fishery in the Adriatic was acute with fisheries reporting great substantial losses in catch due to depredation by dolphins. As a result that led to a number of culling campaigns organised in the 19th and 20th centuries by Adriatic states (Italy, Austria, Yugoslavia) where bounties were paid for each animal landed.

Further, net depredation has been reported as serious issue along the west coast of the Istrian peninsula and in the northern Dalmatian archipelagos (Holcer, *unpublished data*). Such interactions lead to cases of net entanglement and intentional killing (BWI, *unpublished data*) and mortality caused by larynx strangulation (Gomerčić *et al.* 2009)

In some shelf areas, dolphins following trawler boats is relatively regular activity (Fortuna *et al.* 1996; Bearzi & Notarbartolo di Sciara 1997; Casale & Giovanardi 2001; Holcer 2012), potentially causing drowning in the net for dolphins and a loss of catch for fisheries. Pelagic pair trawlers have also been documented to cause dolphin bycatch (Fortuna *et al.* 2010b).

6.1.1.1 Past culling campaigns

Historically, the direct killing of *Tursiops truncatus* was a significant threat to the Adriatic populations. From the early 1930s until the late 1960s the Italian and Yugoslavian governments campaigned for the elimination of Adriatic dolphins, offering fishers rewards per dolphin killed (Table 6). The exact numbers of dolphins killed during and after this campaign were largely undocumented, but experts considered these numbers substantial (Bearzi *et al.* 2004). Despite the existing data failing to specify the dolphin species killed, past literature implies that the two main species were the short-beaked common dolphin and the common bottlenose dolphins (Bearzi *et al.* 2004).

Table 6. Existing numbers on historical killings of dolphins in the Adriatic Sea.

Period	Number of killed dolphins	Area	Source
1929	Unknown (funding sufficient for 250-500 specimens)	Italian coasts (not only Adriatic Sea)	Italian Ministerial Decree (28 december 1928)
1933-35	at least 335 dolphins	Croatian coast	Crnkovic 1958
1955-60	788 dolphins	Croatian coast	Crnkovic 1958; Marelic 1961
1956-57	239 dolphins	Croatian coast	Crnkovic 1958

An unknown number of dolphins were also caught in the northern Adriatic between 1964 and 1978 for live display in captive facilities (Duguy *et al.* 1983; Greenwood & Taylor 1987).

6.1.1.2 Accidental fishery-related mortality (cetacean bycatch)

Little quantitative data exist on past or current cetacean bycatch totals or rates for the Adriatic Sea (see Table 7). Additional descriptive and quantitative data can be found in (Fortuna 2009; Fortuna & Filidei Jr 2010; Fortuna *et al.* 2010b; Fortuna & Filidei Jr 2011; Fortuna & Filidei Jr 2012; Fortuna & Filidei Jr 2013).

Table 7. Annual estimates of bycatch of cetaceans in the Adriatic Sea.

Fishing gear	GFCM Fishing area	Species	Period	Total number (N, CV)	Source
Mid-water pair trawlers	GSA 17	Tursiops (*Tursiops truncatus*)	2006-2012	31 (0.41) average on a 7-years period	Fortuna & Filidei (2013)
	Northern Adriatic (only fishing boats registered in Veneto & Emilia-Romagna)			30 (0.35) average on a 7-years period	

Additional information on likely interactions with fisheries can be found in data collected in Italy (1986-2013) by the national stranding network (http://mammiferimarini.unipv.it). All details on these accounts for the Adriatic Sea only are presented in Table 8.

Table 8. Report from the Italian national stranding network (http://mammiferimarini.unipv.it).

1986-2013	North					Central				South				
Species	Firearm	By catch	Presence of hooks	Presence of nets	Fishing gear marks	Firearm	By catch	Presence of nets	Fishing gear marks	By catch	Presence of hooks	Presence of nets	Fishing gear marks	Total
Tursiops truncatus	3	13		7	1		12	10	2	11	2	4		65
Stenella coeruleoalba						3	3			21	1	6	3	37
Grampus griseus		1	1							2	1	1		6
Undetermined							2	1	1	6		1		11
TOTAL	3	14	1	7	1	3	17	11	3	40	4	12	3	119

6.1.1.3 Competition for resources

One recent analysis of ecosystem structure and fishing impacts in the Adriatic Sea suggested that the role of dolphins is minor in terms of competition for resources and that the greatest pressure comes from fisheries (Coll *et al.* 2007).

6.1.2 Sea turtle-fishery interactions

Interaction with fisheries is one of the main threats for sea turtles world-wide (Casale & Margaritoulis 2010; Casale 2011) and the Adriatic is not an exception (Lazar & Tvrtković 1995; Casale *et al.* 2004; Lazar 2010; Casale 2011).

The highest number of bycatch events was recorded in bottom trawlers (Lazar & Tvrtković 1995; Casale *et al.* 2004; Lazar 2010; Casale 2011), followed by mid-water/pelagic trawlers (Casale *et al.* 2004; Fortuna *et al.* 2010b). While there is no reliable data for gill-net or longlines, experts believe that mortality in these fishing gear is also high (Casale *et al.* 2004; Lazar 2010; Casale 2011).

Existing estimates of loggerhead turtles total bycatch in the Adriatic Sea are provided in Table 9.

Table 9. Annual estimates of bycatch of loggerhead turtles in the Adriatic Sea.

Fishing gear	GFCM Fishing area	Species	Period	Total number (N, CV)	Source
Mid-water pair trawlers	GSA 17	Loggerhead turtle (*Caretta caretta*)	2009	994 (0.02)	Fortuna & Filidei (2010)
			2010	714 (0.05)	Fortuna & Filidei (2011)
			2011	358 (0.29)	Fortuna & Filidei (2012)
			2012	747 (0.14)	Fortuna & Filidei (2013)
	Northern Adriatic (only fishing boats registered in Veneto & Emilia-Romagna)		1999-2000	161 (-)	Casale *et al.* (2004)
			2009	561 (0.02)	Fortuna & Filidei (2010)
			2010	421 (0.21)	Fortuna & Filidei (2011)
			2011	268 (0.30)	Fortuna & Filidei (2012)
			2012	481 (0.17)	Fortuna & Filidei (2013)
Bottom trawlers			1995	2,500 (ND)	Lazar & Tvrtković (1995)
			1999-2000	4,273 (ND)	Casale *et al.* (2004)

6.1.3 The giant devil ray-fishery interactions

Although the interactions of *M. mobular* with fisheries in the Adriatic have been documented for swordfish drifting longlines (Marano *et al.* 1983; Bello 1999), pelagic pair trawlers (Scacco *et al.* 2009), bottom longlines and trammel nets (Table 1 and references therein), no precautionary measures are in place to mitigate human-induced mortality. Moreover, in the Mediterranean the giant devil ray has also been by-caught in purse seiners (Di Natale 1998b; Notarbartolo di Sciara *et al.* 2006), a fishery responsible for the majority of fish caught in the Adriatic Sea. The importance of purse-seiners, in terms of their possible impact on the giant devil ray in the Adriatic, is further stressed when considering that 89% of the total Croatian pelagic fish catch for 2009 was using this gear (IOR 2011), In addition purse seiners constitute about 30% of the total Italian pelagic catch, operating off Abruzzo and Apulia regions (IREPA 2009). This fishery in the southern and the central sub-basins has potentially the most detrimental effect for giant devil rays in the Adriatic Sea due to their feeding habits and epipelagic behaviour (Canese *et al.* 2011).

However, with the exception of the Italian pelagic/mid-water trawlers operating in the northern and central sub-basins, (Fortuna *et al.* 2010b), to our knowledge no other fishery by-catch monitoring scheme exists in the Adriatic Sea. Hence the extent of fishery – giant devil ray interaction is beyond our knowledge for this region. Furthermore, the Adriatic Sea is primarily frequented by large individuals with DW ranging between 2 and 3 m (Table 1). In a K-selected species with life history similar to giant devil rays these size classes are the most sensitive to anthropogenic perturbations (Heppell *et al.* 2000; Heppell *et al.* 2005). Given the protected status and the estimated population decline (Notarbartolo di Sciara *et al.* 2007) an assessment of the impact of fisheries at Adriatic level, coupled with further research on the distribution and abundance, should be underlined as a priority for the elaboration of an effective conservation and management strategy for giant devil rays in the region.

6.2 Gas and Oil exploitation

The exploitation of offshore fields in the Adriatic Sea started in the 1960’s with the Ravenna Mare and Porto Corsini fields. Currently, there are more than 130 different gas and oil extraction installations in the Adriatic (Figure 22), some of which have been abandoned as hydrocarbon reserves were exhausted. Still, the Adriatic Sea, continues to be in the focus of interest of oil and gas industry that continue search for gas and oil and building of new off-shore rigs.

The largest numbers of platforms are positioned along the western coast of the Adriatic Sea, along the Italian coast. In Croatia, smaller number of platforms are positioned in the northern Adriatic where commercial production of gas started in 1999. and additional seven platforms were added to the operations by 2006. Along with gas production, there are several known oil-fields (along western coast) where oil production is under way or planned[1].

The economic crisis and high prices of oil products has further stimulated research in hydrocarbon deposits in the Adriatic Sea. In Croatia, the entire national waters and economic zone has been recently (7th Sep 2013 - 21st Jan 2014) surveyed with 2D seismic technique[2] (Figure 23) and Government of Croatia plans to hold

[1] http://unmig.sviluppoeconomico.gov.it/unmig/monitoraggio/mare/webgis/ge_mare.asp

[2] http://www.spectrumasa.com/technical-paper/croatia-a-new-oil-province-at-the-heart-of-europe

extraction licensing round in for potential investors during 2014[3]. The survey was carried out without any environmental impact study. Further, no monitoring scheme apart from survey operator marine mammal observation was in place. The survey was carried out within the known areas of importance for Cetaceans and sea turtles. In Montenegro, by the end of February 2014 the first bid for awarding concessions for oil and gas exploitation and production activities in the offshore was underway.

Such intensive extraction pressure to already heavily impacted habitats and in a semi-closed basin like the Adriatic Sea it represents a serious threat to large marine vertebrates, particularly Cetaceans.
The most notable direct impact comes from seismic activities aimed at understanding the geology and hydrocarbon beds on the sea bottom. Further, testing and drilling, rig construction and their operation, additional drilling during operational lifetime in order to stop decline in the oil production are additional sources of significant noise pollution and disturbance. Depending on the extracting methodology, particularly during secondary and tertiary recovery, a number of different chemical compounds used for extraction together with hydrocarbons could end up in the environment. Finally, recent catastrophe in the Gulf of Mexico with Deep Water Horizon platform oil spill further stress the potential negative impact of oil and gas extraction from the sea bed.

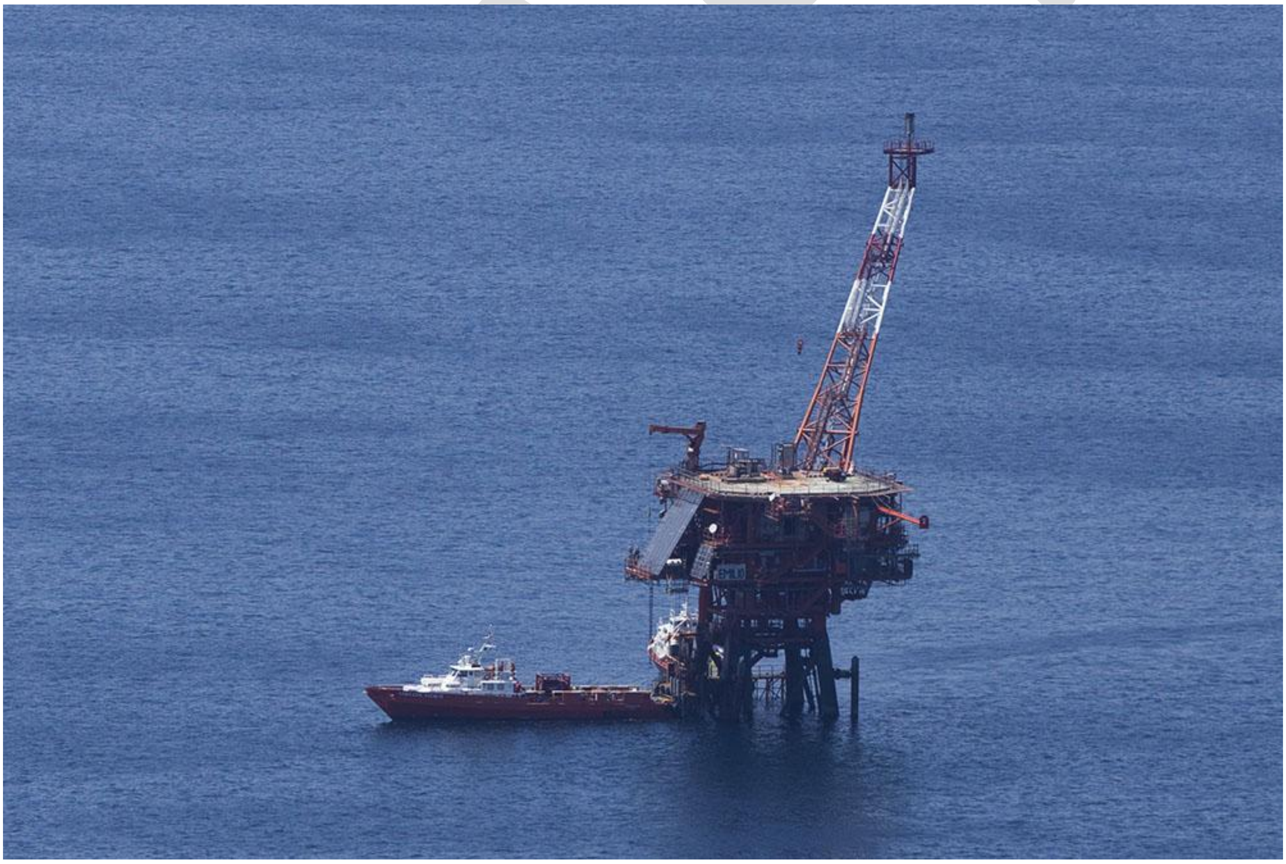


Figure 22 Gas extraction platform in the northern Adriatic Sea. Photo: D.Holcer, BWI

Seismic surveying and additional high-intensity noise during drilling and, additional surveying during exploitation of the gas/oil fields represents a serious threat to Cetaceans. The range of impacts varies from

[3] http://www.mingo.hr/default.aspx?id=4996

direct mortality to short and long term injuries (most notably to auditory system), displacement and disturbance (Gordon *et al.* 2003). Furthermore, the cumulative impact of different types of activities on Cetaceans could be detrimental and therefore precautionary principle and applying of the activities aiming at minimising the uncertainty of the impact should be used. Such activities include environmental impact assessment, mitigation measures, monitoring (pre-, during and post-exposure) and where needed additional research.

