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FIRST CETACEAN AERIAL SURVEY IN THE ADRIATIC SEA: SUMMER 2010[1]

[1] Only preliminary analyses have been carried out for the first report to the Italian Ministry of Environment. Part of this document is based on that report. None of these results presented here can be cited without the written permission of the Authors.

FIRST CETACEAN AERIAL SURVEY IN THE ADRIATIC SEA: SUMMER 2010

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INTRODUCTION

The first aerial cetacean survey in the Adriatic Sea was carried out within the framework of research activities due to fulfil the Italian obligations to Regulation (EC) n. 812/2004 and to the ACCOBAMS ratification laws.
The Italian Institute for Environmental Protection and Research (ISPRA), in cooperation with the Blue World Institute of Marine Research and Conservation (Croatia) conducted the first Adriatic aerial survey in order to provide the first basin-wide information on abundance and distribution of cetaceans - particularly the common bottlenose dolphins (*Tursiops truncatus*) - and protected species in the Adriatic sea. This information will constitute a fundamental step for assessing their status and implementing activities to improve their protection and management at the basin level.

MATERIAL & METHODS

Target species

The main target species of this survey was the bottlenose dolphin (*Tursiops truncatus*), followed by all other cetacean species and sea turtles. Data on elasmobranches, particularly the giant devilray (*Mobula mobular*) were also collected.

Survey design

Based on the oceanographic characteristics of the Adriatic Sea and the existing knowledge on the presence, distribution and relative density of the target species – the bottlenose dolphin – the survey was organised to cover two main strata (1 & 2) and two sub-strata (A & B). See Fig. 1.
Stratum 1 (northern Adriatic) was covered with a series of parallel transects 10 km-spaced, whereas in the Stratum 2 (central and south Adriatic), transects were 20 km-spaced. In addition, the Velebit channel – a very narrow coastal channel of the north-eastern side of the Adriatic – was covered by zigzag transects, providing very high coverage and the easiest path for the plane. Finally, the sub-strata B - Central Adriatic islands - was surveyed through a number of parallel transects 10 km-spaced.
For bottlenose dolphins, low density was expected to be the norm (Azzali *et al*. 1994, Manoukian *et al*. 2001, Bearzi *et al*. 1997, 2004, 2005, 2009a,b; Fortuna 2006; Fortuna *et al*. 2000, 2010; Genov *et al*. 2008; Holcer *et al*. 2008, 2009; Impetuoso *et al*. 2003a,b; Triossi & Tizzi 2003) apart from in Stratum 1 and substrata A and B where higher densities were expected. Stratum 2 covered the most pelagic ecosystem, in which cetacean densities were unknown (but also considered low) and potential sightings included groups of striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), fin whale (*Balaenoptera physalus*), Risso's dolphin (*Grampus griseus*), Cuvier's beaked whale (*Ziphius cavirostris*) and sperm whale (*Physeter macrocephalus*) (Azzali *et al*. 1994; Bearzi et al. 2011; Fortuna et al. 2010; Holcer *et al*. 2007; Lipej et al. 2004; Manoukian *et al*. 2001; Pilleri & Gihr 1977; Pilleri & Pilleri 1982).

Platform, training

A Partenavia-P68 equipped with bubble windows was used as the observation platform (Fig. 2), flying at altitude 650 feet and speed around 90-100 knots depending on prevailing conditions. Training (by

GD who was present from 29 July – 7 August) of the observers and the survey took place between the 29 July and 16 August 2010. The survey itself lasted 17 days. DH, CF and EF acted as observers.

Data collection

Data collection followed standard aerial survey procedures for Distance Sampling-based surveys with respect to sighting and effort data. The primary parameters of interest were: species, school size, perpendicular distance (calculated from the declination angle measured with a hand held inclinometer), time on primary effort, environmental variables (sea state, cloud cover, glare, subjective categorisation of sightings conditions etc).

