Current state of knowledge of Cetacean species in the Adriatic Sea

Draško Holcer (1,2), Caterina M. Fortuna (3), Peter C. Mackelworth (2)

1. Croatian Natural History Museum, Zagreb, Croatia
2. Blue World Institute of Marine Research and Conservation, Veli Lošinj, Croatia
3. Italian National institute for Environmental Protection and Research, Rome

Corresponding author: Drasko.Holcer@hpm.hr

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Summary
Eleven Cetacean species are present with regular populations in the Mediterranean Sea and contiguous area (Notarbartolo di Sciara and 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 and 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 (Hirtz, 1938; 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.

1.1 The common bottlenose dolphin (*Tursiops truncatus*)

1.1.1 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 of Cetacean abundance and distribution in the Adriatic Sea (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 and 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), 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 change 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.

In 2010 (as part of Italian by-catch monitoring scheme, with support from SINP, Croatia) and 2013 (as part of the EU IPA Adriatic NETCET project) aerial surveys were carried out by ISPRA and Blue World Institute, to provide snapshots of the summer distribution and abundance of common bottlenose dolphins in the entire Adriatic Sea (Map in Annex I). 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 and 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 1), with a higher prevalence for areas with depths <100m.

Table 1. Minimum abundance estimates of common bottlenose dolphins in the Adriatic Sea from the aerial survey 2010 (Fortuna et al., 2011b).

Stratum	Sample size	Model	Group density per km^2 (CV)	Animal density per km^2 (CV)	Uncorrected estimate (CV; 95% CIs)	Estimated mean group size (CV)
All Adriatic (survey transect spacing: 20 km; area: about 133,400 km^2)	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.

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).

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 1 (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 2.

Table 2. 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

1.1.1.1 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, possibly followed by habitat degradation and overfishing of prey species (Bearzi et al., 2004; Bearzi et al., 2008b; Bearzi and 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.

1.1.2 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 and 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 and 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)).

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.

1.1.1 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 European 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 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, hake 11%, Sparidae 16%, Gobidae 7,7%, Octopoda 10,3% and Teuthoidea 7.7%. Interestingly, no remains of small pelagic fish were 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 and Giovanardi, 2001; Stewart, 2004; Prihoda, 2005; Fortuna, 2006) and mid-water trawlers (Fortuna et al., 2010; 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 Lošinj area (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.

1.1.2 Conservation status

The Mediterranean subpopulation of the common bottlenose dolphin is listed as "Vulnerable" under IUCN (World Conservation Union) criterion A2dce (Bearzi and 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 Adriatic 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 3.

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 3. 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	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 and Holcer, 2011; Becker et al., 2013; Mackelworth et al., 2013).

1.2 The striped dolphin (*Stenella coeruleoalba*)

1.2.1 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 (Map in Annex I). 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).

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).

Data on the abundance of this species in the Adriatic Sea is summarised in Table 4. Please note that this is to be considered as minimum estimate (uncorrected for availability and perception bias).

Table 4. 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)

1.2.2 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).

1.2.3 Conservation status

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

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

1.3.1 Distribution and abundance

Cuvier's beaked whale 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).
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 Rhodes 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 and Epinat, 2008; Notarbartolo di Sciara and 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 and 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 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 and Meotti, 1991; Carlini et al., 1992; Lefkaditou and Poulopoulos, 1998; Blanco and 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)

1.3.1.1 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 (Map in Annex I). 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. 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).

Records 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.
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. In total, five sightings of Cuvier´s beaked whales were made in aerial surveys 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.

1.3.2 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).

1.3.3 Conservation status

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

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

1.4.1 Distribution and abundance

Risso's dolphins 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).

The Risso's dolphin is present in the entire Mediterranean Sea and is considered a regular inhabitant, although abundance is unknown (Notarbartolo di Sciara and 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 and 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).

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 and 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).

1.4.1.1 Adriatic Sea

Risso's dolphins have been recorded on numerous occasions in the Adriatic Sea. 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. 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., 2010; Holcer et al., 2010; Holcer and 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 (Map in Annex I). 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).

1.4.2 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.

1.4.3 Conservation status

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

1.5 The fin whale (*Balaenoptera physalus*)

1.5.1 Distribution and abundance

Fin whales 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)).

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.

1.5.2 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 and Giovannotti, 2009).