Additionally, a liquid natural gas (LNG) offshore terminal located in the northern Adriatic 9 miles (14 km) offshore of Porto Viro, in Porto Levante, near Rovigo, Italy has been in operation since 2009. An additional offshore terminal is proposed in the Gulf of Trieste in Italy and in Croatia there are plans to build LNG terminal on Krk island in the Kvarner region.

The impact of these terminals on the environment (except those connected with shipping and possible accidents) are not well known but, it is likely that a number of chemical compounds could end up in the environment. Currently there are some questions about Rovigo LNG terminal as there is constant foam of unknown origin present on the sea surface around it.

Figure 23. Map of recent seismic survey in the Adriatic Sea (Map: http://www.spectrumasa.com).

The long term impact of operating gas and oil rigs on marine communities are relatively unknown. Studies show that after initial damage to benthic communities during construction and drilling they recover with impact visible in a limited zone (Daan & Mulder 1996; Gates & Jones 2012). Further, levels of hydrocarbons in the area where oil-based drilling muds were disposed were higher than elsewhere even eight years after drilling while species diversity was lowered (Daan & Mulder 1996). Waste produced during drilling with high levels of hydrocarbons also has largely negative impact on the environment including acute and chronic toxicity (Holdway 2002). Research carried out in the offshore gas field off Ravenna between 2001 and 2005 provided the first information on the common bottlenose dolphin behaviour near gas platforms in the Adriatic Sea. The results showed that dolphin density was higher within 750 m of gas platforms than further and that dolphins were spending more time feeding and milling closer to the gas platforms (Triossi *et al.* 2013). As one of the reason for such behaviour authors indicated possibility that gas platforms aggregate larger number of prey. Nevertheless, if we consider possibility of negative effects of chronic exposure to toxicants in different concentrations, such behaviour of common bottlenose dolphins might have a long-term negative impact on the population.

6.3 Maritime traffic

The Mediterranean Sea is among the busiest shipping routes in the world accounting for 15% of global shipping. The major shipping route that accounts for about 90% of traffic connects Gibraltar (Atlantic) with Suez (Red sea) and Bosporus (Black sea) (Figure 24). Passenger ships and dry cargo ships make up most of the traffic between Mediterranean ports.

Compared to the Mediterranean, there is a relatively moderate traffic branch towards the northern Adriatic ports of Venice, Trieste, Koper and Rijeka. Lesser traffic goes to other Adriatic ports of Zadar, Split, Ploče, Dubrovnik (Hr), Bar (Mn), Bari, Ancona, Brindisi (It) and Durres and Vlorë (Al).

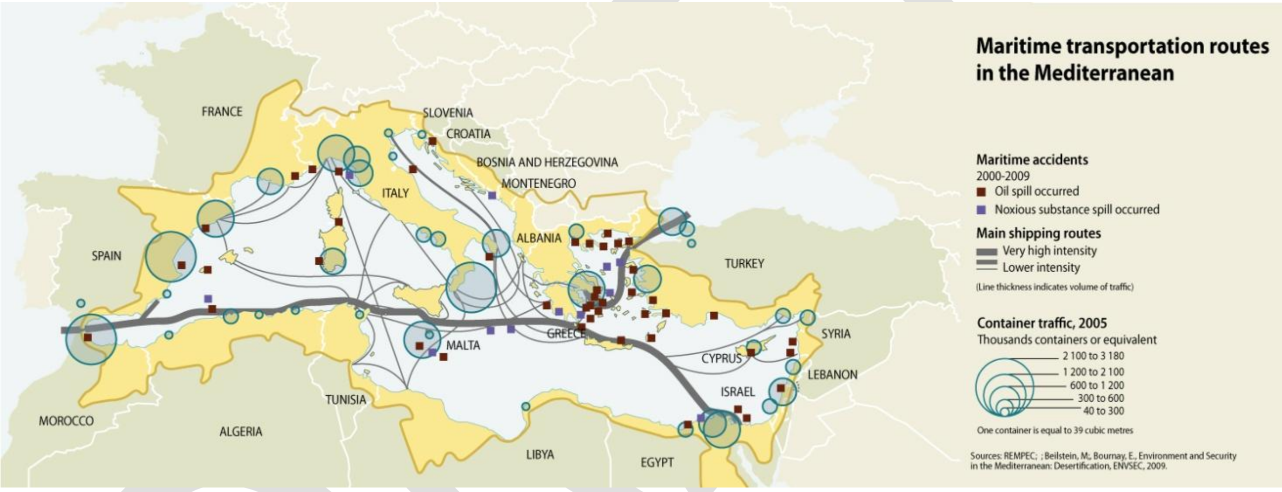


Figure 24. Map of maritime transportation routes in the Mediterranean Sea (Author: GRID-Arendal, http://www.grida.no/).

The northern Adriatic Port Authority intends to increase marine traffic by over 200% in the coming years with major expansion in the four member ports of Venice, Trieste, Koper and Rijeka. Due to the sensitivity of the area it has been proposed as Particularly Sensitive Sea Area (Vidas 2005). If designated it would require special protection through action by the International Maritime Organisation (IMO) to reduce the risk associated with shipping[4].

Maritime traffic in the Adriatic (Figure 25) includes transport routes for tankers with crude oil to northern Adriatic ports, liquefied gas transport to Rovigo LNG terminal, dry cargo and container ships, chemical tankers and passenger ships. Maritime traffic further constitutes of fishing vessels, yachts, recreational boats, military and other official boats and research vessels.

[4] http://www.imo.org/OurWork/Environment/PollutionPrevention/PSSAs/Pages/Default.aspx

Such large shipping produces a number of negative effects on the marine environment. Of particular environmental concern are ballast waters, pollution and oil spill, collision, noise and habitat degradation.

One of the main anthropogenic causes of death for large cetaceans like fin whale and sperm whale in the Mediterranean is boat collision (Weinrich *et al.* 2005). A report by Panigada *et al.* (2006) suggests that 16% of stranded fin whales in the Mediterranean have died because collision with ships. In addition, the boats that are involved in collisions are mostly ferries, cargo and fast ferries (catamarans). Boat collision with Cetaceans in the Adriatic are seldom reported.

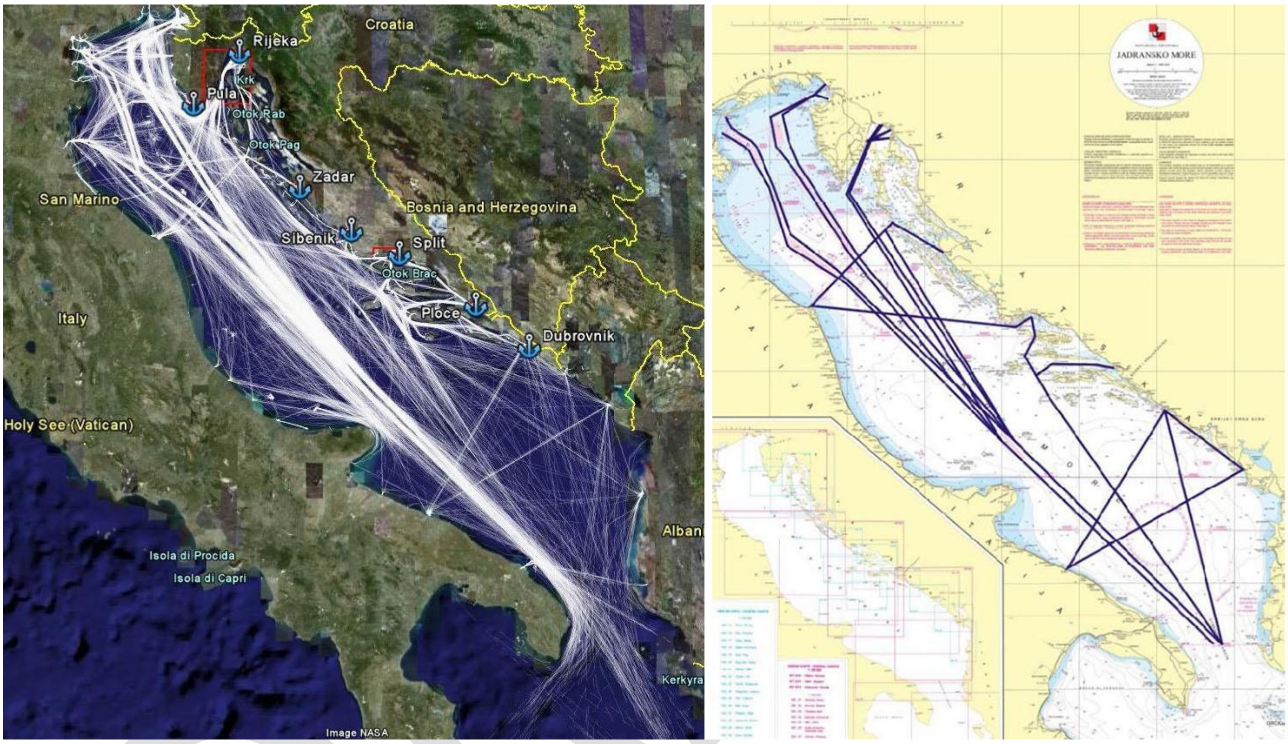


Figure 25. Maritime traffic and traffic separation scheme in the Adriatic Sea (Policy Research Corporation 2011).

As species appearing in the Adriatic are smaller and more agile, collision with larger vessels is highly unlikely (Figure 26). The source of potential concern could be dramatic increase of leisure boat traffic during summer months particularly in the coastal areas (Figure 27). Nevertheless, in over 20 years of regular surveys of coastal communities of common bottlenose dolphins only on a single occasion was an animal observed with healed wounds potentially inflicted by propeller has been encountered (*authors' data*). On one occasion a body of Cuvier's beaked whale with the caudal part of the body cut-off was washed on the beach in near Giancole in 2003 indicating potential collision with larger vessel (Pino d'Astore *et al.* 2008). However, it was impossible to conclude whether animal was alive or dead at the time of collision.

Similarly, collision with fast moving vessels, is of concern for sea turtles (Demetropoulos 2000). In a number of areas with a high intensity of fast traffic a number of turtles injured through collision have been reported (Camiñas & de Málaga 2004). This is of particular importance in areas with a higher abundance of sea turtles, such as the areas adjacent to nesting beaches in the period of mating and nesting (Demetropoulos

2000). Boat collision in the Adriatic Sea is most notable along north and western part (Casale *et al.* 2010).

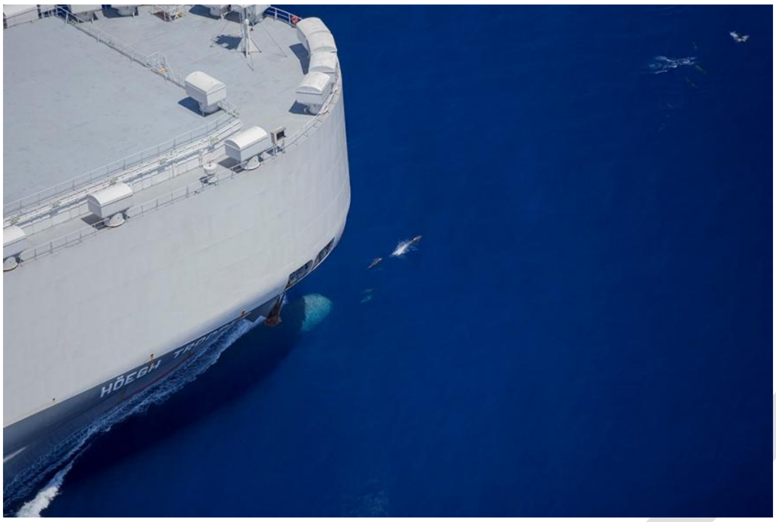


Figure 26. Striped dolphins bowriding in front of the cargo ship, southern Adriatic. Photo: D.Holcer, BWI.

On the contrary, the turtle stranding network along eastern coast rarely report turtles injured with boat collision (*authors data*). This is probably due to the fact that sea turtles do not enter channels along the Croatian coast in the same numbers which is where most of the recreational traffic occurs. Conversely, they are present in high densities in the open waters of the northern Adriatic where they are vulnerable to collision with speedboats exiting Italian harbours.

6.4 Tourism related issues

Tourism is a major economic activity in the region. The seasonal nature of tourism makes its impact even more obvious (Figure 27). While collisions between boats and cetaceans are believed to be rare in this region, both physical and acoustic disturbance is believed to play a significant role in displacing populations in the summer season (Rako, et al., 2012). Work undertaken in the eastern archipelago of Cres-Lošinj suggests that the increase in sea ambient noise, related to the exponential increase in leisure boating in the summer months, acts as a trigger to displace the local population of common bottlenose dolphins in the region (Rako, et al., 2013).

Figure 27. Yacht approaching group of common bottlenose dolphins, central Adriatic. Photo: D.Holcer, BWI.

There have been reports of collisions between sea turtles resting on the surface, or just below, and leisure boats in the region. While numbers are not considered to be high, compared to the bycatch of trawlers and other fishing vessels in the region, it is an aspect that should be considered in the future with increasing numbers of fast moving leisure boats in the region. Of particular concern is impact of tourism on sea turtles causing habitat degradation on turtles nesting sites. Activities related to tourism causing negative impact are recreational activities, beach traffic, lights, noise, development, beach pollution, vegetation planting, boat strikes, fishing and coastal erosion (Demetropoulos 2000)

6.5 Pollution (including marine debris)

Polychlorobiphenyls (PCBs) are among the most common and the most toxic chlorinated hydrocarbons. Their presence in marine environments, including in sea turtles and cetacean tissues of the Adriatic Sea, is well documented (Corsolini *et al.* 1995; Marsili & Focardi 1997; Corsolini *et al.* 2000; Lazar *et al.* 2011b; Lazar *et al.* 2012; Herceg Romanić *et al.* in review). Marine debris is proven to have a widespread negative impact on marine wildlife (Derraik 2002; Baulch & Perry 2014), including sea turtles and cetaceans inhabiting the Adriatic Sea. Pribanić *et al.* (1999) found in a stomach of a striped dolphin stranded in the northern Adriatic different kinds of plastic material (approximately 1.5 litre), including plastic and garbage bags, a rubber glove and cellophane wrapping. Lazar *et al.* (2011a) examined the occurrence of marine debris in the gastrointestinal tract of 54 loggerhead sea turtles (*Caretta caretta*) found stranded or incidentally captured by fisheries in the Adriatic Sea. Marine debris was present in 35.2% of turtles and included soft plastic (68.4% of cases), ropes (42.1%), Styrofoam (15.8%) and monofilament lines (5.3%). Considering the relatively high occurrence of debris intake and possible sub-lethal effects of even small quantities of marine debris, Lazar *et al.* (2011a) concluded that this can be an additional factor of concern for loggerheads in the Adriatic Sea.