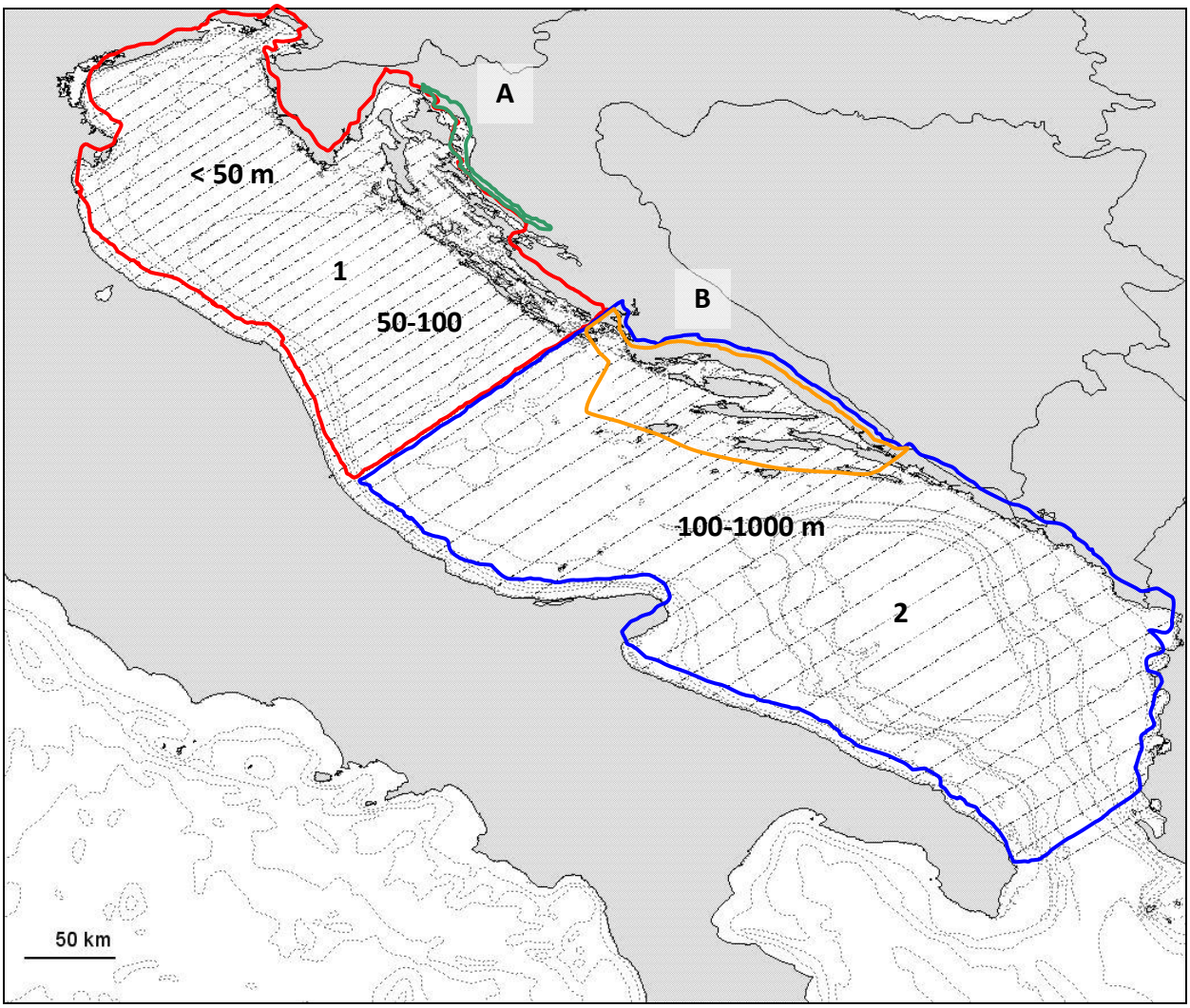

Fig. 1. Strata of the First Survey on Adriatic cetaceans (summer 2010): Stratum 1 (RED), north Adriatic, parallel transects 10 km-spaced; Stratum 2 (BLUE), central and south Adriatic, parallel transects 20 km-spaced; sub-stratum A (GREEN), Velebit channel, zigzag transects (almost full coverage); sub-stratum B (ORANGE), Central Adriatic islands Split archipelago, parallel transects 10 km-spaced.

Fig. 2. Partenavia P-68, pilot (centre: Albertario), three observers (from left: Holcer, Filidei, Fortuna), trainer (right: Donovan) and bubble windows (right corner)

Analysis

To date only preliminary analyses have been undertaken using DISTANCE software and conventional distance sampling (CDS). Details can be found in the many papers by Buckland and colleagues[2]. The results are thus provided as examples and should not be cited or treated as final estimates.

Preliminary results

Flights covered over 18,000 km along 64 predetermined transects, including the necessary transit routes from/to airports and strata. The basin was covered from north to south. About 9,500 km were covered "on-effort" and 1,500 "off-effort".
Table 1 summarises the sightings made during the survey.

Table 1.
Sightings of cetacean species and other protected species recoded in all weather conditions and research effort (ON- and OFF-EFFORT): total numbers and group size

Species	Total n of sightings	Group size (SD; *range*)
Bottlenose dolphin (*Tursiops truncatus*)	126	3,8 (6,3; 1 - 48)
Striped dolphin (*Stenella coeruleoalba*)	85	12,5 (15,3; 1 - 85)
Risso's dolphin (*Grampus griseus*)	11	4,1 (2,9; 1 - 10)
Cuvier's dolphin (*Ziphius cavirostris)*	1	4 (-)
Fin whale (*Balaenoptera physalus*)	1	1 (-)
Sea turtles (mostly *Caretta caretta*)	1.020	1,0 (0,2; 1 - 5)
Giant devilray (*Mobula mobular*)	44	1,2 (0,6; 1 - 4)

Distribution

In general our results showed a certain degree of cetacean diversity in the Adriatic Sea, which reflected the existing knowledge in terms of presence and distribution, but not abundance. Figs 5-10 plot the sightings of all species recorded, including non-cetacean species (they can be found at the end of the paper).
Particularly interesting were the observations made in the central and southern Adriatic Sea (Fig. 3, 4 and 9): a large adult fin whale (*Balaenoptera physalus*) near the island of Palagruža (Croatia) in the central Adriatic; a group of four Cuvier's beaked whale (2 adults, 2 sub-adults) (*Ziphius cavirostris*) and 11 groups of Risso's dolphin (*Grampus griseus*) - for a total of 45 individuals - observed in the south Adriatic over the continental slope.
Fig. 5 shows the distribution map for all species recorded during the survey. The distribution of all cetacean species is shown in Fig. 6. The latter reflects well the current knowledge on cetacean ecology (Bearzi *et al.* 2004, 2009; Holcer *et al*. 2007; Notarbartolo di Sciara and Demma 1994). The only

[2] http://www.ruwpa.st-and.ac.uk/distance/ is an excellent resource for the program DISTANCE and references to Distance sampling theory and practice, including published papers.

species recorded throughout the entire Adriatic Sea was the common bottlenose dolphin (126 groups for a total of over 450 individuals; Fig. 7) which occurred in higher densities than expected. Striped dolphins (*Stenella coeruleoalba*) appeared to be very common in the south Adriatic (with over 1,000 striped dolphins observed in the 85 groups; Fig. 8), whereas it was previously considered occasional. An additional fourteen sightings of unidentified cetacean species are shown in Fig. 9. Finally, the short-beaked common dolphin (*Delphinus delphis*), once considered very common (Bearzi e Notarbartolo di Sciara 1995), was not sighted during the survey.

Abundance

Preliminary Conventional Distance Sampling analyses were carried out on all sightings and effort conducted in "moderate" or "good condition" for different strata (except for the sub-strata B, for which analysis have not yet carried out).
Table 2 shows relevant parameter values for the uncorrected CDS analysis. For these preliminary analyses, as examples only, corrections from other studies were considered to obtain some idea of the possible levels of perception or availability bias, including the group size issue (see Table 3) and the resultant estimates are shown in Table 4.

