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ACCOBAMS SURVEY INITIATIVE - TECHNICAL REPORTS OF THE MEDITERRANEAN AND BLACK SEA SURVEYS

ACCOBAMS SURVEY INITIATIVE

TECHNICAL REPORTS OF THE MEDITERRANEAN AND BLACK SEA SURVEYS

Note of the Secretariat:

This document is aimed at providing the Parties with the technical reports of the regional surveys that were conducted in the Mediterranean Sea in 2018 and in the Black Sea in 2019 in the framework of the ACCOBAMS Survey Initiative and CeNoBS project. The document has been prepared by the ASI Scientific Coordinator and several key partners involved in the effort, including the ASI aerial Team leaders of the Mediterranean Survey, the CeNoBS partners for the Black Sea Survey part and the Permanent Secretariat. The reports included in this document aim to provide a comprehensive and detailed description of all steps and actions taken towards the successful implementation of the surveys, as well as preliminary results, intended data analysis approach and recommendations that may serve future regional surveys.

PART I: ACCOBAMS Survey Initiative - Technical report of the Mediterranean survey

PART II: ACCOBAMS Survey Initiative - Technical report of the Black Sea survey

PART I: ACCOBAMS Survey Initiative - Technical report of the Mediterranean survey

Authors

Simone Panigada, Helder Araujo, Julie Belmont, Ibrahim Benamer, Oliver Boisseau, Ana Cañadas, Léa David, Florence Descroix-Comanducci, Nathalie Di-Méglio, Ghislain Dorémus, Milad Fakhri, Joan Gonzalvo, Draško Holcer, Sharif Jemaa, Gaby Khalaf, Sophie Laran, Giancarlo Lauriano, Célia Le Ravallec, Richard McLanaghan, Ana Moscrop Romulus-Marian Paiu, Morgane Perri, Nino Pierantonio, Dimitar Popov, Vincent Ridoux, José Antonio Vázquez.

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ASI Steering Committee Members: Giancarlo Lauriano, Vincent Ridoux, Boris Daniel, Biljana Aljinovic, Lobna Ben Nakhla, Chedly Rais

ASI Scientific Coordination ad-hoc working group: Phil Hammond, Greg Donovan, Debra Palka, Meike Scheidat, Ana Cañadas, Ibrahim Benamer

ASI Aerial Survey observers: Amalia Alberini, Rimel Ben Messaoud Eyal Bigal, Ariane Blanchard, Amine Bouhadja, Vincent Bretille, Carla Chicote Cécile Dars , Ayhan Dede, Erdem Denayer, Marc Duvilla, Elio Filidei, Manel Gazo, Popi Gikopoulou, Tilen Genov, Amaia Gomez de Segura, Dimitrios Kontakos, , Souad Lamouti, Alessio Maglio, Jure Miočić-Stošić, Niki Pardalou, Monica Perez Gil, Thierry Sanchez, Aviad Scheinin, Sandrine Serre, Imane Tai, Arda Tonay,

ASI Boat Survey observers : Mehraz Abdelkader, Said Ait Taleb, Mustafa Almuntasri, Sid Ahmed Baibbat, Ali Badreddine, Ali Berbash, Mohammed Bouaicha, Youcef Bouzid, Salih Diryaq, El Houari Erroukrma, Alexandros Frantzis, Abir Ghanem, Abdelmadjid Gherdis, Myriam Ghsoub, Abdelrahman Hassoun, Houssein Jaber, Mihailo Jovicevic, Abdelkrim Kalmouni, Niki Koutouzi, Mhamed Laid, Myraim Lteif, Celine Mahfouz, Laura Mannoci, Alhassn Mansor, Badreddine Mekyassi, Yaly Mevorach, Aixa Morata, Anthony Ouba, Ilayda Destan Ozturk, Alexiadou Paraskevi, Jelena Popovic, Almokhtar Saied, , Ali Rahmani, Rabah Selmani, Elie Tarek, Yotam Zuriel.

MCR Team members and crew: Oliver Boisseau, Nicolas Carter, Jack Fabricious, Simon Ingram, Mathew Jerram, Niall MacAllister, Axia Morata, Judith Matz Brian Morrison, Richard McLanaghan, Enrico Pirotta, Jonny Reid, Denise Risch, Conor Ryan Hannah Stowe, Nienke Van Geel.

ASI Technical partners:

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ACCOBAMS Survey Initiative - Technical report of the Mediterranean survey, 2018, ACCOBAMS, Monaco.

CONTENTS

Executive summary

Robust baseline information on parameters such as abundance and density is necessary to inform conservation actions and to implement and evaluate the efficacy of any measures currently in place (Grand et al., 2007). This is particularly true in the Mediterranean and Black Seas, where several of the cetacean populations occurring in the Region are threatened by human activities and maintaining good conservation status requires effective actions (Notarbartolo di Sciara and Birkun, 2010).

In recognizing the uniqueness and the conservation status of these populations and in general of the Mediterranean ecosystem, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) proposed a synoptic survey of the entire ACCOBAMS Region (ASI - ACCOBAMS Survey Initiative). This programme is particularly important in respect of the EU Regulations and Directives, specifically the Habitats Directive and the Marine Strategy Framework Directive as well as other relevant instruments, including but not limited to the “Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean” of the Barcelona Convention, the “Convention on the Conservation of Migratory Species and Wild Animals” (also known as CMS or Bonn Convention), and the “Berne Convention on the Conservation of European Wildlife and Natural Habitats”.

The “ACCOBAMS Survey Initiative” project, officially launched at the Sixth Meeting of the Parties to ACCOBAMS (Monaco, 22-25 November 2016) is a major project of ACCOBAMS that aims to establish an integrated, collaborative and coordinated monitoring system for the status of cetacean populations at the whole ACCOBAMS area level, with the final aim to strengthen the conservation effort and governance for cetacean species. Developed and implemented by the ACCOBAMS Permanent Secretariat, in coordination and with the support of riparian countries and local scientists, the ASI represents an unprecedented effort and a first step to assess cetacean abundance and distribution at the Mediterranean basin-wide level;

Since the beginning of 2017, while pursuing fundraising effort for conducting the ASI in the Black Sea, in accordance with the Scientific Committee recommendation that the two regions could be surveyed separately, the ACCOBAMS Permanent Secretariat has been in contact with all ASI Contact Group Members across the Mediterranean region, to assess and prepare the implementation of the 2018 summer survey, and in particular to assess the authorization requests processes for aerial and/or boat surveys in each country. In continuation of this consultation process, the ACCOBAMS Permanent Secretariat, in collaboration with the Regional Activity Centre for Specially Protected Areas (UNEP/MAP/SPA-RAC), organised an ASI Contact Group Regional Workshop from the 3rd to the 5th of October 2017, in Tunis, Tunisia.

This event gathered ASI Contact Group members and experts from 15 countries of the Mediterranean, and provided a unique opportunity for all ASI partners to work together on the preparation and implementation of the survey in 2018. The few Contact Group members who did not attend the workshop were contacted in parallel through phone meetings, or during physical meetings conducted in the wake of the event. All key aspects for conducting the aerial or ship-based surveys were discussed and strategized.

Following this meeting, effort was dedicated to design the survey according to the different scientific, administrative and geo-political constraints, to draft data collection protocols and to establish links with aerial companies to secure that the proper airplanes were contracted and available for the fieldwork and to select the appropriate research vessels for the visual and acoustic component of the survey.
Two dedicated training workshops were conducted, one to train all the cruise leaders and the observers for the aerial component, organized in Cuers, France, in May 2018 and a second one

targeting visual and acoustic effort from research vessels, organized in Samos, Greece, in June 2018. The rationale for the training workshops was to present, discuss and adapt data collection protocols with the cruise leaders and observers, benefitting from theoretical and practical sessions. The ultimate result was a shared and standardized protocol and software to be used for all surveys present and future, in order to ensure the compatibility of the collected data.

Data collection was concentrated during the summer of 2018, to facilitate a synoptic coverage of the whole Mediterranean Sea in the same time window. Several planes and different research boats were used, with almost 100 scientists and researchers involved. Aerial surveys were complemented by ship-based visual and acoustic surveys, to collect data on deep diving species, such as beaked and sperm whales and to survey waters where it was not possible to use dedicated airplanes.

The collected data are currently being verified and prepared for robust analysis and modelling approaches, which will provide strong and reliable abundance and density estimates, to be used to fulfil conservation requirements and obligations, under both national and international frameworks.

1. Survey preparation

1.1 Coordination scheme and roles of coordinators

The general coordination of the ACCOBAMS Survey Initiative was ensured by the ACCOBAMS Secretariat and involved the participation of several stakeholders and entities (Figure 1).

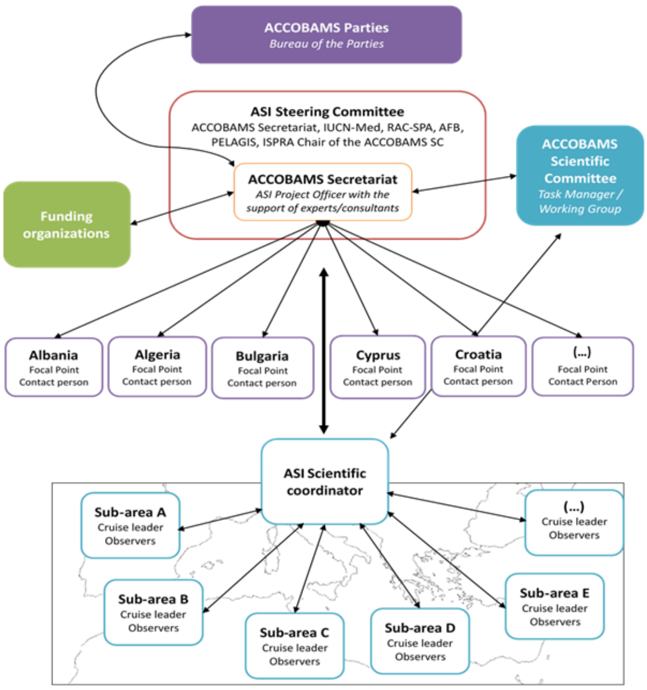


Figure 1: General coordination of the ACCOBAMS Survey Initiative.

For the survey in the Mediterranean Sea, the ACCOBAMS Secretariat specifically and intensively worked in liaison and with the support of the following key stakeholders:

ASI Scientific Coordinator and his *ad hoc* support team:

The ASI Scientific Coordinator supported the ACCOBAMS Secretariat on all the scientific issues related to the implementation of the ASI project.

The ASI Scientific Coordinator and his team were involved with developing all methodological aspects (survey design, protocol, platform selection, equipment), in observer team selection and training and with data acquisition and management by coordinating all the aerial scientific teams during the survey.

PELAGIS Observatory:

PELAGIS observatory was involved in the preparation of the aerial survey campaign and its implementation, as adviser member of the ASI Steering Committee, by providing experienced team leaders and observers for the implementation of the aerial survey, and by assisting the ASI Scientific Coordinator with all aspects linked to the use of the SAMMOA software (preparation of the software, training to the observers, assisting during the survey, verifying and preparing the data collected on SAMMOA for the data analysis).

Marine Research Conservation International (MCR):

MCR was a key partner of the ASI project , through supporting and assisting the ACCOBAMS Secretariat for the implementation of the ASI vessel-based survey component, in particular with aspects related to planning, logistics, vessel requirements and survey equipment needs, survey methodology, training for participants, survey implementation, data management and analysis.

ASI Steering Committee:

The ASI Steering Committee is composed of representatives of key partnering entities (IUCN Centre for Mediterranean Cooperation, Regional Activity Centre for Specially Protected Areas (SPA-RAC), *Agence Française pour la biodiversité* (AFB), *Observatoire Pelagis*, Italian National Institute for Environmental Protection and Research (ISPRA), Chair of ACCOBAMS Scientific Committee). It provides advice and guidance to the ACCOBAMS Secretariat for all aspects linked with the coordination of the ASI project. The ASI Steering Committee was gathered and consulted numerous times during the preparatory phase of the Survey and advised on several strategical aspects, including budget planning, selection of platforms and partners, but also teams review, scientific effort definition etc.

The ACCOBAMS National Focal Points and the ASI Contact Group Members:

This ASI contact group is composed of contact persons in each country who were nominated by the National Focal Points of ACCOBAMS in 2014 in accordance with Resolution 5.9 “Comprehensive cetacean population estimates and distribution in the ACCOBAMS area (ACCOBAMS Survey Initiative)”. The NFP and Contact person roles are to assist the ACCOBAMS Secretariat with the specific following tasks:

- facilitate the process of obtaining permits for vessels and aircrafts to operate in the waters under National jurisdiction;
- co-ordinate the identification of financial and/or in-kind support for the survey;
- identify observer candidates;
- Assist, when and if necessary, the teams during their mission on respective national territories.

1.2 Data collection methodology and related protocols development

Aerial and ship-based surveys applying **line transect distance sampling** methodologies can provide robust estimates of the abundance and density of a species in a given space and time (Buckland et al., 2001, 2000; Buckland, 2004) and can be used to detect potential trends (Taylor et al., 2007) and hence inform conservation.

Data collection protocols for both platforms have been largely adapted from previous similar studies, with an emphasis on a systematic, shared approach throughout the entire Mediterranean Sea. The goal was to provide a template, to be adapted and fine-tuned during a series of dedicated training workshops, where cruise leaders and visual observers would receive full training before the actual start of the field work operations.

ASI aerial survey protocol: the survey was conducted flying along planned transects, primarily in passive mode unless it was necessary to obtain reliable estimates of school size or confirm species by circling on the sighted animals. The survey was then resumed at the exact point it was left and all the secondary sightings (i.e. the additional sightings made after leaving the predetermined trackline) although recorded are not being used to obtain the abundance and density estimates. The environmental conditions, reported by the primary observers, were recorded at the beginning of each transect and/or whenever a change occurred. Those variables include the sea state (Beaufort scale), glare, cloud cover, turbidity of the sea and overall general conditions. Sightings data, also reported by the primary observers, include species, group size and composition, declination angle to the detected animal or group (from which perpendicular distance was calculated), cue, presence of calves, direction of swimming and group behaviour. Other accessory information such as the presence of human activities was also recorded. Observations were made through so-called bubble-windows allowing direct information on the track-line below the plane and recorded on a laptop with dedicated software. The plane position, speed and altitude were continuously recorded through a GPS. The specialist software *SAMMOA* developed by the *Observatoire PELAGIS* was used for all aerial survey data collection.

Vessel surveys conducted during the ASI were either joint acoustic-visual (considered high priority in those areas without aerial surveys) or visual-only (for vessels surveying national coastal waters of Lebanon, for example, and in areas where hydrophones were not permitted). All surveys were conducted from vessels capable of spending extended periods offshore. An elevated observation platform provided an eye-height of at least 5 m above sea level and allowed two trained visual observers to scan from 270 ° to 90 ° of the survey trackline during daylight hours. The vessels were able to break from the survey track during daylight hours to undertake species identification (if required) and to obtain images for photo-identification when appropriate, before returning to the survey track at the point it was left. Those vessels conducting acoustic survey work were selected, or modified where possible, to reduce self-generated noise (e.g. from propeller cavitation or inboard electronic noise). The vessels towed hydrophone arrays capable of detecting all cetacean species, including sperm whales and beaked whales, with a frequency response between 10 Hz and 200 kHz. Acoustic effort was conducted continually throughout the survey period if not constrained by extreme weather conditions or water depths less than 50 m. The specialist *Logger* software (www.marineconservationresearch.org) was used on all vessels to automatically log the track every 10 seconds from GPS; where possible, the direction of travel from a heading sensor, the wind speed and direction from deck instruments and various other parameters were logged automatically every 10 seconds. Environmental information (including sea state, wave and swell height, cloud cover and glare) were logged manually every hour, or when there was a significant change in conditions. Logger was also used to document the survey effort status at all times, as well as to log sightings of marine life, marine debris, fishing vessels and fishing gear. A standardised *Logger* database and set of data entry forms were provided to each vessel participating in the ASI.

1.3 Survey design

Design of blocks

A total of 32 blocks were created (Figure 2). The rationale for the blocks boundaries was the best compromise achieved between oceanographic zones, bathymetric characteristic and political/jurisdictional constraints. The first two are likely to have a marked effect on cetacean distributions. The surface area for each block is shown in Table 1; The design of the blocks was constantly updated as the survey was approaching, to take into consideration last minutes issues related to permit issues and other logistical considerations.

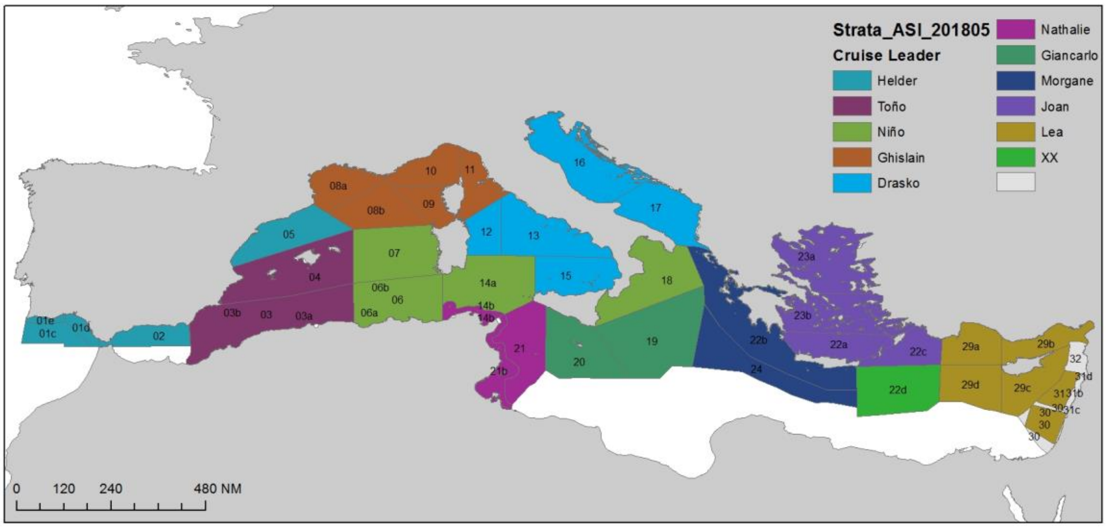


Figure 2. The blocks selected for the entire Mediterranean Sea.

Design of aerial tracks

For all blocks two types of design were attempted: *systematic parallel lines* and *equal spaced zigzag* (ESZ). In both cases, the direction of the tracks was set to be as perpendicular as possible to depth contours and the coast, according to best practice for distance sampling.

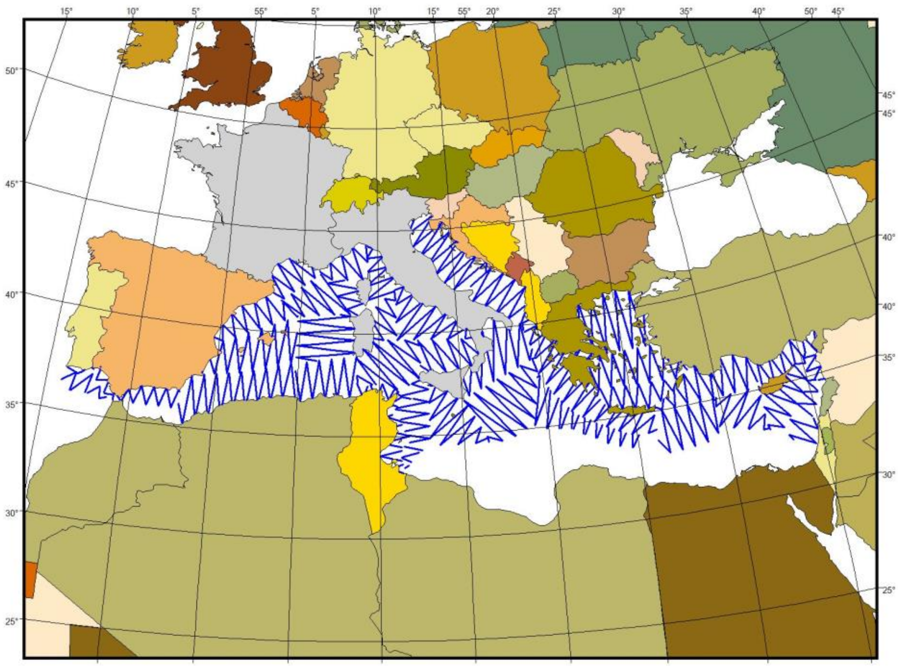


Figure 3. The chosen tracks for the aerial survey.

The design aimed, in both cases, to achieve 3% coverage of the areas. Five hundred iterations of each design were run in order to obtain the map of coverage probability (to assess whether it resulted homogeneous or not), and the mean percentage coverage, mean total on effort trackline length and mean total trackline length (including the off-effort tracks in between on-effort tracklines) (Table1). The proportion of the total track length that is on effort is also provided.

After inspection of the results from each design type, it was concluded that the ESZ was more effective than the parallel design, except in the small coastal blocks, where the parallel design gets more chances for a homogeneous coverage. The selected results are shown in Figure 3. These track lengths only considered the lengths between the initial point and the final point. More time needed to be added to account for flights from and to airports each day. The shapefiles of the survey blocks and the designed tracks presented have been provided as kml and kmz files for the blocks and the tracks, in Google Earth format.

Table1 - Survey design details and expected effort and coverage (lengths are expressed in Km).

Ref	Block	Area (km^2)	Design	Mean % coverage	Mean Total on effort track length	Mean Total track length	Mean On/Total track length
1c	Gulf of Cadiz N-half-offshore	29,285	Equal Spaced ZigZag	3	626	877	0.714
1d	Gulf of Cadiz N-half-shelf-East	8,500	Equal Spaced ZigZag	3.1	265	436	0.608
1e	Gulf of Cadiz N-half-shelf-West	4,326	Parallel	3.1	134	258	0.519
2	Alboran	28,123	Equal Spaced ZigZag	3.1	877	1216	0.721
3	AlgeriaWest complete	109,795	Equal Spaced ZigZag	3	3345	4010	0.834
3a	AlgeriaWest inshore	47,616	Equal Spaced ZigZag	3	1412	2070	0.682
3b	AlgeriaWest offshore	62,181	Equal Spaced ZigZag	3	1838	2471	0.744
4	Baleares	93,066	Equal Spaced ZigZag	3	2758	3276	0.842
5	NE_Spain	53,202	Equal Spaced ZigZag	3	1592	2041	0.780
6	AlgeriaEast complete	66,982	Equal Spaced ZigZag	3	2019	2360	0.856
6a	AlgeriaEast inshore	31,592	Equal Spaced ZigZag	3	963	1279	0.753
6b	AlgeriaEast offshore	35,364	Equal Spaced ZigZag	3	1050	1385	0.758
7	WestSardinia	73,430	Equal Spaced ZigZag	3	2205	2512	0.878
8a	GulfLion Shelf	34,718	Equal Spaced ZigZag	3.1	1069	1329	0.804
8b	GulfLion Deep	46,952	Equal Spaced ZigZag	3.1	1470	1731	0.849
9	PelagosSW	22,642	Equal Spaced ZigZag	2.9	670	875	0.766
10	PelagosNW	34,093	Equal Spaced ZigZag	2.9	988	1269	0.779
11	PelagosE	31,064	Equal Spaced ZigZag	3.1	970	1283	0.756
12	TyrrhenianCWest	27,262	Equal Spaced ZigZag	2.9	796	1101	0.723
13	TyrrhenianCEast	66,588	Equal Spaced ZigZag	3	2046	2511	0.815
14	TyrrhenianSWest	77,001	Equal Spaced ZigZag	3.1	2436	2823	0.863
14b	Tunisia 12nm North	10,552	Parallel	3.2	341	585	0.583
15	TyrrhenianSEast	49,832	Equal Spaced ZigZag	3	1524	1841	0.828
16	AdriaticNC	78,504	Equal Spaced ZigZag	3.1	2456	2934	0.837
17	AdriaticS	57,127	Equal Spaced ZigZag	2.9	1656	2053	0.807
18	IonianN	75,938	Equal Spaced ZigZag	2.9	2239	2655	0.843

19	IonianS	109,913	Equal Spaced ZigZag	3	3288	3775	0.871
20	SIcilySouth	75,043	Equal Spaced ZigZag	3.1	2303	2825	0.815
21	Tunisia offshore	47,062	Equal Spaced ZigZag	3.1	1460	1879	0.777
21b	Tunisia 12nm East	24,568	Parallel	3.1	778	1308	0.595
22a	HellenicTrench North	42,613	Equal Spaced ZigZag	3	1299	1714	0.758
22b	HellenicTrench West	95,136	Equal Spaced ZigZag	3.1	2970	3804	0.781
22c	HellenicTrench East	113,970	Equal Spaced ZigZag	3	3385	3882	0.872
22d	SouthEast Creete	43,772	Equal Spaced ZigZag	3.1	2559	3345	0.765
23a	AegeanN_Greece	69,384	Equal Spaced ZigZag	2.9	2018	2367	0.853
23b	AegeanS_Greece	63,858	Equal Spaced ZigZag	3	1898	2391	0.794
24	IonianSE	63,515	Equal Spaced ZigZag	3	1927	2536	0.760
29a	Cyprus-West	33,608	Equal Spaced ZigZag	3.1	1043	1282	0.814
29b	Cyprus-NEast	31,598	Equal Spaced ZigZag	2.9	961	1330	0.723
29c	Cyprus-SEast	43,364	Equal Spaced ZigZag	3	1348	1739	0.775
29d	Cyprus-SWest	40,838	Equal Spaced ZigZag	3	1227	1524	0.805
30	Israel	27,324	Equal Spaced ZigZag	2.9	821	1009	0.814
31	Lebanon offshore	14,555	Equal Spaced ZigZag	3.1	471	661	0.713
31b	Lebanon 12nm	4,051	Equal Spaced ZigZag	3.3	160	319	0.502
32	Syria	10,133	Equal Spaced ZigZag	3.3	362	518	0.699

Design of vessel-based tracks

As for the vessel-based surveys, equal spaced zigzag transects were designed for several of the ASI survey blocks (Figure 4a&b), namely the Western Basin (1-15), the Hellenic Trench (22), Libya (25 & 26), Lebanon (31), Egypt (27 & 28) and Syria (32). Where required, minor modifications were made to the survey blocks due to ongoing discussions with the relevant permitting authorities, Focal Points and the ACCOBAMS Secretariat. A total of 23,644 km of transects were designed for the vessel-based surveys (Table 2). These transects were designed to provide an acoustic coverage of at least 6% (based on an estimated half strip width of 10 km for sperm whales).