7 Conservation status of considered species

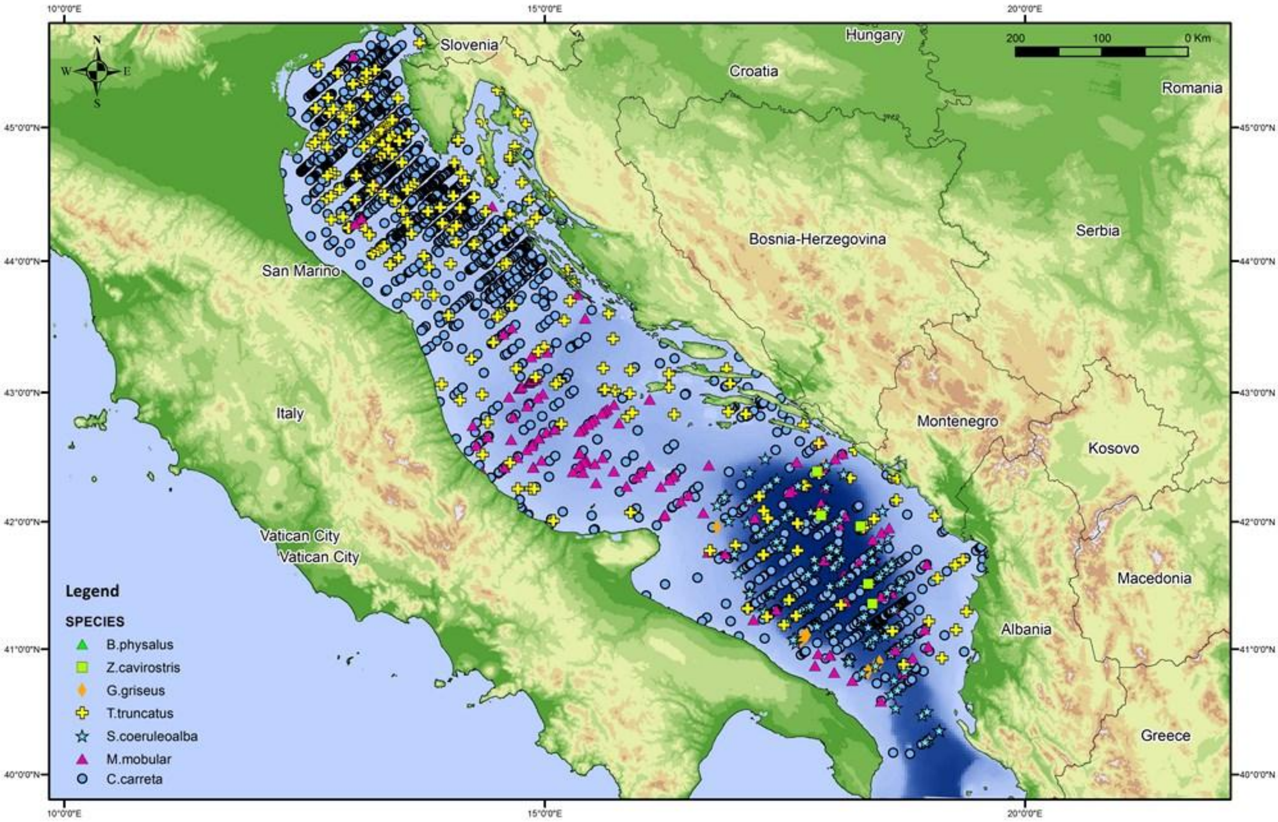
While cetaceans, sea turtles and elasmobranchs are all listed under the IUCN Red books for the countries in the region, the absence of basin wide data, prior to this survey, has meant that all of the species listed here are data-deficient. In order to build upon the preliminary data presented here there is a need to continue basin-wide monitoring of these species. Due to the clearly defined geographical nature of the region a series of aerial surveys, with coordinated boat based surveys, in different seasons could provide vital data to define the conservation status of these species.

8 Hotspots of megafauna *vs* hotspots of anthropogenic activities

Given the nature of the Adriatic Sea - a very complex area in terms of oceanography, presence of biodiversity and economic use - when identifying hotspots for biodiversity we should probably adopt the approach of defining vulnerable marine areas (VMAs; as defined by Zacharias & Gregr 2005). Such an approach requires that after the identification of valued ecological features (VEFs) - i.e. biological or physical features and processes deemed by humans to have environmental, social, cultural or economic significance (Zacharias & Gregr 2005) - VMAs are defined and prioritised through the use of predictive models.

The previous sections show examples of maps of anthropogenic pressures distribution (i.e. maritime traffic and fishery effort). The cumulative effects of human activities on the marine ecosystem must be carefully accounted for in any proposal for conservation measures, including in the designation of marine protected areas.

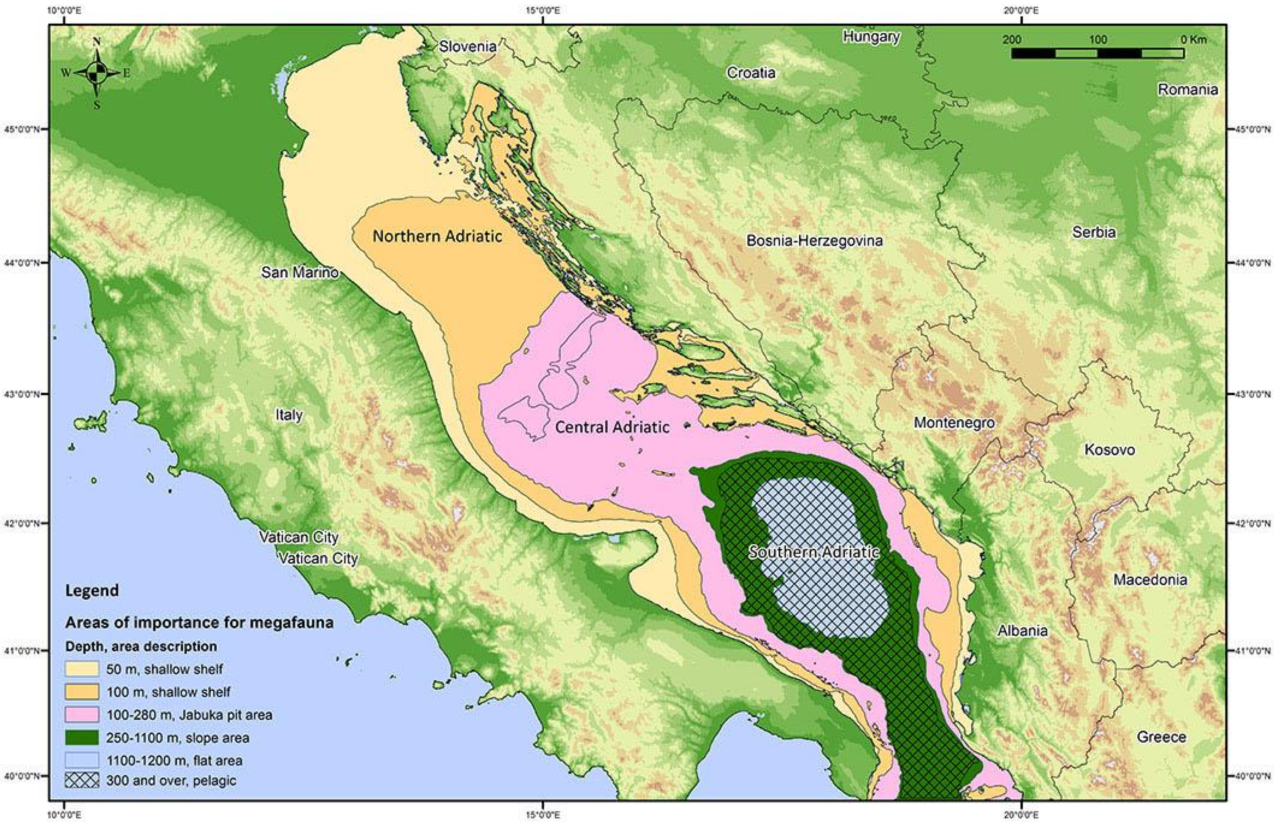
The identification of 'valued ecological features' in Figure 28 shows all sightings of a number of large marine vertebrate species recorded in the Adriatic Sea during the aerial surveys in 2010 and 2013. These species, which included cetaceans, sea turtles and giant devil rays, combined to high-intensity anthropogenic use areas could be used as priority biological features on which to base the identification of vulnerable marine areas.



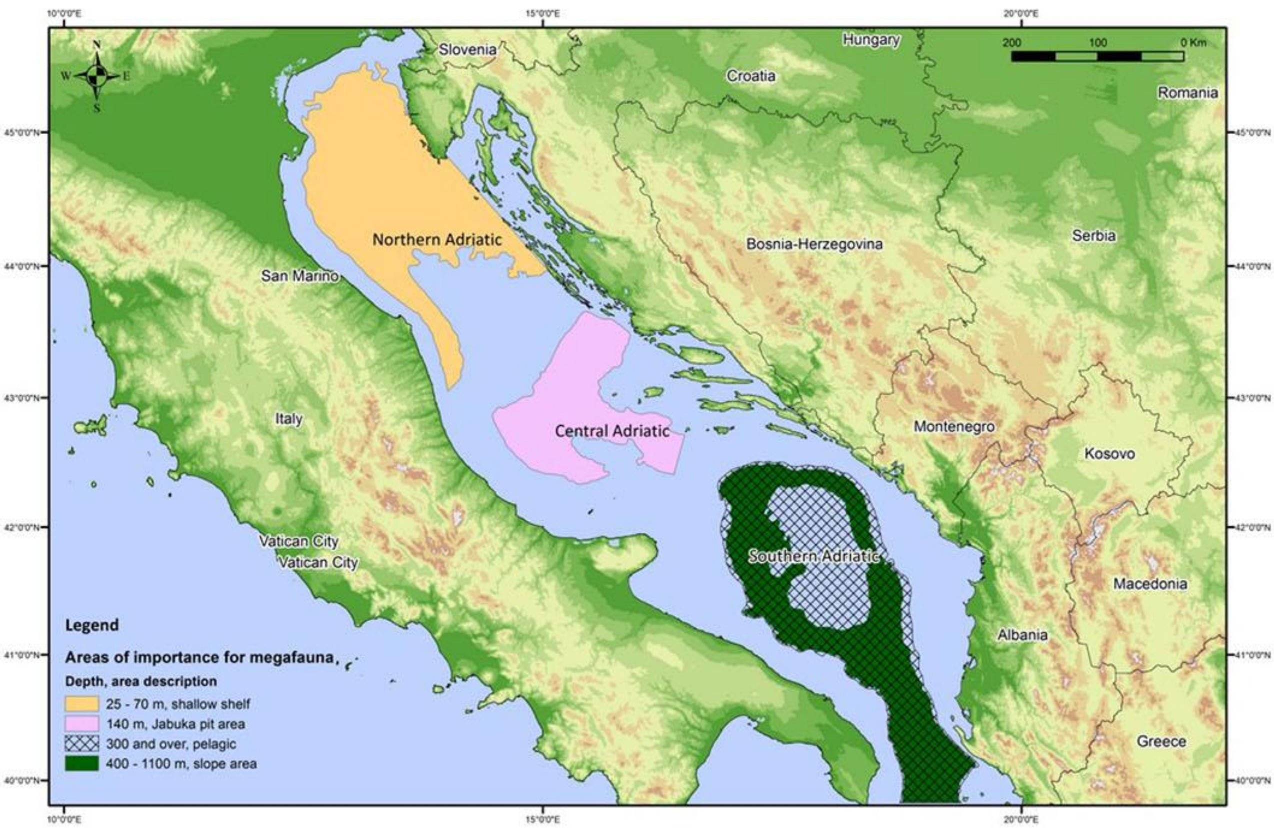
Sightings of large marine vertebrates in the Adriatic Sea during aerial surveys 2010 & 2013

Figure 28. Sightings of large marine vertebrates in the Adriatic Sea recorded during the aerial surveys in 2010 and 2013.

Figure 29 shows two descriptive options of areas of importance for megafauna in the Adriatic Sea, based on ecological aspects of some selected species (biological features). From these very preliminary maps it is clear that portions of both neritic and oceanic environments are important habitats for our selected megafauna. They also highlight that in the oceanic domain, the slope represents an important habitat for species that have less generalists lifecycles than others included in the analysis. These simple descriptive results highlight the need to carefully consider which “valued ecological features” are priority, both in terms of biodiversity and oceanographic features. Moreover, it also suggests that areas of higher intensity use should be defined and superimposed in order to highlight those areas with higher risk of negative interaction.



Areas of importance for megafauna in the Adriatic Sea



Areas of importance for megafauna in the Adriatic Sea

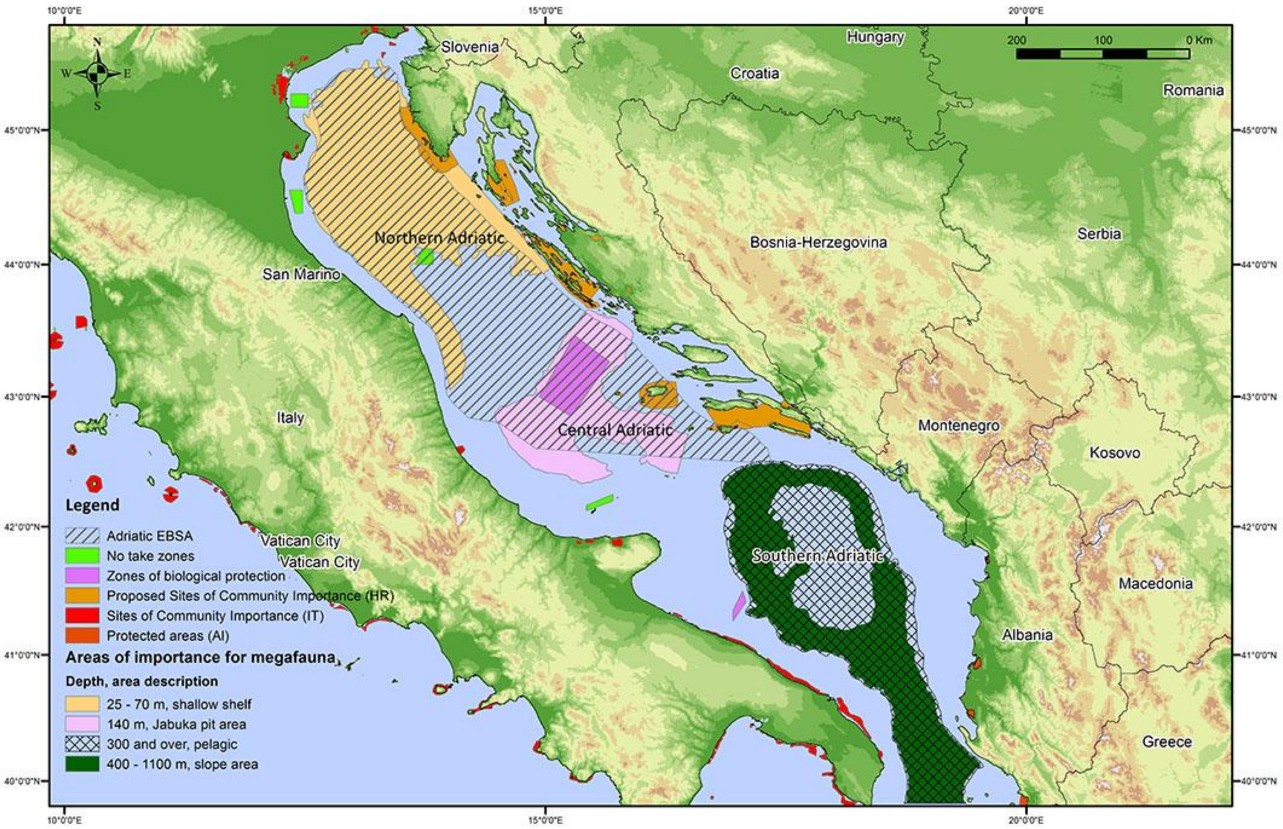
Figure 29a and b. Areas of importance for megafauna in the Adriatic Sea: descriptive options based on ecological aspects of the selected species.