Table 2

Conventional Distance Sampling uncorrected estimates – preliminary results

Species	Stratum	N	Model	Group density per km^2 (CV)	Animal density per km^2 (CV)	Uncorrected estimate (CV; 95% CIs)	Estimated mean group size (CV)
Bottlenose dolphin	All Adriatic (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%)
	North Adriatic (transect spacing: 10 km; area: about 49,000 km^2)	75	Half-normal/Cosine	0.022 (17.2%)	0.056 (20.5%)	2.754 (20.5%; 1,840-4,123)	3.19 (20.8%)
	North Adriatic (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 south Adriatic (transect spacing: 20 km; area: about 73,900 km^2)	23	Uniform/Cosine	0.010 (28.9%)	0.024 (34.8%)	1,786 (34.8%; 903-3,534)	2.87 (18.5%)
	Velebit channel (zig-zag; area: about 800 km^2)	1	Uniform/Cosine	0.014# (104.9%)	0.487# (104.9%)	390# (104.9%; 56-2,773)	35.00 (0.0%)
Striped dolphin	Central and south Adriatic	69	Uniform/Cosine	0.025 (24.6%)	0.208 (29.8%)	15,343 (29.8%; 8,545-27,550)	12.45 (13.6%)
Risso's dolphin	Central and south Adriatic	11	Uniform/Cosine	0.002# (73.6%)	0.007# (78.1%)	510# (78.1%; 124-2,089)	4.09 (21.2%)

#These numbers are not considered reliable for management purposes given their CVs. They are presented here just to give some indication of the order of magnitude of abundance.

Table 3
Potential correction parameters for *Perception bias* (P), *Availability bias* (A) e mean group size issue (G) for bottlenose dolphin and striped dolphins

Species	Bias type	Recorded values	Values	Source
Tursiops truncatus	A	78% time at surface	0.22	Caretta *et al*. 1998.
Tursiops truncatus	A	74% time at surface	0.26	Forcada *et al*. 2004.
Tursiops truncatus	A	78% (ES = 3%) time at surface	0.22	Gomez de Segura *et al*. 2006a.
Tursiops truncatus	G	8 specimens (13% single dolphins)	8 (NE open waters)	Genov *et al*. 2008.
Tursiops truncatus	G	8,3 specimens (SD=9.4) – 14.2 (SD=11.8)	11 (NW open waters)	Triossi e Tizzi 2003.
Tursiops truncatus	G	6,75 specimens (DS=5.87; median=5) (6% single animals)	4 (archipelagos)	Bearzi *et al*. 1997.
Tursiops truncatus	G	6.2 specimens (SD=6.0, median=4)	4	Fortuna 2006.
Stenella coeruleoalba	A	68% (SE = 16%) for small groups (<15 specimens) time at surface	0.32	Gomez de Segura *et al*. 2006a.

Table 4
Conventional Distance Sampling partially corrected estimates for the bottlenose dolphin – preliminary results

Species	Stratum	Estimate of abundance diving time corrected (95% CIs)	Estimate of abundance group size corrected (CV; 95% LF)	Mean group size after correction
Bottlenose dolphin	All Adriatic (transect spacing: 20 km; area: ca 133,400 km^2)	7,336 (4,445-12,108)	10,556 (23.9%; 6,615-16,847)	6.5 (11.9%)
" "	North Adriatic (transect spacing: 10 km; area: ca 49,000 km^2)	3,531 (2,359-5,286)	6,577 (20,3%; 4,412-9,805)	6.2 (11.0%)
" "	North Adriatic (transect spacing: 20 km)	4,626 (2,527-8,467)	6,184 (29.8%; 3,389-11,281)	5.9 (9.0%)
" "	Central and south Adriatic (transect spacing: 20 km; area: ca 73,900 km^2)	2,290 (1,158-4,531)	3,239 (35.4%; 1,623-6,468)	6.1 (22.8%)

CONSIDERATIONS ON LOGISTICS AND TRANSBOUNDARY COOPERATION

The success of any initiative is measurable from the enthusiasm of stakeholders, as much as from the personal view of its coordinators. We therefore believe that the generous words of the Croatian ACCOBAMS Focal Point contained in the Opening Statement of the last ACCOBAMS Meeting of the Parties (2010) best defines the real nature of the First Adriatic Survey achievements. "*This survey represents a valuable contribution to the future implementation of the ACCOBAMS Survey Initiative. Furthermore, due to its transboundary feature, it fully reflects the spirit of regional cooperation promoted through ACCOBAMS*".

Thanks to the additional financial contribution of the Italian Ministry of Environment it was possible to dedicate time and efforts not only to the organisation of the training of the main team of observers and give basic notions to other researchers, but also to the allow full-time attention to the preparation of logistics. Moreover, financial contribution of the State Institute for Nature Protection, Croatia provided funds for training of Croatian researchers and additional survey coverage in the Northern and Central Adriatic.

In terms of organisation, this survey provided excellent opportunity to test the planning and organisational strengths and weaknesses of carrying out an international (in terms of territories) and multinational (in terms of team) aerial survey. The main point is that anyone organising a survey should bear in mind that theory and practice greatly differ and flexibility and swift adjustment are key in making the survey successful.

Some of the lessons learned from organising the first Adriatic survey are summarised in Table 5.