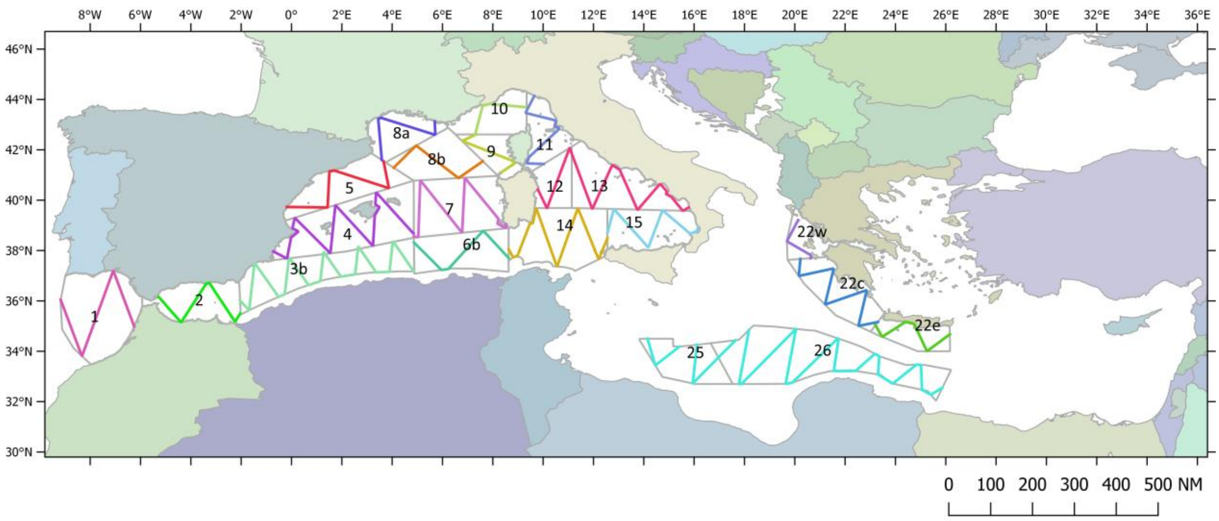


Figure 4a. The designed tracks for the vessel surveys.

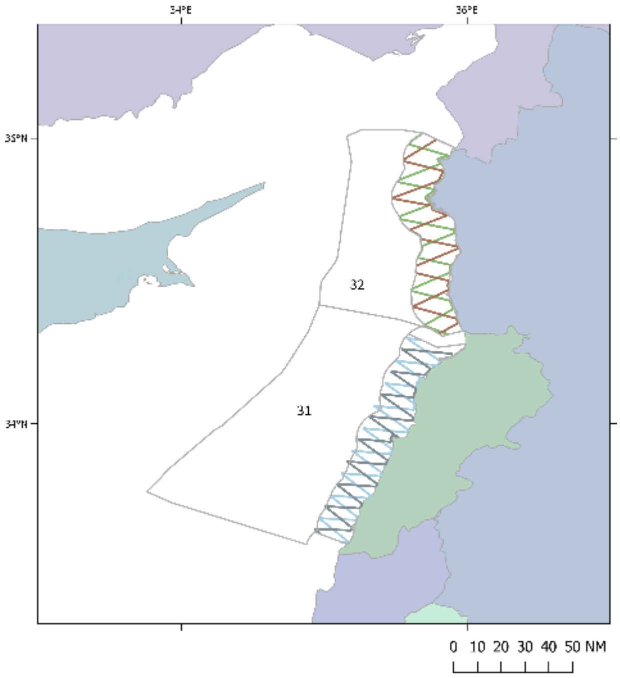


Figure 4b. The designed tracks within 12 nautical miles of land for blocks 31 and 32.

Table 2 - Survey design details and expected effort and acoustic coverage for vessel-based transects (lengths in Km). * represents coverage estimates based on visual detections alone for those surveys that did not use acoustic techniques.

Ref	Block	Area (km²)	Design	% acoustic coverage	Total on effort track length
1	Gulf of Cadiz	91,031	Equal Spaced ZigZag	0.157	932
2	Alboran	28,123	Equal Spaced ZigZag	0.201	722
3b	AlgeriaWest offshore (modified)	83,666	Equal Spaced ZigZag	0.283	1,572
4	Baleares	93,066	Equal Spaced ZigZag	0.204	1,422
5	NE_Spain	53,202	Equal Spaced ZigZag	0.198	791
6b	AlgeriaEast offshore (modified)	57,123	Equal Spaced ZigZag	0.160	567
7	WestSardinia	73,430	Equal Spaced ZigZag	0.240	1,155
8a	GulfLion Shelf	34,718	Equal Spaced ZigZag	0.209	528
8b	GulfLion Deep	46,952	Equal Spaced ZigZag	0.155	507
9	PelagosSW	22,642	Equal Spaced ZigZag	0.267	427
10	PelagosNW	34,093	Equal Spaced ZigZag	0.101	335
11	PelagosE	31,064	Equal Spaced ZigZag	0.233	620
12	TyrrhenianCWest	27,262	Equal Spaced ZigZag	0.117	445
13	TyrrhenianCEast	66,588	Equal Spaced ZigZag	0.117	1,109
14	TyrrhenianSWest	77,001	Equal Spaced ZigZag	0.227	1,214
15	TyrrhenianSEast	49,832	Equal Spaced ZigZag	0.214	742

22w	HellenicTrench West	28,987	Equal Spaced ZigZag	0.340	233
22c	HellenicTrench Centre	50,171	Equal Spaced ZigZag	0.280	845
22e	HellenicTrench East	28,987	Equal Spaced ZigZag	0.260	443
25	LybiaWest	90,100	Equal Spaced ZigZag	0.115	665
26	LybiaEast	153,863	Equal Spaced ZigZag	0.115	1,888
27	EgyptWest	108,623	Equal Spaced ZigZag	0.347	2,939
28	EgyptEast	60,536	Equal Spaced ZigZag	0.193	1,632
31b	Lebanon 12nm	4,051	Equal Spaced ZigZag	0.212*	1,063
32	Syria 12nm	10,138	Equal Spaced ZigZag	0.146*	848

1.4 Platforms, teams and equipment

In order to cover the whole Mediterranean ACCOBAMS area, several platforms were selected. It was decided to invest in priority in aerial surveys, as they tend to be more cost efficient and allow a higher coverage in a shorter time framework. The ACCOBAMS Secretariat started a consultation process with each ACCOBAMS ASI contact Member to inquire about the possibility of flying over national and territorial waters. The process was finalized during the Tunis workshop (October 2017), and bilateral meetings were organized to facilitate the process of requesting permits for aerial surveys and scientific monitoring. For the areas where aerial surveyed were not possible, a different platform, namely a research vessel, was selected.

Aerial Platforms

Once the first draft survey design for the aerial component was ready, an expression of interest was sent to a number of aerial companies to pre-identify potential Aircraft Companies partners. The list was populated according to personal knowledge of the Steering Committee members, who have been involved in large scale aerial surveys of the last few years. After a final tender, four companies were selected, with different suitable planes selected for specific areas. According to previous regional experience, planes characteristics, language for the cruise leaders and the pilots, specific planes were assigned to certain areas. At the end eight planes of three different kinds were used for the survey: 4 Partenavia P68 (Figure 5), 2 Britten Norman BN-2 Islander and 2 Cessna Skymaster O-2 push-pull, all equipped with bubble-windows and suitable for aerial surveys at sea.

Figure 5. Partenavia P68.

Sea Platforms
In consideration of the presence in the area of deep diving species, such as sperm and beaked whales, it was also decided to look for an appropriate vessel equipped with towed hydrophone arrays, to collect acoustic data and allow density and abundance estimated through acoustic locations, instead of visual one. In this view, A partnership was set up with Marine Conservation Research, owners and operators of the R/V Song of the Whale, previously used by the International Fund for Animal Welfare (IFAW), given their long collaboration history with ACCOBAMS and their previous experience in surveying large areas, in particular in the Mediterranean Sea.
In the meantime, a number of other boats and appropriate platforms were selected by the ACCOBAMS Secretariat and the Scientific Coordinator. As a result, the boat Naftilos, belonging to the NGO Archipelagos Marine Research Institute, ACCOBAMS Partner, was identified to cover the Libyan waters, and the R/V Cana, belonging to the CNRS Lebanon, was selected to cover the Lebanese territorial waters up to 12 nautical miles from the coast. Contacts with Egypt and Syria were established, to arrange proper training and participation and to select adequate national research vessel to cover those areas. Effort is still ongoing to facilitate the ship-based survey of Egyptian and Syrian waters.

Teams
The different teams were composed according to previous experience in leading and participating to aerial and boat-based surveys. A list of available observers, both for planes and boats was also prepared, in consideration of previous experience but also to fulfil the strong training and capacity building component and ensuring the participation of scientists and experts from almost all the involved countries, which was an essential part of the entire survey. Observers and cruise leaders were then merged to create a series of complete teams, basing the decision on previous work together and language issues. Some observers were kept as back-up options, in case some last-minute changes and emergencies would arise, to make sure that the monitoring programme would continue without interruptions. In addition, scientists from the Black Sea participated in the survey which allowed them to reinforce their skills in the view of their leadership role for the Black Sea survey.

Equipment
Several sets of survey kits, with all the instruments needed to run an aerial survey were assembled and given to each cruise leader during the Cuers workshop, making sure that everything was in place, tested and working. A few spare kits and parts were kept by the ASI Scientific Coordinators, to be ready to ship replacements in case of malfunctioning and failures.

Each of the 8 aircrafts accommodated at least three scientific crew in addition to the pilot. Target altitude was 183m (600 feet) as several survey: SCANS, SAMM, OBSERVE or REMMOA, with target speed of 100 knots. The data recorder used SAMMOA software, dedicated to data acquisition on marine megafauna from visual observation during aerial survey, developed by Pelagis Observatory-La Rochelle University- CNRS with technical support of a data processing office Code Lutin. SAMMOA is connected to a GPS and has a simultaneously audio recording system. SAMMOA allows to establish a flight plan before take-off, with planned tracklines and observer’s position onboard.
SAMMOA allows the data validation with the same interface and the checking, thanks to the voices recording.

1.5 Administrative preparation

The Administrative preparation of the survey consisted of the following main aspects:

1- **identification of partners and contractors,** through calls or direct establishment of Memorandum of Understanding, negotiations and elaboration of contracts, for all involved stakeholders (national partnering organizations, research institutes, NGO, observers, team leaders, scientific coordination team, aircraft companies, etc.) Considering the large number of involved stakeholders, this work was conducted from April 2017 until the end of the survey (to adapt to last minute changes occurring during the fieldwork).

2- **Logistical preparation and follow-up**: the ACCOBAMS Secretariat was responsible for the preparation and implementation of all meetings, visits, workshop organization during the preparation phase and put in place a system of pre-paid cards for daily life logistics of the teams. In addition, the ACCOBAMS Secretariat provided back up support to all teams during the surveys (last minute flight reservations, hotels, flight plans transmission to relevant authorities…)

3- **Permits and authorization:**

Considering the number of countries involved in the survey, and therefore the number of different administrative contexts to consider, the setting up of the ASI Contact Group was fundamental, so that the ACCOBAMS Secretariat would have, in addition to its direct ministerial/diplomatic contacts, a vis a vis in each country to help with identifying and conducting the processes to obtain relevant authorizations, either for the aerial or the boat-based surveys.

Numerous consultations, meetings and information exchanges were required during the preparation period. This consultative phase started more than a year before the survey start, and was consolidated during the ASI preparation workshop held in October 2017 in Tunisia which brought together the members of the ASI Contact Group. This event allowed participants to identify potential additional problems as well as to validate, modify or supplement the information obtained thus far by the ACCOBAMS Secretariat for the administrative aspects of the implementation of the campaign (permits, flight authorizations, security and military considerations, contracting aspects, security certification, etc.).

From there, the necessary steps were taken to ensure the feasibility of monitoring cetaceans throughout the area, taking into account the constraints, particularities and procedures of each country. This process let to obtaining permits to conduct the work in most of the intended areas of work, in some cases with consequent delay; in a few cases, originally sought authorizations for aerial surveys could not be obtained (e.g. in Egypt, Libya, Morocco and Syria airspaces) and alternative types of platform were mobilized (international or national boats).
Security situations or national restrictions also led the ACCOBAMS Secretariat to adjust the choice of monitoring platforms in certain areas.

1.6 Training workshops

Aerial Survey Training Workshop:
A first training workshop was organized in Cuers, France, where all the teams involved in the aerial monitoring attended both theoretical and practical lessons, for familiarization and preparation for field work activities. During the training workshop, particular emphasis was dedicated to Cruise Leaders to familiarize with the different aspects of the planned field work, including accounting, problem solving, daily planning, etc.

Specific sessions were dedicated to data logging software SAMMOA and species identification, with effort towards a multi-species approach. During the workshop, all the data collection protocols were discussed and modified, in order to facilitate the standardized and shared approach. Data collection instruments were also presented and explained to participants, together with a practical demonstration to each cruise leader individually. WhatsApp groups were also created, to facilitate real time exchanges with the ACCOBAMS Secretariat and Scientific Coordinator, to address daily situations and facilitate the decision process in case of doubts or particular requests.

The last two days of the Cuers training workshop were dedicated to a series of practical flights where cruise leaders and their teams spent a few hours flying over the waters of the Pelagos Sanctuary simulating a real survey, with time to check collected data and amend, and fine tune the data collection protocols, which were extensively discussed and analysed.

Boat-Survey Training Workshop:
Intensive training effort has been dedicated to present, discuss and adapt data collection protocols for boat-based visual and acoustic surveys. During a one-week training workshop in Samos, Greece, researchers from Syria, Lebanon, Libya and Egypt were trained as potential cruise leader or trainers, in order to be able to conduct independent surveys in their home countries, applying the same shared and standardized protocols. Data logging software, sightings protocols, organisation of watch rotas, as well as acoustic methodology were discussed and adapted to the different needs. The training workshop included two days out at sea to test the survey protocol, distance estimation for each sighting and the data collection software Logger 2000; Extensive trouble shooting sessions were dedicated to address potential issues during field work and to make sure each participant was confident in solving and handling specific situations.

2. Aerial and boat survey implementation

2.1 Aerial survey implementation

The Aerial Survey implementation was conducted following the organisational scheme described below (Figure 6).

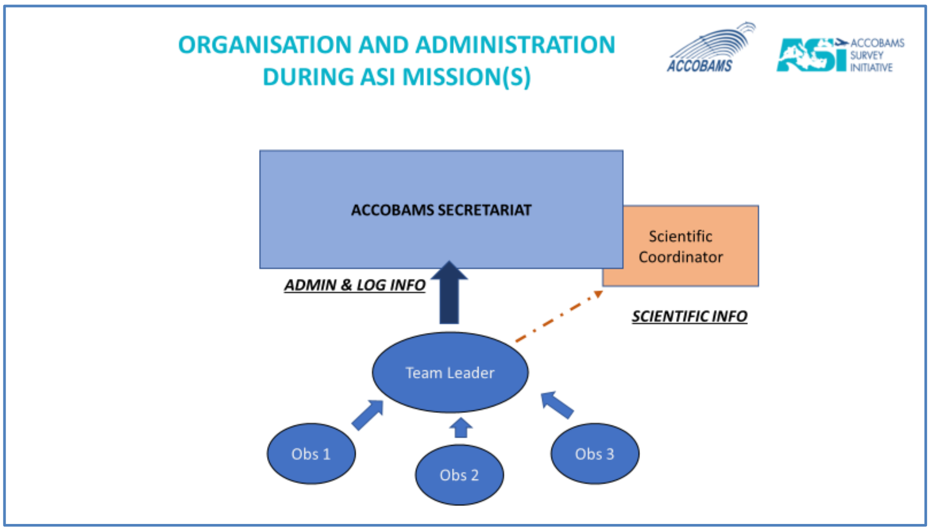


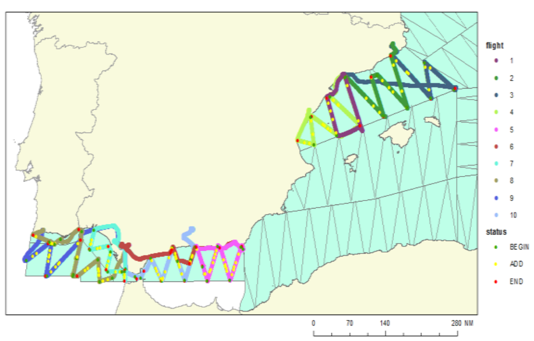
Figure 6: Organisation and administration during the ASI missions.

Data collection for aerial surveys

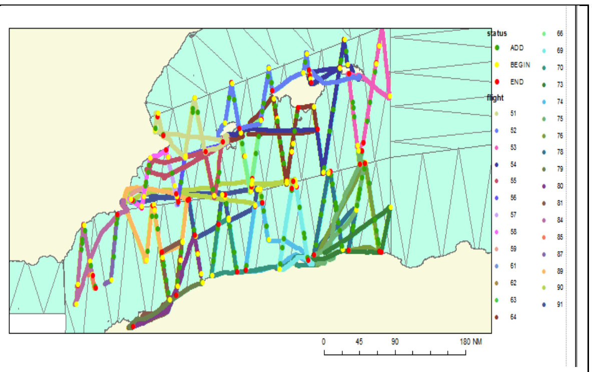
The following table and figures present the subdivision of blocks and Team Leaders, the different planes used to cover each block, a specific code assigned to each data collection computer and the start and end dates of flights (Table 3; Figure 7). The number of total flights recorded on SAMMOA, the dedicated software used for data collection, is also listed in the last column of the table. Each figure represents the effort carried out by single team leaders, with different colours attributed to different flights.

Table 3. Flights information

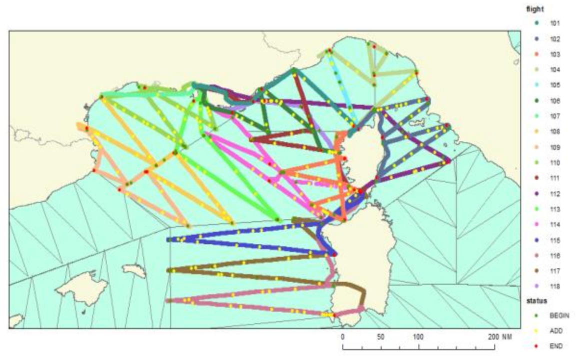
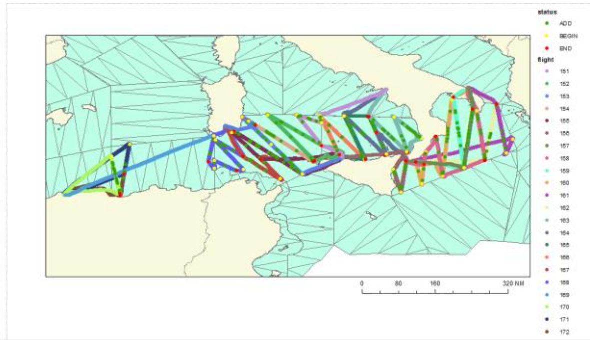
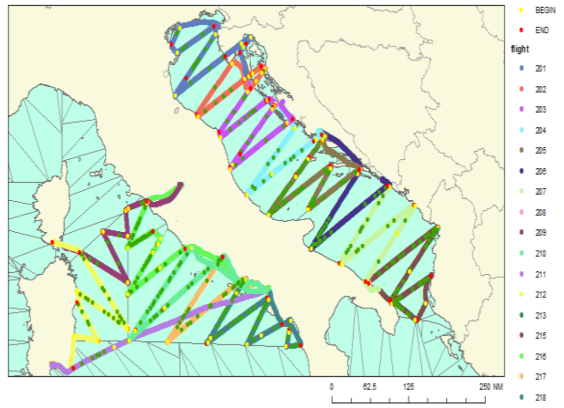
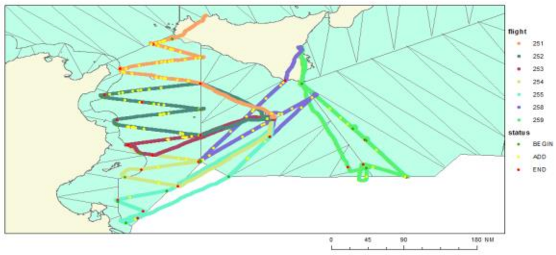
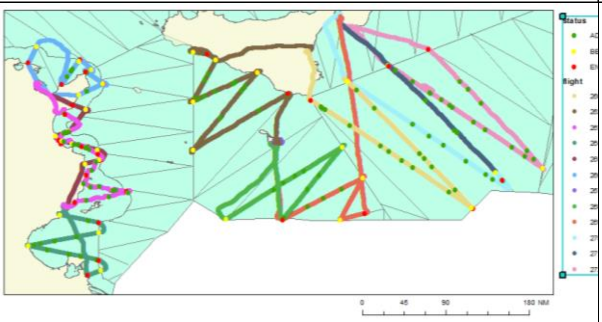
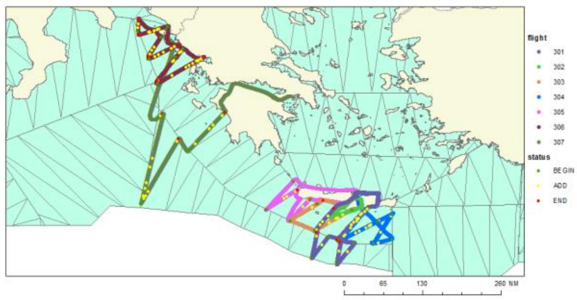
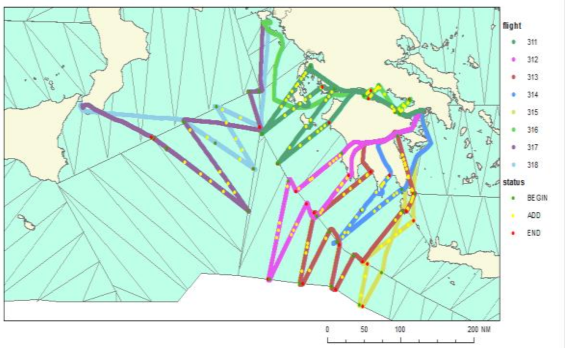
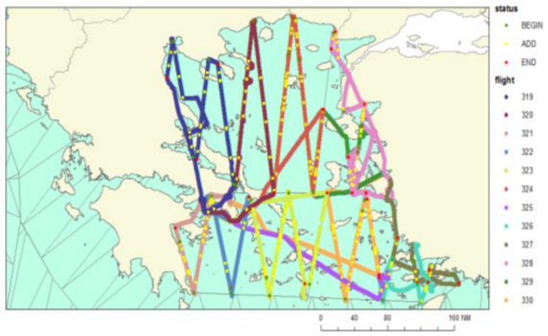
Type of Plane	ID computer and Team number	Team Leader/System	Date of first flight	of last flight	Number of flights on SAMMOA
Partenavia P68	A1	Helder	20/06/18	06/07/18	10 flights
Partenavia P68	B1	Toño	01/07/18	31/07/18	27 flights
Britten Norman BN2	C1	Ghislain	11/06/18	09/07/18	18 flights
Partenavia P68	D1	Nino	20/06/18	19/07/18	22 flights
Partenavia P68	E1	Drasko	03/07/18	28/07/18	15 flights
Cessna 337	F1	Nathalie	21/06/18	01/07/18	7 flights
Cessna 337	F2	Giancarlo	03/07/2018	20/07/2018	8 flights
Cessna 337	F2	Marc	07/07/2018	09/07/2018	4 flights
Britten Norman BN2	G1	Morgane	06/06/18	24/06/18	7 flights
Britten Norman BN2	G2	Joan	03/07/18	21/07/18	8 flights
Cessna 337	G3	Marian	09/08/18	27/08/18	12 flighs
Cessna 337	H1	Léa	25/06/17	22/07/18	11 flights
Cessna 337	H2	Helder	23/07/18	06/08/18	7 flights
Cessna 337	H3	Dimitar	14/08/18	20/08/18	5 flights

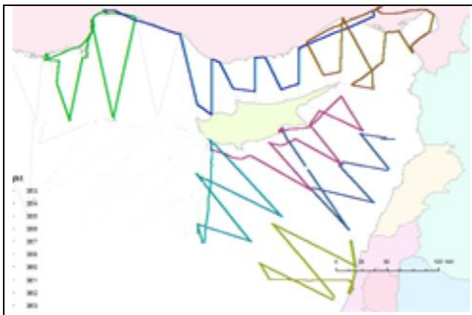


Team A1

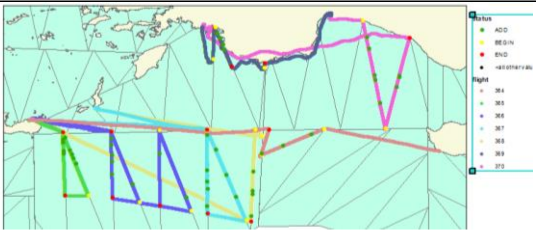


Team B1

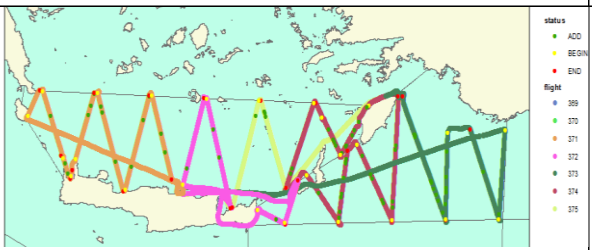
 Team C1	 Team D1
 Team E1	 Team F1
 Team F2	 Team G1
 Team G2	 Team G3



Team H1



Team H2



Team H3

Figure 7- Tracks of the plane during dedicated flights covered by the different teams. Different colors represent different flights.

Data verification and validation

For the aerial surveys, data were validated by the team after each flight and checked by the cruise leader. At the end of the survey, all flights were computed by the teams and general covered area was checked in order to be sure to store all the effort collected. Data check and validation will be done in a second phase to clean the data set in order to prepare for the analysis.

For the vessel-based surveys, data were validated at the end of each survey leg by the senior scientist. Following the completion of fieldwork, a data check and validation was conducted to clean the dataset in preparation for further analysis.

Collected data have been stored into dedicated DropBox folders which were created and shared with Team Leaders. Every day, after data validation, the DropBox folder was updated and the Scientific Coordinator downloaded the files for that specific day. Data were then saved in two separate hard drives and copy of the files was sent regularly to Pelagis, at the University of La Rochelle, for extra storage and for data preparation for the analysis. Data have then been merged into GIS shape files and MS Excel files, for plotting and descriptive statistics.