1.5.3 Conservation status

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

1.6 Other non-regular species

1.6.1 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 and 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 and 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 and Gihr, 1977). During the following years researchers followed the disappearance of the species throughout the northern Adriatic (Bearzi, 1989; Notarbartolo di Sciara and Bearzi, 1992; Bearzi and 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).

1.6.2 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 and 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)

1.6.3 Visitor species

1.6.3.1 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).

1.6.3.2 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 and Piermarocchi, 1992).

1.6.3.3 The humpback whale (*Megaptera novaeangliae*)

Occurrences of humpback whales are rare in the Mediterranean (Notarbartolo di Sciara and 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.

Recommendation for further activities

Taking into consideration presented overview of the status of knowledge of the Adriatic Cetacean species it is recommended to

- Stimulate additional research (genetics, photoidentification, stable isotopes, etc) of the Cetacean species present (particularly in the south) in the Adriatic to identify their population structure and “unit to conserve”;
- Continue with preparation and development of the joint photoidentification catalogue of the common bottlenose dolphins in the Adriatic Sea;
- Continue with regular basin-wide monitoring of species distribution and abundance;
- Identify and monitor impact of fisheries through bycatch monitoring;
- Dedicate special effort in research of the status of Ziphius cavirostris in the south Adriatic, as current data indicate importance of the area, particularly due to the proven presence of calves;
- Identify and monitor the impact of planned and present activities of oil and gas industry; particularly due to extensive increase in planned hydrocarbons extraction;
- Further strengthen regional cooperation in data/sample sharing and in research/monitoring.

