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Research article

Managing multiple pressures for cetaceans' conservation with an Ecosystem-Based Marine Spatial Planning approach

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ABSTRACT

Despite the recognized important ecological role that cetaceans play in the marine environment, their protection is still scarcely enforced in the Mediterranean Sea even though this area is strongly threatened by local human pressures and climate change. The piecemeal of knowledge related to cetaceans' ecology and distribution in the basin undermines the capacity of addressing cetaceans' protection and identifying effective conservation strategies. In this study, an Ecosystem-Based Marine Spatial Planning (EB-MSP) approach is applied to assess human pressures on cetaceans and guide the designation of a conservation area in the Gulf of Taranto, Northern Ionian Sea (Central-eastern Mediterranean Sea). The Gulf of Taranto hosts different cetacean species that accomplish important phases of their life in the area. Despite this fact, the gulf does not fall within any area-based management tools (ABMTs) for cetacean conservation. We pin down the Gulf of Taranto being eligible for the designation of diverse ABMTs for conservation, both legally and non-legally binding. Through a risk-based approach, this study explores the cause-effect relationships that link any human activities and pressures exerted in the study area to potential effects on cetaceans, by identifying major drivers of potential impacts. These were found to be underwater noise, marine litter, ship collision, and competition and disturbance on preys. We draw some recommendations based on different sources of available knowledge produced so far in the area (i.e., empirical evidence, scientific and grey literature, and expert judgement) to boost cetaceans' conservation. Finally, we stress the need of sectoral coordination for the management of human activities by applying an EB-MSP approach and valuing the establishment of an ABMT in the Gulf of Taranto.

1. Introduction

Cetaceans play a critical role in preserving the structure and functioning of the marine food webs contributing to the provision of fundamental ecosystem services (Roman and McCarthy, 2010; Manea et al., 2019). In the Mediterranean Sea, one of the most exploited marine regions impacted by multiple human pressures (Costello et al., 2010; Micheli et al., 2013), 20 cetaceans' species have been recorded, both resident and visitors or vagrant (Pace et al., 2015). Many of them are listed in the IUCN Red List as species under threats of anthropogenic origin. Their populations have been assessed to be strongly reduced in terms of size due to unregulated human actions, and in need of protection (Bearzi et al., 2003; Gonzalvo et al., 2008). Additionally, the identification and implementation of conservation measures favoring cetaceans' resilience to climate-induced changes and environmental variations, which may increase in the Mediterranean Sea, are urgent because such changes can potentially and negatively affect cetacean's conservation status and distribution (Giorgi, 2006; MacLeod, 2009; Albouy et al., 2020). Nonetheless, this is a critical task considering the piecemeal of knowledge related to cetaceans' ecology, life history strategies and distributional ranges in the basin (Panigada et al., 2017). Information on migration patterns of highly mobile species extending

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dynamically within a large range, mainly driven by feeding and reproductive behaviors in the context of changing oceanographic conditions (Hoyt, 2005) are key explanatory variables. Planning for their conservation implies to incorporate all these variables to set up effective management strategies.

Many initiatives are ongoing in the Mediterranean Sea to boost cetaceans' conservation (Table 1). For instance, the Agreement on the Conservation of Cetaceans in the Black Sea Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) is an international legal instrument aiming to protect all cetaceans' species and habitats covered by the agreement through the identification of Critical Cetaceans Habitats (CCH, Notarbartolo di Sciara, 2002). The Ecologically and Biologically Significant marine Areas (EBSAs) identified by the Convention on Biological Diversity (CBD), and the Important Marine Mammals Areas (IMMAs) defined by IUCN Marine Mammal Protected Areas Task Force, have been proposed to support cetaceans' conservation (Notarbartolo di Sciara et al., 2016). All these tools are not legally-binding, but they represent the compass to follow for the establishment of a legally-enforced network of Marine Protected Areas (MPAs) for cetaceans' protection.

Nonetheless, designating priority areas of conservation may not be enough. The paucity of knowledge regarding cetaceans' ecology, the difficulty in forecasting future scenarios of climate change effects (Gissi et al., 2021), and the increasing human-derived pressures in the Mediterranean Sea may cause spatio-temporal shifts of cetacean populations (Piroddi et al., 2017), limiting MPA success. In Europe, the Natura 2000 network presents many limitations and lacks of operational capacity to deal with marine conservation in the European basins (Fraschetti et al., 2018), being mostly absent in Mediterranean open waters and deep-sea environment (Mazaris et al., 2018), and eventually not representing appropriate tools for mobile species conservation (Fortuna et al., 2018) despite some are listed in Annex II of Habitats Directive (EEC, 1992). The adoption of a holistic and integrated approach to limit multiple human pressures affecting cetaceans and the marine environment where they live seems a mandatory step beside the establishment of any area-based management tools (ABMTs) for conservation (Notarbartolo di Sciara et al., 2016). Ecosystem-Based Marine Spatial Planning (EB-MSP) can offer an opportunity to approach conservation problems (Fraschetti et al., 2018; Gissi et al., 2018; Rilov et al., 2020; Vaughan and Agardy, 2020), as in the case of cetaceans by i) addressing direct anthropogenic pressures on cetaceans, and ii) protecting the whole marine ecosystems, thereby guaranteeing the conservation status of cetaceans. EB-MSP is multi-sectoral and focuses on conflict resolution mechanisms between a wide range of uses and the marine environment (Douvere, 2008; Ansong et al., 2017), also outside established and enforced MPAs or conservation-related ABMTs. EB-MSP may boost cetaceans' conservation efforts and the preservation of the key ecosystem processes and functions (Manea et al., 2020) by addressing existing and potential drivers and pressures while coordinating the sustainable management of the coastal and marine human activities that may directly or indirectly affect them.