2.2 Boat survey implementation

MCR assisted and provided guidance with coordination and execution of all vessel surveys (Naftilos of Archipelagos, Cana of CNRS Lebanon, Syrian boat and Egyptian boats) in addition to undertaking visual and acoustic vessel surveys of various blocks of the Mediterranean basin using the R/V Song of the Whale (Figure 8).

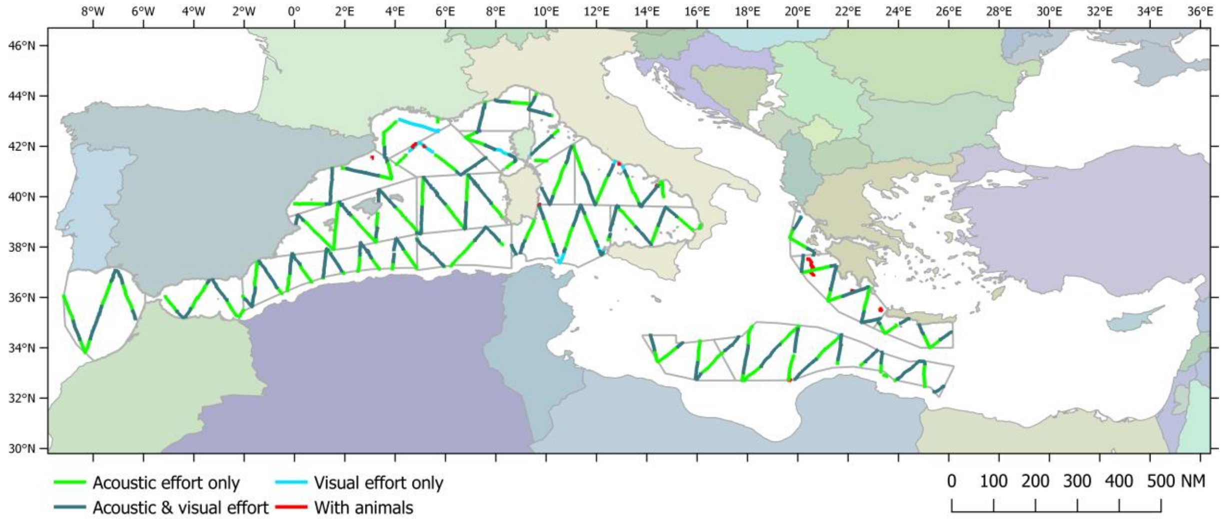


Figure 8- Survey transects conducted by the Song of the Whale team between 28th May and 29th September 2018 by the Song of the Whale team.

3. Preliminary results

3.1 Aerial survey data

These results are not definitive and there are some flights that still need to be validated, some datasets need to be corrected and verified.

The goal of this exercise is to present an update after most of the effort has been carried out during the summer months of 2018. A few areas are still to be surveyed, namely the Syrian and the Egyptian waters, and effort is ongoing with the ACCOBAMS Secretariat to facilitate this process during summer 2019.

Effort is ongoing to prepare a data analysis framework which will facilitate a robust outcome, which will be used by ACCOBAMS Parties and the scientific community at large in shaping and deciding future conservation actions throughout the Basin.

Preliminary calculation of the total aerial survey effort is 71,000 km (using Mercator projection to estimate length), which can be seen in the following map, where different colours represent different planes and research teams used during field-work. Final numbers could probably change during the data analysis effort, once some effort track will be corrected.

The following maps (Figures 9-16) present a preliminary graphic representation of the transects covered and of the different sightings, grouped per taxa and size.

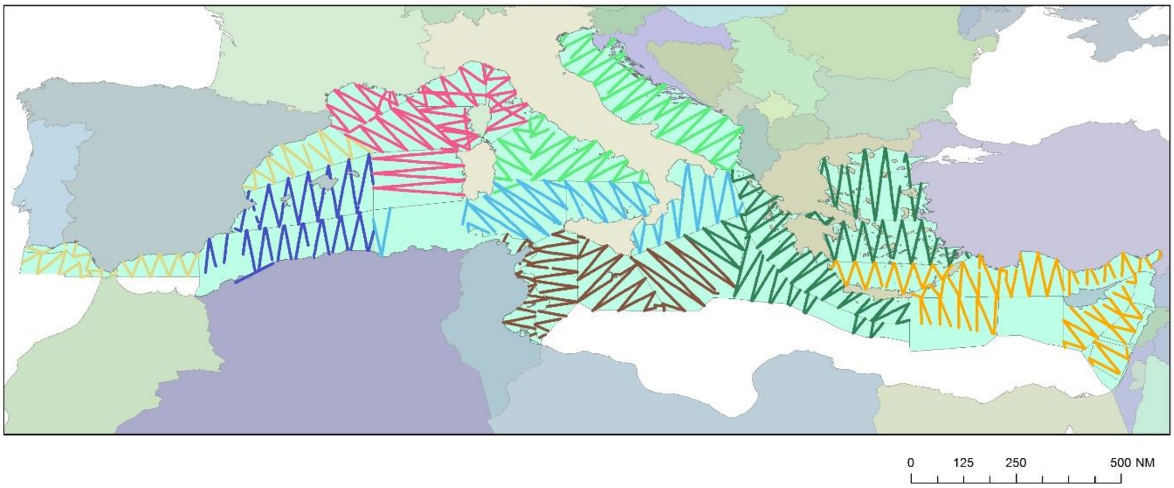


Figure 9 - The total effort covered during the aerial survey campaign in summer 2018.

In summary, during the aerial survey a total of 27,341 sightings on effort were recorded; the vast majority of these being represented by human activities, including trash (plastic or unidentified) - 17,364 sightings.

The following tables present a summary of the sightings recorded during the flights, grouped by taxon and wider categories (Tables 4-8). Once the data will be analysed, dedicated maps and descriptive statistics will be available and provided.

- Fin whales have been regularly sighted in the Ligurian Sea, Gulf of Lions and Gulf of Cadiz, demonstrating previous knowledge of distribution and presence for this species.
- Sperm whales have been sighted along the Hellenic Trench and in the offshore waters of the Sardinia Sea.
- One rare sighting of a minke whale occurred close to the Balearic Islands, while killer whales have been observed in the Strait of Gibraltar - Gulf of Cadiz area.
- Risso's dolphins have been sighted more offshore than originally expected for a species which usually prefers slope areas.
- Pilot whales have been observed all along the Western Mediterranean, more in the northern portion and to a lesser extend in the South.
- Cuvier's beaked whales have been mostly sighted in canyon areas, as expected from current knowledge of this species.
- Common dolphins have been mostly sighted in the Western portion of the Basin and in the Strait of Sicily.
- Bottlenose dolphins appear to be very common in the northern portion of the Adriatic Sea, in the Strait of Sicily and along the coast, with some sighting more offshore.
- Striped dolphins are mostly distributed in the offshore waters and appear to be the most abundant species throughout the Mediterranean Sea.

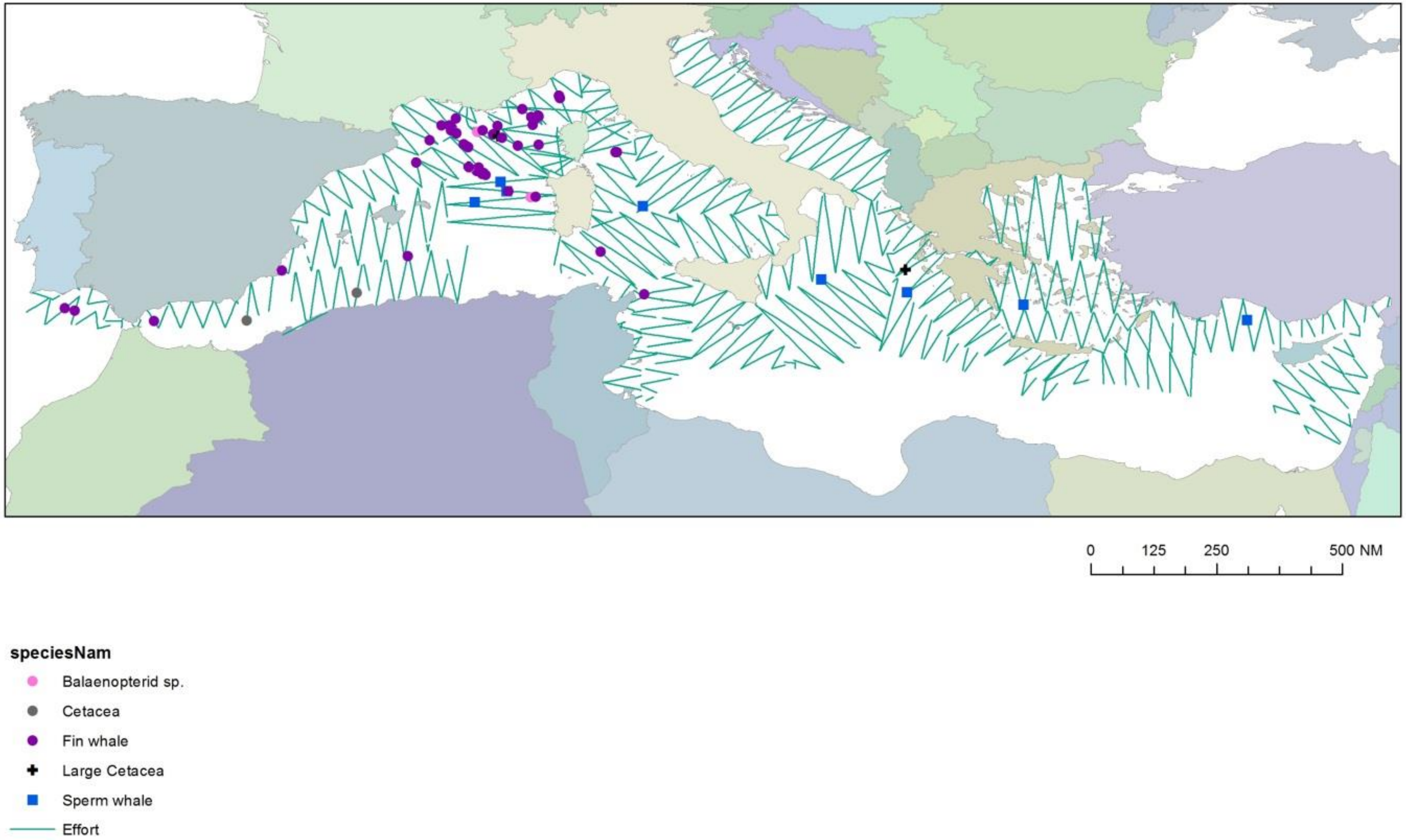


Figure 10 - Fin and sperm whale sightings, including some un-identified large specimens.

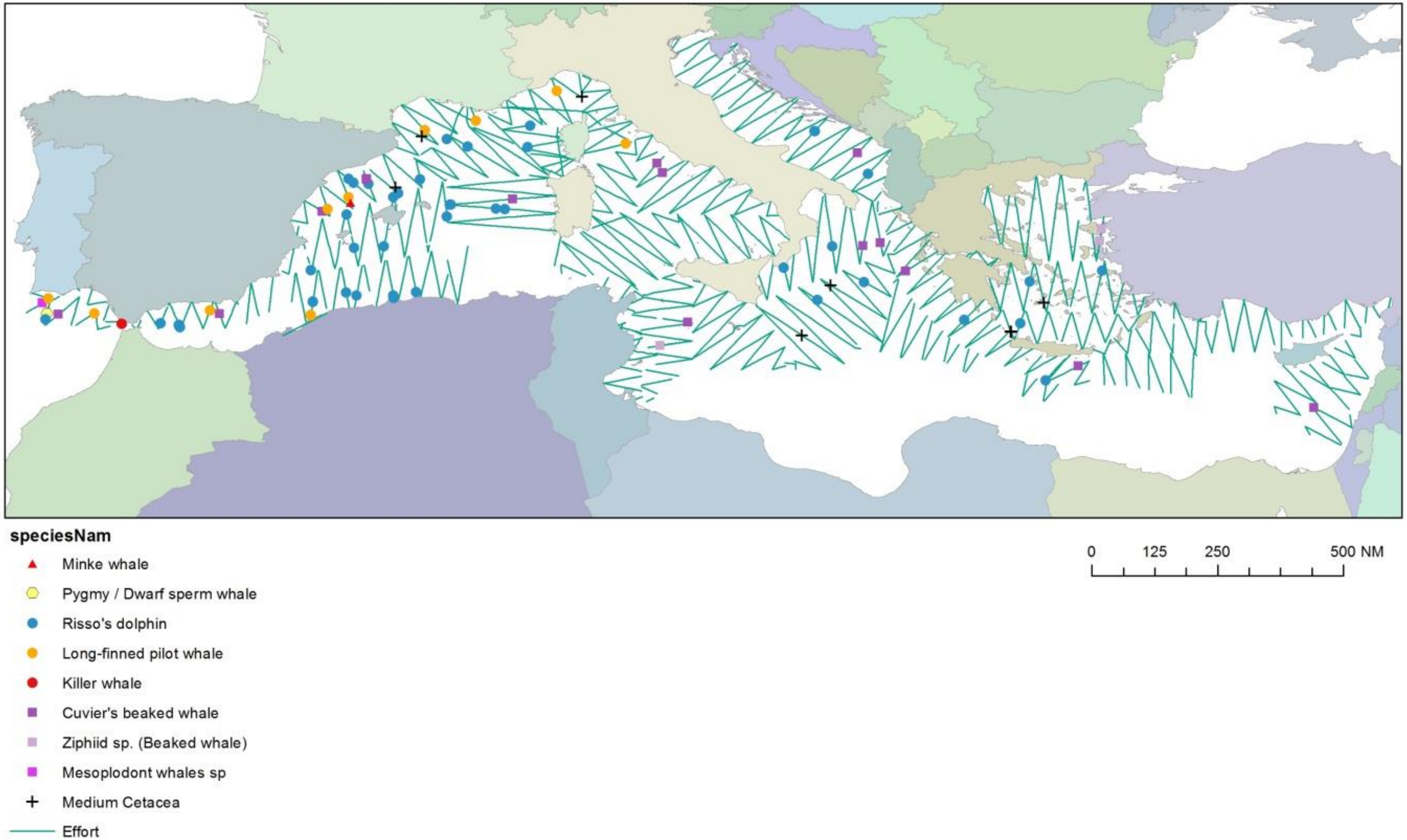


Figure 11 - Medium size cetaceans sightings, including some un-identified beaked whales.

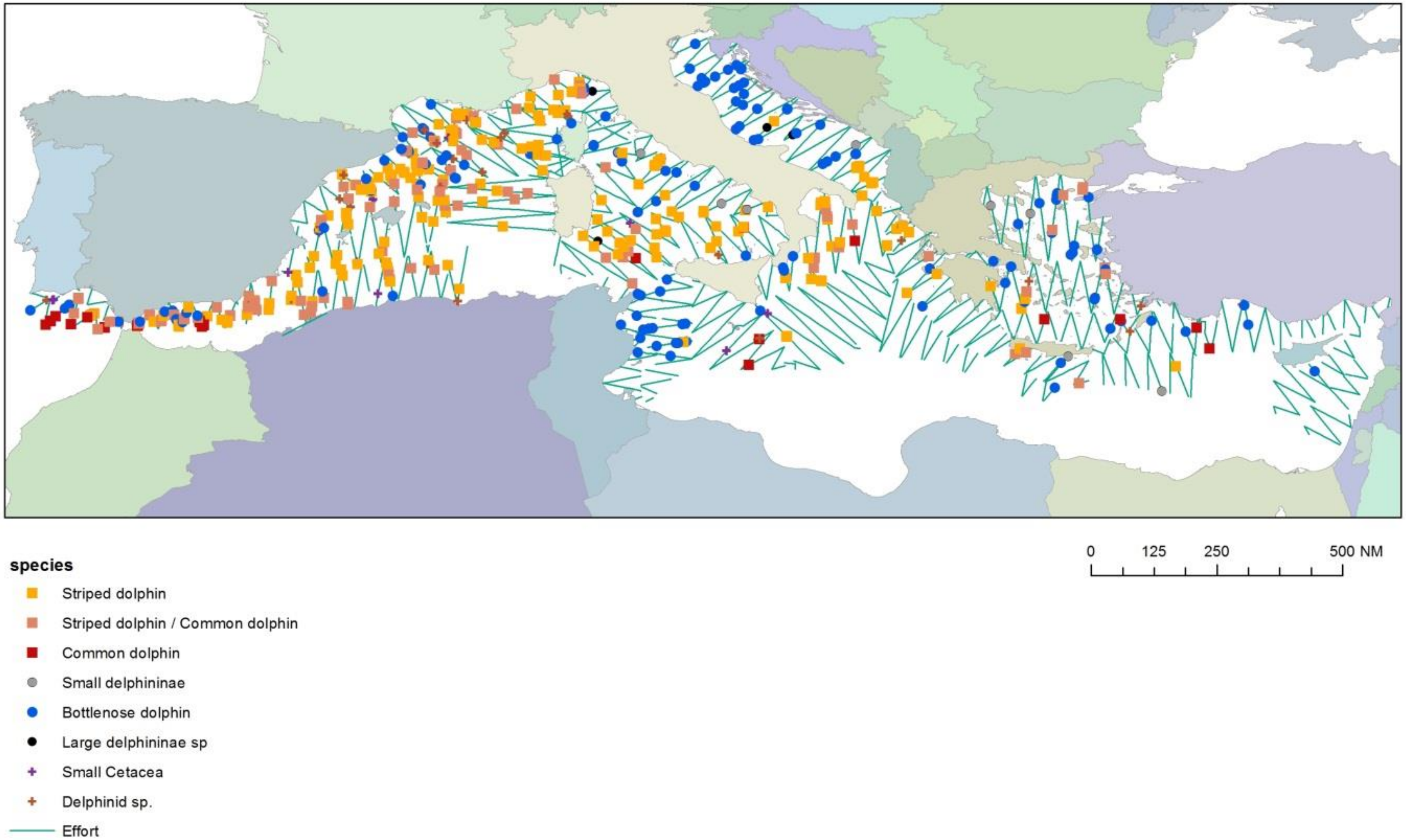


Figure 12 - Small size cetaceans sightings, including some mixed groups of striped and common dolphins.

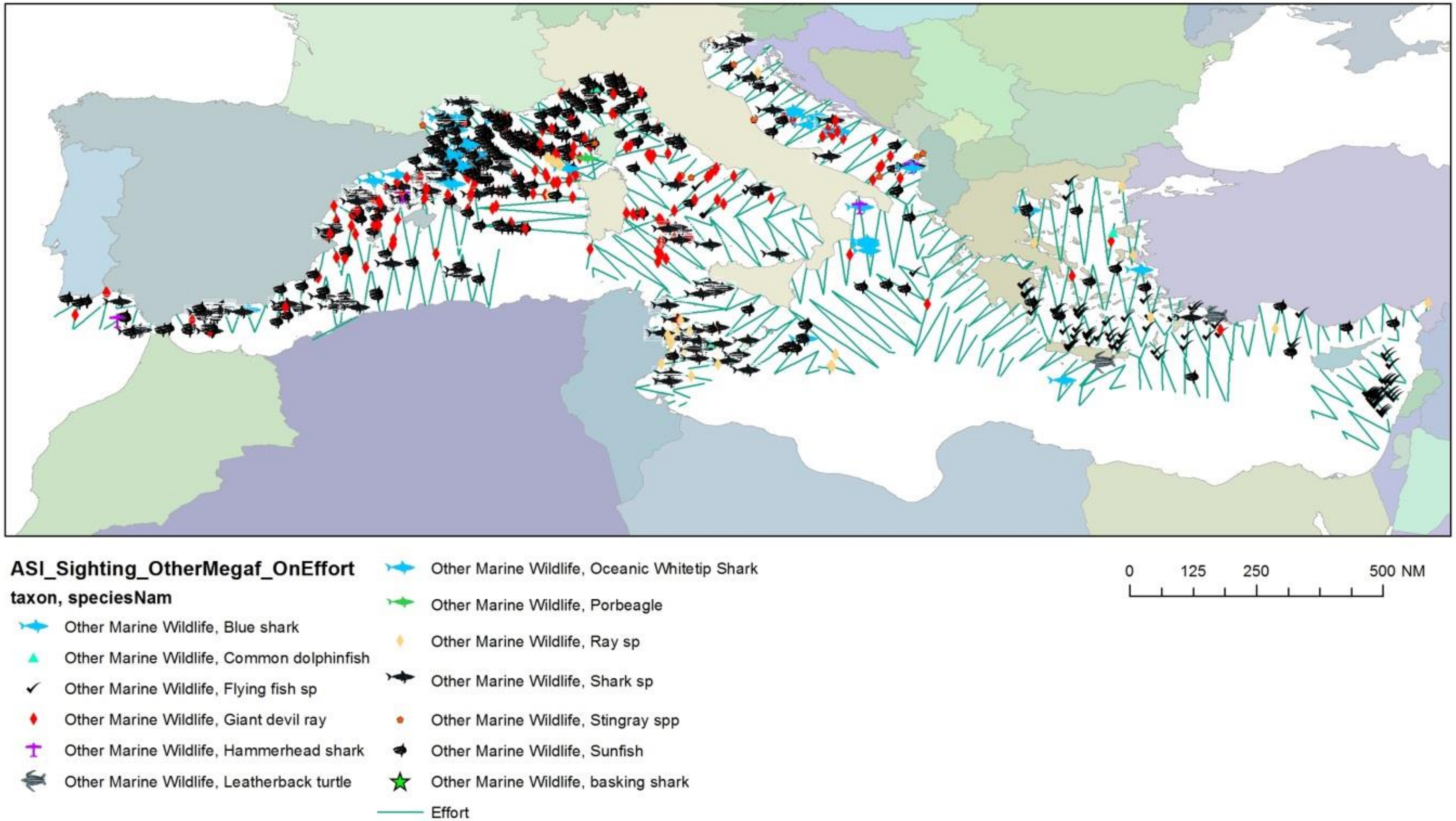


Figure 1 - Small size cetaceans sightings, including some mixed groups of striped and common dolphins.

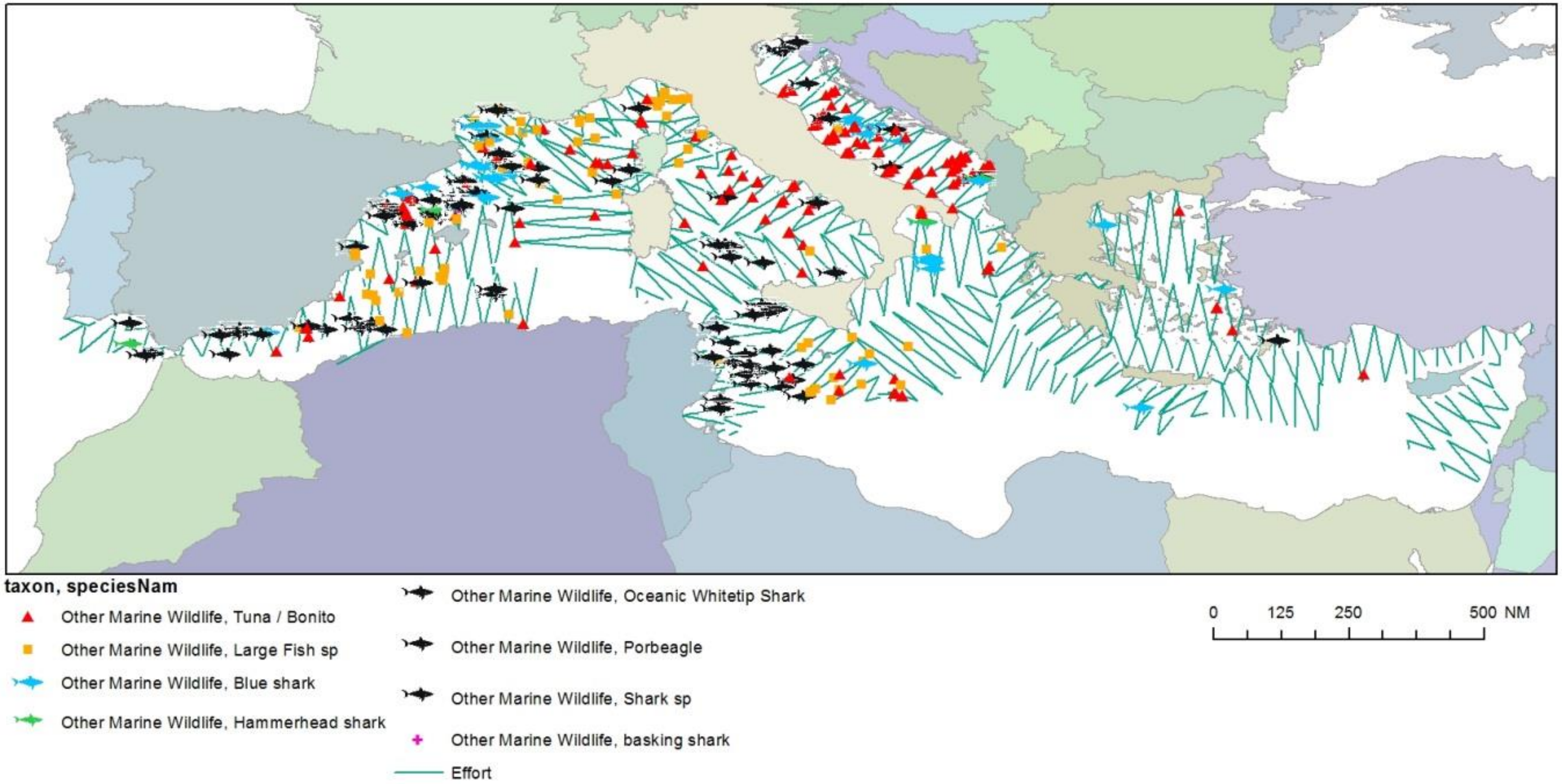


Figure 2- Fish and elasmobranch sightings.