Hence, based on the existing knowledge of the region, including aspects related to anthropogenic pressures (e.g. bycatch, human disturbance, habitat loss/degradation, alien invasive species, overexploitation, pollution), and oceanographic characteristics, a predictive model should be applied to identify 'vulnerable marine areas' that need stricter protection and/or management, considering the following parameters:
a) areas with encounter densities higher than a given % (80% could be an option) of “pelagic species”, “continental shelf species” and “slope species”;
b) areas with annual traffic intensity higher than a given % (80% could be an option);
c) areas with annual effort of bottom fishing activities higher than a given % (80% could be an option);
d) areas with annual effort of set-nets fishing activities higher than a given % (80% could be an option);
e) areas with annual effort of pelagic longlines fishing activities higher than a given % (80% could be an option).

Reference points for species density and activities intensity and the right combination of species to be considered, should be object of a thorough scientific and technical discussion. Identifying vulnerable marine areas will ultimately help define areas that need specific protection and/or management of human uses.

9 Protected areas and other management actions for important habitats' protection

The Adriatic has been recognised as an important habitat for many protected species. While there is no Adriatic agreement on protection of biodiversity in the basin there are multiple initiatives, such as the Adriatic-Ionian (established in May 2000) as a platform for cross-border/international between Albania, Croatia, Greece, Italy, Montenegro, and Slovenia. Within the European Union strategy, the Adriatic Sea is a sub-region of the MSFD (Council Directive 2008/56/EC) underlining its importance as a region for conservation and management of sea use. Finally, the majority of the northern Adriatic is recognised as an Ecologically or Biologically Significant Area (EBSA) under the Convention for Biological Diversity (Rio, 1992), also recognised by the Convention for the Protection of the Marine Environmental and Coastal Region of the Mediterranean (Barcelona, 1976, 1995). This region was identified based on expert opinions for areas important for marine turtles, nursery areas for elasmobranchs, suitable areas for small pelagics, and deep-sea coral reefs (Notarbartolo di Sciara 2010).



Areas of importance for megafauna in the Adriatic Sea

Figure 30 Areas of importance for megafauna in the Adriatic Sea, protected areas and identified EBSA

All of the species listed in this report are migratory to an extent that they move between borders of the adjacent states. As such the Convention on Migratory Species (Bonn, 1979) should play a strong role in the region. The CMS fulfils its obligations in two manners, under appendix I, species identified as being in danger of extinction are protected directly by imposition of strict conservation objectives on party States. However, the primary role of CMS is to foster regional agreements convened under the convention for species that have an unfavourable conservation status or would benefit from international cooperation, under appendix II. In the case of the Mediterranean Sea the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) (Monaco, 1996) is the primary agreement for the conservation of migratory cetaceans.

There are over 30 MPAs registered in the region, the majority being located on the Italian coast, however there are increasing numbers of initiatives being promoted (Mackelworth *et al.* 2013b). On the eastern coast, with the inclusion of Croatia into the EU, there has been a push to designate sites under the Natura 2000 network of the Habitats Directive (Council Directive 92/43/EEC), many of these areas have the potential to be important habitats for the species listed in this report. In those regions still outside the EU, the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979) provides the option for the creation of the Emerald Network. The results of this study indicate areas that are potentially important to the large marine vertebrates in the Adriatic Sea. The northern and central Adriatic areas coincide in some instances to the previously identified regions of the northern Adriatic Sea EBSA. The southern region has not been, as yet, identified as a region of importance for conservation. The maps provided here are descriptive outputs of the results of the two aerial surveys; as such they do not provide full information on the conservation potential of the region. The absence of the analysis of the anthropogenic pressures of the region require that these areas should only be regarded as the starting point for the identification of appropriate conservation measures for the species identified in the region. The definition of spatial or temporal protective measures should be an iterative and adaptive process involving all of the authorities and stakeholders of the region.

10 References

ACCOBAMS SC. (2012) Statement of concern about atypical mass strandings of beaked whales in the Ionian Sea.

Affronte, M., Stanzani, L. A. & Stanzani, G. (2003) First record of humpback whale, *Megaptera novaeangliae* (Barowski, 1781) in the Adriatic Sea. *Annales Series Historia Naturalis* **13**: 51-54.

Aguilar, A. (2000) Population biology, conservation threats and status of Mediterranean striped dolphins (*Stenella coeruleoalba*). *Journal of Cetacean Research and Management* **2**: 17-26.

Aguilar, A. & Gaspari, S. (2012) *Stenella coeruleoalba* (Mediterranean subpopulation). URL http://www.iucnredlist.org/.

Airoldi, S., Bendinoni, F., Azzellino, A., Fadda, V. & Profice, A. (2005) Abundance estimates of Risso's dolphins (*Grampus griseus*) in the Western Ligurian Sea through photographic mark-recapture. *European Research on Cetaceans* **19**: 109.

Akyol, O., Erdem, M., Unal, V. & Ceyhan, T. (2005) Investigations on drift-net fishery for swordfish (*Xiphias gladius* L.) in the Aegean Sea. *Turkish Journal of Veterinary and Animal Sciences* **29**: 1225-1231.

Arbelo, M., De Quiros, Y. B., Sierra, E., Méndez, M., Godinho, A., Ramírez, G., Caballero, M. J. & Fernández, A. (2008) Atypical beaked whale mass stranding in Almeria's coasts: pathological study. *Bioacoustics* **17**(1-3): 294-297.

Artegiani, A., Bregant, D., Paschini, E., Pinardi, N., Raicich, F. & Russo, A. (1997) The Adriatic Sea general circulation. Part I: Air-sea interactions and water mass structure. *Journal of Physical Oceanography* **27**(8): 1492-1514.

Azzellino, A., Gaspari, S., Airoldi, S. & Nani, B. (2008) Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western Ligurian Sea. *Deep-Sea Research Part I-Oceanographic Research Papers* **55**(3): 296-323.

Bauchot, M. L. (1987) Requins, raies et autres batoidés. In: *Fiches FAO d'identification des éspèces pour les besoins de la pêche*, eds. W. Fischer, M. L. Bauchot & D. C. Schneider, pp. 768–885. Rome: FAO.

Baulch, S. & Perry, C. (2014) Evaluating the impacts of marine debris on cetaceans. *Marine Pollution Bulletin*: 1-12.

Bearzi, B. (2003) *Delphinus delphis* (Mediterranean subpopulation). URL http://www.iucnredlist.org/.

Bearzi, G. (1989) Contributo alle conoscenze sulla biologia di *Tursiops truncatus* (Montagu, 1821) nel mare Adriatico settentrionale. In: p. 172. Padova: University of Padova.

Bearzi, G. (2000) First report of a common dolphin (*Delphinus delphis*) death following penetration of a biopsy dart. *Journal of Cetacean Research and Management* **2**(3): 217-221.

Bearzi, G., Azzellino, A., Politi, E., Costa, M. & Bastianini, M. (2008a) Influence of seasonal forcing on habitat use by bottlenose dolphins *Tursiops truncatus* in the northern Adriatic Sea. *Ocean Science Journal* **43**(4): 175-182.

Bearzi, G., Costa, M., Politi, E., Agazzi, S., Pierantonio, N., Tonini, D. & Bastianini, M. (2009) Cetacean records and encounter rates in the northern Adriatic Sea during the years 1988-2007. *Annales, Series Historia Naturalis* **19**(2): 145-150.

Bearzi, G. & Fortuna, C. M. (2012) *Tursiops truncatus* (Mediterranean subpopulation). URL http://www.iucnredlist.org/.

Bearzi, G., Fortuna, C. M. & Reeves, R. R. (2008b) Ecology and conservation of common bottlenose dolphins *Tursiops truncatus* in the Mediterranean Sea. *Mammal Review* **39**: 92-123.

Bearzi, G., Holcer, D. & Di Sciara, G. N. (2004) The role of historical dolphin takes and habitat degradation in shaping the present status of northern Adriatic cetaceans. *Aquatic Conservation-Marine and Freshwater Ecosystems* **14**(4): 363-379.

Bearzi, G. & Notarbartolo di Sciara, G. (1995) A comparison of the present occurrence of bottlenose dolphins, *Tursiops truncatus*, and common dolphins, *Delphinus delphis*, in the Kvarneric (northern Adriatic Sea). *Annales Series Historia Naturalis* **7**: 61-68.

Bearzi, G. & Notarbartolo di Sciara, G. (1997) Bottlenose dolphins following bottom trawlers in the Kvarnerić (northern Adriatic Sea). *European Research on Cetaceans* **11**: 202-204.

Bearzi, G., Notarbartolo di Sciara, G. & Fortuna, C. M. (1998) Unusual sighting of a striped dolphin (*Stenella coeruleoalba*) in the Kvarneric, Northern Adriatic Sea. *Natura Croatica* **7**(3): 169-278.

Bearzi, G., Notarbartolo di Sciara, G. & Politi, E. (1997) Social ecology of bottlenose dolphins in the Kvarnerić (northern Adriatic Sea). *Marine Mammal Science* **13**(4): 650-668.

Bearzi, G., Pierantonio, N., Affronte, M., Holcer, D., Maio, N. & Notarbartolo Di Sciara, G. (2011a) Overview of sperm whale *Physeter macrocephalus* mortality events in the Adriatic Sea, 1555–2009. *Mammal Review* **41**: 276-293.

Bearzi, G., Politi, E., Agazzi, S. & Azzellino, A. (2006) Prey depletion caused by overfishing and the decline of marine megafauna in eastern Ionian Sea coastal waters (central Mediterranean). *Biological Conservation* **127**(4): 373-382.

Bearzi, G., Politi, E. & di Sciara, G. N. (1999) Diurnal behavior of free-ranging bottlenose dolphins in the Kvarnerić (northern Adriatic Sea). *Marine Mammal Science* **15**(4): 1065-1097.

Bearzi, G., Politi, E., Fortuna, C. M., Mel, L. & Notarbartolo di Sciara, G. (2000) An overview of cetacean sighting data from the northern Adriatic Sea: 1987–1999. *European Research on Cetaceans* **14**: 356-361.

Bearzi, G., Reeves, R. R., Notarbartolo-Di-Sciara, G., Politi, E., Canadas, A. N. A., Frantzis, A. & Mussi, B. (2003) Ecology, status and conservation of short-beaked common dolphins *Delphinus delphis* in the Mediterranean Sea. *Mammal Review* **33**(3-4): 224-252.

Bearzi, G., Reeves, R. R., Remonato, E., Pierantonio, N. & Airoldi, S. (2011b) Risso's dolphin *Grampus griseus* in the Mediterranean Sea. *Mammalian Biology - Zeitschrift für Säugetierkunde* **76**(4): 385-400.

Becker, E. A., Pavlović, A., Nemet, S. & Mackelworth, C. P. (2013) Legal issues concerning the Cres-Lošinj marine habitat and protected area legislation in Croatia. *Environs Environmental Law And Policy Journal UC Davis* **37**(1): 1-25.

Bello, G. (1999) The Chondrichthyans of the Adriatic Sea. *Acta Adriatica* **40**(1): 65-76.

Bello, G., Lipej, L. & Dulčić, J. (2012) Comments on a finding of *Mobula mobular* (Mobulidae) in the Adriatic Sea. *Cybium* **36**(4): 575-577.

Benović, A., Fonda-Umani, S., Malej, A. & Specchi, M. (1984) Net-zooplankton biomass of the Adriatic Sea. *Marine Biology* **79**: 209-218.

Bilandžić, N., Sedak, M., Đokić, M., Đuras Gomerčić, M., Gomerčić, T., Zadravec, M., Benić, M. & Prevendar

Crnić, A. (2012) Toxic element concentrations in the bottlenose (*Tursiops truncatus*), striped (*Stenella coeruleoalba*) and Risso's (*Grampus griseus*) dolphins stranded in Eastern Adriatic Sea. *Bulletin of Environmental Contamination and Toxicology* **89**(3): 467-473.

Blanco, C., Raduan, M. A. & Raga, J. A. (2006) Diet of Risso's dolphin (*Grampus griseus*) in the western Mediterranean Sea. *Scientia Marina* **70**(3): 407-411.

Blanco, C. & Raga, J. A. (2000) Cephalopod prey of two *Ziphius cavirostris* (Cetacea) stranded on the western Mediterranean coast. *Journal of the Marine Biological Association of the United Kingdom* **80**(2): 381-382.

Boisseau, O., Lacey, C., Lewis, T., Moscrop, A., Danbolt, M. & Mclanaghan, R. (2010) Encounter rates of cetaceans in the Mediterranean Sea and contiguous Atlantic area. *Journal of the Marine Biological Association of the United Kingdom* **90**(8): 1589-1599.

Bradai, M. N. & Capape, C. (2001) Capture du diable de mer *Mobula mobular* dans le Golfe de Gabes. *Cybium* **25**: 389-391.

Broderick, A. C., Coyne, M. S., Fuller, W. J., Glen, F. & Godley, B. J. (2007) Fidelity and over-wintering of sea turtles. *Proceedings of the Royal Society B-Biological Sciences* **274**(1617): 1533-1538.

Broderick, A. C., Glen, F., Godley, B. J. & Hays, G. C. (2002) Estimating the number of green and loggerhead turtles nesting annually in the Mediterranean. *Oryx* **36**(3): 227-235.