Table 5
Important factors to take into account when planning similar surveys

Issue	Accent on	Description
1.Planning phase of scientific activities		
Choice and testing of platform, equipment and software	Equipment needs to be robust (but there is no need for 'fancy' hardware), software and drivers need to be tested few times before the starting. Main components need to be doubled (GPS, netbook or notebook and clinometers) as backup.	Equipment needs to be checked if it can tolerate heat, vibration etc. Back-up equipment needs to be taken on board. Software needs to be installed and tested on all platforms used
Team training	Teams need to simulate different circumstances, learn common procedures and understand the implications of improper application of methods to the data and hence the analysis and results.	Initial training of observers that have not worked in similar type of surveys is necessary to avoid potential problems that can arise during the initial phases of the survey when team starts data collection in different ways or with different priority species.
Training of new observers	Training (partial or complete) of observers that are new to distance sampling procedure or cetaceans research should be seen as	Such involvement secures local participation and support, and better involvement of local institutions and authorities because it is seen as beneficial for both sides.

	integral part of any ACCOBAMS survey and perceived as an investment into future activities.	Furthermore, it can provide additional funding
Development of procedures	Procedures developed should involve data gathering, data quality checking, data manipulation and data storage.	Adopted procedures and checking ensures a streamlining of the data gathering process and an improvement of final results. Immediate correction saves time and helps avoiding errors.
Certainty *vs*. efficiency in data collection	It is necessary to determine behaviour in unplanned situation (i.e. 'interesting' species and/or events)	How to avoid errors in data collection, individual bias, etc. Circling or not? Precise count or not? Documenting or not?
2. Planning phase of survey logistics		
Obtaining of needed permits, support letters, flight plans, etc.	Authorities, personal and institutional contacts	In order to carry out research in national territories different countries request different permits. People that should help in obtaining the permits are not always the most motivated or interested (in our case one of the focal points replied to our requests 4 months after survey was finished). Therefore, the involvement of alternative contacts is necessary.
Adhering to national legislation	Electronic versions of all types of documents need to be onboard on board	All documents needed for obtaining the various permits and additional documents like personal documents (ID cards, passports, medical documents, insurances etc), project elaborations etc. should be carried at all times. In a number of situations such documents may be needed immediately and great delays can be overcome if they are ready.
Identification of authorities	Different jurisdictions - nature conservation, military, flight control, aerial filming, customs, police, etc.	In planning of the survey, authorities need to be contacted for a number of reasons – their support can help in solving many unforeseen problems, they have legal right to know what is going on in their respective countries, their support may bring additional funding and better solutions. One permanent member of the team per language/country should be selected whenever possible, as "flying crew".
Identification of partners	Transfer of knowledge and results, creation of regional synergy	Motivated local partners are crucial to help in solving many problems, from language barriers to local knowledge on "how things work". Respectful behaviour towards local experts and partners bring additional motivation, and training of local partners brings further benefits both to local community and to further international survey and conservation efforts. Understanding of the methods and results that local partners obtain from participating through training can further enhance the conservation effects of the obtained results.
"Ground crew"	Regardless of careful planning, aerial survey brings a big number of uncertainties – bad weather, changes of flight plan in the air, lack of suitable fuel in some airports/countries, etc.	For example – a small change in wind speed can cause good conditions to become bad. As a consequence a decision on how to proceed needs to be made and it may require landing at other than the planned airport. Delay with customs, lack of fuel, void flight plan and/or lack of permit to enter national airspace can change the schedule. Further, storms and bad weather can last for days and can ground a survey for a while. Such change in the schedule can cause additional financial strain on the budget, cause delays etc. but also change the logistical plans on where to sleep, how to prepare for a new day, organise data of the day etc. In overcoming such issues, a ground "crew" personnel fully aware of the entire process and capable of sorting out things on the spot and based on a short information exchange is crucial. Copies of all documents and communication should be left and forwarded to the survey field base/ground coordinator.
Internet access	Efficient communication and information exchange	One of the keys for good and smooth project operation is Internet access, especially for checking, sometimes three times per day, the weather forecast and the planning of the daily flights. Every care should be devoted to prepare and plan on how to gain Internet access during survey (local pre-paid cards, free WI-FI). Fast communication also facilitates quick problem solving.

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This international project including high seas and national waters of all of the Adriatic countries, benefited from the support of a number of local institutions and organisations:
the Croatian Natural History Museum, the Croatian State Institute for Nature Protection, the Albanian Association for Protection of Aquatic Wildlife, the Institute for Marine Biology of Kotor from Montenegro and the Institute of the Republic of Slovenia for Nature Conservation and the Slovenian NGO Morigenos - Marine Mammal Research and Conservation Society. The research has been carried out under valid research and flight permits issued by relevant national administration (Croatian Ministry of Culture, Croatian State Geodetic Administration, Croatian Civil Aviation Agency, Croatian Air traffic Control, Ministry for Spatial Planning and Environment and the Ministry of Defence of Montenegro, Ministry of the Environment and Spatial Planning of Slovenia, Albanian Ministry of Environment, Forests and Water Administration and Albanian Ministry of Public Works and Transport, Civil aviation authority).
The entire process has been supported by the ACCOBAMS Secretariat and ACCOBAMS national focal points. Additional support was also given by Simone Panigada (Tethys Research Institute, Italy). One of us (GD) who carried out the training acknowledges the support given by the International Whaling Commission. Especial thanks to the pilot was Michele Albertario (MACH014, Italy).

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Fig. 3. Fin whale (*Balaenoptera physalus*) sighted north of Palagruža Island (Croatia, central Adriatic)