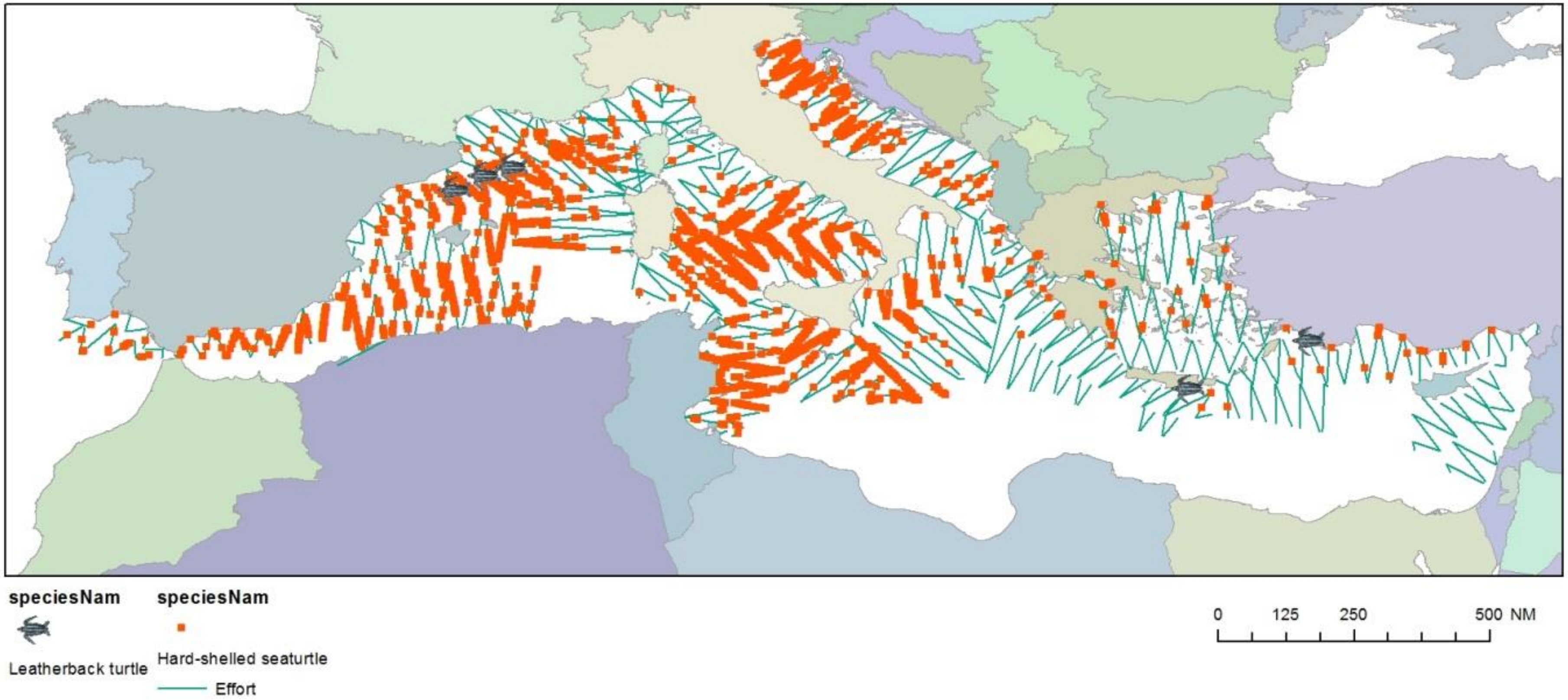


Figure 3 - Turtle sightings, mainly loggerhead turtles and come leatherback sightings.

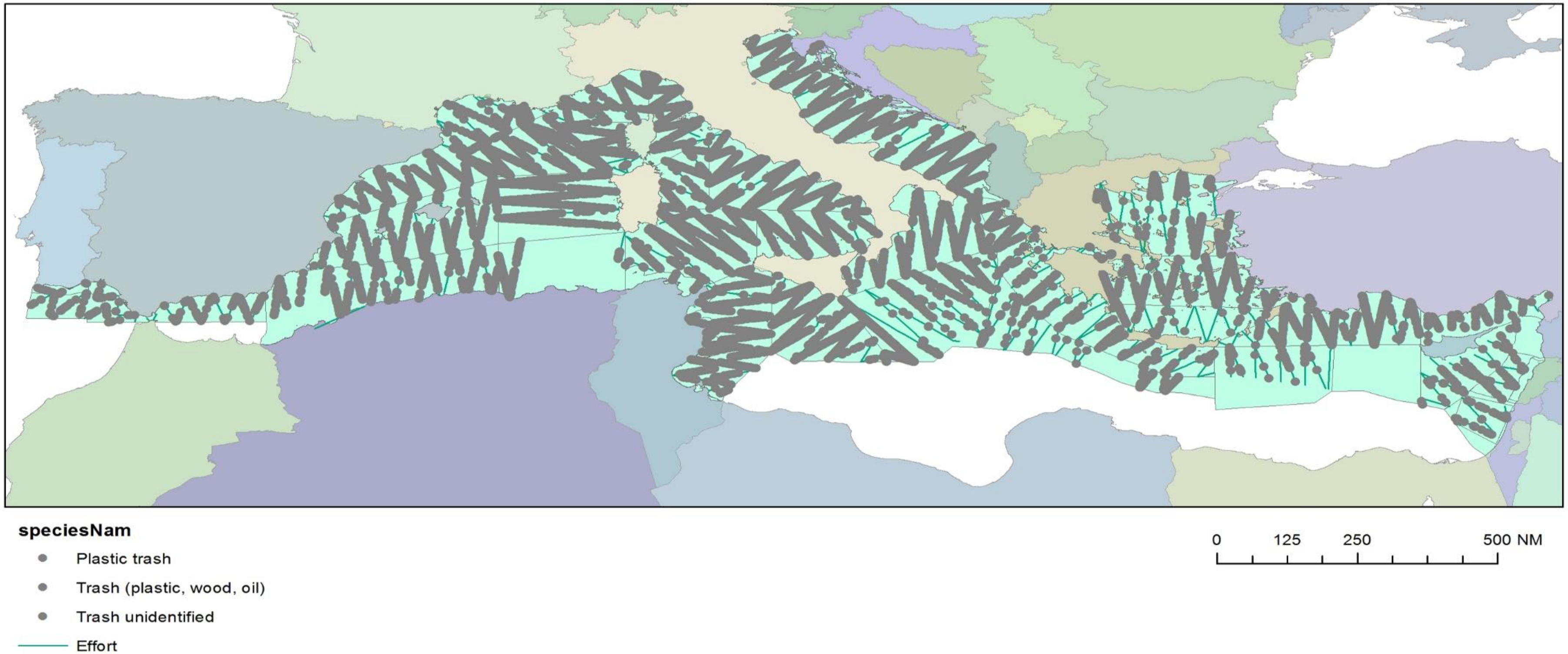


Figure 4 - Marine litter, including plastic and wood trash.

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Table 4- Summary of cetacean sightings observed in each of the survey blocks

	01c	01d	01e	02	03	04	05	06	07	08a	08b	09	10	11	12	13	14	15	16	17	18	19	20	21	21b	22a	22b	22c	22d	23a	23b	24	29a	29c	30	Total
Balaenopterid sp.									1	1	2																									4
Bottlenose dolphin	5	2		11	2	2	4			12	9	2	1	7	4	8		2	28	7	4	1		15	5	2	4	2		11	6	1	2	1		160
Common dolphin	12	1		11													1	1			1		2			2		1					1			33
Cuvier's beaked whale	1			1			3		1							2				1	2			1			2								1	15
Delphinid sp.	1				5	5	4	2		3	6		2			1	1	1					3				2	1			2		1			40
Fin whale	2			1	1	1	1		2	7	15	2	9		2		1							1												45
Killer whale		2																																		2
Large Cetacea											2																1									3
Large delphinidae sp														1			1		1	1																4
Long-finned pilot whale	1		1	1	2		2			2			1	1																						11
Medium Cetacea							1			1			1									2				2					1					8
Mesoplodont sp	1																																			1
Minke whale							1																													1
Pygmy / Dwarf sperm whale	1																																			1
Risso's dolphin	1			8	11	8	5		8	1	1	2								3	2	3				1	2				2					58
Small Cetacea			2		1	2	1			2	1		1				1					1	1	1												14
Small delphinidae	1														1	5				1							2		1	2						13
Sperm whale									5							1						1					1				1		1			10
Striped dolphin	6			15	22	23	29	2	5	18	5	6	27	2	2	14	18	6	1	9	18	4		1			13		1		6					253
Striped dolphin / Common dolphin	5	3		20	22	10	5		7	27	6	1	11	2	1		5				6						4			4	3					142
Ziphiid sp. (Beaked whale)																								1						2						3
Total	**37**	**8**	**3**	**68**	**68**	**51**	**56**	**4**	**29**	**74**	**47**	**13**	**53**	**13**	**10**	**31**	**28**	**10**	**30**	**22**	**33**	**12**	**6**	**20**	**5**	**7**	**31**	**4**	**2**	**19**	**21**	**1**	**5**	**1**	**1**	**823**

Table 5- Summary of other Vertebrates observations, with number of sightings and total number of animals.

Other vertebrates	# of sightings	# of animals
Basking shark	1	3
Blue shark	37	42
Common dolphinfish	4	5
Fish sp	30	116
Flying fish sp	104	263
Giant devil ray	216	420
Hammerhead shark	4	12
Hard-shelled sea turtle	3653	3949
Large Fish sp	81	215
Leatherback turtle	5	5
Oceanic Whitetip Shark	4	4
Porbeagle	1	1
Ray sp	44	82
Shark sp	102	187
Small Fish sp	106	3064
Stingray spp	15	16
Sunfish	341	377
Swordfish, sailfish, marlin	230	257
Tuna/Bonito	169	6040
Total	**5594**	**23320**

Table 6- Summary of birds observations, with number of sightings and total number of animals.

Birds	# of sightings	# of animals
Atlantic puffin	2	2
Audouin's gull	1	1
Auk sp	1	1
Bird of prey undetermined	2	2
Black-headed gull	2	2
Common gull	11	12
Cormorant / shag sp	17	34
Cory's shearwater	662	1895
Duck sp	3	28
European storm-petrel	30	41
Falcon sp	2	2
Gannet	40	140
Grebe sp	1	1
Gull sp	230	1210
Heron sp	1	1
Land Bird	25	535
Large "grey" gull sp	541	2186
Large shearwater sp.	211	631
Larids unidentif.	159	1247
Mediterranean gull	26	265
Medium gull sp	88	267
Pelican sp.	2	3
Shearwater sp.	31	490
Shore bird unidentif.	6	7
Skua	6	6
Small gull sp	156	658
Small shearwater sp.	219	1198
Swift undeterminded	4	4
Tern sp.	87	129
Unidentified Bird	92	356
Total	**2659**	**11355**

Table 7 - Summary of cetaceans observations, with number of sightings and total number of animals.

Marine mammals	# of sightings	# of animals
Balaenopterid sp.	4	10
Bottlenose dolphin	160	1171
Cetacea	2	3
Common dolphin	33	920
Cuvier's beaked whale	15	47
Delphinid sp.	40	741
Fin whale	45	69
Killer whale	2	13
Large Cetacea	3	12
Large delphinidae sp	4	10
Long-finned pilot whale	11	81
Medium Cetacea	8	37
Mesoplodont whales sp	1	3
Minke whale	1	1
Pygmy / Dwarf sperm whale	1	1
Risso's dolphin	58	350
Small cetacean	14	48
Small delphinidae	13	121
Sperm whale	10	24
Striped dolphin	253	5577
Striped dolphin / Common dolphin	142	2508
Ziphiid sp. (Beaked whale)	3	4
Total	**823**	**11751**

Table 8 - Summary of human activities observations, with number of sightings and total number of animals.

Human activities	# of sightings	# of items
Administrative boat (navy, custom, coast guard)	8	11
Boat using for Passive fishing gear	13	22
Bulk cargo	2	2
Containership	2	2
Ferry	15	15
Fishing Aggregating Device	1	1
Fishing boat (professional)	70	74
Fishing buoy, set net	423	527
Fishing farm	22	22
Fishing trash (net part, buoy?)	295	316
Gill-netter	16	16
Longliner	2	2
Merchant ship (containership, cargo, tanker)	107	107
Non identified ship	8	8
Oil slick	90	92
Plane	2	2
Plastic trash	12028	28611
Platform	2	2
Pleasure boat	40	61
Sailing boat	232	310
Seiner	11	12
service boat for wind farm, ?.	14	14
Small motor boat	235	384
Small traditional fishing boat	8	11
Trash (plastic, wood, oil)	163	184
Trash unidentified	4788	12324
Trawler	88	89
Unnatural wood	332	342
Total	**19017**	**43563**

3.2 Boat-based survey data

Different research boats were employed to survey the Mediterranean Sea concurrently with the aerial survey effort. In some instances, both the airplane and the boat were used, while in other occasions only one of the two methods was applied. Acoustic surveys were particularly important to monitor deep diving species, such as sperm and beaked whales, which tend to spend most of the time underwater and are therefore less amenable to be spotted visually /by aerial surveys. In other situations, such as in the Egyptian, Libyan, Lebanese, Syrian and Moroccan waters, it was not possible to conduct an aerial survey and therefore a boat survey was the only possible option.

The following research vessels have been used, while some areas still need to be covered.

- R/V Song of the Whale: this boat was used to the Western Mediterranean Sea and the Hellenic Trench. A detailed summary of the results is presented in the next section of this report.
- R/V Cana: this boat, belonging to the Lebanese National Council for Scientific Research (CNRS) was used to survey the territorial waters of Lebanon in August 2018. Effort started on August 8th and ended on 11th September.
- R/V Naftilos: this boat was used to survey some of the offshore waters of Greece, between Malta and Libya. Due to unforeseen logistical and operating constraints, the area originally assigned to Naftilos was covered by Song of the Whale in September 2018, after the Hellenic Trench survey.

R/V Cana

The Lebanese research vessel Cana was used in August 2018 to survey the territorial waters, with two sets of tracks, crossing the coastline perpendicularly and going from north to south and back again. The tracks were interrupted a few nautical miles from the Syrian and Israel borders. The tracks of the R/V Cana are shown in Figure 17.

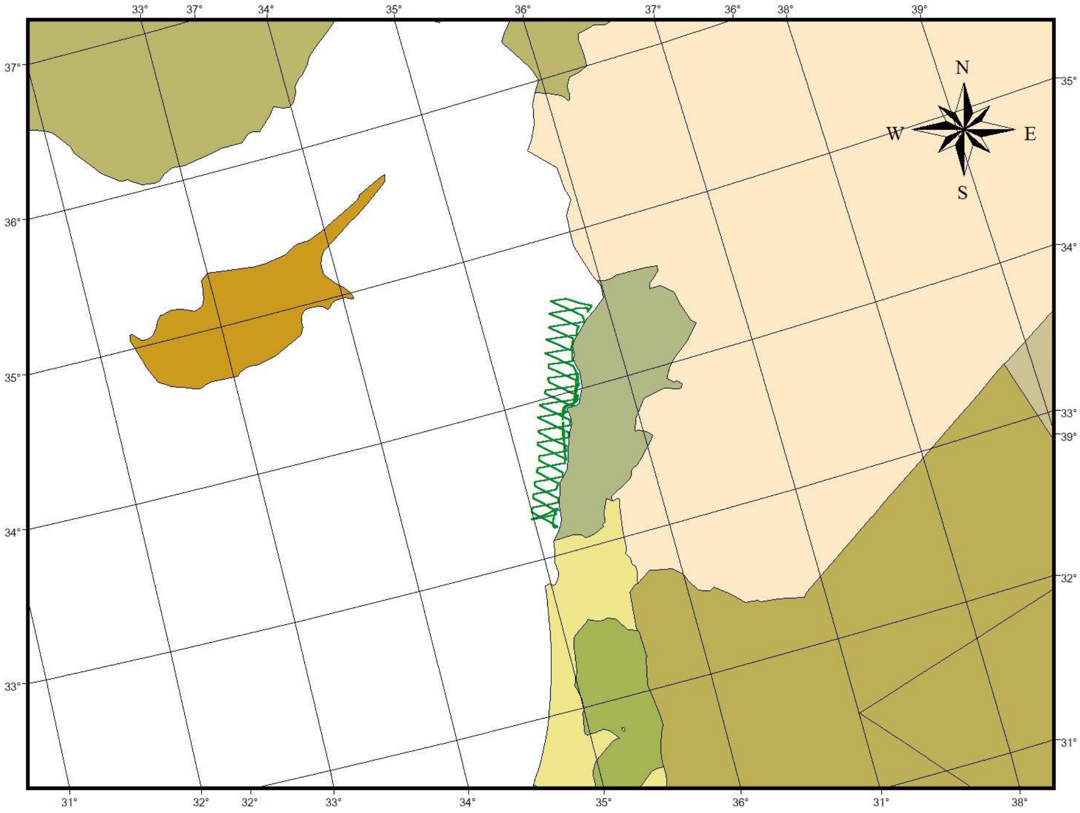

Figure 17 - The tracks of the R/V Cana along the Lebanese coast.

R/V Song of the Whale

A total of 17,272 km of survey transects were designed using the Distance software for the vessel-based surveys conducted by the Song of the Whale team in the ASI blocks 1 to 15, 22, 25 and 26 (figure 4a). Between 28th May and 29th September 2018, the Song of the Whale team completed 21,829 km of survey effort as part of the ACCOBAMS Survey Initiative, in both the eastern and western basins (**Erreur ! Source du renvoi introuvable.**;
Table). Of this effort, approximately 14,449 km (66 %) was "on track", i.e. following pre-determined survey transects with 24-hour acoustic effort (and visual effort during daylight hours when weather conditions were appropriate).

Over 80 % or the designed transects were completed; segments of some transects could not be completed for several reasons, including lack of suitable depth for the vessel and/or towed hydrophone array, the need to bypass islands/reefs and permitting constraints. Globally, an acoustic coverage of 22 % was realised, based on the effective strip (half) width of 10 km derived previously for the acoustic detection of sperm whales from Song of the Whale using acoustic techniques (Table 9).

Initial results from ongoing acoustic analyses are presented below and summarise acoustic detections of small odontocetes (figure 18) and beaked whales (figure 19). In addition to these acoustic detections, nine species of cetacean were identified during the visual surveys (Table); these included fin whale and sperm whale (Figures 20 and 21), Cuvier's beaked whale (Figure 22), long-finned pilot whale, Risso's dolphin and rough-toothed dolphin (Figure 23), and common bottlenose dolphin, common dolphin and striped dolphin (Figure 24). Most sightings of cetaceans were made to the west of Corsica and Sardinia (Table 12), although these data have not yet been corrected for effort.

In addition to cetacean sightings, several non-mammalian vertebrate species were encountered including several fish species (Figure 25) and turtles (Figure 26). Sightings of marine debris were also logged during the surveys (Figure 27); of the 2489 items seen, over 86 % were plastic (**Erreur ! Source du renvoi introuvable.**).

The towed hydrophone array was monitored every 15 minutes and the species and/or acoustic events heard were logged on a subjective scale of 0 (*i.e.* not heard) to 5 (*i.e.* nothing else audible). These data have currently not been validated and must be considered with caution; however, summary plots are provided for anthropogenic noise from military sonar and seismic surveys (Figure 28) and shipping (Figure 29).

The results presented here are preliminary and more detailed analysis is currently ongoing.

Table 9. A summary of effort in each of the ASI blocks surveyed by the *Song of the Whale* team. The total length of the transects generated using the Distance software are summarised as 'designed effort'. The actual effort undertaken in the field is summarised as 'realised effort' and involved following pre-determined survey transects with 24-hour acoustic effort (and visual effort during daylight hours when weather conditions were appropriate). Numbers in parentheses represent the percentage of transects that were completed with appropriate research effort. Incidental effort incorporated those periods with acoustic and/or visual effort when not following survey transects. Total effort incorporates those periods with neither acoustic nor visual effort, in addition to periods on track or with incidental effort. The survey coverage provided for each block is summarised as 'acoustic coverage' and is based on an effective strip (half) width of 10 km for sperm whales.

Block	Designed effort (km)	Realised effort (km)	Incidental effort (km)	Total effort (km)	Acoustic coverage	Start date	End date
Block 1	971	872 (90 %)	214	1,143	0.149	28/05	01/06
Block 2	718	515 (72 %)	709	1,301	0.153	01/06	11/06
Block 3	1,572	1,520 (97 %)	256	1,812	0.274	11/06	28/09
Block 4	1,502	1,057 (70 %)	449	2,008	0.164	15/06	29/09
Block 5	791	559 (71 %)	365	995	0.150	03/07	10/07
Block 6	567	465 (82 %)	432	912	0.134	20/06	28/09
Block 7	1,150	994 (86 %)	90	1,092	0.206	24/06	28/06
Block 8a	528	330 (62 %)	83	527	0.133	10/07	12/07
Block 8b	507	381 (75 %)	98	546	0.122	12/07	14/07
Block 9	427	291 (68 %)	81	372	0.191	14/07	16/07
Block 10	335	247 (74 %)	24	357	0.100	16/07	21/07
Block 11	620	324 (52 %)	63	497	0.126	21/07	22/07
Block 12	445	381 (86 %)	134	515	0.201	22/07	24/07
Block 13	1,109	839 (76 %)	130	978	0.178	24/07	28/07
Block 14	1,214	958 (79 %)	301	1,894	0.185	21/06	27/09
Block 15	742	622 (84 %)	133	815	0.196	28/07	01/08
Block 22west	233	209 (90 %)	55	403	0.306	14/08	18/08
Block 22centre	845	1,036 (90 %)	695	1,772	0.245	18/08	06/09
Block 22east	443	499 (82 %)	226	829	0.205	21/08	06/09
Block 25	665	646 (97 %)	4	761	0.268	07/09	23/09
Block 26	1,888	1,707 (90 %)	492	2,302	0.250	07/09	16/09
Total track	17,272	14,449 (81 %)	5,034	21,829	0.218	28/05	29/09

Table 10. A summary of all sightings made during the ASI from *Song of the Whale*. * summary figures for cetaceans only.

Clade	Number of sightings	Mean group size	Min. group size	Max. group size
CETACEA				
Bottlenose dolphin	26	5.4	1	25
Common dolphin	29	10.5	1	70
Cuvier's beaked whale	2	1.3	1	2
Fin whale	24	1.8	1	12
Long-finned pilot whale	6	10.4	2	30
Risso's dolphin	7	4.4	1	12
Rough-toothed dolphin	1	6.0	6	6
Sperm whale	26	1.7	1	7
Striped dolphin	130	10.4	1	100
Unidentified dolphin	73	5.9	1	100
Unidentified whale	8	1.1	1	2
FISH				
Jumping fish	100	20.4	1	1000
Sunfish	17	1.1	1	2
Unidentified shark	4	1.0	1	1
Other species	7	2.8	1	20
TURTLES				
Loggerhead turtle	96	1.1	1	3
Unidentified turtle	37	1.2	1	6
UNKNOWN	25	1.2	1	4
Total*	332	7.3	1	100

Acoustic analysis of broadband recordings

An initial analysis has been conducted by the Song of the Whale team using the recordings made during the ASI survey in the summer of 2018. Recordings made at a sampling rate of 192 kHz encompass the known bandwidth of most odontocete vocalisations (2-96 kHz), and thus are suitable for detecting beaked whales, sperm whales and all other small/medium species. Although a more detailed analysis of sperm whale clicks is ongoing, provisional results for the acoustic detection of beaked whales and small/medium odontocetes is presented here.

Small/medium odontocetes were detected throughout the study area (n = 980), with highest densities in the western basin (Figure 18). The largest aggregations of dolphins detected acoustically were in the contiguous regions, with a maximum group size of approximately 40 individuals. A gradient of group size was evident, meaning smaller groups were encountered as the surveys headed eastwards. Although densities were at their lowest in the eastern basin, multiple groups of dolphins were detected acoustically in the Hellenic Trench, albeit in small clusters. Further analysis is currently underway to identify detections to the species level where possible.

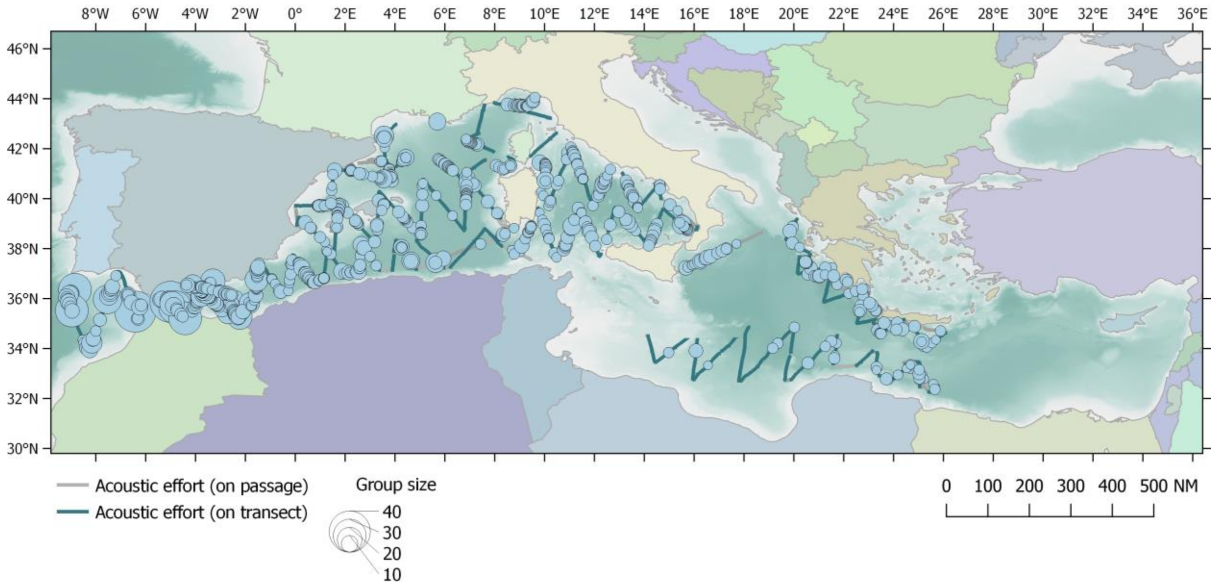

Figure 18 - Acoustic detections of small/medium odontocetes made during the Song of the Whale acoustic surveys of summer 2018. The surface area of the symbols is proportionate to group size.

A total of 18 detections of beaked whale clicks were made during the ASI surveys (Figure 19). On average, beaked whale detections were made up of approximately 70 clicks; long click trains such as these allow estimations to be made of foraging depth using surface echoes and this analysis is currently ongoing. Estimated groups sizes were small (< four individuals)..