Brusina, S. (1889) Sisavci Jadranskog mora. *Rad JAZU* **95**: 79-177.

Burgess, E., Dimech, M., Caruana, R., Darmanin, M., Raine, H., Harrison, A. & Schembri, P. (2010) Non-target bycatch in the Maltese blue fin tuna (*Thunnus thynnus*) longline fishery (Central Mediterranean). *Col. Vol. Sci. Pap. ICCAT* **65**(6): 2262-2269.

Camiñas, J. A. & de Málaga, C. O. (2004) Sea turtles of the Mediterranean Sea: population dynamics, sources of mortality and relative importance of fisheries impacts. *FAO fisheries report* (738): 27-84.

Cañadas, A. (2011) Estimate of abundance of beaked whales in the Alboran Sea. In: *63. meeting of the Scientific Committee of International Whaling Commission*, p. 16. Tromsø, Norway: International Whaling Commission.

Cañadas, A. (2012) *Ziphius cavirostris* (Mediterranean subpopulation). URL http://www.iucnredlist.org/details/full/16381144/0.

Cañadas, A., Fortuna, C., Pulcini, M., Lauriano, G., Bearzi, B., Cotte, C., Raga, J. A., Panigada, S., Politi, E., Rendell, L., B-Nagy, A., Pastor, X., Frantzis, A. & Mussi, B. (2011) Accobams collaborative effort to map high-use areas by beaked whales in the Mediterranean. In: *63 Scientific Committee Meeting of the International Whaling Commission*, Tromso, Norway: International Whaling Commission.

Canadas, A. & Hammond, P. S. (2008) Abundance and habitat preferences of the short-beaked common dolphin *Delphinus delphis* in the southwestern Mediterranean: implications for conservation. *Endangered Species Research* **4**: 309-331.

Canadas, A., Sagarminaga, R., De Stephanis, R., Urquiola, E. & Hammond, P. S. (2005) Habitat preference modelling as a conservation took proposals for marine protected areas for cetaceans in southern Spanish waters. *Aquatic Conservation-Marine and Freshwater Ecosystems* **15**(5): 495-521.

Canese, S., Cardinali, A., Fortuna, C. M., Giusti, M., Lauriano, G., Salvati, E. & Greco, S. (2006) The first identified winter feeding ground of fin whales (*Balaenoptera physalus*) in the Mediterranean Sea. *Journal of the Marine Biological Association of the United Kingdom* **86**(4): 903-907.

Canese, S., Cardinali, A., Romeo, T., Giusti, M., Salvati, E., Angiolillo, M. & Greco, E. (2011) Diving behaviour of giant devil ray in the Mediterranean Sea. *Endangered Species Research* **14**: 171-176.

Capapé, C., Bouchereau, J. L. & Tomasini, J. A. (1990) Présence du diable de mer *Mobula mobular* (Bonnaterre, 1788) (Pisces, Rajiformes, Mobulidae) dans le golfe d'Aigues-Mortes : anatomie de la ceinture pelvienne et des ptérygopodes. *Mesogee* **50**: 9-14.

Capapé, C., Guelorget, O., Vergne, Y., Marques, A. & Quignard, J. P. (2006) Skates and rays (Chondrichtes) from waters off the Languedocian coast (southern France, northern Mediterranean): a historical survey and present status. *Annales Series Historia Naturalis* **16**(2): 165-178.

Caputo, V. & Giovannotti, M. (2009) Haplotype characterization of a stranded *Balaenoptera physalus* (Linnaeus, 1758) from Ancona (Adriatic Sea, Central Italy). *Hystrix-Italian Journal of Mammalogy* **20**(1): 83-85.

Carlini, R., M, P. & Wurtz, M. (1992) Cephalopods from the stomach of a Cuvier's beaked whale, *Ziphius cavirostris*, (Cuvier, 1823) stranded at Fiumicino, Central Tyrrhenian Sea. In: *European Research on Cetaceans*, ed. P. G. H. Evans, pp. 190–191. San Remo, Italy: European Cetacean Society.

Carreras, C., Pascual, M., Cardona, L., Aguilar, A., Margaritoulis, D., Rees, A., Turkozan, O., Levy, Y., Gasith, A., Aureggi, M. & Khalil, M. (2007) The genetic structure of the loggerhead sea turtle (*Caretta caretta*) in the Mediterranean as revealed by nuclear and mitochondrial DNA and its conservation implications. *Conservation Genetics* **8**(4): 761-775.

Casale, M. & Giovanardi, O. (2001) Alimentazione opportunistica di *Tursiops truncatus* presso le reti a strascico: osservazioni in un'area del Nord Adriatico. In: *5° Conv. Naz. Cetacei e Tartarughe marine*, Monte Argentario.

Casale, P. (2008) Incidental catch of marine turtles in the Mediterranean Sea: captures, mortality, priorities. *WWF Italy, Rome*: 64.

Casale, P. (2011) Sea turtle by-catch in the Mediterranean. *Fish and Fisheries* **12**(3): 299-316.

Casale, P., Abbate, G., Freggi, D., Conte, N., Oliverio, M. & Argano, R. (2008) Foraging ecology of loggerhead sea turtles *Caretta caretta* in the central Mediterranean Sea: evidence for a relaxed life history model. *Marine Ecology-Progress Series* **372**: 265-276.

Casale, P., Affronte, M., Insacco, G., Freggi, D., Vallini, C., d'Astore, P. P., Basso, R., Paolillo, G., Abbate, G. & Argano, R. (2010) Sea turtle strandings reveal high anthropogenic mortality in Italian waters. *Aquatic Conservation-Marine and Freshwater Ecosystems* **20**(6): 611-620.

Casale, P., Freggi, D., Basso, R. & Argano, R. (2005) Oceanic habitats for loggerhead turtles in the Mediterranean sea. *Marine Turtle Newsletter* **107**: 10-11.

Casale, P., Freggi, D., Basso, R., Vallini, C. & Argano, R. (2007a) A model of area fidelity, nomadism, and distribution patterns of loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea. *Marine Biology* **152**(5): 1039-1049.

Casale, P., Laurent, L. & De Metrio, G. (2004) Incidental capture of marine turtles by the Italian trawl fishery in the north Adriatic Sea. *Biological Conservation* **119**(3): 287-295.

Casale, P. & Margaritoulis, D. (2010) *Sea turtles in the Mediterranean: distribution, threats and conservation priorities*. Gland, Switzerland: IUCN/SSC Marine turtle specialist group.

Casale, P., Mazaris, A. D., Freggi, D., Basso, R. & Argano, R. (2007b) Survival probabilities of loggerhead sea turtles (*Caretta caretta*) estimated from capture-mark-recapture data in the Mediterranean Sea.

Scientia Marina **71**(2): 365-372.

Casale, P., Mazaris, A. D., Freggi, D., Vallini, C. & Argano, R. (2009) Growth rates and age at adult size of loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea, estimated through capture-mark-recapture records. *Scientia Marina* **73**(3): 589-595.

Casale, P., Nicolosi, P., Freggi, D., Turchetto, M. & Argano, R. (2003) Leatherback turtles (*Dermochelys coriacea*) in Italy and in the Mediterranean basin. *Herpetological Journal* **13**(3): 135-139.

Celona, A. (2004) Caught and observed giant devil rays *Mobula mobular* (Bonnaterre, 1788) in the Strait of Messina. *Annales, Series Historia Naturalis* **14**(1): 11-18.

Centro Studi Cetacei. (1987) Cetacei spiaggiati lungo le coste Italiane, I. Rendiconto 1986. *Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano* **128**(3-4): 305-313.

Centro Studi Cetacei. (1995) Cetacei spiaggiati lungo le coste Italiane. VII. Rendiconto 1992. (Mammalia). *Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano* **134**(2): 285-298.

Coll, M., Santojanni, A., Palomera, I., Tudela, S. & Arneri, E. (2007) An ecological model of the Northern and Central Adriatic Sea: Analysis of ecosystem structure and fishing impacts. *Journal of Marine Systems* **67**(1-2): 119-154.

Corsolini, S., Aurigi, S. & Focardi, S. (2000) Presence of polychlorobiphenyls (PCBs) and coplanar congeners in the tissues of the Mediterranean loggerhead turtle *Caretta caretta*. *Marine Pollution Bulletin* **40**(11): 952-960.

Corsolini, S., Focardi, S., Kannan, K., Tanabe, S., Borrell, A. & Tatsukawa, R. (1995) Congener profile and toxicity assessment of polychlorinated biphenyls in dolphins, sharks and tuna collected from Italian coastal waters. *Marine Environmental Research* **40**(1): 33-53.

Couturier, L. I. E., Bennett, M. B. & Richardson, A. J. (2013) Mystery of giant rays off the Gaza strip solved. *Oryx* **47**(04): 480-480.

Couturier, L. I. E., Marshall, A. D., Jaine, F. R. A., Kashiwagi, T., Pierce, S. J., Townsend, K. A., Weeks, S. J., Bennett, M. B. & Richardson, A. J. (2012) Biology, ecology and conservation of the Mobulidae. *Journal of Fish Biology* **80**(5): 1075-1119.

Cushman-Rosin, B., Gačić, M., Poulani, P., Artegiani, A. & (Eds). (2001) *Physical oceanography of the Adriatic Sea. Past, present and future*. Dordrecht: Kluwer Academic Publishers.

D'Amico, A., Bergamasco, A., Zanasca, P., Carniel, S., Nacini, E., Portunato, N., Teloni, V., Mori, C. & Barbanti, R. (2003) Qualitative correlation of marine mammals with physical and biological parameters in the Ligurian Sea. *Ieee Journal of Oceanic Engineering* **28**(1): 29-43.

Daan, R. & Mulder, M. (1996) On the short-term and long-term impact of drilling activities in the Dutch sector of the North Sea. *ICES Journal of Marine Science: Journal du Conseil* **53**(6): 1036-1044.

Dalebout, M. L., Robertson, K. M., Frantzis, A., Engelhaupt, D. A. N., Mignucci-Giannoni, A. A., Rosario-Delestre, R. J. & Baker, C. S. (2005) Worldwide structure of mtDNA diversity among Cuvier's beaked whales (*Ziphius cavirostris*): implications for threatened populations. *Molecular Ecology* **14**(11): 3353-3371.

Demetropoulos, A. (2000) Impact of tourism development on marine turtle nesting: strategies and actions to minimise impact. In: *Convention on the Conservation of European Wildlife and Natural Habitats, Strasbourg*.

Derraik, J. G. B. (2002) The pollution of the marine environment by plastic debris: a review. *Marine Pollution Bulletin* **44**: 842-852.

Di Natale, A. (1998a) By-catch of shark species in surface gear used by the Italian fleet for large pelagic species. *Col. Vol. Sci. Pap. ICCAT* **48**(3): 138-140.

Di Natale, A. (1998b) Observations on by-catch from a tuna trap fishery off the Algarve (southern Portugal). *Col. Vol. Sci. Pap. ICCAT* **48**(3): 138-140.

Di Natale, A., Mangano, A., Maurizi, A., Montaldo, L., Navarra, E., Pinca, S., Schimmenti, G., Torchia, G. & Valastro, M. (1995) A review of driftnet catches by the Italian fleet: species composition, observers data and distribution along the net. *Col. Vol. Sci. Pap. ICCAT* **44**(1): 226-235.

Drouot, V., Berube, M., Gannier, A., Goold, J. C., Reid, R. J. & Palsboll, P. J. (2004) A note on genetic isolation of Mediterranean sperm whales (*Physeter macrocephalus*) suggested by mitochondrial DNA. *Journal of Cetacean Research and Management* **6**(1): 29-32.

Duguy, R., Besson, J., Casinos, A., Di Natale, A., Filella, S., Raduàn, A., Raga, J. A. & Viale, D. (1983) L'impact des activités humaines sur les cétacés de la Méditerranée occidentale. *Rapports de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée* **28**: 219-222.

Faber, G. L. (1883) *The fisheries of the Adriatic and the fish thereof. A report of the Austro-Hungarian sea-fisheries, with detailed description of the Adriatic gulf.* London: Bernard Quaritch.

Fonda-Umani, S. (1996) Pelagic production and biomass in the Adriatic Sea. *Scientia Marina* **60**(Supl 2): 65-77.

Fortuna, C., Bearzi, G. & Delfino, G. (1996) Surfacing patterns of bottlenose dolphins following bottom trawlers in the Kvarnerić (Northern Adriatic Sea). *European Research on Cetaceans* **10**: 244.

Fortuna, C. M. (2006) Ecology and conservation of bottlenose dolphins (*Tursiops truncatus)* in the North-Eastern Adriatic sea. In: p. 275. St. Andrews, UK: University of St. Andrews.

Fortuna, C. M. (2009) Report for Italy under Council Regulation (EC) 812/2004 - Year 2008. In: *Rapporto tecnico preparato per il Ministero delle politiche agricole, alimentari e forestali*, p. 9. ISPRA.

Fortuna, C. M., Acquarone, M., Annunziatellis, A., Arcangeli, A., Azzelino, A., Baccetti, N., Bellingeri, M., Bonizzoni, S., Borsani, F. J., Caliani, I., Canese, S., Canneri, R., Cerioli, N., De Lucia, A., Dimatteo, S., Fanizza, C., Filidei Jr, E., Fossi, C., Garibaldi, F., Gaspari, S., Giovanardi, O., Giusti, M., Gnone, G., Guidetti, P., Holcer, D., Lauriano, G., Marsili, L., Mazzola, A., Mo, G., Moulins, A., Mussi, B., Notarbartolo di Sciara, G., Orsi Relini, L., Pace, D. S., Panigada, S., Pavan, G., Podestà, M., Pulcini, M., Raicevich, S., Randi, E., Romeo, T., Rosso, M., Sala, A., Tepsich, P., Zimmer, W. & Zizzo, N. (2013) MSFD Supporting document on the Initial Assessment on Cetaceans, including methodology, data used and results. In: p. 62. Rome: ISPRA.

Fortuna, C. M., Canese, S., Giusti, M., Revelli, E., Consoli, P., Florio, G., Greco, S., Romeo, T., Andaloro, F., Fossi, M. C. & Lauriano, G. (2007) An insight into the status of the striped dolphins, *Stenella coeruleoalba*, of the southern Tyrrhenian Sea. *Journal of the Marine Biological Association of the United Kingdom* **87**(5): 1321-1326.

Fortuna, C. M. & Filidei Jr, E. (2010) Annual Report on the implementation of Council Regulation (EC) 812/2004 – 2009. In: *Rapporto tecnico preparato per il Ministero delle politiche agricole, alimentari e forestali*, p. 13. ISPRA.