Fig. 4a Group of at least 4 Risso's dolphins, two underwater

Fig 4b. Group of Cuvier's beaked whale sighted in the south Adriatic

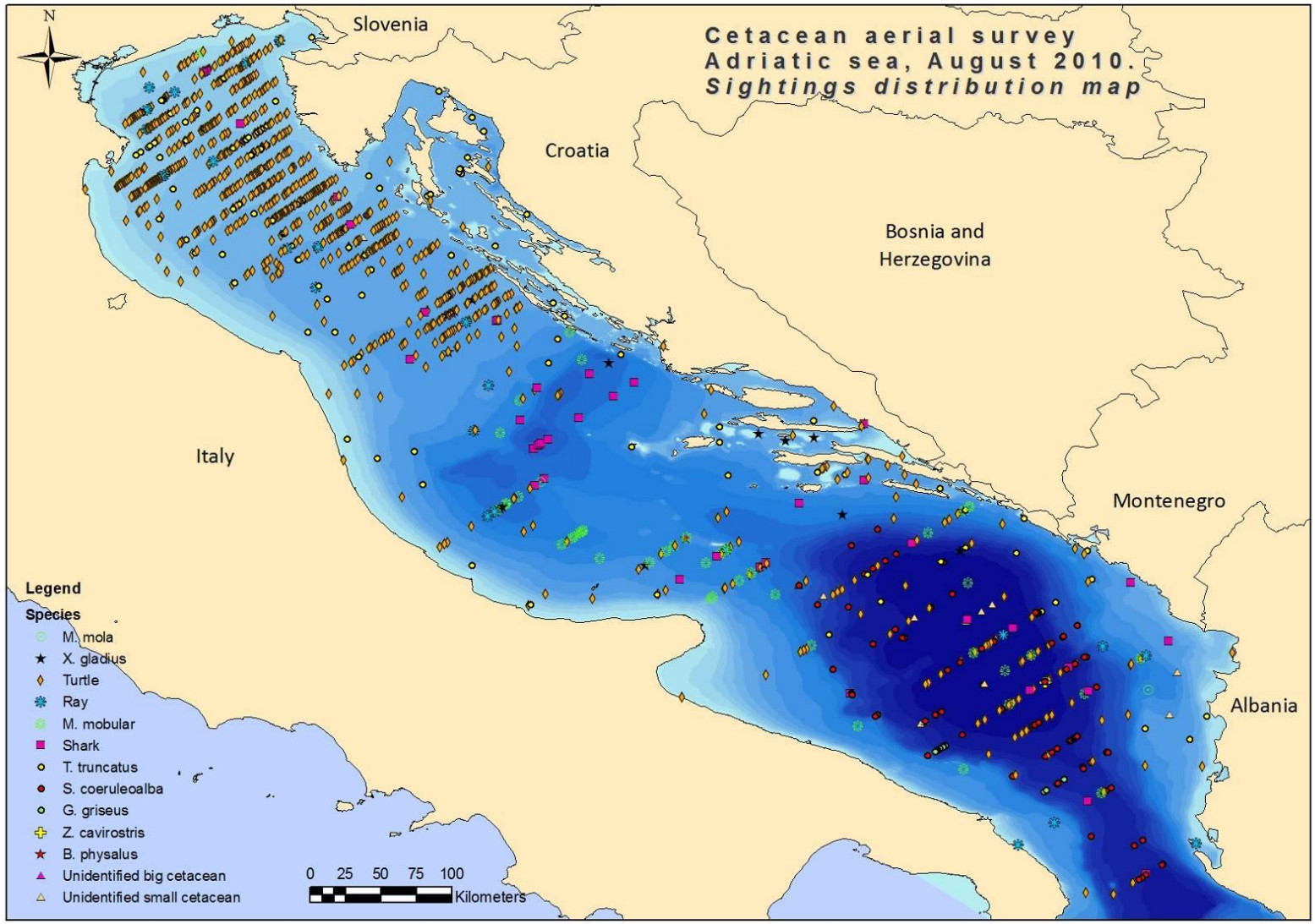

Figure 5. Distribution of sightings of megafauna in the Adriatic Sea (August 2010): sunfish, swordfish, sea turtle, pelagic ray, giant devilray, shark, bottlenose dolphin, striped dolphin, Risso's dolphin, Cuvier's beaked whale, unidentified big cetacean and unidentified small cetacean