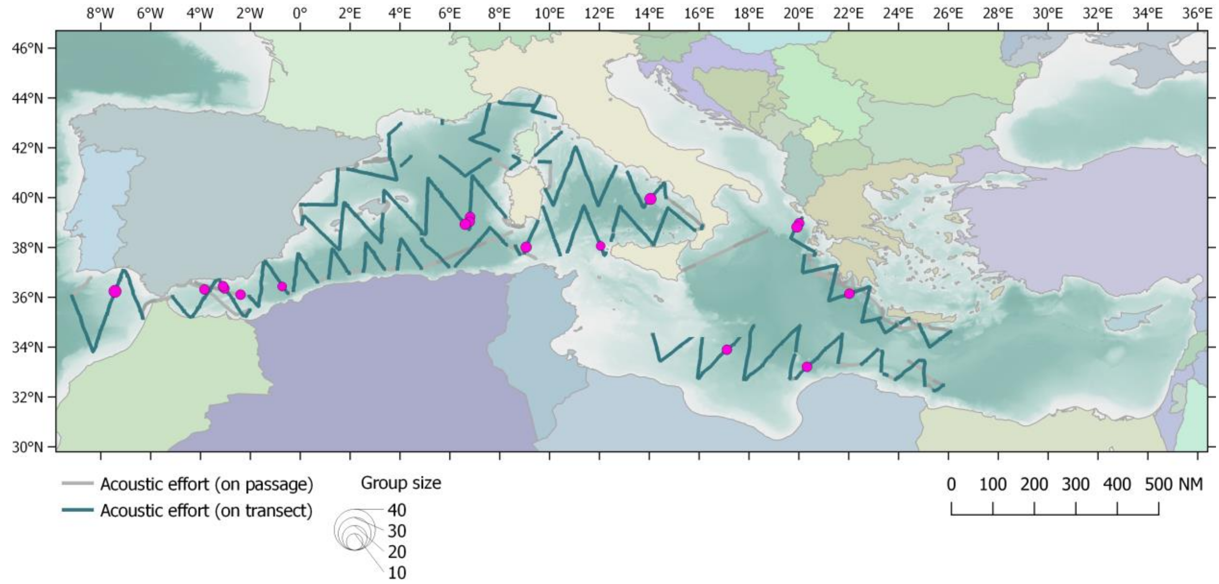

Figure 19 - Acoustic detections of beaked whales made during the Song of the Whale acoustic surveys of summer 2018. The surface area of the symbols is proportionate to group size.

Fin whale

Fin whales were encountered during the Song of the Whale survey blocks Balearic Sea, Gulf of Lion and Ligurian Sea (Figure 20).

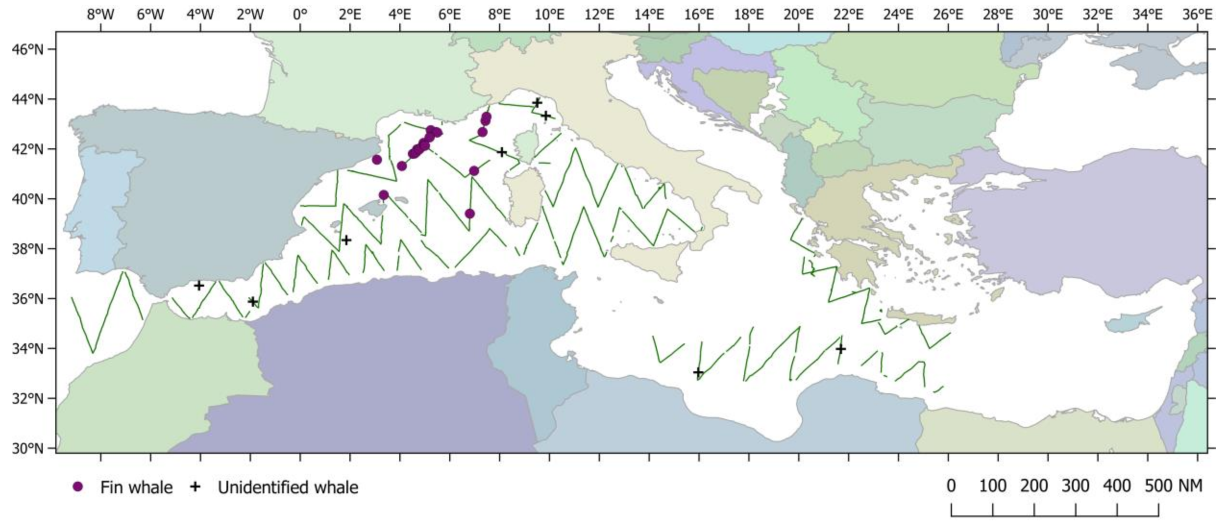

Figure 20 - Sightings of fin whales made by the Song of the Whale team during the ASI survey (purple circles). Sightings of unidentified large whales are also shown.

Sperm whale

Sperm whales were encountered throughout the survey area. Detections were made in the contiguous region in the approaches to the Strait of Gibraltar (Figure 21). There was a detection of a sperm whale off Libya, this is only the second documented encounter with a living whale in Libyan waters; the first encounter was an individual encountered by the Song of the Whale team in 2007 (Boisseau et al., 2010).

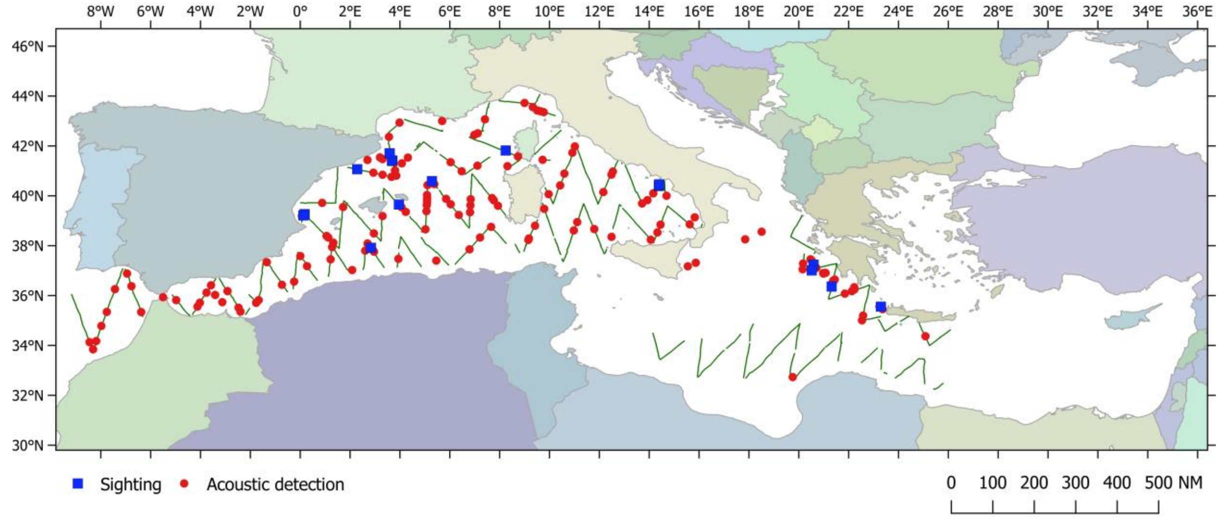

Figure 5 - Sightings/detections of sperm whales made by the Song of the Whale team during the ASI survey (blue squares/red circles respectively).

Cuvier's beaked whale

The Song of the Whale team made what is presumed to be the first documented sighting of a living beaked whale in Morocco's Atlantic waters. The team also detected beaked whales in Libya waters, another first. In addition, detections were made during the ASI vessel surveys to the west of Sardinia and Sicily (Figure 22).

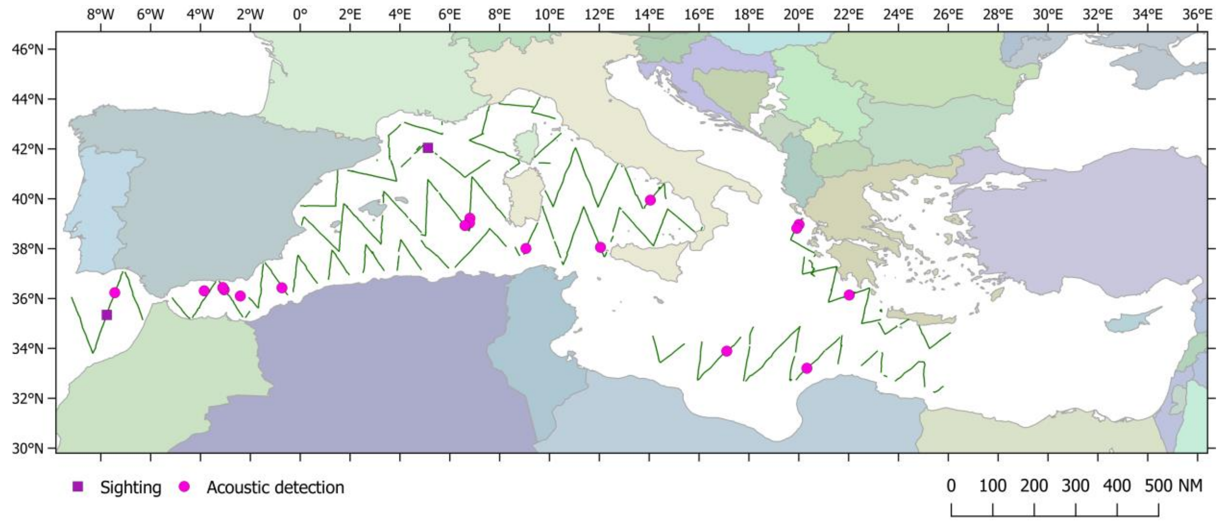

Figure 22 - Sightings/detections of beaked whales made by the Song of the Whale team during the ASI survey (pink squares/circles respectively).

Other medium-sized cetaceans

Long-finned pilot whales were only encountered in the western basin, where previous studies have led to this species being considered common (Figure 23). Risso's dolphins were only seen in the western basin. Rough-toothed dolphins were encountered once by the Song of the Whale team in Greek waters,

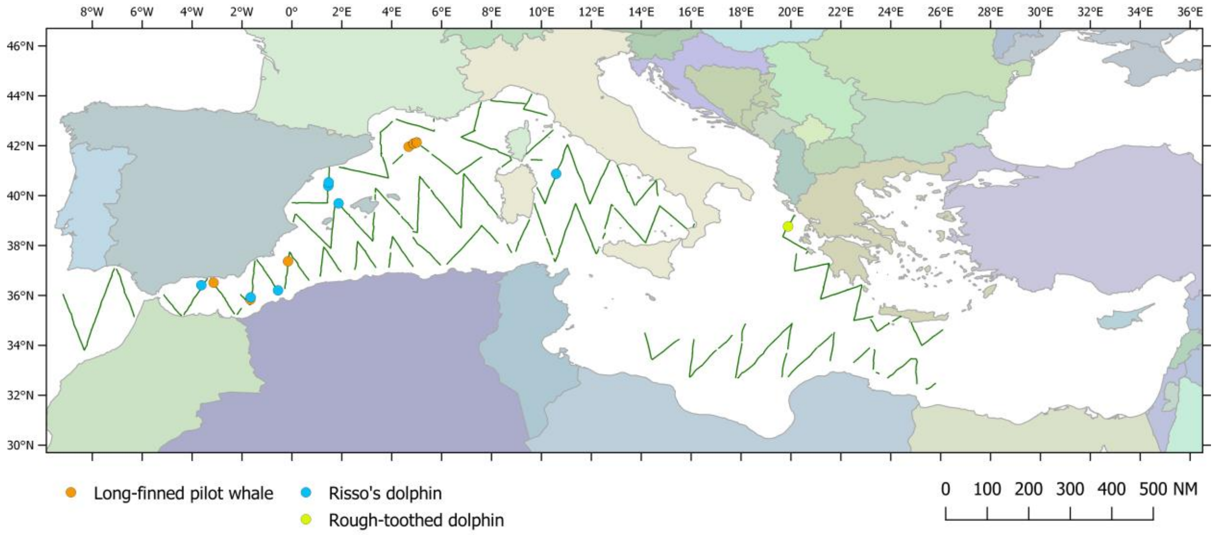

Figure 6 - Sightings of pilot whales, Risso's dolphins and rough-toothed dolphins made by the Song of the Whale team during the ASI survey (orange, blue and yellow circles respectively).

Small sized cetaceans

Bottlenose dolphins were seen in scattered and fragmented groups, as appears usual for this species in the Mediterranean; they were encountered in their typical habitat, namely inshore and coastal waters (Figure 24). Common dolphins were also encountered throughout their known range, although sightings around Sicily and the southern Tyrrhenian Sea are of importance as this area is considered data deficient for this species. Striped dolphins were seen throughout both the western and eastern basins in keeping with its description as the most common and ubiquitous cetacean in the Mediterranean Sea.

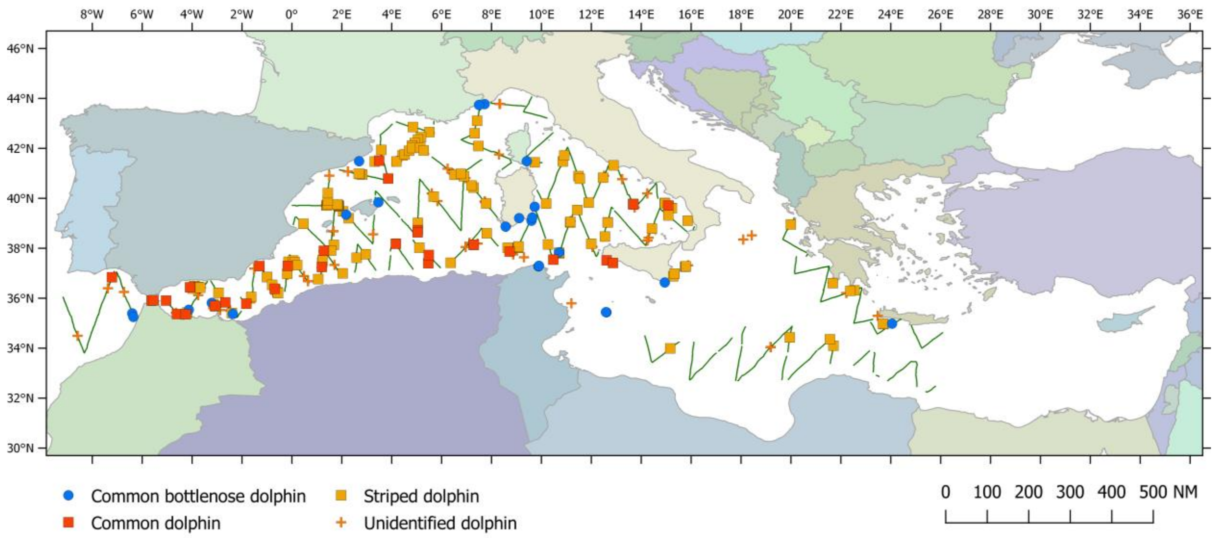

Figure 24 - Sightings of bottlenose, common and striped dolphins made by the Song of the Whale team during the ASI survey (blue circles, red squares and orange squares respectively).

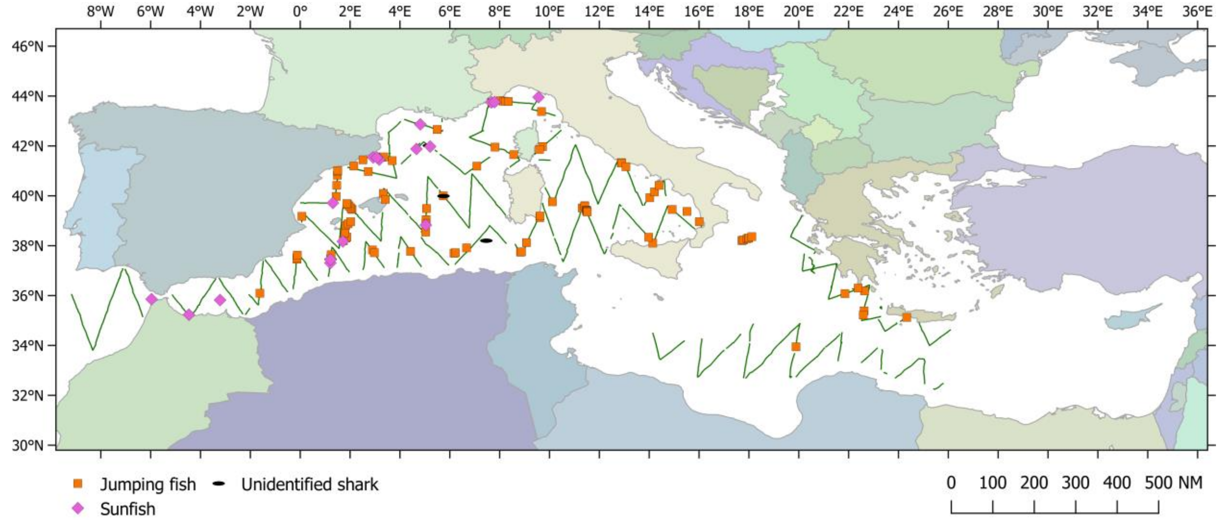

Figure 25 - Sightings of all fish species made from Song of the Whale.

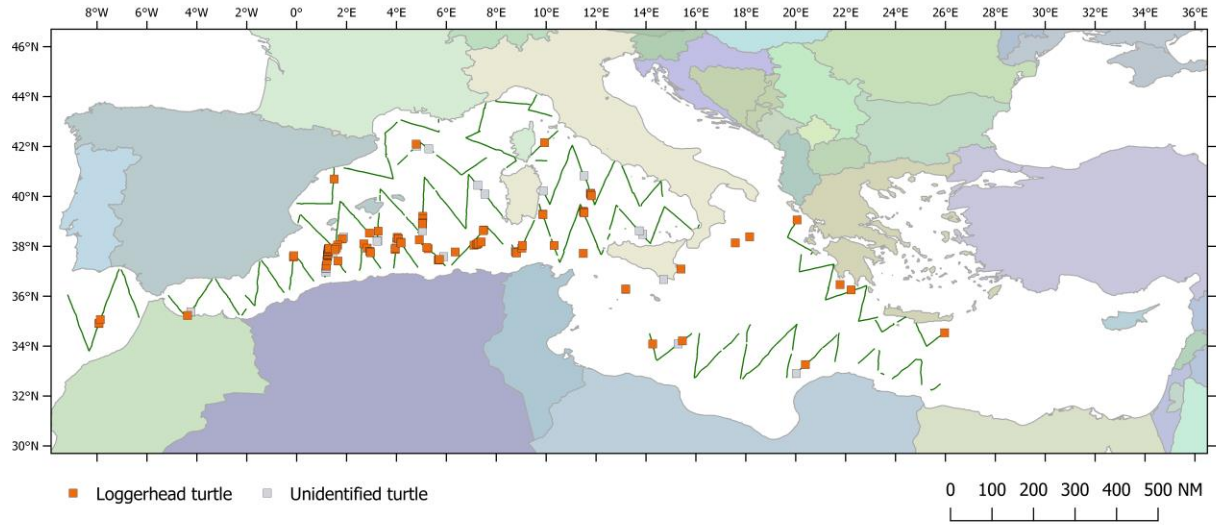

Figure 26 - Sightings of all turtle species made from Song of the Whale.

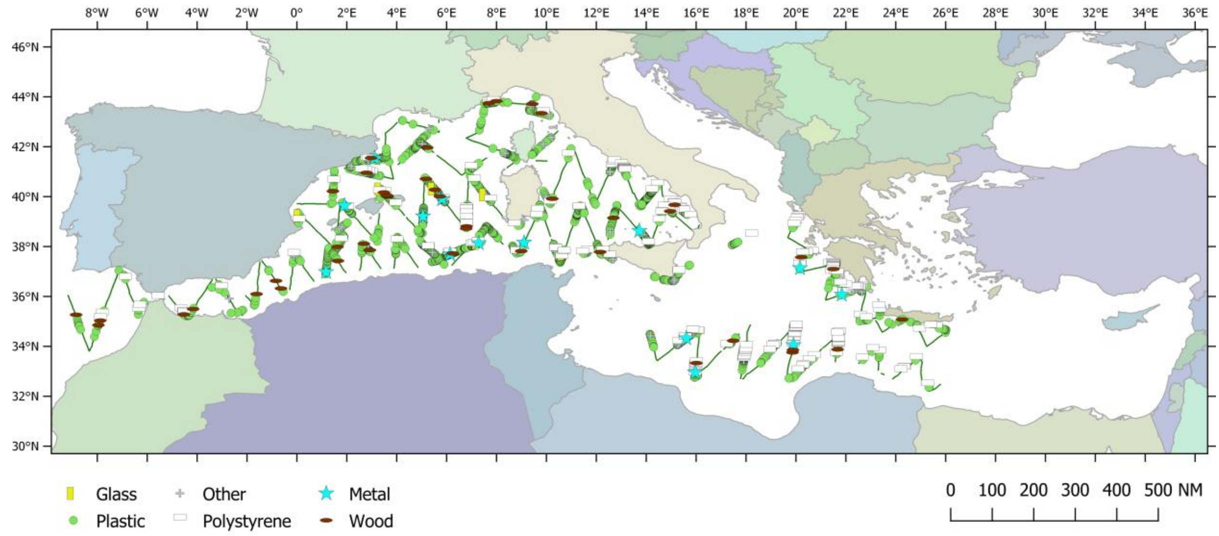

Figure 27 - Sightings of marine debris made from Song of the Whale.

Table 11 - Count of the different categories of marine debris seen in each survey block from Song of the Whale.

Block	Plastic	Polystyrene	Wood	Metal	Glass	Other	Total
1	26	5	3	-	-	1	35
2	39	6	2	-	-	1	48
3	124	2	6	1	-	2	135
4	132	6	6	1	2	5	152
5	138	7	3	1	-	8	157
6	272	7	1	2	1	2	285
7	260	10	5	3	2	7	287
8a	26	-	-	-	-	1	27
8b	68	1	2	-	-	2	73
9	34	-	-	-	-	1	35
10	53	4	2	-	-	-	59
11	62	1	2	-	-	5	70
12	22	2	1	-	-	1	26
13	147	17	1	-	-	4	169
14	226	15	2	1	1	9	254
15	136	14	2	1	-	5	158
22w	15	8	-	-	-	1	24
22c	74	31	2	2	-	5	114
22e	25	3	1	-	-	-	29
25	92	8	1	2	-	7	110
26	176	51	4	1	-	10	242
Total	2147	198	46	15	6	77	2489

Table 12. Cetacean species seen when "on track" (i.e. following transects with visual effort during daylight when weather conditions were appropriate).

Block	Common bottlenose dolphin		Common dolphin		Cuvier's beaked whale		Fin whale		Long-finned pilot whale		Risso's dolphin		Rough-toothed dolphin		Sperm whale		Striped dolphin		Unidentified dolphin		Unidentified whale		Total
	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	
1	2		1			1													3				7
2	1	3	4	4					1			1					2	8	3	3		1	31
3			7						2		2				1		16	3	9	1	1		42
4	1	1					1				1				3	1	9	3	4	3		1	28
5		1	1	1				1			2				2	7	8	1	6				30
6		1	1	2													3	1	2	2			12
7			2					1							1		7		6				17
8a							3	3							2		3	4					15
8b						1	8	4	2	1							6	3	3	2			30
9															1		2		1		1		5
10		2					3										1		2				8
11		1															1		1		2		5
12											1						3						4
13			1	1												4	6	7	4				23
14	1	6	1	1													12		4	2			27
15																	4	1	2				7
18																		6		3			9
20		3		2																1			6
21		2																		1			3
22w														1			1						2
22c																4	2	1	1	1			9
22e		1															2			1			4
25																	1				1		2
26																	3		2		1		6
Total	5	21	18	11	0	2	15	9	5	1	6	1	0	1	10	16	92	38	53	20	6	2	332

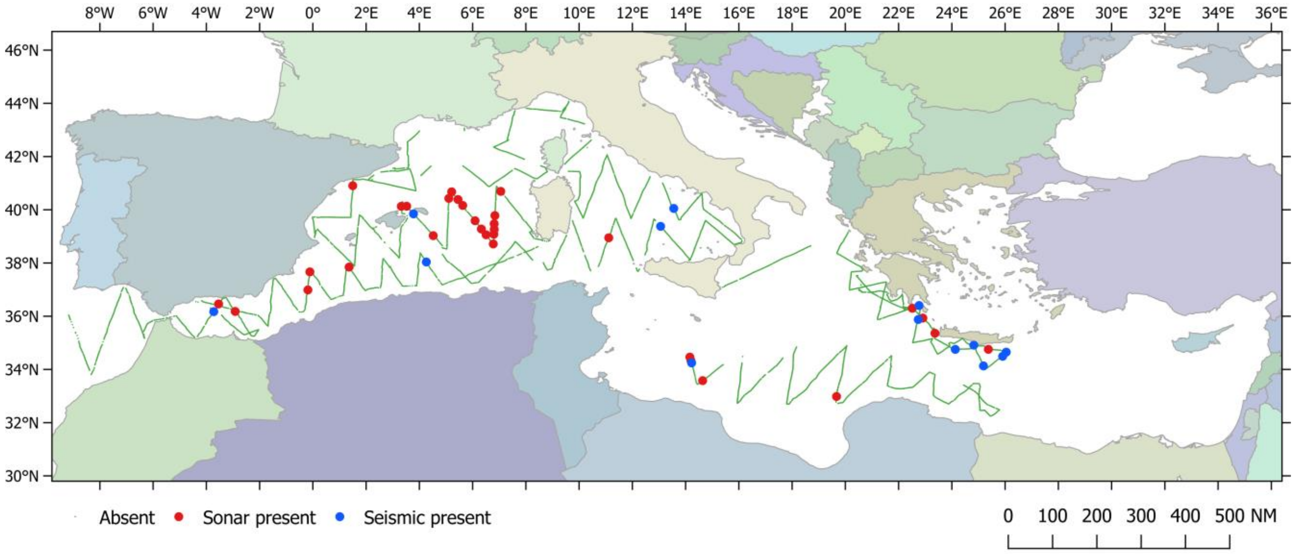

Figure 28 - Listening posts at which sonar signals and/or seismic airguns were heard. Note: although only preliminary, each data point represents a unique detection (i.e. a separate operation).