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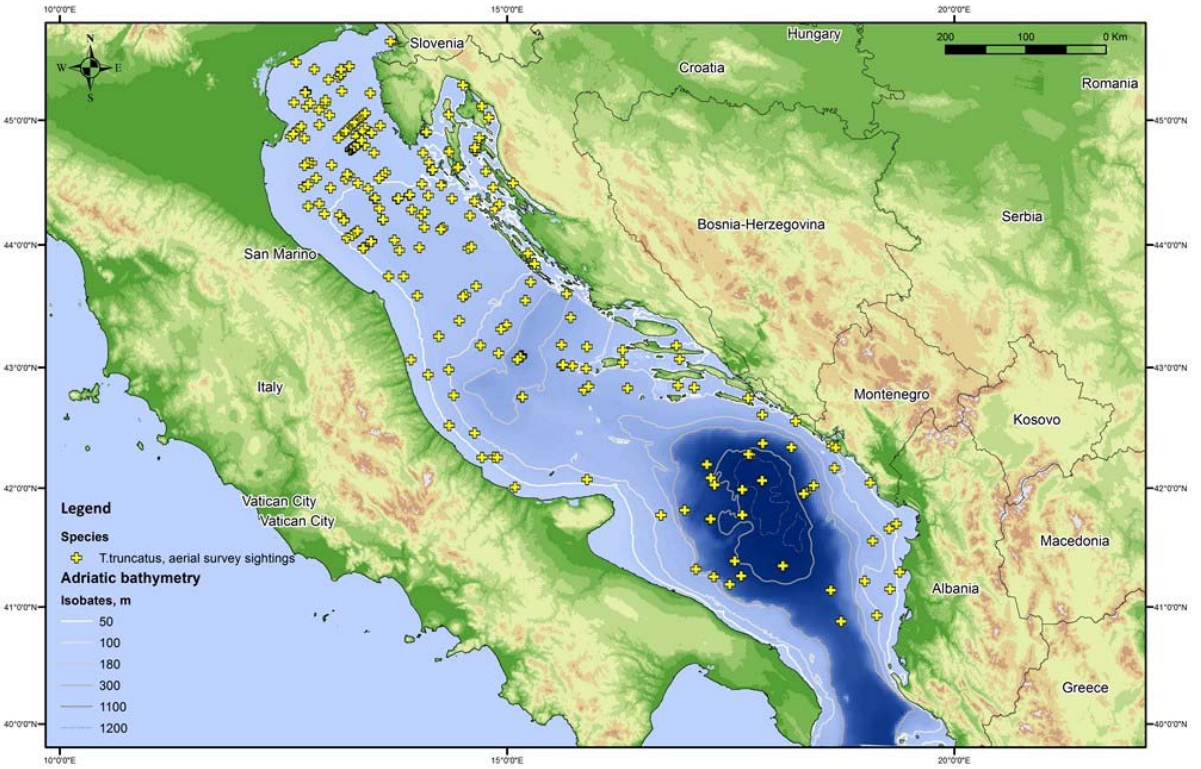
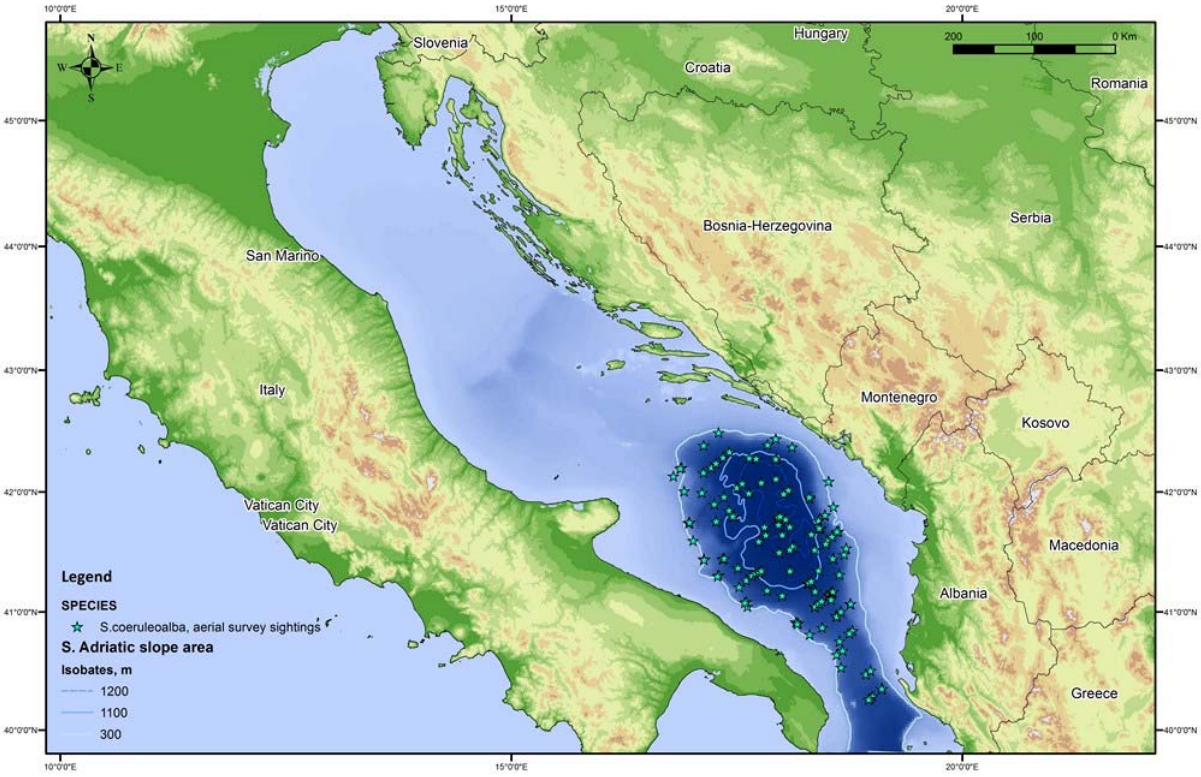
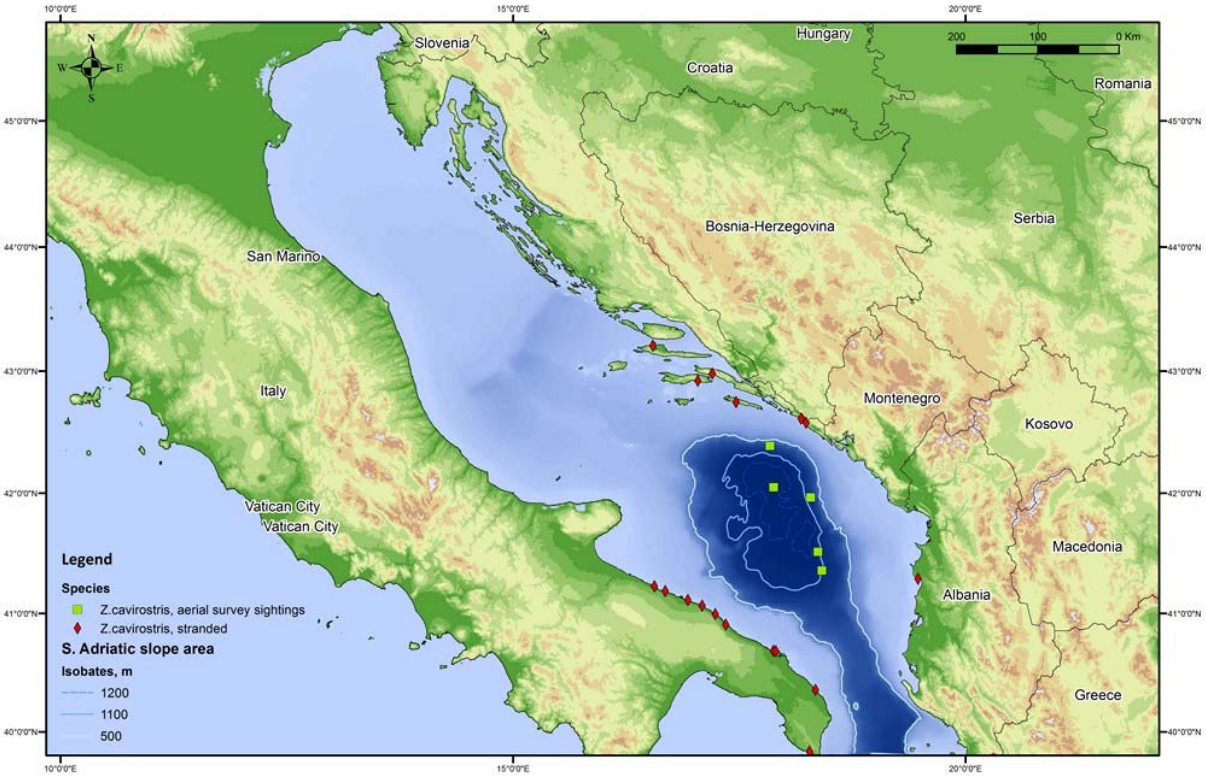
Annex I – Cetacean species distribution and sightings maps in the Adriatic Sea