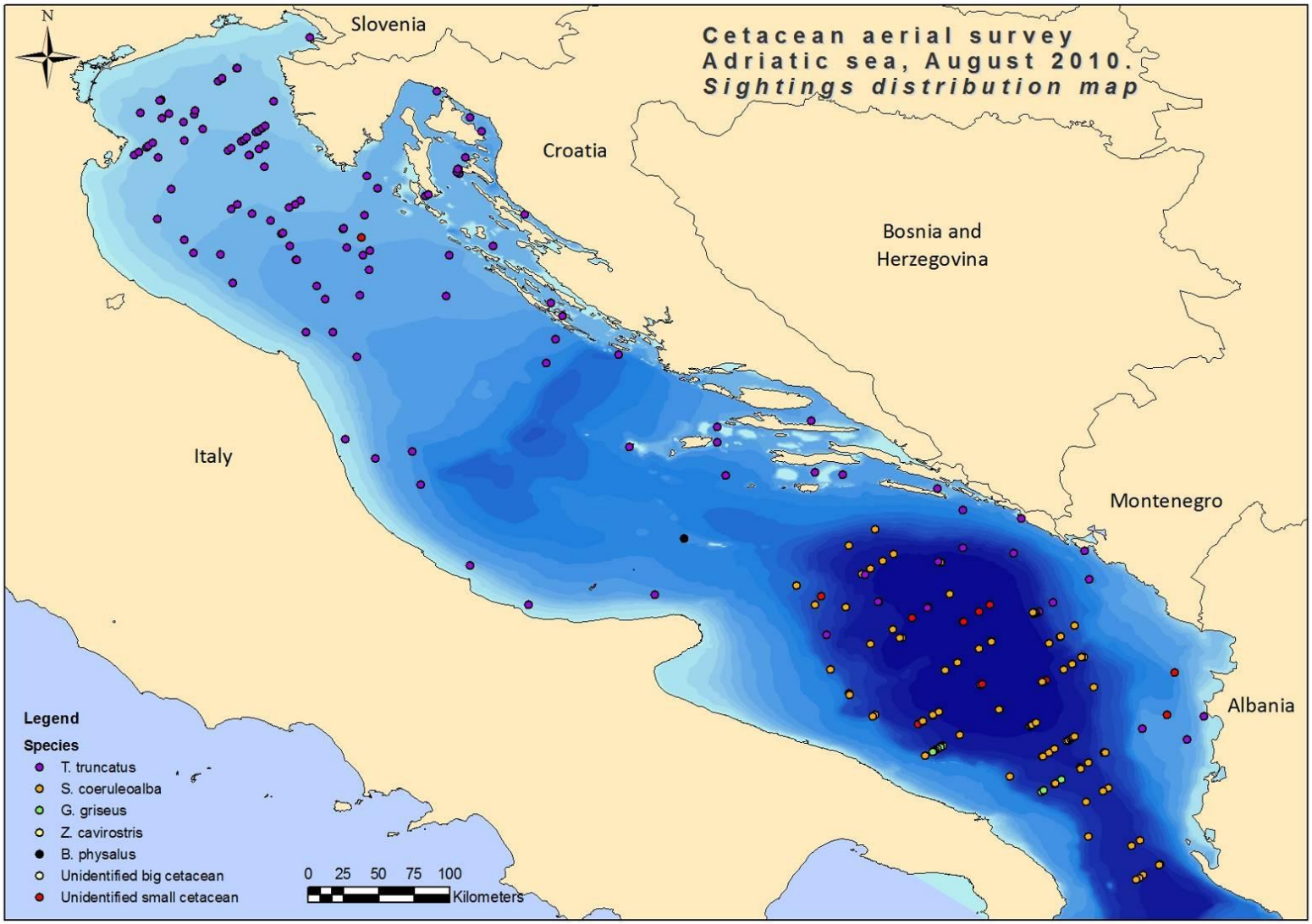

Figure 6. Distribution of sightings of cetacean species only in the Adriatic Sea (August 2010)

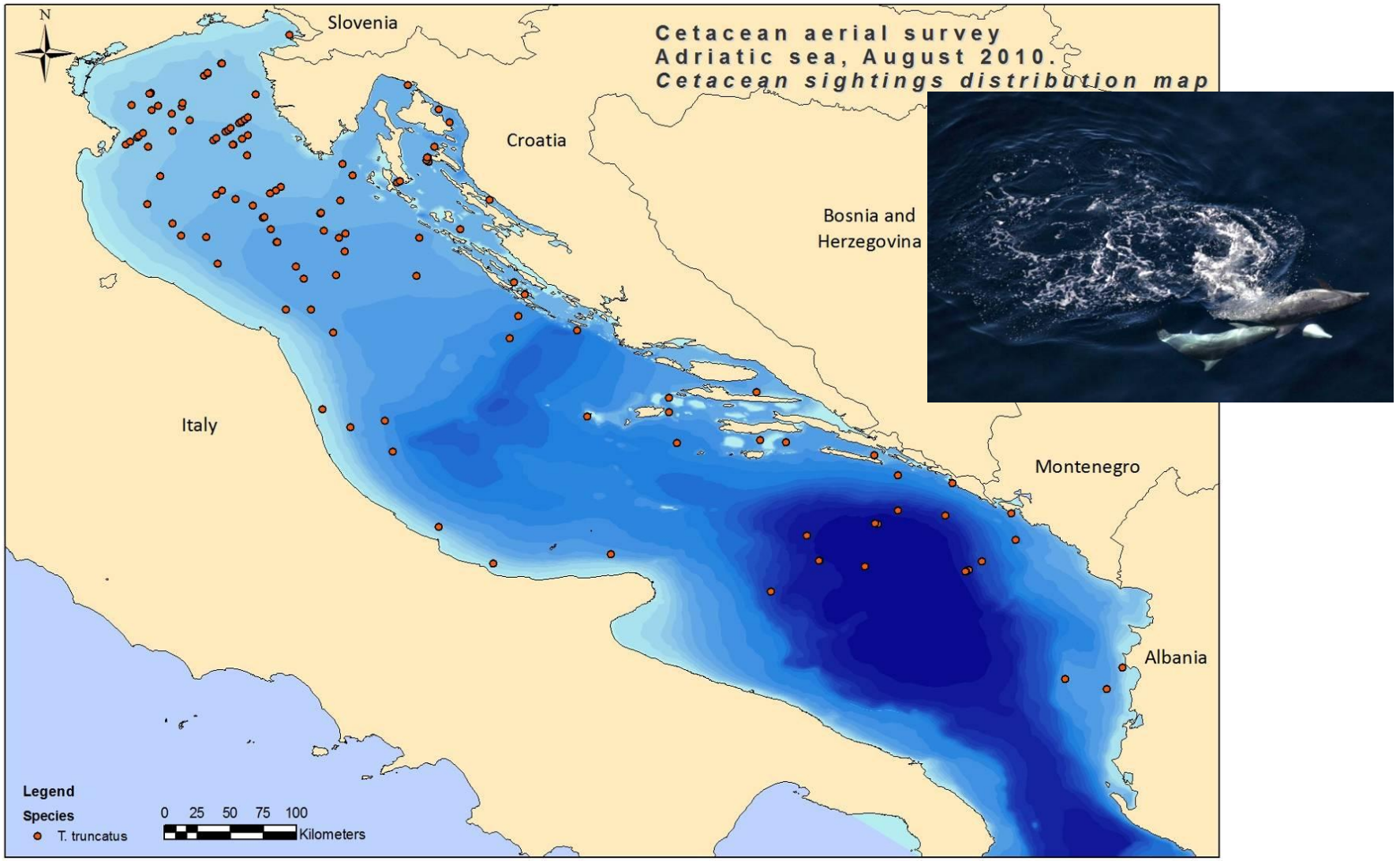

Figure 7. Distribution of sightings of bottlenose dolphin (*Tursiops truncatus*) in the Adriatic Sea (August 2010)