Fortuna, C. M. & Filidei Jr, E. (2011) Annual Report on the implementation of Council Regulation (EC)

812/2004 – 2010. In: *Rapporto tecnico preparato per il Ministero delle politiche agricole, alimentari e forestali*, p. 10. ISPRA.

Fortuna, C. M. & Filidei Jr, E. (2012) Annual Report on the implementation of Council Regulation (EC) 812/2004 – 2011. In: *Rapporto tecnico preparato per il Ministero delle politiche agricole, alimentari e forestali*: ISPRA.

Fortuna, C. M. & Filidei Jr, E. (2013) Annual Report on the implementation of Council Regulation (EC) 812/2004 – 2012. In: *Rapporto tecnico preparato per il Ministero delle politiche agricole, alimentari e forestali*: ISPRA.

Fortuna, C. M., Holcer, D., Filidei, E. j. & Tunesi, L. (2011a) Relazione finale del progetto "Valutazione dell'impatto della mortalita causata da attivita di pesca su Cetacei e tartarughe marine in Adriatico: primo survey per la stima dell'abbondanza". In: *Prot. MIPAAF DG PEMAC n. 1690 del 10/02/2010 e al Prot. MATTM DPN n. 27623 del 23/12/2009*, p. 75. Rome: ISPRA.

Fortuna, C. M., Holcer, D., Filidei Jr, E., Donovan, G. P. & Tunesi, L. (2011b) The first cetacean aerial survey in the Adriatic sea: summer 2010. In: *7th Meeting of the ACCOBAMS Scientific committee*, p. 16.

Fortuna, C. M., Kell, L. T., Holcer, D., Canese, S., Filidei Jr, E., Mackelworth, C. P. & Donovan, G. P. (in press) Summer distribution and abundance of the giant devil ray (*Mobula mobular*) in the Adriatic Sea: baseline data for an iterative management framework. *Scientia Marina*.

Fortuna, C. M., Vallini, C., De Carlo, F., Filidei, E. j., Lucchetti, A., Gaspari, S., Fossi, M. C., Maltese, S., Marsili, L., Bottaro, M., Ruffino, M., Scacco, U., Giovanardi, O., Mazzola, A., Sala, A. & Tunesi, L. (2010a) Relazione finale del progetto "Valutazione delle catture accidentali di specie protette nel traino pelagico (BYCATCH III)". In: p. 84.

Fortuna, C. M., Vallini, C., Filidei Jr, E., Ruffino, M., Consalvo, I., di Muccio, S., Gion, C., Scacco, U., Tarulli, E., Giovanardi, O. & Mazzola, A. (2010b) By-catch of cetaceans and other species of conservation concern during pair trawl fishing operations in the Adriatic Sea (Italy). *Chemistry and Ecology* **26**(SUPPL. 1): 65-76.

Fortuna, C. M., Wilson, B., Wiemann, A., Riva, L., Gaspari, S., Matesic, M., Oehen, S. & Pribanic, S. (2000) How many dolphins are we studying and is our study area big enough? In: *European Research on Cetaceans 14*, eds. P. G. H. Evans, R. Pitt-Aiken & E. Rogen, pp. 370-373. Cork, Ireland.

Francese, M., Picciulin, M., Tempesta, M., Zuppa, F., Merson, E., Intini, A., Mazzatenta, A. & Genov, T. (2007) Occurrence of Striped dolphins (*Stenella coeruleoalba*) in the Gulf of Trieste. *Annales, Series Historia Naturalis* **17**: 185-190.

Francese, M., Zucca, P., Picciulin, M., Zuppa, F. & Spoto, M. (1999) Cetaceans living in the North Adriatic Sea (Gulf of Trieste–Grado lagoon): intervention protocol for healthy and distressed animals. *European Research on Cetaceans* **13**: 410-415.

Frantzis, A. (1998) Does acoustic testing strand whales? *Nature* **392**: 29.

Frantzis, A., Alexiadou, P., Paximadis, G., Politi, E., Gannier, A. & Corsini-Foka, M. (2003) Current knowledge of the cetacean fauna of the Greek Seas. *Journal of Cetacean Research and Management* **5**: 219-232.

Freedman, A. H., Portier, K. M. & Sunquist, M. E. (2003) Life history analysis for black bears (*Ursus americanus*) in a changing demographic landscape. *Ecological Modelling* **167**(1): 47-64.

Galov, A., Lauc, G., Nikolić, N., Šatović, Z., Gomerčić, T., Gomerčić, M. Đ., Kocijan, I., Šeol, B. & Gomerčić, H.

(2009) Records and genetic diversity of striped dolphins (*Stenella coeruleoalba*) from the Croatian coast of the Adriatic Sea. *Marine Biodiversity Records* **2**: e98.

Gannier, A. (2011) Using existing data and focused surveys to highlight Cuvier's beaked whales favourable areas: A case study in the central Tyrrhenian Sea. *Marine Pollution Bulletin* **63**(1): 10-17.

Gannier, A. & Epinat, J. (2008) Cuvier's beaked whale distribution in the Mediterranean Sea: Results from small boat surveys 1996-2007. *Journal of the Marine Biological Association of the United Kingdom* **88**(6): 1245-1251.

Gaspari, S. (2004) Social and population structure of striped and Risso's dolphins in the Mediterranean Sea. In: *School of Biological and Biomedical Sciences*, p. 170. Durham: University of Durham.

Gaspari, S., Airoldi, S. & Hoelzel, A. R. (2007) Risso's dolphins (*Grampus griseus*) in UK waters are differentiated from a population in the Mediterranean Sea and genetically less diverse. *Conservation Genetics* **8**(3): 727-732.

Gaspari, S., Holcer, D., Mackelworth, P., Fortuna, C., Frantzis, A., Genov, T., Vighi, M., Natali, C., Rako, N., Banchi, E., Chelazzi, G. & Ciofi, C. (2013) Population genetic structure of common bottlenose dolphins (*Tursiops truncatus*) in the Adriatic Sea and contiguous regions: implications for international conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*: n/a-n/a.

Gaspari, S. & Natoli, A. (2012) *Grampus griseus* (Mediterranean subpopulation).

Gates, A. R. & Jones, D. O. (2012) Recovery of benthic megafauna from anthropogenic disturbance at a hydrocarbon drilling well (380 m depth in the Norwegian Sea). *PLoS ONE* **7**(10): e44114.

Genov, T., Bearzi, G., Bonizzoni, S. & Tempesta, M. (2012) Long-distance movement of a lone short-beaked common dolphin *Delphinus delphis* in the central Mediterranean Sea. *Marine Biodiversity Records* **5**: null-null.

Genov, T., Kotnjek, P., Lesjak, J. & Hace, A. (2008) Bottlenose dolphins (*Tursiops truncatus*) in Slovenian and adjacent waters (Northern Adriatic sea). *Annales, Series Historia Naturalis* **18**(2): 227-244.

Genov, T., Kotnjek, P. & Lipej, L. (2009a) New record of the humpback whale (*Megaptera novaeangliae*) in the Adriatic Sea. *Annales, Series Historia Naturalis* **19**(1): 25-30.

Genov, T., Wiemann, A. & Fortuna, C. M. (2009b) Towards identification of the bottlenose dolphin (*Tursiops truncatus*) population structure in the north-eastern Adriatic sea: preliminary results. *Varstvo narave* **22**: 73-80.

Giglioli, E. H. (1880) *Elenco dei Mamiferi: degli Uccelli e dei Rettili ittiofagi appartenento alla fauna italica e catalogo degli anfibi e dei Pesci italiani*. Firenze: Stamperia Reale.

Giovagnoli, L. (2013) Adriatic Shipping Company marine mammal sightings in the Adriatic Sea 1988-2000. URL http://seamap.env.duke.edu/dataset/865.

Golani, D. & Levy, Y. (2005) New records and rare occurrences of fish species from the Mediterranean coast of Israel. *Zoology in the Middle East* **36**: 27–32.

Gomerčić, H., Đuras Gomerčić, M., Gomerčić, T., Lucić, H., Dalebout, M., Galov, A., Škrtić, D., Ćurković, S., Vuković, S. & Huber, Đ. (2006a) Biological aspects of Cuvier's beaked whale (*Ziphius cavirostris*) recorded in the Croatian part of the Adriatic Sea. *European Journal of Wildlife Research* **52**(3): 182-187.

Gomerčić, H., Đuras Gomerčić, M., Gomerčić, T., Lucić, H., Škrtić, D., Ćurković, S., Vuković, S., Huber, Đ., Gomerčić, V. & Bubić Špoljar, J. (2006b) Abundance and mortality of Risso's dolphins (*Grampus *griseus*) in the last 15 years in the Croatian part of the Adriatic sea. In: *9th Croatian Biological Congress*, eds. V. Bessendorfer & G. I. V. Klobučar, pp. 297-298. Rovinj: Croatian Biological Society.

Gomerčić, M. D., Galov, A., Gomerčić, T., Škrtić, D., Ćurković, S., Lucić, H., Vuković, S., Arbanasić, H. & Gomerčić, H. (2009) Bottlenose dolphin (*Tursiops truncatus*) depredation resulting in larynx strangulation with gill-net parts. *Marine Mammal Science* **25**(2): 392-401.

Gómez de Segura, A., Crespo, E., Pedraza, S., Hammond, P. & Raga, J. (2006) Abundance of small cetaceans in waters of the central Spanish Mediterranean. *Marine Biology* **150**(1): 149-160.

Gómez de Segura, A., Hammond, P. S. & Raga, J. A. (2008) Influence of environmental factors on small cetacean distribution in the Spanish Mediterranean. *Journal of the Marine Biological Association of the United Kingdom* **88**(Special Issue 06): 1185-1192.

Gordon, J., Gillespie, D., Potter, J., Frantzis, A., Simmonds, M. P., Swift, R. & Thompson, D. (2003) A review of the effects of seismic surveys on marine mammals. *Marine Technology Society Journal* **37**(4): 16-34.

Greenwood, A. G. & Taylor, D. C. (1987) Clinical and pathological findings in dolphins in 1977. *Aquatic Mammals* **6**: 33-38.

Hanski, I. (2005) Landscape fragmentation, biodiversity loss and the societal response. *EMBO reports* **6**(5): 388-392.

Hanski, I. & Gaggiotti, O. E. (2004) Metapopulation biology: past, present, and future. In: *Ecology Genetics and Evolution of Metapopulations: Standard Methods for Inventory and Monitoring*, eds. I. Hanski & O. E. Gaggiotti, pp. 3-22. Academic Press.

Hemida, F., Mehezem, S. & Capapé, C. (2002) Captures of the giant devil ray, *Mobula mobular* Bonnaterre, 1788, (Chondrichthyes:Mobulidae) off the Algerian coast (southern Mediterranean). *Acta Adriatica* **43**(2): 69-76.

Heppell, S. S., Caswell, H. & Crowder, L. B. (2000) Life histories and elasticity patterns: perturbation analysis for species with minimal demographic data. *Ecology* **81**(3): 654-665.

Heppell, S. S., Heppell, S. A., Read, A. & Crowder, L. B. (2005) Effects of fishing on long-lived marine organisms. In: *Marine Conservation Biology*, eds. E. Norse & L. Crowder, pp. 211-231. Washington, DC: Island Press.

Herceg Romanić, S., Holcer, D., Lazar, B., Klinčić, D., Mackelworth, C. P. & Fortuna, C. M. (in review) Organochlorine contaminants in tissues of common bottlenose dolphins, *Tursiops truncatus*, from north-eastern Adriatic Sea.

Heyning, J. (1989) Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. In: *Handbook of marine mammals*, eds. S. H. Ridgway & R. J. Harrison, pp. 289-308. London: Academic Press.

Hirtz, M. (1922) Kit debeloglavac, *Globicephalus melas* (Traill) u vodama Hrvatske. *Glasnik Hrvatskog Naravoslovnog Društva* **34**: 84-89.

Hirtz, M. (1938) Rijetke vrste delfina u vodama Korčule. *Priroda* **27**(1): 25-28.

Holcer, D. (1994) Prospective of cetology in Croatia. *European Research on Cetaceans* **8**: 120-121.

Holcer, D. (2006) Kratkokljuni obični dupin (Short-beaked common dolphin), *Delphinus delphis* Linnaeus, 1758 In: *Crvena knjiga sisavaca Hrvatske (Red book of mammals of Croatia)*, ed. N. Tvrtković, p. 127. Zagreb: Ministarstvo kulture, Državni zavod za zaštitu prirode.

Holcer, D. (2012) Ecology of the common bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821) in the

Central Adriatic sea. In: *Faculty of Sciences*, p. 208 + LIV. Zagreb: University of Zagreb.

Holcer, D., Di Sciara, G. N., Fortuna, C. M., Lazar, B. & Onofri, V. (2007) Occurrence of Cuvier's beaked whales in the southern Adriatic Sea: Evidence of an important Mediterranean habitat. *Journal of the Marine Biological Association of the United Kingdom* **87**(1): 359-362.

Holcer, D. & Fortuna, C. M. (2011) The aerial survey of cetacean abundance in the areas of Kvarner/Kvarnerić and Central Adriatic: August 2010. A project report to State institute for nature protection, Zagreb. In: p. 26. Vis: Blue World Vis.

Holcer, D., Fortuna, C. M., Nimak, M., Mackelworth, C. P., Pleslić, G., Jovanović, J. & Krstinić, P. (2008a) Jadranski projekt dupin - Vis. Izvještaj o obavljenom preliminarnom istraživanju dobrih dupina (*Tursiops truncatus*) šireg područja otoka Visa tijekom 2008. godine. In: p. 27. Veli Lošinj: Plavi svijet Institut za istraživanje i zaštitu mora.

Holcer, D., Lazar, B., Mackelworth, P. & Fortuna, C. M. (2013) Rare or just unknown? The occurrence of the giant devil ray (*Mobula mobular*) in the Adriatic Sea. *Journal of Applied Ichthyology* **29**(1): 139-144.

Holcer, D., Mackelworth, P. & Fortuna, C. M. (2002) Present state of understanding of the Cetacean fauna of the Croatian Adriatic sea. *European Research on Cetaceans* **16**.

Holcer, D., Nimak, M., Pleslić, G. & Jovanović, J. (2008b) Adriatic dolphin project research report: Lastovo 2008. In: p. 6. Veli Lošinj: Blue World Institute of Marine Research and Conservation.

Holcer, D., Nimak, M., Pleslić, G., Jovanović, J. & Fortuna, C. M. (2009) Survey of bottlenose dolphins (*Tursiops truncatus*) in the area of Lastovo island, Adriatic sea. In: *10th Croatian Biological Congress*, eds. V. Besendorfer, N. Kopjar, Ž. Vidaković-Cifrek, M. Tkalec, N. Bauer & Ž. Lukša, pp. 300-301. Osijek: Croatian Biological Society.