European Member States are facing the challenge to balance conservation targets and socio-economic development goals while elaborating their marine spatial plans, which need to be enforced by year 2021 (EC, 2014a). In Italy, the MSP process is now in its full path. Scientific knowledge and conservation objectives identification are necessary to inform the ecosystem-based management actions and the zoning of Italian marine areas. In this study, we focus on cetaceans as a conservation priority for the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea, Fig. 1). This area is important for different dolphin and whale species, as shown by empirical evidence and long-term monitoring (Dimatteo et al., 2011; Carlucci et al., 2016, 2017, 2018a,b, 2020a; Fanizza et al., 2018; Ciccarese et al., 2019; Azzolin et al., 2020; 2018; Papale et al., 2020). Starting from the maritime and land-based human activities in the Gulf of Taranto, the cause-effect relationships of direct and indirect human-induced pressures on cetaceans were explored adopting a risk-based approach (Stelzenmüller et al., 2018, 2020). The precautionary principle in an EB-MSP proposal was coherently adopted to inform effective management actions of human activities to control related pressures on cetaceans, eventually considering the establishment of conservation-related ABMTs in the Northern Ionian Sea (Central-eastern Mediterranean Sea).

2. Methods

2.1. Knowledge co-production framework and cause-effect relationships analysis

A knowledge co-production framework is developed to explore the cause-effect relationships within a risk-based approach (Stelzenmüller et al., 2018, 2020) to human activities, related pressures and the impacted biota with special regard to cetaceans in the Gulf of Taranto (Northern Ionian Sea). The risk-based approach was entailed in the analysis with its core steps, namely risk identification, risk analysis, and risk evaluation. The steps were anchored to the premises of clear conservation objectives, a prerequisite for the approach application, and incorporating uncertainty based on the reliability level of the available knowledge (Shabtay et al., 2019). The framework is structured in three phases. In phase one, we defined the criteria to operationalize cetaceans' conservation and gathered information for the knowledge co-production; in phase two, we performed a cause-effect relationships analysis. In phase three, the knowledge was finally applied to provide a set of recommendations to guide the setting up of conservation measures for cetaceans within EB-MSP, and the eventual establishment of a protected area in the Gulf of Taranto.

2.1.1. Phase 1: Information gathering for the knowledge co-production

To guide the knowledge co-production, we screened the official documents of the ABMTs and initiatives that promote or aim to protect the marine mammals in the Mediterranean Sea (Table S1) to define: i) the criteria guiding the establishment of a protected area for cetaceans' conservation (e.g. ecological requirements, level of vulnerability): ii) any information on the human-derived pressures and impacts that these conservation instruments aim to manage, and iii) any reference to the sources of knowledge and information to inform management (e.g., empirical data, expert judgement) (Table 1).

To respond to this knowledge need, we collected data and information, both spatially explicit and not. Firstly, we identified the different cetaceans' species present in the Gulf of Taranto and their legal source of protection (Table S2). Species' distribution, if known, was considered as a support base to inform spatial management priorities. Habitats recognized as of priority for conservation (e.g., *Posidonia* beds and Cold Water Coral habitats, CWC) were also considered and mapped with the available spatial information (Table S2). Finally, maritime and land-based activities, present or foreseen in the Gulf of Taranto, and related management and governance systems, were listed (Table S3).

2.1.2. Phase 2: Cause-effect relationships analysis

The cause-effect relationships between the human activities present in the Gulf of Taranto and the cetacean species health were described. We adopted a risk-based approach, adapted from Stelzenmüller et al. (2018, 2020), and the related concepts and glossary (Stelzenmüller et al., 2018 and references therein). Indeed, we referred to *Human activities* as activities that could alter marine ecosystems and change their capacity to provide benefits now and in the future, *Pressure* as an event or agent (biological, chemical or physical) exerted by one or more human activities to elicit an effect (that may lead to harm or cause adverse impacts), and *Receptor,* which is any living organisms, the habitat which supports such organisms, or natural resources which could be adversely affected by environmental contaminations. The pressures derived from each human activity and their possible effects on cetaceans were analyzed individually with the aim of depicting their

Table 1

Criteria of site selection, expanded from Asaad et al. (2017) and IUCN Marine Mammal Protected Areas Task Force (2018), and references that address the definition of the knowledge and information needed to inform site selection criteria and to manage the sites of ABMTs and non-legally-binding tools for the protection of cetaceans in the Gulf of Taranto. The review of the criteria is drawn on legal sources that are relevant for the conservation management problem addressed in this study (previously selected, Table S1). U = unique, rare habitat; F=Fragile, sensitive habitat; E = Ecological integrity; R = Representativeness; C=Conservation concern; RR = Restricted Range; B=Biological diversity; I=Important area for life history stages.