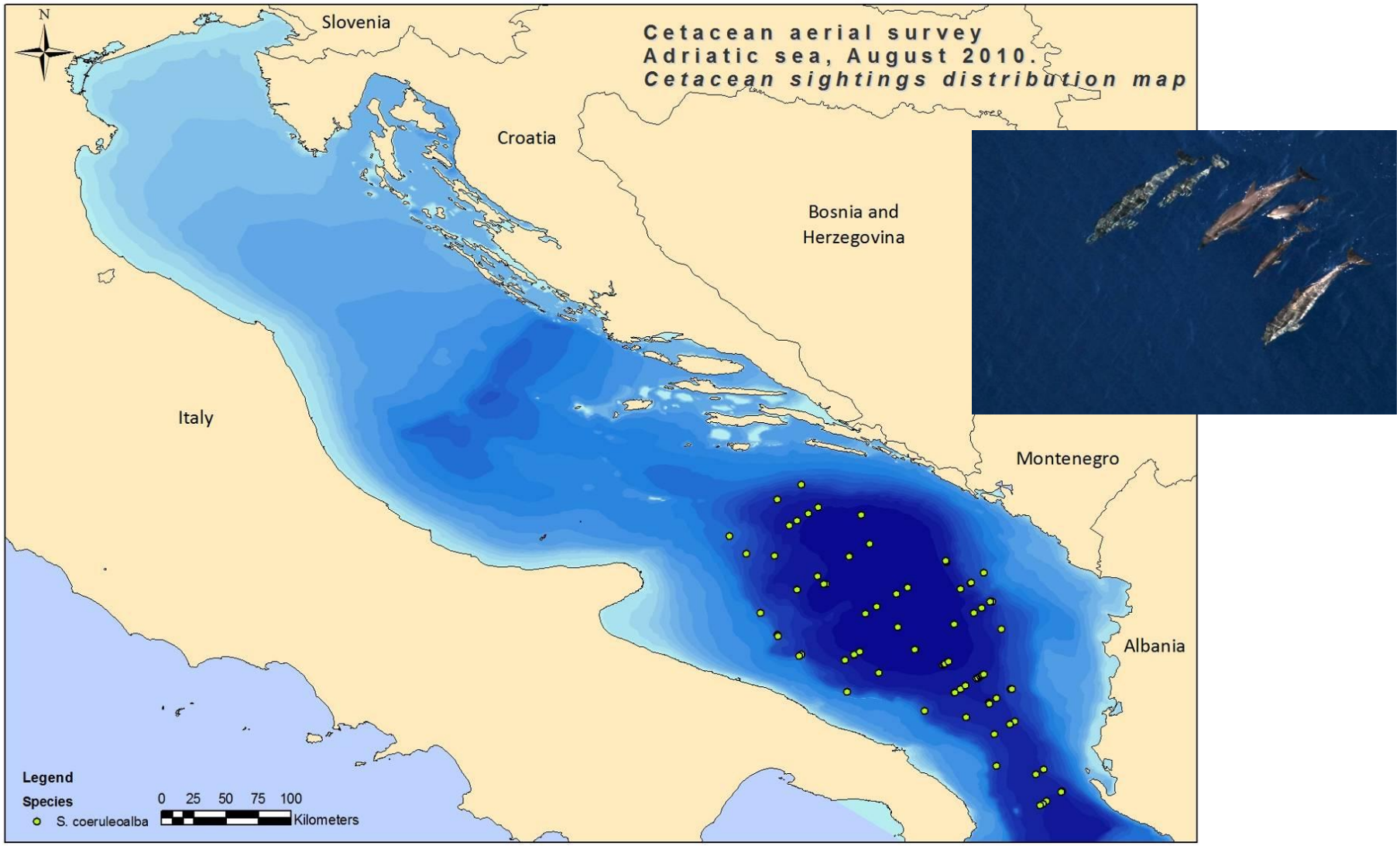

Figure 8. Distribution of sightings of striped dolphin (*Stenella coeruleoalba*) in the Adriatic Sea (August 2010)