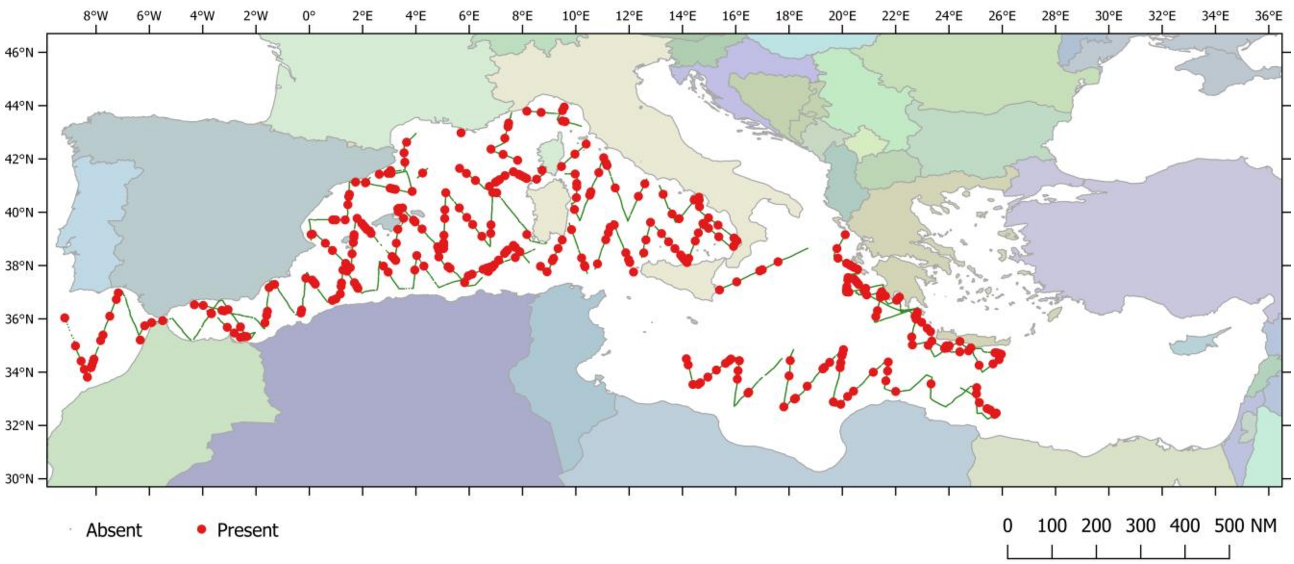

Figure 29 - Listening posts at which ship noise was heard. Note: although only preliminary, each data point represents a unique detection (i.e. a separate vessel).

Although detailed analysis is still ongoing, the initial results of the R/V Song of the Whale surveys may be summarised as follows:

- Small/medium sized odontocetes were detected acoustically throughout the study area with the largest aggregations in the contiguous Atlantic waters (up to 40 individuals). Heading east, smaller groups were more usual.
- Preliminary analysis suggests that 18 acoustic detections of beaked whales were recorded, in small groups (<4 animals), as has previously been reported in the Mediterranean.
- Fin whales were encountered within the typical range (Balearic Sea, Gulf of Lion and Ligurian Sea).
- A sperm whale was detected off Libya – only the second documented encounter with a living whale in Libyan waters; the first encounter was documented by the SOTW team in 2007. Previously strandings have been reported from Libya and Egypt.
- Sperm whales were widely encountered in deep waters of the western basin.

- A Cuvier's beaked whale was sighted off the Atlantic coast of Morocco, apparently the first documented sighting in Atlantic waters off Morocco. Additional individuals were also detected acoustically in the region. Beaked whale clicks were also detected for the first time in Libyan waters.
- Rough-toothed dolphins were sighted in Greek waters

4. Conclusions, future effort and recommendations

This report presents a summary of the different phases that lead to this unprecedented effort, covering aspects from survey design to training workshops and data collection effort. Some effort is still ongoing and funds have been secured to conduct a similar effort in the Black Sea in summer 2019, as it was originally envisaged under the framework of the ACCOBAMS Survey Initiative.

Data collection was mainly conducted at the same time during the summer 2018, in order to allow a synoptic coverage of the entire Mediterranean Sea; this has not been possible for the whole area but we are confident that the different period for some areas will not negatively affect the overall results. While Egyptian waters and Syrian coastal waters could not be surveyed in 2018, it will be done during the summer 2019.

Collected data are now under validation by a selected team of scientists, who will check all the tracks, all the sightings and will prepare the dataset for the foreseen analysis. The following section presents in detail the analytical framework we are currently considering, with a special emphasis on the participatory approach and the overall coordination of the analysis.

4.1 Analytical framework

Dedicated analyses of the full data set

The origins of the synoptic survey proposal (ACCOBAMS 2nd Scientific Committee Meeting, Istanbul, Turkey, 2003) and its primary objective i.e. to obtain an overall picture of the distribution and abundance of cetaceans throughout the entire Mediterranean Sea, require the development of robust estimates that can be considered as baseline data for further systematic monitoring programmes, and are comparable amongst all areas. These data will improve the current knowledge on cetacean status, facilitate the development of targeted conservation and mitigation measures and allow the development of effective long-term monitoring programmes.

The tools necessary to analyse the abundance data collected during this major synoptic survey are sophisticated and data hungry. Following the precedent of previous large-scale multinational abundance surveys[1], it is essential that a coordinated analytical effort be undertaken by a small team of dedicated and experienced scientists with the appropriate expertise. Analysing the entire dataset together in this way has important statistical advantages (e.g. the sample size is much larger for the detection functions where team, platform and other parameters differing among areas can be introduced as potential covariates affecting the detection function), ensuring a consistent approach to model selection and leading to the development of as robust estimates as possible.

The analysis will provide comparable results at a variety of scales, from local to global. Thus, the ASI results will represent a baseline dataset for the entire Mediterranean Region and will facilitate the implementation of systematic long-term monitoring programmes, to assess and evaluate trends in density and abundance over time and space at appropriate management scales.

It is expected that all the marine mammal data and other large vertebrates (i.e. marine turtles, giant devil rays, Atlantic sun fish), as well as sea birds, will be covered by this data analysis proposal. The robustness of the analysis will depend on the number of sightings and the quality of the collected data. We are planning to analyse pollution (marine debris) data as a whole, but not as individual "garbage types", as they do request

[1] SCANS I, II and III, CODA, and by the Mediterranean Ziphius initiative

specific knowledge which is beyond our expertise. We are available to help and support in the identification of experts who may be interested in further analysing the available data. We also envisage and believe that there will be the possibility to focus on specific analysis for specific datasets; we will be available to facilitate this and allow data transfer and adequate follow-up once needed.
Acoustic data will be analysed separately by MCR, while visual data collected by the different research vessels will be analysed together with those collected by airplanes. However, because of the limitation in sample size when the full data set is split at species level, the initial step of the design-based analysis (determination of Effective Strip Width, ESW) will be conducted by MCR after merging the ASI visual data set with visual data sets from previous MCR survey conducted from the same platform (R/V Song Of The Whale) in the Mediterranean. The ASI data set together with the taxon-specific vessel ESW will then be usable in the model-based approach. Regular ongoing communication will continue with MCR, so that inputs for the data analysis will be flowing both ways.

Technical aspects of the design-based data analysis

The programme DISTANCE version 7.2 will be used to estimate abundance using either Multiple Covariate Distance Sampling (MCDS) or Mark-Recapture Distance Sampling (MRDS). Both engines may incorporate covariates that affect the detectability, in addition to the perpendicular distance of the observed animal(s) from the survey transect line, in the estimation of a detection function. MRDS in addition allows for the creation of a common detection function for species with similar detectability and an abundance estimate for each of them to be derived separately when there are insufficient data to create separate detection functions.
In Conventional Distance Sampling (where no covariates are included in addition to perpendicular distance), animal abundance in each stratum is estimated by:

$$\hat{N} = A\frac{n}{2L\hat{\mu}}\hat{E}[s]$$

where, for each stratum, A is the area, L is the total search effort, n is the number of primary sightings, $\hat{\mu}$ is the estimated effective strip half-width (esw) which provides a measure of how far animals are seen from the transect line, and $\hat{E}[s]$ is the estimate of mean group size for the species concerned.
In MCDS and MRDS, covariates other than perpendicular distance are included in the detection function and hence the esw ($\hat{\mu}$) becomes a function of the covariates, Z. Abundance is estimated using a Horvitz-Thompson-like estimator:

$$\hat{N} = A\frac{n}{2L}\hat{E}[s]\sum_{i=1}^{n}\frac{1}{\hat{\mu}(Z_i)}$$

where Z represents the covariates in sighting i. The explanatory covariates may include sea state, a subjective sighting condition index, glare, water turbidity, cloud cover, group size, team of observers and others.
A variance estimate for $\widehat{N}$ is obtained by combining the variance estimates of the three components: encounter rate, detection function and estimated group size, using the delta method.

Technical aspects of the model-based data analysis

Density surface models will be produced by modelling species abundance as a function of environmental covariates. A spatial grid will be created covering the survey area to provide values of environmental covariates for the effort segments and to predict abundance spatially. The resolution of the grid cells will be chosen as the finest consistent resolution that captures all available environmental covariates. Environmental data will be thus assigned to the centre of each grid cell.
Environmental variables will be derived from a large number of data sources. They will include variables such as water depth (m), distance to the several depth contours (as proxies for coastal, continental shelf, oceanic habitats, etc.), distance to canyons and seabed slope. As indices of marine hydrology and/or biological activity/primary productivity, we will include sea surface temperature (°C), mixed layer depth (m) and levels of chlorophyll-a (mg/l).
The count of groups in each segment will be used as the response variable. The abundance of groups will be modelled using a Generalized Additive Model (GAM) with a logarithmic link function, and a Tweedie error distribution, very close to a Poisson distribution but allowing for some over-dispersion. The general structure of the model is:

$$\hat{N}_i = \exp\left[\ln(a_i) + \theta_0 + \sum_k f_k(z_{ik})\right]$$

where the offset ai is the effective search area for the ith segment (calculated as the length of the segment multiplied by twice the effective strip half-width – esw), Ө is the intercept, fk are smoothed functions of the explanatory covariates, and zik is the value of the kth explanatory covariate in the ith segment. The esw will be obtained for each species/species group from their detection function, according to the covariates included in it.

Abundance per species in each grid cell will be obtained by multiplying the abundance of groups, predicted from the best fitting model, by the mean group size estimated for each substratum or the modelled group sizes if spatial variation is observed.

Variance of abundance will be estimated by a non-parametric bootstrap procedure. The delta method will be used to combine the CV from the bootstrap with the CV from the detection function and from the model. The 95% CIs will be obtained using the final CV and assuming the estimates were lognormally distributed. All modelling will be carried out using the statistical software R (R Core Team 2017) using the mgcv package (Wood 2006).

ASI Participatory process and capacity building

The analysis of the ASI data will be done through a participatory approach, reflecting the collaborative nature of the ASI project and the involvement of all Mediterranean scientists.

To achieve this, it is of paramount importance to establish a participatory and capacity building component with different scientists from each country, strongly engaged in learning and applying the analytical approach. Three regional workshops will be organized, taking into account the available budget, with both theoretical and practical sessions, during which participants will have the chance to individually prepare the data for abundance estimates and run the different models and present and discuss results with the trainers. In this way, results obtained by the participants will be compared with the results obtained by the expert analysts, and the differences will be discussed in plenary sessions - an effective way of learning.

The workshops organization will follow the standard procedures developed by international experts and already applied in the ACCOBAMS region (e.g. Estimating marine mammal abundance and life history parameters, 12-16 December 2016, Constanta, Romania). The basic structure of the workshop will include theoretical and practical sessions on Line Transect Distance Sampling, with survey design, data collection and data analysis with the dedicated software Distance. A simulated field work - with known real abundance - and data analysis will be carried out during the workshop. Mark-recapture methodologies could also be presented and discussed, including specific training modules with software Mark, depending on participants' specific requirements and time available.

It is expected that most workshop participants will learn to understand and implement a design-based analysis (Fig. 30a), using and understanding the dedicated software Distance. Both Conventional Distance Sampling (CDS) and Multi-Covariate Distance Sampling (MCDS) will be described, allowing participants to use different variables, such as sea state, observers etc., to model the detection function in assessing abundance. Design-based methods will allow each participant to learn and feel comfortable in organising line transect surveys, knowing how to collect data and how to analyse them. The results could then be applied regionally to assess trends in density and distribution over time and space. Power analysis will also be applied to evaluate the strength of the results and the power to detect trends.

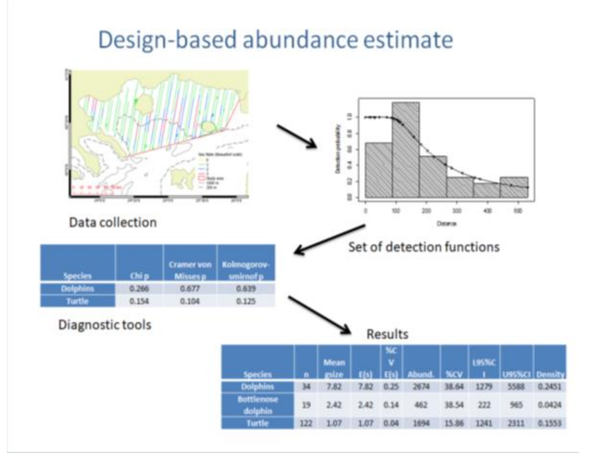

Figure 30a - Draft schematic of model-based analytical process.

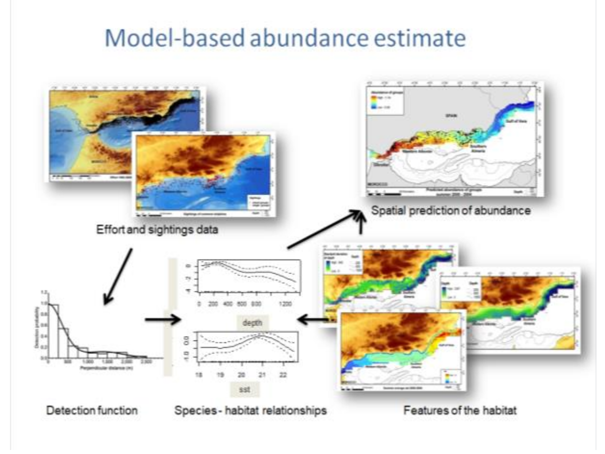

Figure 30b - – Draft schematic of design-based analytical process.

There is a very much steeper and longer learning curve to understand, implement and interpret a model-based analysis. Based on previous experience, the large majority of people who will attend these workshops will not be R-users, will be unfamiliar with regression modelling and will find this very challenging. Upon budget availability, a two-stage workshop could be considered in those cases where model-based analysis to generate density surfaces (Fig. 30b), by more experienced local scientists, will be requested.

It will be however of paramount importance that a participatory approach will be followed when interpreting the ASI results, both locally and regionally, to facilitate the adoption and implementation of conservation and mitigation measures. Inputs from all countries will be requested in order to provide recommendations and conservation actions, based on recommendations resulting from the ASI. Depending on the available budget, a general workshop, presenting the results of the ASI should be organized, allowing the possibility to discuss and comment the result and facilitate the use of these results to inform and implement conservation and mitigation measures.

Before and during these seminars, each country will have the opportunity to discuss specific issues and each trainer will be available to provide insights and suggestions both on analytical methodology and data collection and monitoring protocols, to be implemented after the ASI in summer 2018. Lectures will also be dedicated to report and publication writing, to facilitate workshop participants to present their data in national and international fora, as well as on peer reviewed journals.

Draft design-based workshop outline

Introduction

- Introduction to line transect sampling
- Line transect survey design
- Line transect data collection (practical with simulated data)

Organization of data from a line transect survey (practical)

Using Distance software

- Data entry
- Detection function, diagnostics, abundance estimation, variance estimation
- Data analysis (practical)

Conclusions from data analysis of survey data, including comparison with results by the analysis team.

Advanced topics: animals missed on the transect line, responsive movement (time availability dependant).

Draft model-based workshop outline

Introduction

- Introduction to spatial modelling: from dots on a map to predicted surfaces

- Introduction to the analytical framework

Types of data
- Surveys (effort, sightings, sighting conditions, distance data)
- Environmental data (locational, physiographic, biological, anthropogenic)
- Data processing/organisation
- Survey data (effort segments with associated sighting conditions, sightings and environmental covariates; sightings associated with sighting conditions to estimate probability of detection)
- Environmental data (constructing and populating a grid; GIS)

Modelling
- GAMs
- Autocorrelation in survey data and collinearity (correlation) among environmental covariates
- Model selection (AIC, other diagnostics)
- Estimating precision (bootstrapping)

Using the results
- Increasing ecological understanding (species-habitat relationships; limitations)
- Making maps and acknowledging gaps

4.2 Lessons learnt and recommendations

This section aims to build on the ASI 2018 summer survey experience in order to support any similar future survey exercise, by highlighting difficulties encountered along the preparation and implementation of the survey, associated solutions, by emphasizing on strengths and weaknesses of the approach taken and when possible, by providing recommendations. The following information are issued from questionnaires completed by aerial team leaders after the survey, as well as feedback from main boat survey partners, the ACCOBAMS Secretariat and the Scientific coordinator. This report doesn't address national or local specificities, but any additional advice may be provided at the ACCOBAMS Secretariat level.

RESEARCH PERMITS AND ADMINISTRATION

- A significant challenge encountered in planning the aerial and vessel surveys was in obtaining permits. In some cases, research and/or flying permits were released late in relation to the start of the fieldwork which even led to postpone several surveys, resulting in additional costs. The following recommendations may help address this particular issue:
    - Starting permit application process as early as possible (taking into account that permit applications are dependent on a range of other aspects of project planning being in place and agreed well in advance of applications being made. Ideally, all survey operation details are to be completed ahead, including platform selection, team composition, calendar and precise survey design)
    - Identify the right person to support the application through the appropriate channels within each of the national authorities. National focal points and contact persons are not always aware of national requirements for aerial/vessel surveys and the relevant persons in charge should be identified and contacted as soon as possible in the preparation phase.
    - It is crucial to determine and agree in advance with the aircraft company the responsibility of the latter in obtaining civil aviation permits.

- Some difficulties have been described with the need to inform local authorities about flight plans for the next day. Ideally, this could be addressed in the longer term, with more flexibility and easiness. While depending mainly on local procedures, it is important to comply precisely with requested process in order to create a climate of trust which certainly helps.
- Several issues with aerial photography from plane have also been discussed; sometime it is important to have a camera on-board for species identification and group size assessment and this should not create issues with authorities. When preparing the survey, specific attention should be taken to use of cameras

on board of the planes as, in many countries, this is subject to specific authorisations and requires military approval.

- Some countries administration systems imply accommodating National Military/Government representatives' on-board planes of boat. Having an extra person can have consequences on the survey effort: increase of costs, with per-diem and food and lodging for the extra person, but also reduction of the endurance of the plane, increasing the weight on-board. On small vessels, while providing maximum numbers of spaces for scientific participants is the priority, flexibility in participant numbers may be required in order to fulfil requirements of national diplomatic clearances, sometimes at short notice.

DESIGN OF THE SURVEY

- The main drive for survey design should be biological and ecological and the design should not be modified by geo-political constraints. This may not be always a feasible option, as sometimes local situation does influence the way a survey is designed. One option to further discuss and assess is whether survey blocks should take into consideration the position of air space boundaries, as Flight Information Region (FIR), since this may decrease maritime boundaries related issues when addressing permit aspects. This should not by any means jeopardize the Equal Coverage Probability of a survey, which would negatively affect and bias the scientific value of the entire mission.
- The definitive transect map should be available at an earlier stage, to allow Cruise Leaders and pilots to familiarize with it and prepare the survey taking into account different constraints, such as flying over military areas. The final survey design, if available in advance, could be used with national authorities to prepare the flights and discuss additional possibilities to fly over temporally closed areas.
- The final protocol just decided during the training was confusing for observers: A workshop or a pre training session with only the Cruise Leaders and ACCOBAMS Secretariat staff to discuss and finalize field protocols some weeks/days before the actual training with the observers could be useful.

PLATEFORMS SELECTION AND USE

PLANES AND AIRPORTS

- Plane selection is another very crucial issue, since different planes have different characteristics and may be more suitable for specific tasks. Extra care and detailed selection factors should be used when proceeding with the selection of the aircraft companies and contract drafting (company experience in the different areas is essential in particular). Even if flexibility is required in this type of exercise, attention should be given so that terms of contracts are well respected along the survey work.
- Pilots' experience should also be taken into consideration, as this may influence the daily operations and the contacts with authorities. More experienced pilots could maybe handle different situations in a better and more 'diplomatic' way, thus facilitating finding solutions and exploring ways to solve and handles potential controversial issues. Experienced pilots can spend more time flying over the sea and tend to be less stressed; on the other hand they may need more resting time between flights and allow only one flight per day.
- Technical aspects, such as power supply and intercom on board should be double checked with pilots and cruise leaders (CL) before starting the mission, as they may interfere with the daily operations and create potential problems.
- The selection of airports is very important as it may affect time for boarding, handling costs and operational flights. Most of the times choosing a small airport is not an option as there are not many airports and not all of them have the facilities for small planes used for aerial monitoring.
- A detailed planning of each transect with the pilots and the Cruise Leaders would allow some better usage of the available airports and therefore reduce transit time between transects and airport. Usually, information and availability of AVGAS 100LL fuel is scarce and poorly known, which may negatively affect the performance of the survey. Detailed discussion with the pilots and the Cruise Leaders on the endurance and number of hours per flight per plane would be very useful.

BOATS

- The identification, selection of suitable additional vessels, and the vessel owner/operator's organisational and operations experience and capacity, posed quite significant challenges – in terms of assessing capacity, capability and operational suitability for remote offshore operations.
- As with the aerial surveys, the overarching aim to foster and build local/regional capacity can sometimes be difficult to fulfil when considering the need for specialist and experienced operations to survey large, remote and challenging offshore environments. Significant time, resources and effort were taken up on certain of these aspects.

<u>TEAMS AND TRAINING</u>

- Timetabling, scheduling and logistical challenges had to be overcome in order to combine scientific research priorities (and the need to cover a vast survey area on a limited budget), with the parallel aims of building capacity (e.g. training and providing opportunities to inexperienced field workers) and public outreach / engagement activities. The participants selected to join the vessel-based surveys were quite variable in aptitude and experience levels, and, on occasion, this put increased pressure on other team members in the field, in order to maintain scientific aims and objectives. Discussions around available time, resources and priorities helped to resolve timetabling and scheduling issues, but inevitably some compromises were necessary.

- Training for aerial survey observers and cruise leaders is a very delicate and complicated issue. Ideally, one survey should be conducted by the most experienced and trained observers available, in order to minimize biases and improve data collection. This goes against capacity building and training effort; in order to address this, maybe longer training sessions should be implemented, with more time allocated to protocols and effective sighting time on the planes. Economic constraints should be carefully evaluated, as this may have significant funding implications.

<u>COORDINATION OF OPERATIONS & LOGISTICS</u>

- Constant communication between the ACCOBAMS Secretariat, the Scientific Coordinator and Cruise Leaders has been very effective and allowed to solve many problems and issues almost in real time. Dedicated WhatsApp groups and emails have been created, facilitating easy and fast exchanges. Best solution was to dedicate emails to official messages and to leave WhatsApp for daily and urgent communications.
- Communication with local authorities not always easy; sometime there was a need for daily phone call and or using fax machines, which nowadays tend to be hard to find and rather obsolete. Local call may be expensive in some Countries and may need to acquire local sim cards.
- There were specific challenges posed by remotely supporting and assisting the 'national' vessel surveys; this was a project priority, also in terms of capacity building – but in practical/logistical/scientific terms is rather difficult to manage remotely. A national coastal survey was successfully undertaken off Lebanon, but surveys of Egyptian and Syrian waters remain to be completed due to various practical and political complications.

<u>SECURITY AND SAFETY</u>

- Issues relating to security and safety (given the political instability in some parts of the region) were of significance in planning the vessel surveys specifically, as the vessel and team were potentially close to, or in the areas identified as being a security risk. Planning thus had to include discussions of areas to be avoided due to safety concerns, and the development of protocols to manage potential contacts with migrant vessels, etc. This required significant extra time in discussions with the ASI planning team, insurance companies, and in obtaining specialist advice in relation to security and safe operations in certain areas.

PART II: ACCOBAMS Survey Initiative - Technical report of the Black Sea survey

CeNoBS –Technical report of the Black Sea aerial survey

CONTENTS

Introduction

The Black Sea is one of the most vulnerable regional seas and Romania and Bulgaria are the European Member States responsible for the implementation of the Marine Strategy Framework Directive (MSFD), in close collaboration with the other non-EU countries. This project is funded under the Call for proposals "Marine Strategy Framework Directive - Second Cycle: Implementation of the new GES Decision and Programmes of Measures", and has a duration of 24 months, from January 2019 until December 2020.

The two descriptors that are tackled by the CeNoBS project are Descriptor 1 – marine mammals/cetaceans and Descriptor 11 – noise in the Black Sea, improving the second cycle of MSFD implementation, by achieving greater consistency and coherence in determining, assessing and achieving good environmental status. The proposed activities will fill the lack of background data on the distribution/abundance of cetacean populations and on bycatch pressure in the Black Sea and the lack of national expertise to implement effective noise monitoring.

The main objectives of this project are:

I. assessing D1 cetaceans related criteria and establishment of thresholds values,
II. assessing and supporting the development of D11 monitoring in the Black Sea,
III. enhancing coordination among the Black Sea region throughout the dissemination of the project activities, results and outcomes.

This preliminary technical report deals with one aspect of Work Package 2, and specifically focuses on the 'Assessment of cetacean populations distribution and abundance at the regional scale', which has been coordinated by the ACCOBAMS Secretariat.

Main aim of this activity is to assess cetacean's density and abundance in the Black Sea, by applying the most robust and up-to-date methodology. Shared and systematic protocols have been used, to facilitate data comparison and to create a baseline data to allow future analysis in time and space, to assess eventual trends. A robust analytical modelling framework is currently being applied to the dataset, facilitating training activities for scientists in the region and encouraging a participatory approach.

Establishing the GES for D1 is conditioned by robust and up-to-date knowledge of the different cetacean species in the entire basin. Due to the restraints posed for the moment in the area, the project proposes the biggest coverage ever included in a cetacean Black Sea survey, allowing to cover half of the sea. Russian colleagues are working towards a similar survey in Russian waters, using the same methodology and protocols, to allow statistical comparison of the results and to facilitate merging the data for the analysis.

The results will be used to initiate the definition of thresholds values for cetaceans related indicators and criteria, in particular D1C2 (cetaceans populations abundance) and D1C4 (cetacean distributional range), in line with the new GES Decision (Decision 2017/848).

1. Survey preparation

1.1 Coordination scheme and roles of coordinators

The general coordination of the Black Sea Survey was ensured by the ACCOBAMS Secretariat and Mare Nostrum, in their respective capacities of CeNoBS Coordinator and CeNOBS Partner responsible for the **Activity 2.2. Assessment of cetacean populations distribution and abundance at the regional scale.**

Among other things, Mare Nostrum and the ACCOBAMS Secretariat were in charge of following up the administrative processes; ensuring the contracting part for the scientific coordination; ensuring the selection and contracting of the Aircraft company; organizing the training and the Team selection and daily life during the fieldwork.