Initiatives	Criteria for site selection								References to the knowledge base for the elaboration of decisions for site selection and for the management of the sites	Sources
	Habitats				Species					
	U	F	E	R	C	RR	B	I		
Specially Protected Areas of Mediterranean Importance (SPAMI)	+		+	+	+	+	+		The site selection, in the respect of the specificity characterizing each protected site, and the protection measures for a SPAMI must take account of the following basic aspects: i) release or dumping of wastes and other substances likely directly or indirectly to impair the integrity of the area, ii) introduction or reintroduction of any species into the area, iii) any activity or act likely to harm or disturb the species, or that might endanger the conservation status of the ecosystems or species or might impair the natural, cultural or aesthetic characteristics of the area; iv) the regulation applicable to the zones surrounding the area in question. Sites will be selected on a scientific basis and included in the list according to their qualities. Protection, planning and management measures must be based on an adequate knowledge of the elements of the natural environment and of socio-economic and cultural factors that characterize each area. In case of shortcomings in basic knowledge, an area proposed for inclusion in the SPAMI List must have a program for the collection of the unavailable data and information.	UNEP/MAP RAC/SPA, 1995
Special Areas of Conservation (SAC)			+	+	+	+	+	+	About management measures, the formulation of conservation measures is based on a sound information base on the following topics (EC, 2012): i) existing conditions in the site, ii) existing conditions on the species and habitats status, iii) the main pressures and threats that can affect them, iv) the existing land uses and stakeholders' interests, etc. The main land uses and activities that can influence the conservation status of relevant habitats and species should be identified as well as the identification of all relevant stakeholders that need to be involved or consulted in the management planning process. This analysis allows considering potential conflicts and possible ways and means to solve them. It is useful to identify and map the precise location of the key natural features (habitat types and species) and the existing and planned socio-economic activities in the site. These maps are useful to discuss with stakeholders about the site management needs. The ecological requirements of the natural habitat types in Annex I and of the species in Annex II present on the site involve all the ecological needs which are deemed necessary to ensure the conservation of the habitat types and species. They can only be defined on a case-by-case basis and using scientific knowledge.	DG Environment, 2007; EC, 2012; EC, 2018
Marine Protected Area (Ecologically and Biologically Significant Areas, EBSA)	+	+	+	+	+	+	+	+	UNEP (2012) discusses the process of describing areas meeting EBSA criteria, including knowledge production and the use of expert opinion to populate the criteria. Multiple sources are: Scientific publications, "Grey literature", including unpublished reports; Reports from scientific cruises; Fisheries data; Internet-based databases and repositories (which may include bathymetric and species distribution data, as well as other GIS data); Conference presentations; Indigenous and local communities and other expert knowledge.	Secretariat of the Convention on Biological Diversity, 2004; UNEP, 2008, 2012
Important Marine Mammal Areas (IMMAs)	+				+	+	+	+	The objective of an independent, expert-based, IMMA process is to provide advice on marine mammal conservation priorities in an area-based context to assist in national and international conservation efforts including the identification of Key Biodiversity Areas (KBAs) and EBSAs. This will be of interest to marine mammal scientists, conservationists, MPA managers and spatial planners. (p. 8) IMMAs are determined through an expert-led process involving the collation and assessment of evidence against a set of selection criteria. This process aims to engage a wide range of representatives within the marine mammal science and conservation communities where much of the evidence necessary to assess IMMAs is held. Experts are selected based	IUCN Marine Mammal Protected Areas Task Force, 2018

(*continued on next page*)

Table 1 (*continued*)

Initiatives	Criteria for site selection								References to the knowledge base for the elaboration of decisions for site selection and for the management of the sites	Sources
	Habitats				Species					
	U	F	E	R	C	RR	B	I		
									on their knowledge, experience and skills relevant to the marine mammal species and habitats in the region as well as to the task of weighing evidence and applying the IMMA selection criteria. Potential sources of information are actively sought in the process of engaging with experts and other holders of evidence on a region-by-region basis. (p. 9) In the process of definition of the Area of interest, the proponents are called to supply information for the creation of a joint regional Inventory of Knowledge using a standardised Data Appraisal Form. (p. 9) In data poor regions, the assembled experts for that region will need to take difficult decisions on how and where to identify IMMAs. It may be that a data gap analysis reveals the need for specific research that can be stimulated by the expert assessments and recommendations from the workshops. (p. 75)	
Cetacean Critical Habitats (CCH)		+	+		+	+	+	+	Other criteria for the identification of sites containing CCHs in need of protection: I) Conflicts between cetaceans and fishing activities have been reported; ii) significant or frequent bycatch of cetaceans is reported; iii) Intensive whale watching or other marine tourism activities occur, iv) Navigation presents a potential threat to cetaceans. In every one of the above cases, ACCOBAMS advises careful consideration of whether the threat can be the focus of regulatory action that is generic, or whether MPA creation taken as the next appropriate step from CCH classification would provide necessary added conservation value. (IUCN Marine Mammal Protected Areas Task Force, 2018, p. 47). The identification is based on the overlapping of IMMAs and mapping of anthropogenic threats. Identification process is based on monitoring data obtained from any researchers' surveys, when made available (Res. 6.13), and it is based on scientific and expert knowledge. Specific human-derived pressures are considered in CCH of priority of protection identification process, which are those derived by fishery, anthropogenic noise, ship strikes, commercial cetacean-watching, marine debris. Also climate change impacts are of concern. Starting from the available knowledge on the negative impacts of such pressures on cetaceans (Res. 4.9, Res. 2.16, Res. 7.12, Res. 7.16, Res. 7.15, Res. 4.14), gathered mainly through monitoring activities, the call for Conservation Plans in CCHs finds its origin. Monitoring activities are also required addressing human-derived pressures, such as the identification of fishing gear abandoned and lost, ensuring their traceability (Res. 7.11). Socio-economic studies are also required, for balancing management measures in the identified CCHs (Res. 7.11).	ACCOBAMS, 2017; IUCN Marine Mammal Protected Areas Task Force, 2018