Holcer, D., Nimak Wood, M., Fortuna, C. M., Mackelworth, P., Rako, N., Dobrić, V. & Cukrov, M. (2010) Utvrđivanje brojnosti i distribucije dupina na području Viškog arhipelaga, te davanje preporuka za očuvanje i održivo korištenje utvrđenih posebno značajnih područja. In: p. 61. Veli Lošinj: Plavi svijet.

Holcer, D., Notarbartolo di Sciara, G., Fortuna, C. M., Onofri, V., Lazar, B. & Tvrtković, N. (2003) The occurrence of Cuvier’s beaked whale (*Ziphius cavirostris*) in Croatian Adriatic waters. In: *Proceeding of Abstracts of Eight Croatian Biological Congress*, eds. V. Besendorfer & N. Kopjar, pp. 255-256. Zagreb, Croatia: Croatian Biological Society.

Holcer, D., Wiemann, A., Mackelworth, P. & Fortuna, C. M. (2008c) Preliminary results on the distribution and abundance of Cetaceans in the Croatian southern Adriatic sea. In: *22nd conference of the European Cetacean Society*, Egmond aan Zee, Netherlands: European Cetacean Society.

Holdway, D. A. (2002) The acute and chronic effects of wastes associated with offshore oil and gas production on temperate and tropical marine ecological processes. *Marine Pollution Bulletin* **44**(3): 185-203.

Impetuoso, A., Wiemann, A., Antollovich, W., Holcer, D., Mackelworth, P. C. & Fortuna, C. M. (2003) A preliminary study of Cetacean presence and abundance in the archipelago of the Kornati National park (Croatia). In: *8th Croatian Biological Congress*, eds. V. Besendorfer & N. Kopjar, Zagreb, Croatia, 27.09 - 2.10.2003: Croatian Biological Society.

IOR. (2011) Baza podataka i pokazatelja stanja morskog okoliša, marikulture i ribarstva. Temperatura, salinitet i gustoća morske vode (Database and indicators of the state of marine environment, mariculture and fisheries. Temperature, salinity and sea water density). URL http://jadran.izor.hr/azo/.

IREPA. (2009) Official Fishery Data. URL http://www.irepa.org/stistan/sisdati.html.

Jardas, I. (1985) Pregled riba (sensu lato) Jadranskog mora (Cyclostomata, Selachii, Osteichthyes) s obzirom na taksnonmiju i utvrđeni broj (Overview of fish species /sensu lato/ of the Adriatic Sea based on their taxonomy and abundance). *Biosistematika* **11**(1): 45-74.

Jardas, I. (1996) *Jadranska ihtiofauna (Adriatic ichtyofauna)*. Zagreb: Školska knjiga.

Jardas, I., Pallaoro, A., Vrgoč, N., Jukić-Peladić, S. & Dadić, V. (2008) Golub uhan *Mobula mobular*. Red data book of saltwater fish of Croatia. 266-267.

Jribi, I., Bradai, M. N. & Bouain, A. (2007) Impact of trawl fishery on marine turtles in the Gulf of Gabes, Tunisia. *Herpetological Journal* **17**(2): 110-114.

Kammigan, I. C., Bräger, S., Hennig, V., Wiemann, A. & Impetuoso, A. (2008) Ecology of bottlenose dolphins (*Tursiops truncatus*) in the Kornati National Park, Croatia: Population estimation, group composition and distribution. In: *22nd Annual Conference of the European Cetacean Society*, eds. G. J. Pierce, E. Philips & R. Lick, Egmond aan Zee, The Netherlands: European Cetacean Society.

Kasparek, M., Godley, B. J. & Broderick, A. C. (2001) Nesting of the green turtle, *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs. *Zoology in the Middle East* **24**(1): 45-74.

Kolombatović, G. (1894) Godišnje izvješće C. K. velike realke u Splitu (Yearly report of the Royal High School in Split). In: p. 54. Split: A.Zannoni.

Kovačić, I., Gomerčić, M. Đ., Gomerčić, H., Lucić, H. & Gomerčić, T. (2010) Stomach contents of two Cuvier's beaked whales (*Ziphius cavirostris*) stranded in the Adriatic Sea. *Marine Biodiversity Records* **3**.

Kruse, S., Caldwell, D. & Caldwell, M. (1999) Risso's dolphin *Grampus griseus* (G. Cuvier, 1812). In: *Handbook of marine mammals*, eds. S. H. Ridgway & R. Harrison, pp. 183-212. Academic Press, San Diego.

Lamani, F., Peja, N. & Ruka, E. (1976) Balena me sqep e Kyvierit (*Ziphius cavirostris*) ne bregdetin shqiptar. *Buletini i Shkencave te Natyres* **1**: 73-78.

Laran, S., Joiris, C., Gannier, A. & Kenney, R. D. (2010) Seasonal estimates of densities and predation rates of cetaceans in the Ligurian Sea, northwestern Mediterranean Sea: an initial examination. *J Cetacean Res Manag* **11**: 31-40.

Laurent, L., Bradai, M., Hadoud, D., El Gomati, H. & Hamza, A. (1999) Marine turtle nesting activity assessment on Libyan coasts, Phase 3: Survey of the coast to the West of Misratah. *RAC/SPA and UNEP, Tunis*.

Laurent, L., Casale, P., Bradai, M. N., Godley, B. J., Gerosa, G., Broderick, A. C., Schroth, W., Schierwater, B., Levy, A. M., Freggi, D., Abd El-Mawla, E. M., Hadoud, D. A., Gomati, H. E., Domingo, M., Hadjichristophorou, M., Kornaraky, L., Demirayak, F. & Gautier, C. (1998) Molecular resolution of marine turtle stock composition in fishery bycatch: a case study in the Mediterranean. *Molecular Ecology* **7**(11): 1529-1542.

Lauriano, G., Panigada, S., Fortuna, C. M., Holcer, D., Filidei Jr, E., Pierantonio, N. & Donovan, G. P. (2011) Monitoring density and abundance of cetaceans in the seas around Italy through aerial surveys: a summary contribution to conservation and the future ACCOBAMS survey. In: *63. Meeting of the IWC Scientific committee*, p. 5.

Lazar, B. (2010) Ekologija i zaštita glavate želve *Caretta caretta* (Linnaeus 1758) u istočnom Jadranu (Ecology and conservation of loggerhead turtle *Caretta caretta* (Linnaeus 1758) in the Eastern Adriatic). In: *Biološki odsjek, PMF*, p. 239. Zagreb: Sveučilište u Zagrebu.

Lazar, B., Casale, P., Tvrtković, N., Kožul, V., Tutman, P. & Glavić, N. (2004a) The presence of the green sea turtle, *Chelonia mydas*, in the Adriatic Sea. *Herpetological Journal* **14**(3): 143-147.

Lazar, B., Gargia-Borboroglu, P., Tvrtkovic, N., Ziza, V. & Seminoff, J. (2003) Temporal and spatial distribution of the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea: a seasonal migration pathway. In: *22. Annual Symposium on Sea Turtle Biology and Conservation*, ed. J. Seminoff, pp. 283-284. Miami, USA: NOAA/NMFS.

Lazar, B., Gračan, R., Katić, J., Zavodnik, D., Jaklin, A. & Tvrtković, N. (2011a) Loggerhead sea turtles (*Caretta caretta*) as bioturbators in neritic habitats: an insight through the analysis of benthic molluscs in the diet. *Marine Ecology-an Evolutionary Perspective* **32**(1): 65-74.

Lazar, B., Holcer, D., Mackelworth, P., Klinčić, D. & Herceg Romanić, S. (2012) Organochlorine contaminant levels in tissues of a short-beaked common dolphin, *Delphinus delphis*, from northern Adriatic Sea. *Natura Croatica* **21**(2): 391-401.

Lazar, B., Lipej, L., Holcer, D., Onofri, V., Ziza, V., Tutman, P., Marcelja, E. & Tvrtkovic, N. (2008) New data on the occurrence of leatherback turtles *Dermochelys coriacea* in the Eastern Adriatic Sea. *Vie Et Milieu-Life and Environment* **58**(3-4): 237-241.

Lazar, B., Margaritoulis, D. & Tvrtkovic, N. (2004b) Tag recoveries of the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea: implications for conservation. *Journal of the Marine Biological Association of the United Kingdom* **84**(2): 475-480.

Lazar, B., Maslov, L., Romanic, S. H., Gracan, R., Krauthacker, B., Holcer, D. & Tvrtkovic, N. (2011b) Accumulation of organochlorine contaminants in loggerhead sea turtles, *Caretta caretta*, from the eastern Adriatic Sea. *Chemosphere* **82**(1): 121-129.

Lazar, B. & Tvrtković, N. (1995) Marine turtles in the eastern part of the Adriatic Sea: preliminary research. *Natura Croatica* **4**: 59-74.

Lazar, B. & Tvrtković, N. (2003a) Corroboration of the critical habitat hypothesis for the loggerhead sea turtle *Caretta caretta* in the eastern Adriatic Sea. In: *Proceedings of the first Mediterranean conference on marine turtles. Barcelona Convention–Bern Convention–Bonn Convention (CMS)*, pp. 165-169.

Lazar, B. & Tvrtković, N. (2003b) Marine turtles and fisheries in the Mediterranean: are we missing something? In: *Annual Symposium on Sea Turtle Biology and Conservation*, ed. J. Seminoff, pp. 5-6. Miami, USA: NOAA/NMFS.

Lazar, B., Žiža, V. & Tvrtković, N. (2006) Interactions of gillnet fishery with loggerhead sea turtles *Caretta caretta* in the northern Adriatic Sea. In: *26th Annual Symposium on Sea Turtle Biology and Conservation*, eds. M. Frick, A. Panagiotopoulos, A. Rees & K. Williams, p. 252. Crete, Greece: International Sea Turtle Society.

Leatherwood, S., Perrin, W. F., Kirby, V. L., Hubbs, C. L. & Dahlheim, M. (1980) Distribution and movements of Risso's dolphin, *Grampus griseus*, in the eastern North Pacific. *Fishery Bulletin* **77**(4): 951-963.

Lefkaditou, E. & Poulopoulos, Y. (1998) Cephalopod remains in the stomach-content of beaked whales, *Ziphius cavirostris* (Cuvier 1823) from the Ionian Sea. In: *Rapport du 35e Congres de la Commision Internationale pour l'Exploration Scientifique de la Mer Mediterranee*, pp. 460–461. Dubrovnik, Croatia: CIESM.

Lewison, R. L., Crowder, L. B., Read, A. J. & Freeman, S. A. (2004) Understanding impacts of fisheries bycatch on marine megafauna. *Trends in Ecology & Evolution* **19**(11): 598-604.

Lipej, L., Dulčić, J. & Kryštufek, B. (2004) On the occurrence of the fin whale (*Balaenoptera physalus*) in the northern Adriatic. *Journal of the Marine Biological Association of the United Kingdom* **84**(4): 861-862.

Mackelworth, P. & Holcer, D. (2011) The Cres-Lošinj Special Marine Reserve – governance analysis. In: *Governing Marine Protected Areas: getting the balance right – Volume 2*, eds. P. J. S. Jones, W. Qiu & E. M. De Santo, pp. 206- 222. Nairobi: Technical Report to Marine & Coastal Ecosystems Branch, UNEP.

Mackelworth, P., Holcer, D. & Fortuna, C. (2013a) Unbalanced governance: the Cres-Lošinj Special Marine Reserve, a missed conservation opportunity. *Marine Policy* **41**: 126-133.

Mackelworth, P., Holcer, D. & Lazar, B. (2013b) Using conservation as a tool to resolve conflict: Establishing the Piran–Savudrija international Marine Peace Park. *Marine Policy* **39**(0): 112-119.

MacLeod, C. D. (2005) Niche partitioning, distribution and competition in North Atlantic beaked whales. In: *School of Biological Sciences*, p. 238. Aberdeen,UK: University of Aberdeen.

MacLeod, C. D. (2006) How big is a beaked whale? A review of body length and sexual size dimorphism in the family Ziphiidae. *Journal of Cetacean Research and Management* **7**(3): 301–308.

Maffucci, F., Kooistra, W. H. C. F. & Bentiveyna, F. (2006) Natal origin of loggerhead turtles, *Caretta caretta*, in the neritic habitat off the Italian coasts, Central Mediterranean. *Biological Conservation* **127**(2): 183-189.

Mannini, P. & Massa, F. (2000) Brief overview of Adriatic fisheries landing trends (1972-97). In: *Report of the First Meeting of the AdriaMed Coordination Committee. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-01*, pp. 31-49.

Mannini, P., Massa, F. & Milone, N. (2005) Adriatic Sea fisheries: outline of some main facts. *STUDIES AND REVIEWS* **199**: 124.

Marano, G., Vaccarella, R., Bello, G. & Pastorelli, A. M. (1983) Prime osservazioni sulla pesca di *Xiphias gladius* L. (Osteichtes) nel Basso Adriatico. *Thalassia salentina* **13**: 50-59.

Margaritoulis, D. (1988) Post-nesting movements of loggerhead sea turtles tagged in Greece. *Rapp. Comm. int. Mer Médit* **31**(2): 284.

Margaritoulis, D., Argano, R., Baran, I., Bentivegna, F., Bradai, M., Camiñas, J. A., Casale, P., De Metrio, G., Demetropoulos, A. & Gerosa, G. (2003) Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives. *Loggerhead Sea Turtles (editors: AB Bolten, BE Witherington). Smithsonian Institution Press, Washington DC*.

Margaritoulis, D. & Teneketzis, K. (2001) Identification of a developmental habitat of the green turtle in Lakonikos Bay, Greece. In: *First Mediterranean conference on marine turtles*, p. 170.

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**(2): 129-180.

Matić-Skoko, S., Stagličić, N., Kraljević, M., Pallaoro, A., Tutman, P., Dragičević, B., Grgičević, R. & Dulčić, J. (2011) Croatian artisanal fisheries and the state of it's littoral resources on the doorstep of entering the EU: effectiveness of conventional management and perspectives for the future. *Acta Adriatica* **52**(1): 87-100.

Mazzariol, S., Di Guardo, G., Petrella, A., Marsili, L., Fossi, C. M., Leonzio, C., Zizzo, N., Vizzini, S., Gaspari, S., Pavan, G., Podestà, M., Garibaldi, F., Ferrante, M., Copat, C., Traversa, D., Marcer, F., Airoldi, S., Frantzis, A., De Bernaldo Quirós, Y., Cozzi, B. & Fernández, 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): e19417.

Micheli, F., Halpern, B. S., Walbridge, S., Ciriaco, S., Ferretti, F., Fraschetti, S., Lewison, R., Nykjaer, L. & Rosenberg, A. A. (2013) Cumulative human impacts on Mediterranean and Black Sea marine ecosystems: assessing current pressures and opportunities. *PLoS ONE* **8**(12): e79889.