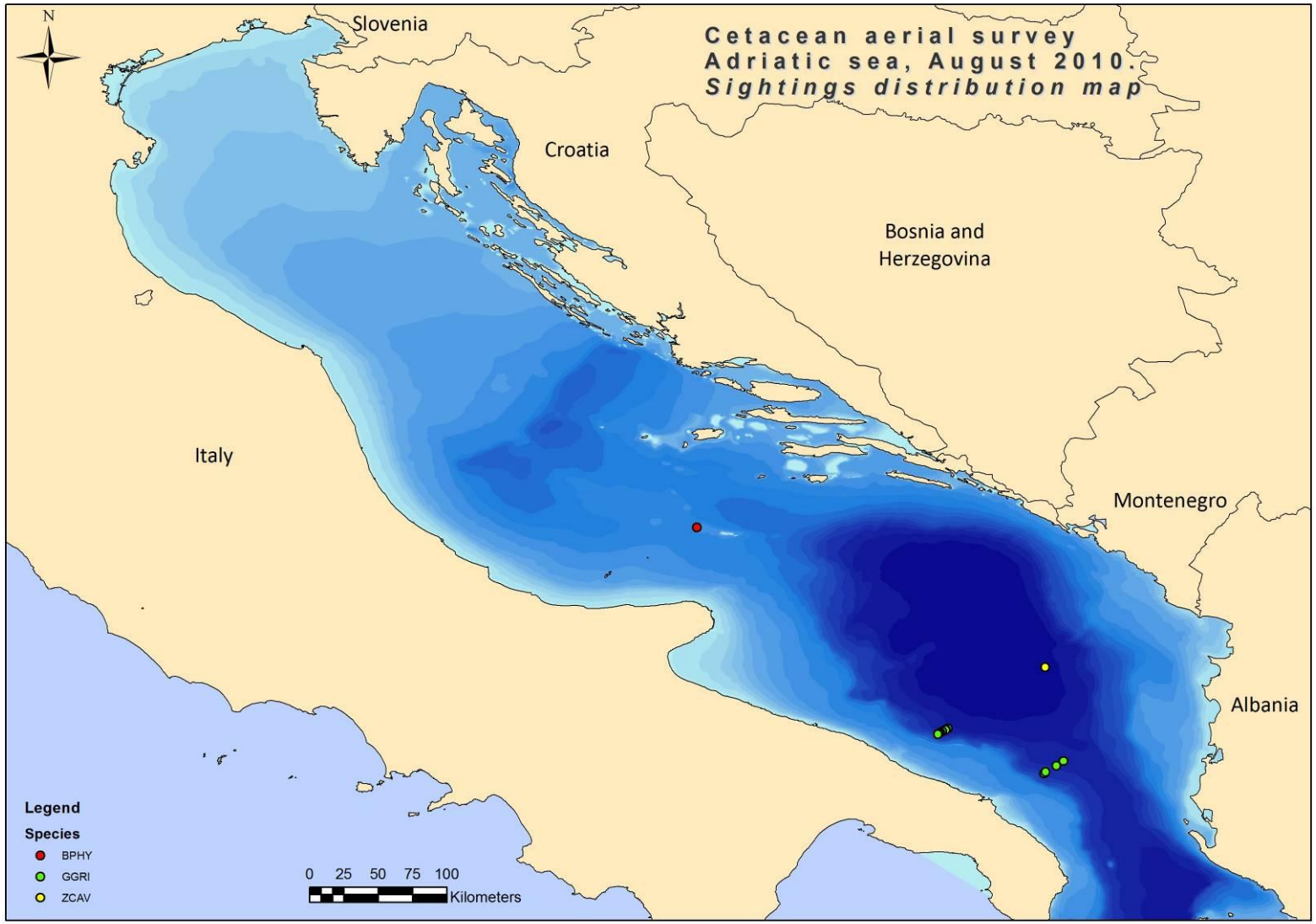

Figure 9. Distribution of sightings of Cuvier's beaked whale (yellow), Risso's dolphin (green), fin whale (red) in the Adriatic Sea (August 2010)

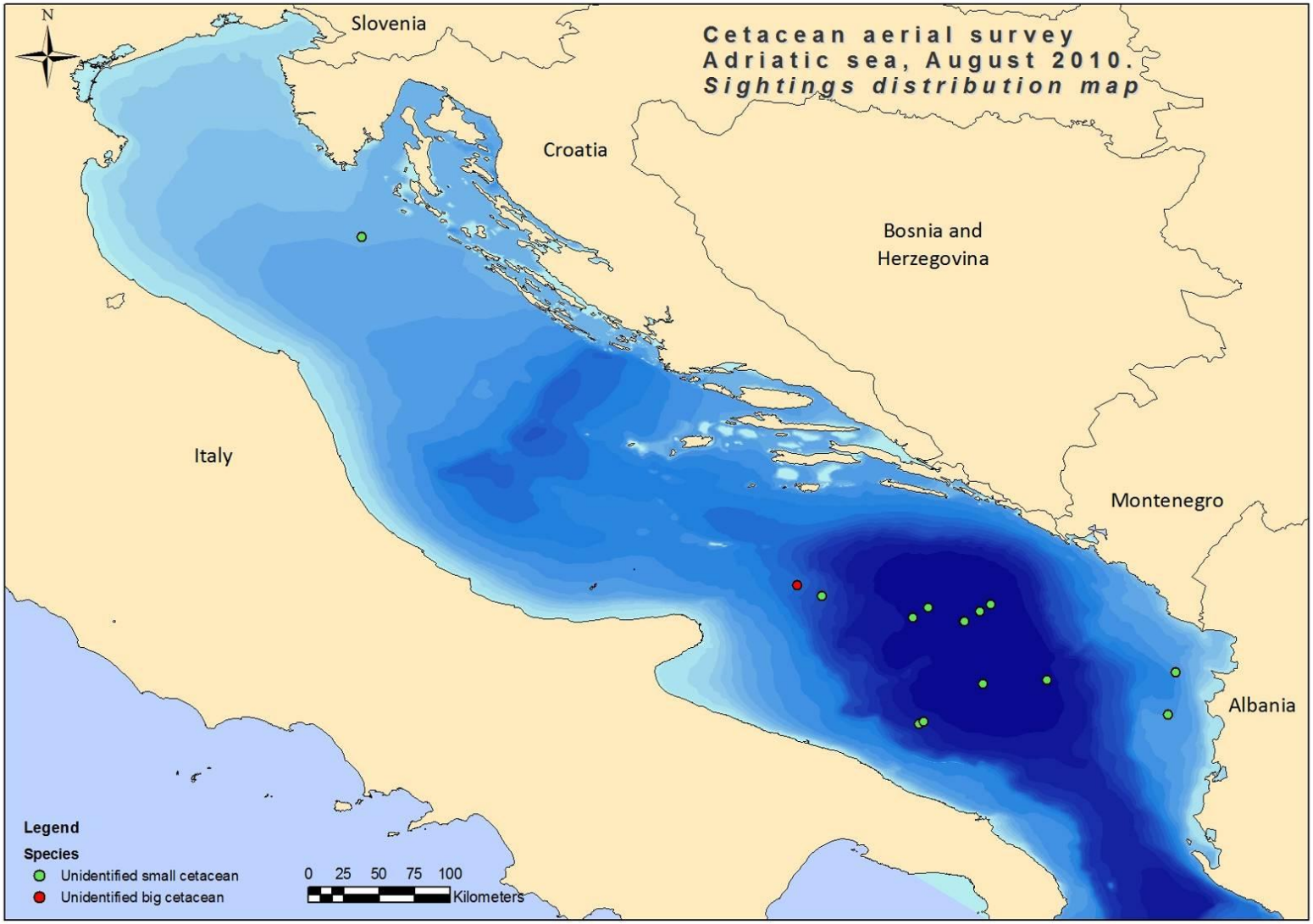

Figure 10. Distribution of sightings of unidentified species (small and big) in the Adriatic Sea (August 2010)