spatial footprint. We characterized the human activities by defining diverse pressure transfer agents. Each activity can rise a multiplicity of pressures, which can translate in diverse effects on the environment (Elliott et al., 2020). Thus, we coined and differentiated the pressure transfer agents that link each human activity and the derived pressures to zooming in specificities related to the human activity to be managed. For instance, the fishery activity was associated to diverse fishery-derived pressures depending on the pressure transfer agents, namely trawling activity, longline technique, small-scale fishery, purse seine, or ghost fishing due to loss of fishing gears. This is a common approach in cumulative impact assessment (e.g., Menegon et al., 2018; Farella et al., 2020). The human-derived pressures (identified in phase 1) were defined as direct or indirect. Direct pressures were those acting on the receptor of the pressure, e.g., ship collisions on cetaceans. While indirect pressures were those altering the environmental quality, both biotic and abiotic conditions, thus generating some effects on cetaceans' ecology (e.g., prey depletion due to fishing catches, the degradation of a key habitat for foraging or breeding).

For the aim of our study, the only receptors we considered were the cetaceans. These were considered at the species level (e.g., *Stenella coeruleoalba* and *Tursiops truncatus*) or at the population level (e.g., small odontocetes and all cetaceans) depending on the knowledge available to feed the cause-effect relationships analysis.

The analysis was based on the integration of several knowledge sources: i) empirical data produced through focalized research in the study area; ii) relevant information from both scientific and grey literature; iii) local experts to corroborate the information collected in the desk analysis, and to add with new information based on their local ecological knowledge. These were scientists focusing on the bio-ecology of cetaceans, MPA managers, environmental non-governmental organizations (NGOs) managers engaged in fishery, and managers involved in cultural and touristic activities. Expert elicitation activity was carried out through semi-structured interviews following an *ad hoc* questionnaire (Table S4). We adopted this knowledge framework to implement a rapid assessment through a composite indicator to quantify the pressures extent by scoring their i) frequency (i.e., rare, occasional, seasonal, monthly, and daily), ii) level (i.e., no pressure, minor, medium, devastating/medium, devastating/lethal), iii) magnitude (i.e., acting at species or at population levels) (Table S5). In case of "unknown" values of the attributes, we associate a medium score applying the precautionary

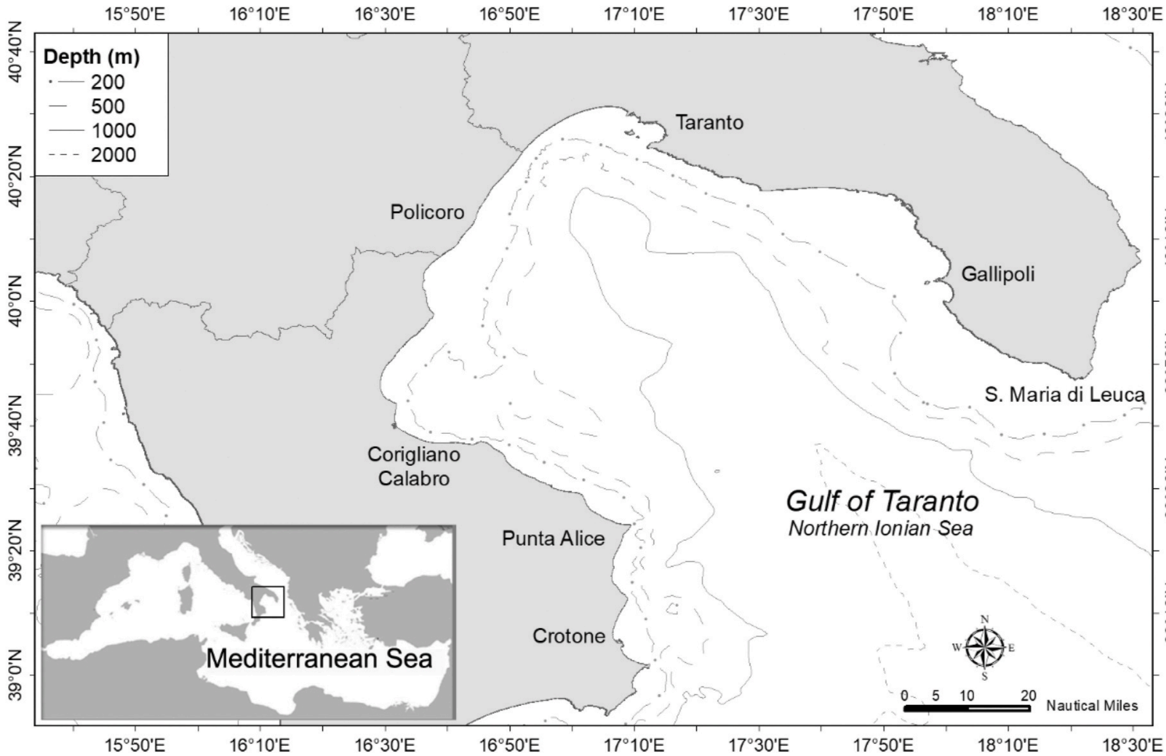

Fig. 1. The Gulf of Taranto. The case study area, within the Northern Ionian Sea, Central-eastern Mediterranean Sea.