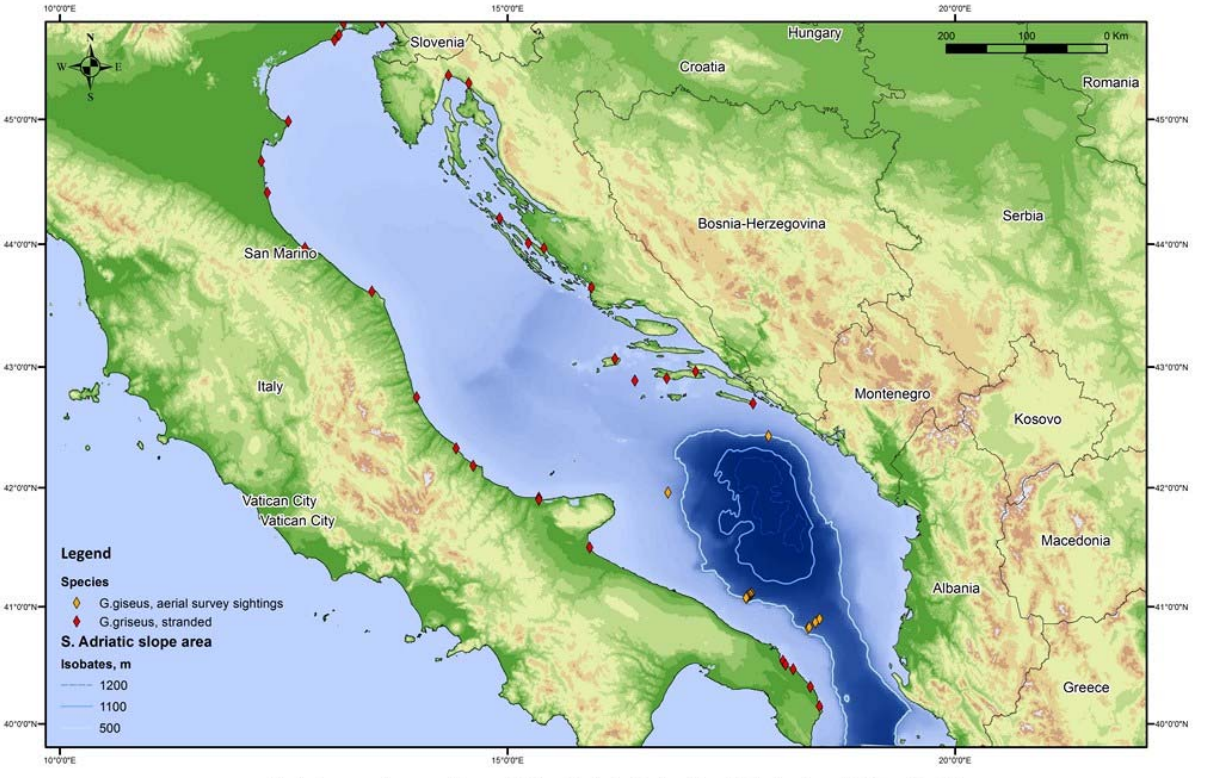
Sightings of common bottlenose dolphin the Adriatic Sea (2010 & 2013)