The coordinators specifically worked in liaison and with the support of the following key stakeholders:

ASI Scientific Coordinator and his ad hoc support team:

The ASI Scientific Coordinator supported the coordinators on all the scientific issues related to the implementation of the Survey. The Scientific Coordinator was involved with developing all methodological aspects (survey design, protocol, platform selection, equipment), in observer team selection and training and with data acquisition and management by coordinating all the aerial scientific teams during the survey.

EcoOcéan Institut

EcoOcéan Institut was involved in the preparation of the aerial survey campaign and its implementation by assisting the Scientific Coordinator with all aspects linked to the use of the SAMMOA software (preparation of the software, training to the observers in order to ensure coherency in the data collection, assisting during the survey, verifying and preparing the data collected on SAMMOA for the data analysis).

CeNoBS Scientific coordinators and specialists of the consortium

CeNoBS Scientific coordinators and specialists of the consortium were supporting the ASI Scientific Coordinator in the scientific issues related to the development of methodological aspects, training of the observer and data collection and transfer to the ASI coordinator and EcoOcéan Institute for validation and further analysis.

1.2 Data collection methodology and related protocols development

Cetacean populations distribution and abundance have been assessed through a regional aerial survey aimed at collecting visual observations of cetaceans following specific and shared protocols. The aerial survey methodology offers the possibility of a large coverage in a short period of time, and is the most precise approach for estimating the abundance of the species. The Black Sea is known for its rough sea conditions and the capacity of going from 0 sea state to 5 sea state in a matter of minutes. Therefore, using planes has allowed the necessary flexibility for easily adapting to weather constraints.

The line transect distance sampling method has been used for the survey. This method is based on a statistical approach: data are collected by observers on board of aircrafts following specific transects designed to ensure an equal coverage and representation of the study area. This approach is used in several other contexts (SCANS initiative – Small Cetaceans in the European Atlantic waters and North Sea – and more recently during the Mediterranean surveys conducted by ACCOBAMS in 2018 within the framework of the ACCOBAMS Survey Initiative project), and it is globally recognized as the best approach to assess distribution, density and abundance of cetacean species at large scale. In particular, several EU-countries implement this methodology as part of their cetaceans MSFD monitoring programmes.

The data collection protocols and the survey design have been prepared by a Scientific Coordinator in close collaboration and consultation with scientists from Mare Nostrum and Green Balkans and the other project partners. The aerial survey has covered the waters of Romania, Bulgaria, Turkey, Ukraine and Georgia (territorial waters and exclusive economic zones) following pre-defined transect lines within different blocks. The survey design has been lately adjusted according to Flight Information Regions (FIRs) constraints, as this was precluding the possibility of flying in specific areas.

While targeting cetaceans was the highest priority during the aerial survey, other relevant observations were made in relation with D1 (biodiversity) and human activities (marine traffic, fisheries). In relation with the GES descriptors, the aerial survey did also collect information on D10 Marine Litter. The aerial survey has been conducted using small planes equipped with 2 engines, high wings and bubble windows, to allow the vertical view from the observers. Flights have been conducted during daytime, with good weather conditions.

1.3 Survey design

A total of 6 blocks were originally created (Fig. 1). The rationale for the blocks boundaries was the best compromise achieved between oceanographic zones, bathymetric characteristic and political/jurisdictional constraints. The first two are likely to have a marked effect on cetacean distributions. The design of the blocks was constantly updated as the survey was approaching, to take into consideration last minutes issues related to permit issues and other logistical considerations, such as FIR boundaries regulations.

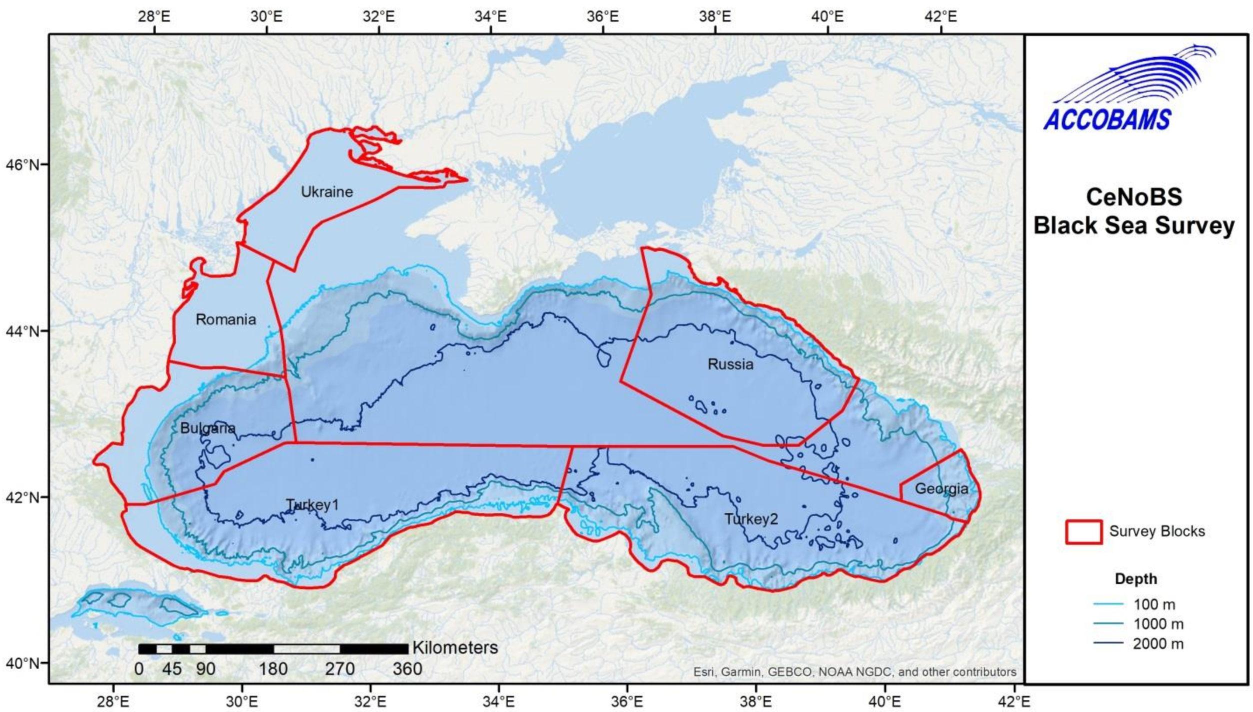

Fig. 1 – The original six blocks and the Russian block, added in a second phase.

For all blocks equal spaced zigzag (ESZ) design was selected. The direction of the tracks was set to be as perpendicular as possible to depth contours and the coast, according to best practice for distance sampling.

The design aimed to achieve a minimum of 3% coverage of the areas, in order to be consistent with the Mediterranean survey, conducted in summer 2018. Five hundred iterations of each design were run in order to obtain the map of coverage probability (to assess whether it resulted homogeneous or not), and the mean percentage coverage, mean total on effort trackline length and mean total trackline length.

The survey design was performed using the dedicated software Distance 7.3; the software allows to choose the effort for each block, the orientation of the different tracks and calculate the best route to guarantee that each area has the same possibility of being covered by the planes. This is called Equal Coverage Probability and makes sure that the collected data are robust and statistically valid (please see Buckland et al., 2001, Introduction to Distance Sampling for further information and details on the methodology). The selected tracks for the CeNoBS project allowed a final coverage of 5% for all the areas.

Figure 2 shows the tracks actually covered during the survey by the two teams and planes.

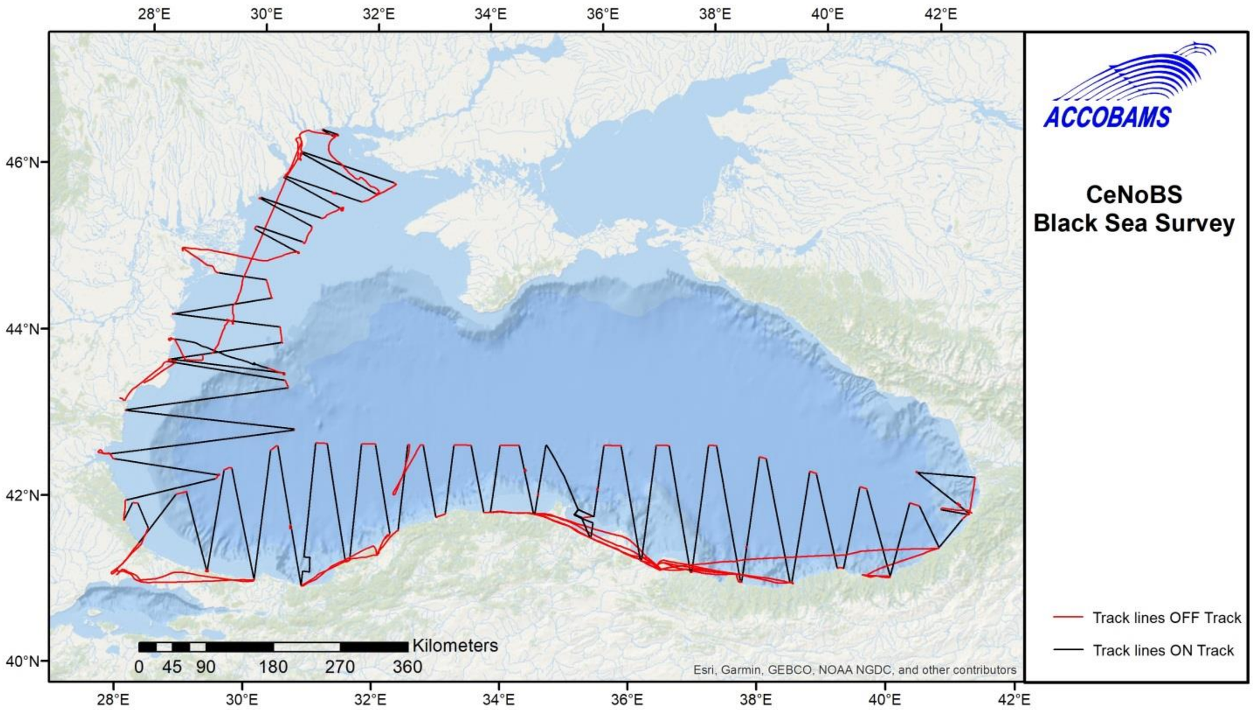

Fig. 2 – The tracks covered by the two planes (black=on effort; red=off effort).

1.4 Platforms, teams and equipment

There have been 2 teams, one per plane, composed of one Team Leader and two observers each. In addition to the observation work, the Team leader fulfilled the specific task to coordinate the flight planning with the pilot and organizing the logistics of the team. The research teams were mixed, involving observers with experience in aerial surveys and observers that have been trained for their first aerial survey, thus implementing the capacity building component of the project, in light of future cycles of implementation of MSFD. The teams also had mixed representation in terms of participating countries, involving scientists from Romania, Bulgaria, Turkey and Ukraine.

Both teams have worked under the supervision of the Scientific Coordinator who was in charge of the different phases before the field work, as well as a regular monitoring of the implementation of the aerial surveys, to ensure appropriate use of the methodology, providing guidance and advice to the Team Leaders in their flight planning, and to validate the collected data. The survey coordinator was also in charge of training of the teams on the line transect methodology and data collection protocols.

A couple sets of survey kits, with all the instruments needed to run an aerial survey were assembled and given to each cruise leader during the Tulcea workshop (June 2019), making sure that everything was in place, tested and working. A few spare kits and parts were kept by the ASI Scientific Coordinators, to be ready to ship replacements in case of malfunctioning and failures.

Each of the 2 aircrafts accommodated at least three scientific crew in addition to the pilot. Target altitude was 183m (600 feet) as customarily dealt in other surveys such as SCANS, SAMM, OBSERVE or REMMOA, and ASI, with target speed of 100 knots. The data recorder used SAMMOA software, dedicated to data acquisition on marine megafauna from visual observation during aerial survey, developed by Pelagis Observatory-La Rochelle University- CNRS with technical support of a data processing office Code Lutin. SAMMOA is connected to a GPS and has a simultaneously audio recording system. SAMMOA allows to establish a flight plan before take-off, with planned tracklines and observer's position onboard. SAMMOA also allows the data validation with the same interface and the checking, thanks to the voice recordings associated to each visual observation.

1.5 Administrative preparation.

The Administrative preparation of the survey consisted of the following main aspects:

Logistical preparation and follow-up*:*

Mare Nostrum was responsible for the preparation and implementation of meetings, workshop organization during the preparation phase and for the daily life logistics of the teams, contracting services in order to put in place the International training for aerial observers, in June 2019 in Tulcea for specialists from all riparian countries of Black Sea; contracting the aerial service (planes). This raised the capacity for both EU member states and Non-member states in implementing monitoring actions using the same protocols for further common analysis.

Particularly for the survey mission the members were covered by the service contract contracted by Mare Nostrum in the frame of the project.

Mare Nostrum together with the ACCOBAMS Secretariat and Scientific coordinators developed a communication and transfer of information procedure in order to assure the security and safekeeping of data collected during each day of mission. Non-stop availability was assured by all the specialists involved.

Next steps will include a workshop on data analysis which will increase the capacity on this field of science in the region.

Permits and authorization:

Considering the number of different administrative contexts to consider (6 countries), a contact Group was made under the ACCOBAMS Secretariat coordination to help with identifying and conducting the processes to obtain relevant authorizations for the aerial surveys in each country. Considering previous experience with the ASI in Turkey, the Research Permit in this country was submitted directly by the ACCOBAMS Secretariat.

Several consultations, meetings and information exchanges were conducted during the preparation period for the administrative aspects of the implementation of the campaign (permits, flight authorizations, security and military considerations, contracting aspects, security certification, etc.).

From there, the necessary steps were taken to ensure the feasibility of monitoring cetaceans throughout the area, taking into account the constraints, particularities and procedures of each country. This process led to obtaining permits to conduct the surveys in all the intended areas of work, the flight company contracted was handling the rest of the permit requests. However, some restrictions had to apply because of security situations or FIR constraints, which led to adjust survey design in some areas.

1.6 Aerial Survey Training workshop

A dedicated training workshop was organized in Tulcea, Romania, between 13 and 15 June 2019, where all the teams involved in the aerial monitoring attended both theoretical and practical lessons, for familiarization and preparation for field work activities.. During the training workshop, particular emphasis was dedicated to Team Leaders to familiarize with the different aspects of the planned field work, including accounting, problem solving, daily planning, etc.

Specific sessions were dedicated to data logging software SAMMOA and species identification, with effort towards a multi-species approach. During the workshop, all the data collection protocols were presented and discussed, in order to facilitate the standardized and shared approach. Data collection instruments were also presented and explained to participants, together with a practical demonstration to each Team Leader individually. WhatsApp groups were also created, to facilitate real time exchanges with the ACCOBAMS Secretariat and Scientific Coordinator, to address daily situations and facilitate the decision process in case of doubts or particular requests.

The last day of the Tulcea training workshop was dedicated to a series of practical flights where team leaders and their teams spent a few hours flying over the waters of the Black Sea simulating a real survey, with time to check collected data, and fine tune the data collection protocols, which were extensively discussed and analysed.

Considering SAMMOA training, several sessions have been run:

- ***Introduction and "take in hands"***: a plenary session has been realized, based on a PPT, explaining the software and the different windows. Attention has been driven on the important points crucial for the quality of the data: Begin/End, species/angle, environmental conditions. The second support was the doc on SAMMOA, explaining in a detailed way the different steps.

- ***Installation and material***: a practical session has been done on the way to install the software on a computer and all the participants installed it on their own computer and help each other for that.

- ***Appropriation***: they learn then how to create the metadata for a specific survey, here CeNoBS.

- ***Use and training***: a practical part has followed on how to enter the data, and all participants tried within the room and then during the training flights.

- ***Validation and quality***: then the validation of the first training flights has been realized in plenary session with the training flights projected on a screen and correction made in real time in front of all, with discussion on environmental conditions, encounters with mix groups of species, and other points where doubts or uncertainties on how to deal with such data arose. The validation of the second training flights has been made in front of all by the leaders themselves.

- ***Homogeneity***: At the end, several PPTs with pictures of species, boats, and environmental conditions (partly completed with pictures of the participants) were projected and discussions run on the criteria use, and also each time the link was made on how to enter this encounter in SAMMOA with the codes. This altogether exercise should ensure homogeneity among observers in collecting data (put the same code for the same things).

Support: guide of SAMMOA + mini-guide on "how to create a new specific survey". Important points that rose from the discussion have been clarified and added or detailed within the protocol after the training and before the survey.

2. Aerial Survey implementation

2.1 Data collection for aerial surveys

The survey was conducted flying along the planned surveys primarily in passive mode, unless it was necessary to obtain reliable estimates of school size or confirm species by circling on the sighted animals. The survey was then resumed at the exact point it was left and all the secondary sightings (i.e. the additional sightings made after leaving the predetermined trackline) although recorded have not been used to obtain the abundance and density estimates. The environmental conditions, reported by the primary observers, were recorded at the beginning of each transect and/or whenever a change occurred. The variables are the sea state (Beaufort scale), glare, cloud cover, turbidity of the sea and overall general conditions. Sightings data, also reported by the primary observers, included species, group size and composition, direction of swimming and group behaviour. Other accessory information such as the presence of human activities was also recorded. Observations were made through so-called bubble-windows allowing direct information on the track-line below the plane and recorded on a laptop with dedicated software. The plane position, speed and altitude were continuously recorded through a GPS.

2.2 Data verification and validation

EcoOcéan Institut took part to the training and significant amount of time has been spent there to ensure good coding of the data with the software for all observers. Plenary sessions have been run to train, discuss and fix the different parameters to collect within SAMMOA, with the right codes. This process enhances the coherence and standard way to collect data and reduce a lot of mistakes, heterogeneity between observers or missing data. The attendees went through the auto-validation process together during the training, so the data received had a high quality. The communication through the WhatsApp group with team leaders helped in real time to solve problems with the software and data storage, and verification of the data collected.

At the end of the survey EcoOcéan Institut proceed with the Pre-treatment of the data collected during the survey (data verifying, data cleaning, and data extracting) in view of the analysis, in direct link with team leaders. The data have been sent to the persons in charge of the analysis based on her recommendation for the format and under the supervision of the Scientific Coordinator.

An online workshop is currently being organized with the survey coordinator, the survey team leaders, the observers and also the data preparator to validate aggregation and validation of collected data, pre-treatment and discuss the process for data analysis following a participative approach.

3. Preliminary results and Analytical approach

Aerial flights were conducted between June 17th and July 4th 2019. Two planes were employed during the survey, one starting from Ukraine in the North-West portion of the Black Sea and a second one surveying Turkish and Georgian waters, from east to west. Thanks to the *momentum* generated by CeNoBS, a third plane is currently undertaking an aerial survey in the Russian waters – thanks to a collaboration with ACCOBAMS and the EU-UNDP EMBLAS+ Programme - and their data will be added to CeNoBS results once ready.

Data analysis is currently ongoing, with a preference to wait for the Russian data to be available and integrate them in the overall analysis of the Black Sea. Given the relatively short period of time between the two surveys, and the expert knowledge that Black Sea cetaceans do not extensively migrate in this time-frame, it is considered adequate to pull the data together.

This report presents sightings maps subdivided by species and human pressure and a final section on some preliminary considerations. An online workshop will be organized in the next couple of weeks with the survey coordinator, the survey team leaders and observers to streamline the process for data analysis following a participative approach.

A total of 1755 cetacean sightings were observed during the aerial survey, with 3669 individuals from 3 different species (Table 1). A total of 80,776 kilometres have been surveyed by the two planes in the different blocks, with 54,470 Km on effort and 26,306 km off effort. A summary is presented in Table 2.

Tab. 1 – The total number of sightings (left) and individuals (right) observed during the aerial surveys.

Species	Number of sightings
Bottlenose dolphin	121
Common dolphin	716
Delphinid sp.	33
Harbour porpoise	885
Total	**1755**

Species	Number of individuals
Bottlenose dolphin	339
Common dolphin	1751
Delphinid sp.	55
Harbour porpoise	1524
Total	**3669**

Tab. 2 – The total number of kilometres covered per block on effort and off effort.

Block	Km on effort	Km off effort	Total Km
Bulgaria	1115.53	159.59	1275.12
Georgia	210.36	119.12	329.48
Romania	816.32	548.44	1364.76
Turkey1	2211.47	2118.79	4330.26
Turkey2	2203.03	1413.32	3616.34
Ukraine	767.39	747.33	1514.72
Total	**7324.09**	**5123.21**	**12447.31**

The following figures present the geographical distribution of the different species of cetaceans observed, together with human pressures as they were sighted and recorded by the two planes (Figs. 3-11).

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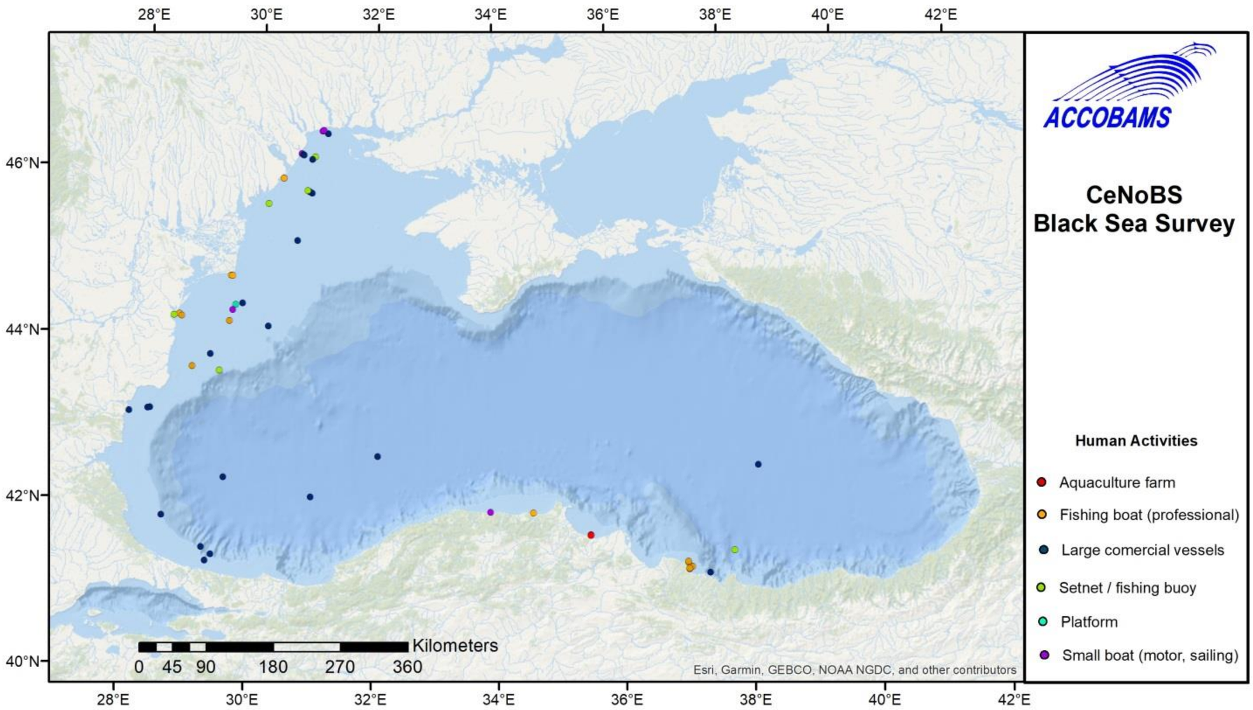

Fig. 3 – Human activities in terms of naval traffic and aquaculture farms.

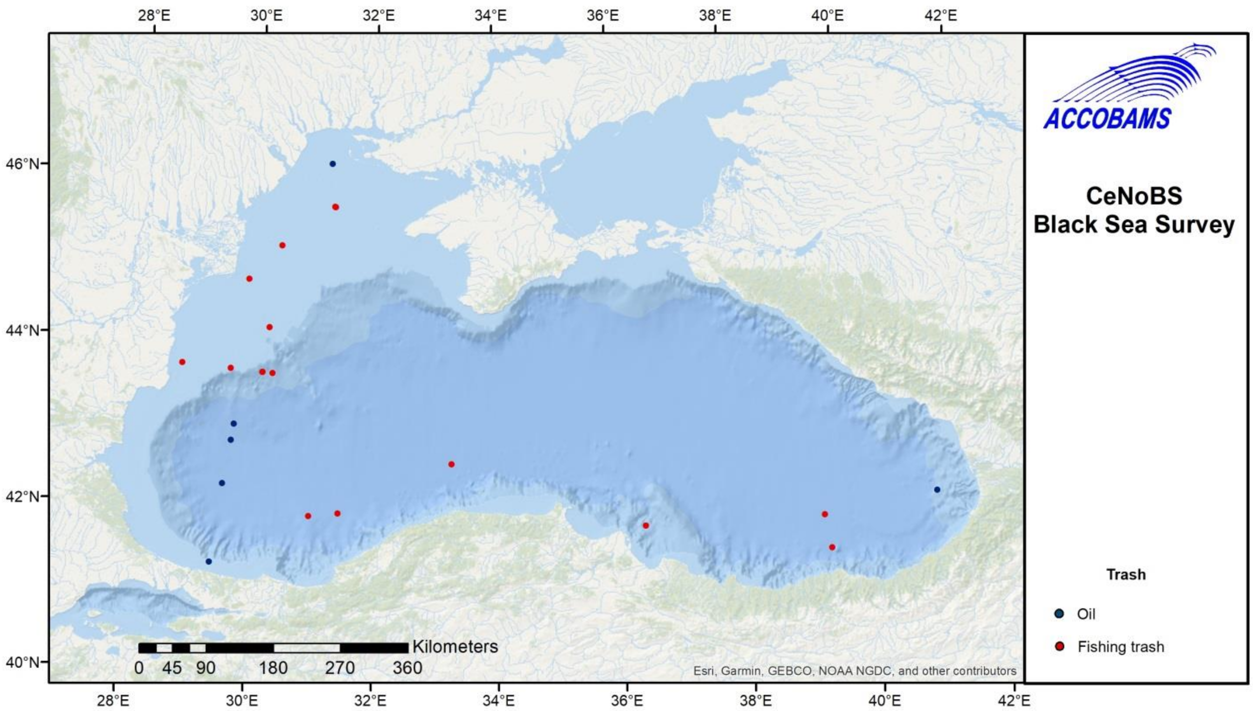

Fig. 4 – Oil pollution and fishing trash observed by the planes.