principle. The final score of each pressure was defined by the sum of frequency, level, and magnitude values.

To capture the uncertainty deriving from the multiple knowledge sources (Walker et al., 2003; Stelzenmüller et al., 2015; Gissi et al., 2017; Shabtay et al., 2019), we qualitatively defined a confidence level based on the empirical evidence available for each cause-effect chain. The confidence was "high" when empirical evidence of pressures and potential impacts on cetaceans was available for the investigated area; "medium" when empirical evidence was available from scientific studies on cetaceans carried out in other marine areas; "low" for the cause-effect chains mentioned by the experts but for which empirical evidence in the Gulf of Taranto was not available.

2.1.3. Phase 3: Recommendations for cetaceans' protection in an EB-MSP approach

In the third phase, some recommendations on management actions to support the conservation of cetaceans in the Gulf of Taranto were elaborated. The recommendations were rooted on the criteria and related knowledge for site selection and management compiled in phase 1. Thus, they were distillated through the risk-based approach in the form of risk evaluation, based on the knowledge co-production framework (phase 1), and the risk identification and analysis, based on the cause-effect relationships analysis (phase 2). We drew recommendations about measures to manage direct and indirect pressures causing potential negative effects on cetaceans. The assigned confidence value for each cause-effect relationship drove the recommendations towards precautionary management measures.

3. Results

3.1. Species and habitats of conservation priority

The knowledge framework we built in phase 1 provided evidences that the Gulf of Taranto hosts several cetaceans' species and habitats of conservation priority (Tables S2). The study area was found to be a critical habitat (Hoyt, 2005; ACCOBAMS-ECS-WK Threats, 2017) for the striped dolphin (*S. coeruleoalba*) and common bottlenose dolphin (*T. truncatus*) (Carlucci et al., 2016, 2017, 2018a, b; Ciccarese et al., 2019; Santacesaria et al., 2019; Azzolin et al., 2020; Papale et al., 2020), as well as the Risso's dolphin (*Grampus griseus*) (Maglietta et al., 2018; Carlucci et al., 2018c, 2020a), the sperm whale (*Physeter microcephalus*) (Bellomo et al., 2019), the Cuvier's beaked whale (*Ziphius cavirostris*) (Podestà et al., 2016; Carlucci et al., 2020b) and the fin whale (*Balaenoptera physalus*) (Dimatteo et al., 2011; Fanizza et al., 2014). Furthermore, we found recently published evidence that cetaceans are relevant keystone predators in the food web of the Gulf of Taranto (Ricci et al., 2019; Carlucci et al., 2020c). In particular, the striped dolphin was described as a key player able to exercise top-down control on several trophic levels activating cascading effects (Ricci et al., 2020a). The knowledge about the spatial distribution of density of both striped and common bottlenose dolphins (Fig. 2a and b), as well as about the persistent area where the striped dolphins conduct their feeding, resting, socializing and traveling activities (Fig. S1), is available for the study area and reported in Carlucci et al. (2018b) and (2018a), respectively. In particular, the related outcomes are based on the sighting data collected during surveys carried out in the period from April 2009 to December 2016 (Fig. 2c), and were obtained by applying, respectively, the Delta approach on Random Forest (DaRF) regressions, considering as predictive variables a mix of environmental and anthropogenic features characterizing the area, and a geostatistical analysis. In addition, a recent phylogenetic study focused on the striped dolphins highlighted the presence of different haplotypes able to constitute sub-populations phylogenetically isolated from each other (Ciccarese et al., 2019).

We found that the Gulf of Taranto is also constellated by key vulnerable habitats (Fig. 2c). These include deep-sea and pelagic habitats identified as of priority for conservation (Manea et al., 2020). A NW–SE submarine canyon called the 'Taranto Valley' (Harris and Whiteway, 2011), the deep CWC province offshore from Santa Maria di Leuca (SML CWC), and the Amendolara shoal (Bo et al., 2011; Capezzuto et al., 2010; Carlucci et al., 2018d; Chimienti et al., 2019; Castellan et al., 2019; D'Onghia et al., 2016) characterized the Northern Ionian Sea. The geomorphology in the area involves a complex distribution of