Ministarstvo kulture RH. (2006) Rješenje o preventivnoj zaštiti dijela mora uz istočne obale otoka Cresa i Lošinja u kategoriji posebnog rezervata - rezervata u moru. In.

Mioković, D., Kovačić, D. & Pribanić, S. (1999) Stomach content analysis of one bottenose dophin (*Tursiops truncatus*, Montagu 1821) from the Adriatic Sea. *Natura Croatica* **8**: 61-65.

Moulins, A., Rosso, M., Nani, B. & Wurtz, M. (2007) Aspects of the distribution of Cuvier's beaked whale (*Ziphius cavirostris*) in relation to topographic features in the Pelagos Sanctuary (north-western Mediterranean Sea). *Journal of the Marine Biological Association of the United Kingdom* **87**(1): 177-186.

Nada, M. & Casale, P. (2008) Marine turtles in the Mediterranean Egypt: threats and conservation priorities. *WWF Italy, Rome*: 29.

Natoli, A., Birkun, A., Aguilar, A., Lopez, A. & Hoelzel, A. R. (2005) Habitat structure and the dispersal of male and female bottlenose dolphins (*Tursiops truncatus*). *Proceedings of the Royal Society B-Biological Sciences* **272**(1569): 1217-1226.

Nimak-Wood, M., Pleslić, G., Rako, N., Mackelworth, P., Holcer, D. & Fortuna, C. M. (2011) Presence of a solitary striped dolphin (*Stenella coeruleoalba*) in Mali Lošinj harbour, northern Adriatic sea, Croatia. *Vie et Milieu* **61**(2): 87-93.

Notarbartolo-Di-Sciara, G., Zanardelli, M., Jahoda, M., Panigada, S. & Airoldi, S. (2003) The fin whale *Balaenoptera physalus* (L. 1758) in the Mediterranean Sea. *Mammal Review* **33**(2): 105-150.

Notarbartolo di Sciara, G. (2005) Giant devilray or devil ray *Mobula mobular* (Bonnaterre, 1788). In: *Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. Status Survey*, eds. S. L. Fowler, R. D. Cavanagh, M. Camhi, G. H. Burgess, G. M. Cailliet, S. V. Fordham, C. A. Simpfendorfer & J. A. Musick, p. 461. Cambridge: IUCN/SSC Shark Specialist Group.

Notarbartolo di Sciara, G. (2010) Methods for the identification of EBSAs in the Adriatic Sea. In: *3rd International Workshop on Biodiversity in the Adriatic: Towards a representative network of MPAs in the Adriatic*, Piran, Slovenia.

Notarbartolo di Sciara, G. & Bearzi, G. (1992) Cetaceans in the northern Adriatic Sea: past, present, and future. *Rapport Commisione Internationale Mer Méditerranée* **33**: 303.

Notarbartolo di Sciara, G. & Bianchi, I. (1998) *Guida degli squali e delle razze del Mediterraneo*. Padova: Franco Muzzio Editore.

Notarbartolo di Sciara, G. & Birkun, A. (2010) *Conserving whales, dolphins and porpoises in the Mediterranean and Black Seas: an ACCOBAMS status report*. Monaco: ACCOBAMS.

Notarbartolo di Sciara, G., Holcer, D. & Bearzi, G. (1994) Past and present status of cetaceans in the northern and central Adriatic Sea. In: *Proceeding of Abstracts of the 5th Congress of biologists of Croatia*, ed. H. Gomerčić, pp. 401-402. Pula, Croatia: Croatian Biological Society.

Notarbartolo di Sciara, G. & Serena, F. (1988) Term embryo of *Mobula mobular* (Bonnaterre, 1788) from the Northern Tyrrhenian Sea (Chondrichthyes, Mobulidae). *Atti Soc. ital. Sci. Nat. Museo Civ. Stor. Nat. Milano* **129**(4): 396-400.

Notarbartolo di Sciara, G., Serena, F. & Mancusi, C. (2006) *Mobula mobular.* IUCN Red List of Threatened Species. Version 2011.1. URL http://www.iucnredlist.org/.

Notarbartolo di Sciara, G., Serena, F. & Mancusi, C. (2007) Giant devil ray *Mobula mobular* (Bonnaterre, 1788). In: *Overview of the Conservation Status of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea*, eds. R. D. Cavanagh & C. Gibson, p. 42. Gland, Switzerland: The World Conservation Union (IUCN).

Notarbartolo Di Sciara, G. N., Venturino, M. C., Zanardelli, M., Bearzi, G., Borsani, F. J. & Cavalloni, B. (1993) Cetaceans in the Central Mediterranean Sea - distribution and sighting frequencies. *Bollettino di zoologia* **60**(1): 131-138.

Palsboll, P. J., Berube, M., Aguilar, A., Notarbartolo-Di-Sciara, G. & Nielsen, R. (2004) Discerning between recurrent gene flow and recent divergence under a finite-site mutation model applied to North Atlantic and Mediterranean Sea fin whale (*Balaenoptera physalus*) populations. *Evolution* **58**(3): 670-675.

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.

Panigada, S. & Notarbartolo di Sciara, G. (2012) *Balaenoptera physalus* (Mediterranean subpopulation). URL http://www.iucnredlist.org/.

Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A. & Weinrich, M. T. (2006) Mediterranean fin whales at risk from fatal ship strikes. *Marine Pollution Bulletin* **52**(10): 1287-1298.

Pilleri, G. & Gihr, M. (1977) Some records of cetaceans in the Northern Adriatic Sea. *Investigations on Cetacea* **8**: 85-88.

Pino d'Astore, P., Bearzi, B. & Bonizzoni, S. (2008) Cetacean strandings in the province of Brindisi (Italy, southern Adriatic sea). *Annales, Series Historia Naturalis* **18**(1): 29-38.

Pleslić, G., Rako-Gospić, N., Mackelworth, C. P., Wiemann, A., Holcer, D. & Fortuna, C. M. (2014) How many bottlenose dolphins (*Tursiops truncatus*) inhabit the former Cres-Lošinj Special Marine Reserve, Croatia? *European Research on Cetaceans* **28**.

Pleslić, G., Rako, N., Mackelworth, C. P., Wiemann, A., Holcer, D. & Fortuna, C. M. (2013) The abundance of common bottlenose dolphins (*Tursiops truncatus*) in the former marine protected area of the Cres-Lošinj archipelago, Croatia. *Aquatic Conservation: Marine and Freshwater Ecosystems*.

Podestà, M., D'amico, A., Pavan, G., Drougas, A., Komnenou, A. & Portunato, N. (2006) A review of Cuvier's beaked whale strandings in the Mediterranean Sea. *Journal of Cetacean Research and Management* **7**(3): 251-261.

Podestà, M. & Meotti, C. (1991) The stomach contents of a Cuvier's beaked whale *Ziphius cavirostris*, and a Risso's dolphin *Grampus griseus*, stranded in Italy. In: *Fifth Annual Conference of the European Cetacean Society*, ed. P. G. H. Evans, pp. 58–61. Sandefjord, Norway: European Cetacean Society.

Policy Research Corporation. (2011) The potential of maritime spatial planning in the Mediterranean Sea; case study report: the Adriatic Sea. In: p. 59. Antwerp.

Praca, E. & Gannier, A. (2008) Ecological niches of three teuthophageous odontocetes in the northwestern Mediterranean Sea. *Ocean Science* **4**(1): 49-59.

Pribanić, S., Holcer, D. & Mioković, D. (1999) First report of plastic ingestion by striped dolphin (*Stenella coeruleoalba*) in the Croatian part of the Adriatic Sea. *European Research on Cetaceans* **13**: 443–446.

Prihoda, J. (2005) Group characteristics of bottlenose dolphins (*Tursiops truncatus*) in the Kvarnerić (northern Adriatic Sea) in the presence of trawling vessels. In: *Department of Ecology*, p. 63. University of Szeged.

Rakaj, N. (1995) *Ichthyofauna in Albania*. Tirana: University of Tirana.

Rako, N., Holcer, D. & Fortuna, C. M. (2009) Long-term inshore observation of a solitary striped dolphin, *Stenella coeruleoalba,* in the Vinodol Channel, northern Adriatic Sea (Croatia). *Natura Croatica* **18**(2): 427-436.

Rees, A. F., Saad, A. & Jony, M. (2008) Discovery of a regionally important green turtle *Chelonia mydas* rookery in Syria. *Oryx* **42**(3): 456-459.

Regner, S. (1996) Effects of environmental changes on early stages and reproduction of anchovy in the Adriatic Sea. *Scientia Marina* **60**(Supl. 2): 167-177.

Revelles, M., Caminas, J. A., Cardona, L., Parga, M., Tomas, J., Aguilar, A., Alegre, F., Raga, A., Bertolero, A. & Oliver, G. (2008) Tagging reveals limited exchange of immature loggerhead sea turtles (*Caretta caretta*) between regions in the western Mediterranean. *Scientia Marina* **72**(3): 511-518.

Revelli, E., Pusser, T., Bocconcelli, A., Ballardini, M., Sturlese, A. & Johnson, M. P. (2008) Photoidentification catalog of Cuvier's beaked whale (*Ziphius cavirostris*) in the Ligurian Sea. URL http://hdl.handle.net/1912/2165.

Rosso, A., Moulins, A., Ballardini, M., Gelsomino, F. & Wurtz, M. (2007) Preliminary estimation of the population size of Cuvier's beaked whale (*Ziphius cavirostris*) in the northern Ligurian sea. *Rapp. Comm. int. Mer Médit* **38**: 582.

Rosso, M., Ballardini, M., Moulins, A. & Würtz, M. (2011) Natural markings of Cuvier's beaked whale *Ziphius cavirostris* in the Mediterranean Sea. *African Journal of Marine Science* **33**(1): 45-57.

Russo, A. & Artegiani, A. (1996) Adriatic Sea hydrography. *Scientia Marina* **60**(2): 33-43.

Scacco, U., Consalvo, I. & Mostarda, E. (2009) First documented catch of the giant devil ray *Mobula mobular* (Chondrichthyes: Mobulidae) in the Adriatic Sea. *Marine Biodiversity Records* **2**: 1-4.

Schembri, T., Ferguson, I. K. & Schembri, P. (2003) Revision of the records of shark and ray species from the Maltese islands (Chordata: Chondrichthyes). *Central Mediterranean naturalist* **4**(1): 71-104.

Schroth, W., Streit, B. & Schierwater, B. (1996) Evolutionary handicap for turtles. *Nature* **384**: 521-522.

Sella, I. (1995) Sea turtles in the Eastern Mediterranean and northern Red Sea In: *Biology and Conservation of Sea Turtles*, ed. K. A. Bjorndal, pp. 417-423. Washington D.C.: Smithsonian Institution Press.

Serena, F. (2005) *Field identification guide to the sharks and rays of the Mediterranean and Black Sea*. Rome: FAO.

Skrivanić, A. & Zavodnik, D. (1973) Migrations of the sardine (*Sardina pilchardus*) in relation to hydrographical conditions of the Adriatic sea. *Netherlands Journal of Sea Research* **7**: 7-18.

Sprčić, A. (2011) Prehrana dobrog dupina (*Tursiops truncatus*, Montagu 1821) u sjeveroistočnom Jadranu. In: *Prirodoslovno-matematički fakultet, Biološki odsjek*, p. 53. Zagreb: Sveučilište u Zagrebu.

Stanzani, L. & Piermarocchi, C. (1992) Cattura di alcuni individui di *Pseudorca crassidens* (Owen, 1846) in Adriatico. *Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano* **133**: 85-95.

Stewart, S. E. (2004) Diet analysis of bottlenose dolphin population (*Tursiops truncatus*, Montagu, 1821) in proposed Cres-Losinj Marine Protected Area (MPA), Croatia. In: p. 74. University College of London.

Storai, T., Zinzula, L., Repetto, S., Zuffa, M., Morgan, A. & Mandelman, J. (2011) Bycatch of large elasmobranchs in the traditional tuna traps (tonnare) of Sardinia from 1990 to 2009. *Fisheries Research* **109**: 74-79.

Storelli, M. M., Zizzo, N. & Marcotrigiano, G. O. (1999) Heavy metals and methylmercury in tissues of Risso's dolphin (*Grampus griseus*) and Cuvier's beaked whale (*Ziphius cavirostris*) stranded in Italy (South Adriatic Sea). *Bulletin of Environmental Contamination and Toxicology* **63**(6): 703-710.

Stossich, M. (1880) Prospetto della Fauna del mare Adriatico. *Boll. Soc. Adr. Sci. Nat. Trieste* **5**: 18-71.

Šoljan, T. (1948) *Ribe Jadrana (The fishes of the Adriatic)*. Zagreb: Nakladni zavod Hrvatske.

Triossi, F., Willis, T. J. & Pace, D. S. (2013) Occurrence of bottlenose dolphins *Tursiops truncatus* in natural gas fields of the northwestern Adriatic Sea. *Marine Ecology* **34**(3): 373-379.

Trois, E. (1894) Elenco dei cetacei dell'Adriatico. *Atti Regio Istituto Veneto di Scienze Lettere e Arti* **7**(5): 1315-1320.

UNEP. (2011) Sub-regional report on the "Identification of important ecosystem properties and assessment of ecological status and pressures to the Mediterranean marine and coastal biodiversity in the Adriatic Sea. In: *10th Meeting of Focal Points for SPAs* ed. U. D. M. WG.359/Inf.10, p. 63. Marseille, France: UNEP.

Valle, A. (1900) Sulla comparsa di un *Grampus griseus* nelle acque istriane. *Bollettino Società Adriatica Scienze* (20): 81-87.

Vidas, D. (2005) The Adriatic Sea as a particularly sensitive sea area: from initiative to implementation. In: *Pre-Accession Maritime Strategy of the Republic of Croatia (CD-publication)*, p. 11. Zagreb: Croatian Ministry of the Sea.

Weinrich, M., Panigada, S. & Guinet, C. (2005) Report of the joint ACCOBAMS/Pelagos workshop on large whale ship strikes in the Mediterranean Sea. In: p. 35. Monaco: ACCOBAMS

Wurtz, M., Poggi, R. & Clarke, M. R. (1992) Cephalopods from the stomachs of a Risso's dolphin (*Grampus griseus*) from the Mediterranean. *Journal of the Marine Biological Association of the United Kingdom* **72**(4): 861-867.

Zucca, P., Di Guardo, G., Francese, M., Scaravelli, D., Genov, T. & Mazzatenta, A. (2005) Causes of stranding in four Risso's dolphins (*Grampus griseus*) found beached along the North Adriatic sea coast. *Veterinary Research Communications* **29**: 261-264.

-