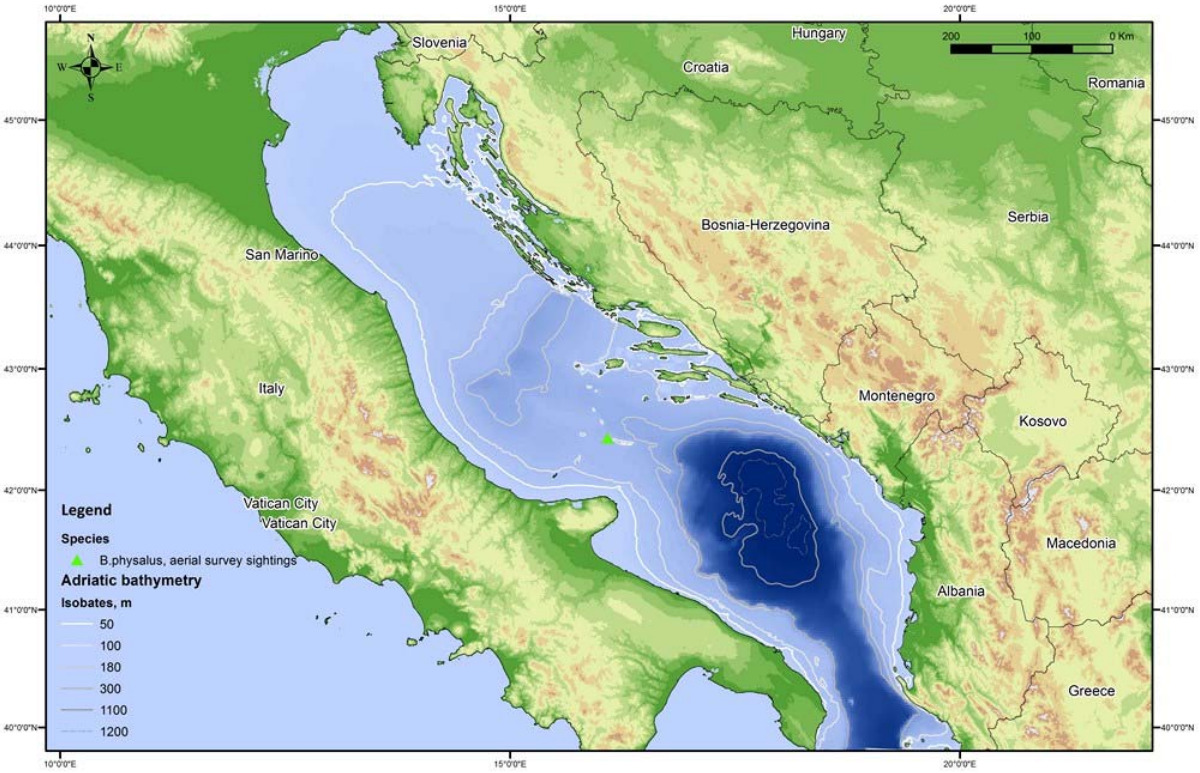
Sightings of striped dolphin in the Adriatic Sea (2010 & 2013)



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



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



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