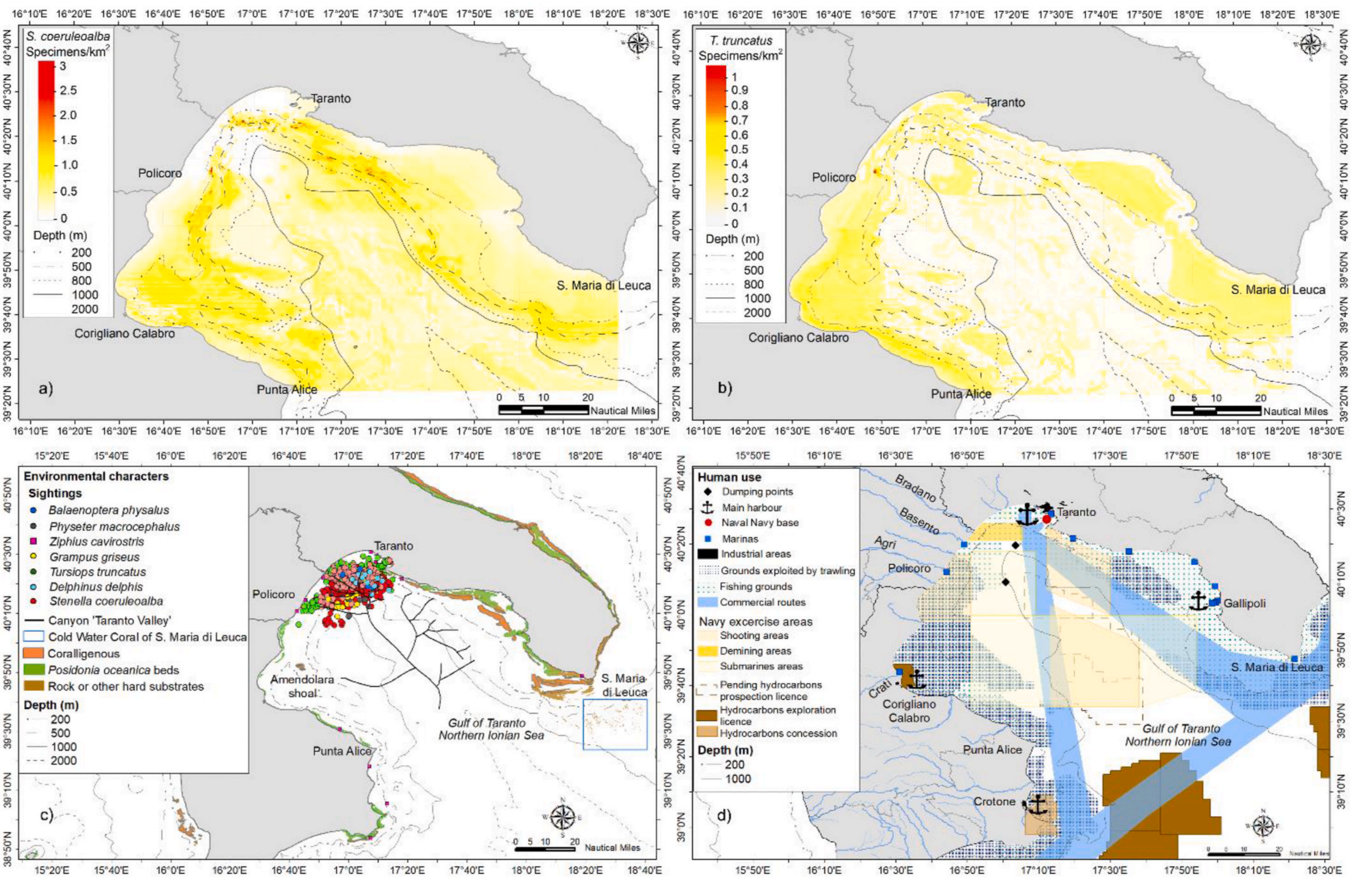

Fig. 2. Available knowledge on the spatial distribution of species and habitats of conservation priority including cetaceans and specific seabed habitats (panels a–c), and on human activities (panel d) in the Gulf of Taranto. Data sources for human activities are reported in Table S3.

water masses with a mixing of surface and dense bottom waters that leads the occurrence of high seasonal and decadal variability in upwelling currents that support surface primary production (Bakun and Agostini, 2001; Civitarese et al., 2010; Pinardi et al., 2016). Sensitive shallower habitats are also present, as *Posidonia oceanica* beds and coralligenous outcrops. Our review revealed that these habitats are partially protected by two Marine Protected Areas (Porto Cesareo and Capo Rizzuto MPAs) and diverse Natura 2000 sites along the Gulf of Taranto coastline (Table S6; Fig. S1).

The knowledge framework developed here provided evidence that all these habitats play a fundamental ecological role in the Northern Ionian Sea. Indeed, they support high biological diversity providing food, sheltering and breeding habitats for both benthic and pelagic organisms, including cetaceans and their preys (Moors-Murphy, 2014; Fiori et al., 2014; Bo et al., 2011; Marbà et al., 2014; Ballesteros, 2006Sion et al., 2019; Ricci et al., 2021). They represent important habitats for the life history of diverse marine species, and have been acknowledged of being vulnerable to human pressures.

3.2. Human activities

The Gulf of Taranto is characterized by the presence of several maritime and land-based human activities that can influence the conservation status of species and habitats of priority for conservation (Fig. 2d, Table S3). Their planning and management regime is structured in a multilevel governance system. National (i.e., ministries) and supranational (i.e., General Fishery Commission of the Mediterranean, GFCM) authorities are mainly responsible for maritime activities, while the regional and sub-regional ones (i.e., municipalities) are responsible for land-based activities.