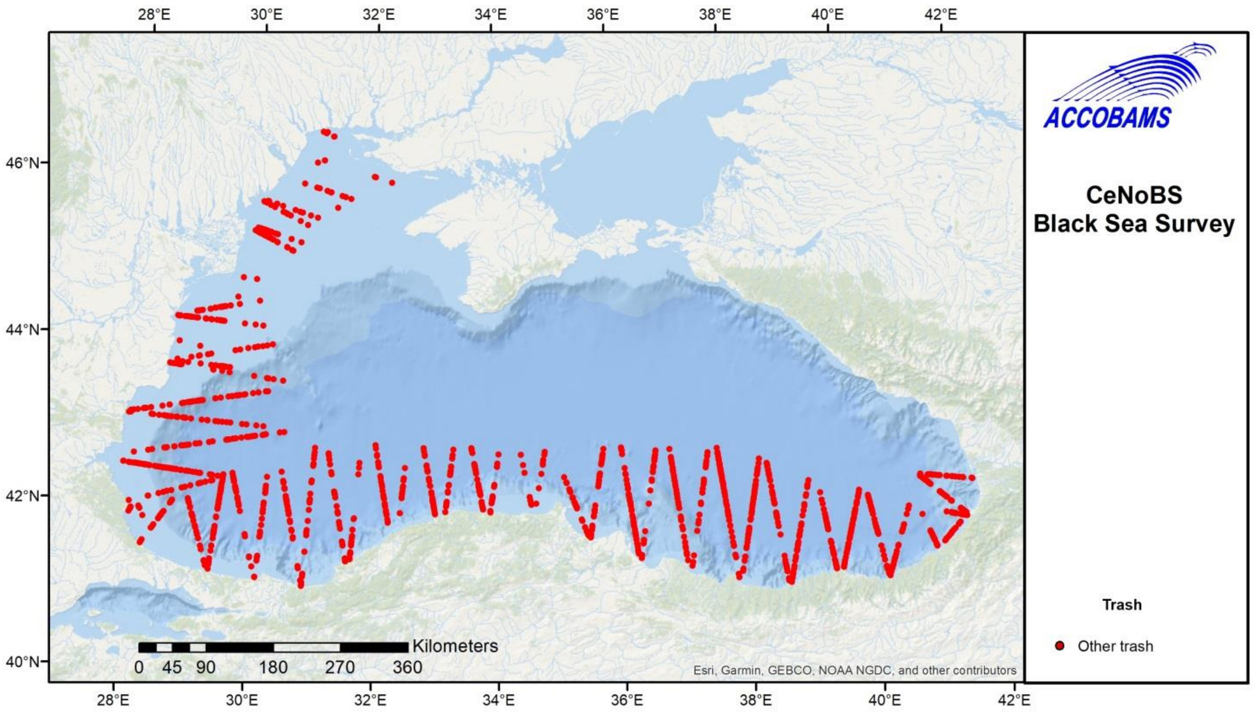

Fig. 5 – Marine debris, including plastic debris, observed during the surveys.

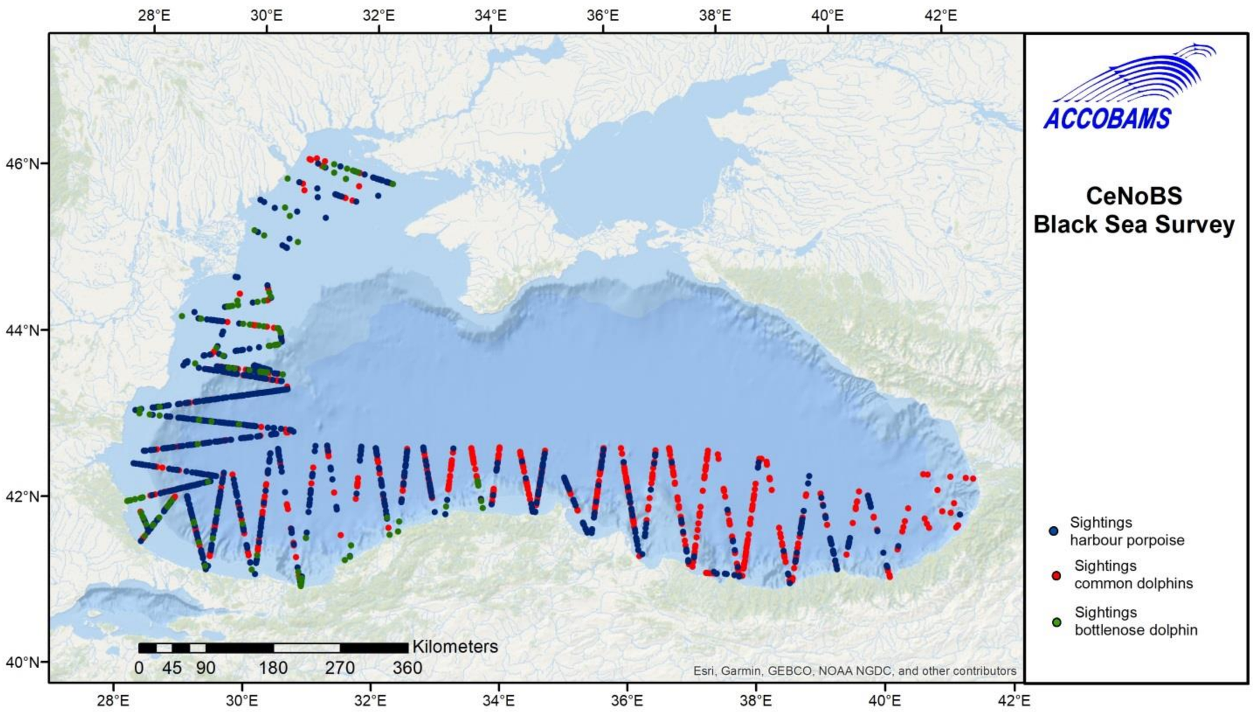

Fig. 6 – Cetaceans sightings observed during the surveys.

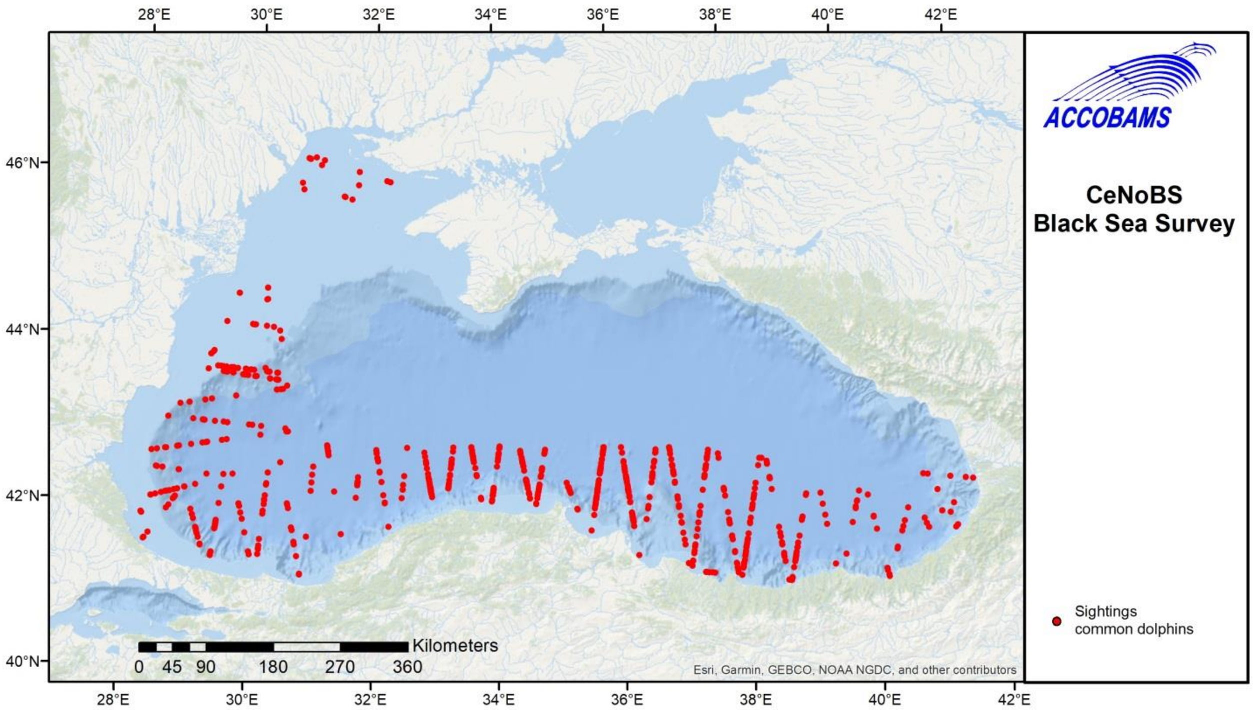

Fig. 7 – Black Sea common dolphins observed during the surveys.

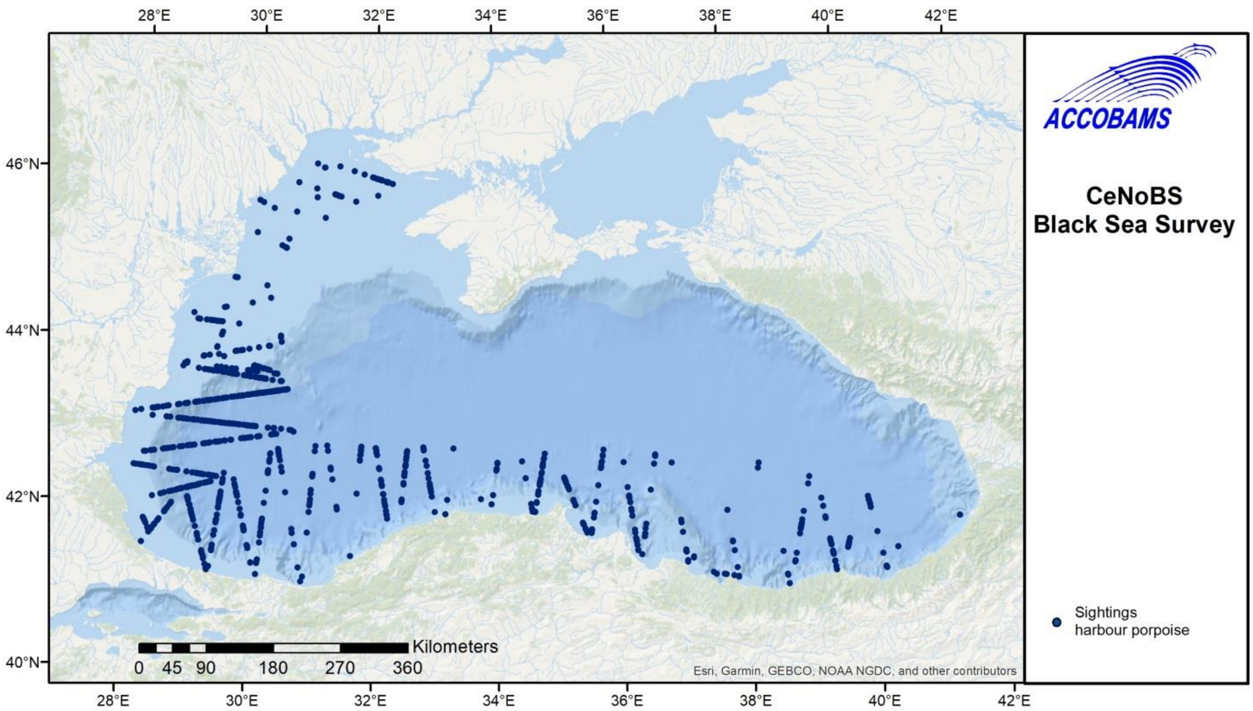

Fig. 8 – Black Sea harbour porpoises observed during the surveys.

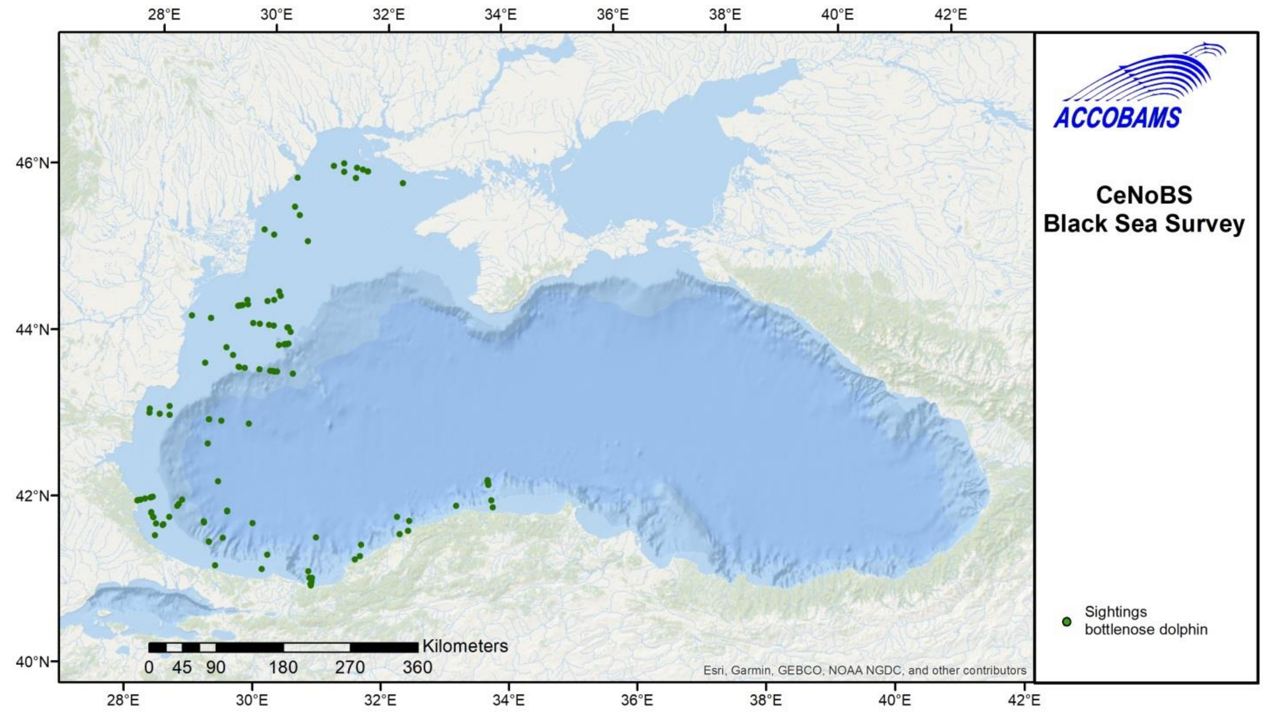

Fig. 8 – Black Sea bottlenose dolphins observed during the surveys.

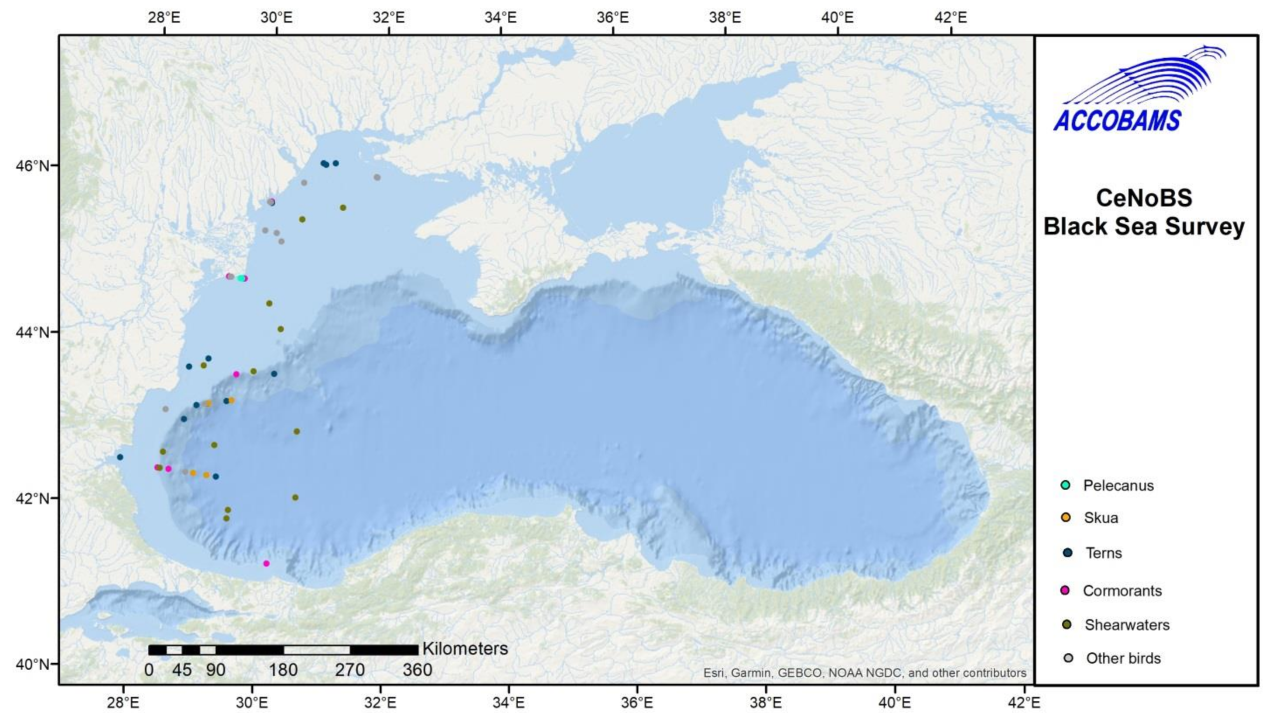

Fig. 10 – Marine birds observed during the surveys.

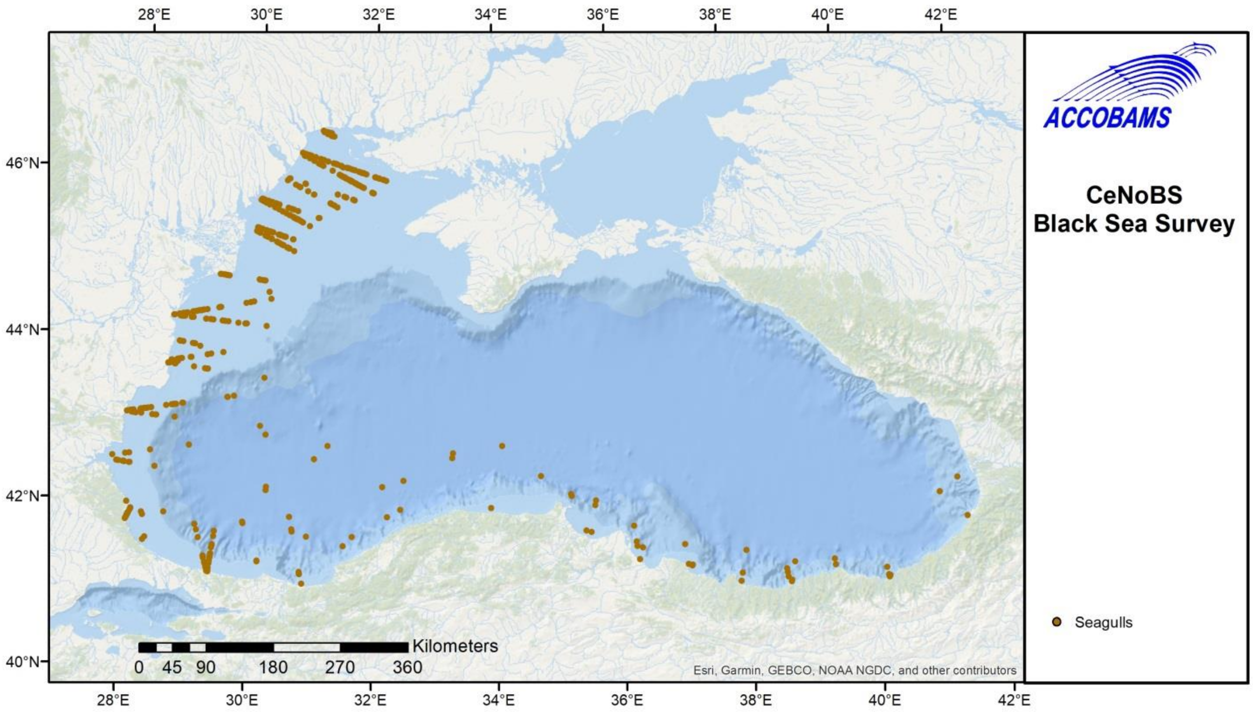

Fig. 11 – Different seagull species observed during the surveys.

Analytical approach

The collected data will be analyzed to estimate abundance, density and assess distribution of the different species. Data analysis will be performed with the support of skilled experts, using both model-based and design-based frameworks.

Design-based estimation

For the analysis, both the Covariate Distance Sampling (CDS) and the Multi Covariate Distance Sampling (MCDS) approaches will be followed using program DISTANCE v7.2. The latter allows incorporation of additional explanatory variables to perpendicular distance in the estimation of the detection function, in order to estimate the effective strip width (esw) under observation.

A detection function will be obtained for the species with enough sample size to estimate it: bottlenose dolphins, common dolphins and harbour porpoises.

Right truncation of the perpendicular distance data will be explored prior to the analysis, following the recommendations of Buckland et al. (2001). Segments of tracks and sightings with sea state 4 will be excluded from the analysis. Explanatory covariates to model detection probability, in addition to perpendicular distance, will include: Beaufort sea state, Searching condition, Observer, Team (the pair of observers on searching effort), glare and turbidity, all of them treated as factors. Final selection of the best model will be done mainly using the Akaike Information Criteria (AIC) but also looking at the performance of the diagnostics: the qq-plot, and the goodness of fit tests (chi-square, Kolmogorov-Smirnov and Cramer-von Mises).

To estimate the mean group size, the bias regression method (a regression of observed group size against distance to estimate the average population group size, as the expected value at distance of 0) will be used if regression will be significant at an alpha-level of 0.15, otherwise the mean of the observed groups will be used if not significant. This approach is intended to reduce bias if there is a tendency for smaller clusters to be missed more than large clusters at large distances from the track line.

Animal abundance will then be estimated according to a Horvitz-Thompson-like estimator formula:

$$\hat{N} = A\frac{n}{2\mathrm{L}}\hat{E}[s]\sum_{i=1}^{n}\frac{1}{\hat{\mu}(z_i)}$$

Where:

A = study area

n = number of sightings

L = total search effort (total transect length)

μ = effective strip width estimated (esw)

E [s] = estimate of mean group size

Z = covariates

Model-based estimation

A spatial models will be created for each of the species.

A spatial grid of will be created covering the whole study area, characterized according to several spatial and environmental variables. The covariates to be tested in the model will include: (a) spatial (latitude and longitude), (b) fixed (depth, distance to coast, distance to the 200, 1000 and 2000m isobaths - Distcoast, Dist200, Dist1000 and Dist2000 respectively -, slope, aspect), and (c) dynamic (survey period averages of sea surface temperature (sst), chlorophyll concentration (chl), sea surface currents (ssc) and chl gradients). Depth will be extracted from ETOPO and its derivates were obtained from it using ArcGis. Appropriate distances from different bathymetric lines will be selected according to the specific characteristics of the study area (e.g. Distance to 20m and 100m for NW part where water is rather shallow).

All on-effort transects (i.e. where searching conditions were acceptable) will be divided into segments (mean= 2.8 km; max= 5.4 km) with homogeneous effort types, and under the assumption that little variability in physical and environmental features occurred, as they were split off to fit each in a grid cell. Therefore, each segment will be associated with the values of the covariates of the specific cell in which it fell. As for the design-based method, segments of tracks and sightings with sea state 4 will be excluded from the analysis.

Using the count of animals in each segment as the response variable, the abundance of groups will be modelled using a Generalized Additive Model (GAM) with a logarithmic link function, and a Tweedie error distribution. Tweedie distributions are a special case of an exponential dispersion model which will have mean μ and variance ϕμp, where ϕ > 0 is a dispersion parameter, and p, called the index parameter, (uniquely) determines the distribution in the Tweedie family. The general structure of the model will be:

$$\hat{N}_i = \exp\left[\ln(a_i) + \theta_0 + \sum_k f_k(z_{ik})\right]$$

where the offset a_i is the effective search area for the i^{th} segment (calculated as the length of the segment multiplied by twice the effective strip width - esw), is the intercept, f_k are smoothed functions of the explanatory covariates, and z_{ik} is the value of the kth explanatory covariate in the i^{th} segment. The esw will be obtained for each species from their detection function, according to the covariates included in it.

Models will be fitted using the R package 'mgcv' version 1.7-22 (Wood 2006), and manually selected using three diagnostic indicators: (a) the Generalised Cross Validation score (GCV, (Wood 2000), (b) the percentage of deviance explained, and (c) the probability that each variable was included in the model by chance. The decision to include/drop a term from the model will be adopted following the criteria proposed by (Wood 2001).

The estimated abundance of animals for each grid cell will be calculated directly or as the product of the predicted abundance of groups and its stratified mean expected group size for dolphins. The point estimate of total abundance will be obtained by summing the abundance estimates in all grid cells over the study area.

Finally, to obtain the coefficient of variation and percentile based 95% confidence intervals, using day as the resampling unit, 400 non-parametric bootstrap re-samples will be applied to the whole modelling process. In each bootstrap replicate, the degree of smoothing of each model term will be selected by the statistical package, thus incorporating some model selection uncertainty in the variance.

4. Conclusions, annexed effort and recommendations

This report presents a first snapshot of the different sightings collected during the aerial surveys over the waters of Ukraine, Romania, Bulgaria, Turkey and Georgia through the CeNoBS project. As soon as the Russian team will complete their survey, the report will be integrated with the additional data provided.

The number of cetaceans' sightings is considerable and a preliminary qualitative analysis shows how the South-Western portion of the Black Sea appears as the area with the highest density of cetaceans.

Harbour porpoises are by far the most numerous species, with 50% of the total sightings; this is followed by common dolphins, with 41% of the sightings, and bottlenose dolphins, with 7% of the total observations. The geographical distribution of the different species appears rather non homogenous, but this will be further confirmed by the spatial modeling framework which will be applied to the dataset.

Human pressures have been observed all over the study area, with an alarmingly high number of plastic debris, evenly distributed throughout the Black Sea.

Marine birds and seagulls seem to be mainly distributed in the western part of the Black sea, with lower number of sightings towards the eastern portion of the study area. Seagulls in particular appear to be most abundant in the Ukrainian waters, with higher numbers of sightings reported from that area.

The density and abundance data will provide better insights on the spatial distribution of the different species in the Black Sea and will set the basis for future monitoring programs to assess trends in time and space.