The port of Taranto is the endpoint of the Scandinavian-Mediterranean Corridor of the Trans-European Transport Network (TEN-T) (EU, 2013). The Port Strategic Plan (Municipality of Taranto, 2018) issued by the Taranto Port System Authority (a decentralized territorial body of the Italian Ministry of Infrastructures) foresees the expansion of the logistic platform and intermodality infrastructures to host the forecasted increase of commercial and passenger transport at year 2030 (Autorità di Sistema Portuale del Mare Ionio, ASPMI, 2017). Major merchant shipping routes from the Port of Taranto directed towards the Strait of Gibraltar and the Suez Canal (ASPMI, 2017) north-south cross the Gulf of Taranto (source: https://www.marinetraffic.com, accessed at 14/03/2020), with 1993 ship transits at year 2019 (Table S7).

Taranto also hosts the most important naval base and arsenal of the Italian Navy. Different areas for the execution of navy exercises such as surface and submarine naval manoeuvres, and a shooting range, both taking place from 2 to 6 times per year and enforced by Coast guard ordonnances (source: http://www.guardiacostiera.gov.it/taranto/Pages/ordinanze.aspx, accessed at 16/07/2020), are located in the central area of the gulf.

Concessions of hydrocarbon exploration by means of seismic air-gun surveys are present in the gulf, some of which has been permitted or under evaluation by the Italian Ministry for Economic Development (source: https://unmig.mise.gov.it/index.php/it/2-non-categorizzato/2036046-ricerca-e-coltivazione-di-idrocarburi, accessed at 16/07/2020). Other hydrocarbon exploration areas are present at the boundary of the gulf (Fig. 2d).

Intense fishing activity is also recorded in the basin with trawlers, long-liners, gill-netters, trammel netters and purse seiners distributed in different fishing harbours along the coasts (Carlucci et al., 2016; Russo et al., 2017). However, bottom trawling activity is banned below 1000 m depth (Manea et al., 2020). The Gulf of Taranto is part of the GSA 19 where fishery is managed under the compartments of Gallipoli, Taranto, Corigliano Calabro, and Crotone (Cataudella and Spagnolo, 2011). In 2016, there were 863 active vessels of these compartments dedicated to trawling (MIPAAF, 2018). However, the number decreased after the last funds disbursed to favour the temporary interruption of some fishing enterprises (MIPAAF, 2019), and it is expected to decrease further in the future.

With respect to the land-based activities, heavy industries are mainly concentrated in Taranto (Ben Meftah et al., 2008) with the steel production, an oil refinery and a cement plant. Population density related to the high level of urbanization of the coastal areas of the Gulf of Taranto (Ladisa et al., 2010) increases significantly in summer due to intense seasonal coastal tourism. Tourists arrivals and overnight stays have shown a positive trend in the area since 2016 (Becheri and Morvillo, 2019), and arrivals in the provinces around the Gulf of Taranto tripled the coastal resident population in year 2019 (Table S8). Coastal tourism constitutes one of the major economic drivers of Apulia, Basilicata, and Calabria regions (respectively, sources: https://www.agenziapugliapromozione.it/, https://www.aptbasilicata.it/, http://www.turiscalabria.it/, accessed at 16/07/20), driving also nautical recreational activities, including an increase in pleasure boating, which currently counts in the Gulf of Taranto 3949 berths distributed in 13 marinas (Table S9). The Macro-regional strategy of the Adriatic and Ionian Region (EUSAIR, EC, 2014b) foresees the sustainable increase of coastal tourism, fishery activities, maritime transport, and related socio-economic activities for the Gulf of Taranto.

Water management is in charge of the Southern Apennines Basin Authority, managing three sub-basins characterized by the presence of short and torrential-like and seasonally flowing rivers (Pantaleone et al., 2018). Only four rivers flowing into the Gulf of Taranto (Basento, Agri, Bradano in Basilicata, Crati in Calabria) are classified of second order according to the Italian National Legislative Decree 152/2006, e.g., whose catchment area is greater than 400 km^2 (Fig. 2d). These are the main corridors connecting land and marine environments potentially most responsible for the transport of contaminants and waste at sea.

The governance system is complicated by the authorities in charge of environmental protection and monitoring activities. The Ministry of the Environment is in charge of MPAs designation. Coastal MPAs are currently managed by the Regions with ad-hoc management bodies. Regional environmental authorities of Apulia, Basilicata, and Calabria are responsible for water quality monitoring of coastal marine areas up to 1 nautical miles (Italian Legislative Decree 152/2006). The Ministry of the Environment is in charge of the EU Marine Strategy Framework Directive 2008/56/EC (MSFD, EC, 2008) implementation, and the Italian Institute for Environmental Protection and Research (ISPRA) of the MSFD monitoring in coastal and marine waters; at present, MSFD monitoring are not publicly available.

Finally, the demand of marine space for offshore wind farms, cruise ship traffic, and whale watching has been recorded in the gulf, with their own specific responsible authorities and management systems.

3.3. Cause-effect relationships analysis

We identified direct and indirect pressures driving potential impacts affecting cetaceans (Table S10) through the use of the multiple sources of knowledge (i.e., empirical evidence, information from scientific and grey literature, and local expert knowledge). We adapted the analysis on the base of the available knowledge that was diverse in relation to the

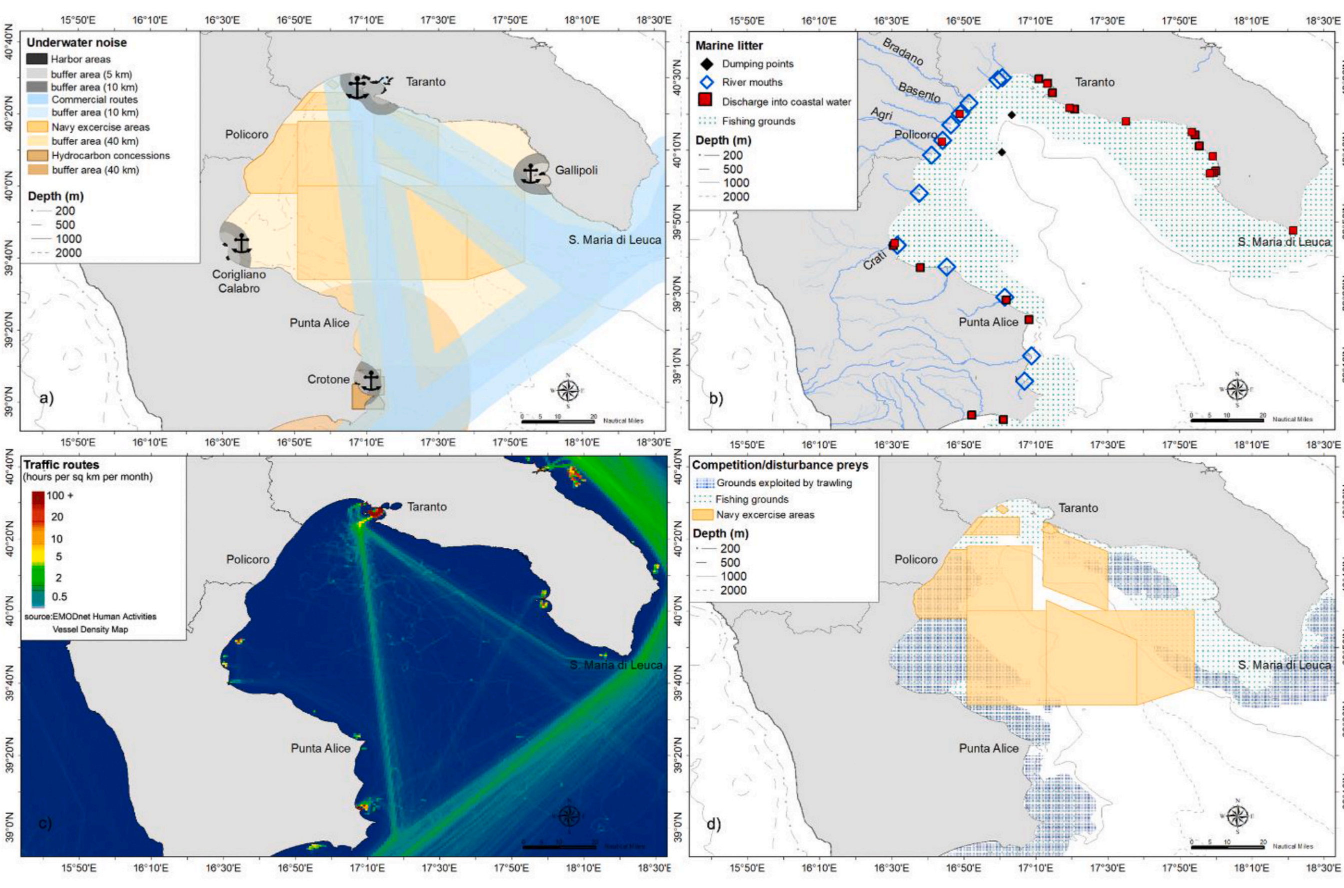

Fig. 3. Potential spatial footprint and source site of the human-derived direct and indirect pressures possibly affecting cetacean populations in the Gulf of Taranto (Northern Ionian Sea). Spatial footprints of a) underwater noise, b) marine litter, c) traffic routes and maritime traffic density as a potential for ship collisions, and d) competition/disturbance on preys.

receptors of the analyzed pressures (at population or at species levels, i.e., *Z. cavirostris, B. physalus, P. macrocephalus* and *T. truncatus*) (Table S10).

Among the documented direct pressures (Fig. 3, Fig. 4a), the underwater noise is the one with the highest number of pressure transfer agents being potentially generated by a multiplicity of uses, namely navy, hydrocarbon exploration, maritime transport, coastal tourism, and coastal development. Underwater noise reaches the highest total pressure score, from 1.2 to a maximum of 2.8 (Table S10). We found information related to the potential propagation of underwater noise being able to represent its possible footprint starting from the location where human activities generating it are set (e.g. harbours and navy exercise areas, Fig. 3a and Table S10). Underwater noise potentially covers the entire gulf, as it can propagate for long spatial ranges (Podestà et al., 2016; Carlucci et al., 2020b). This pressure is known to affect all cetaceans' species (Gordon et al., 2003; Popper and Hawkins

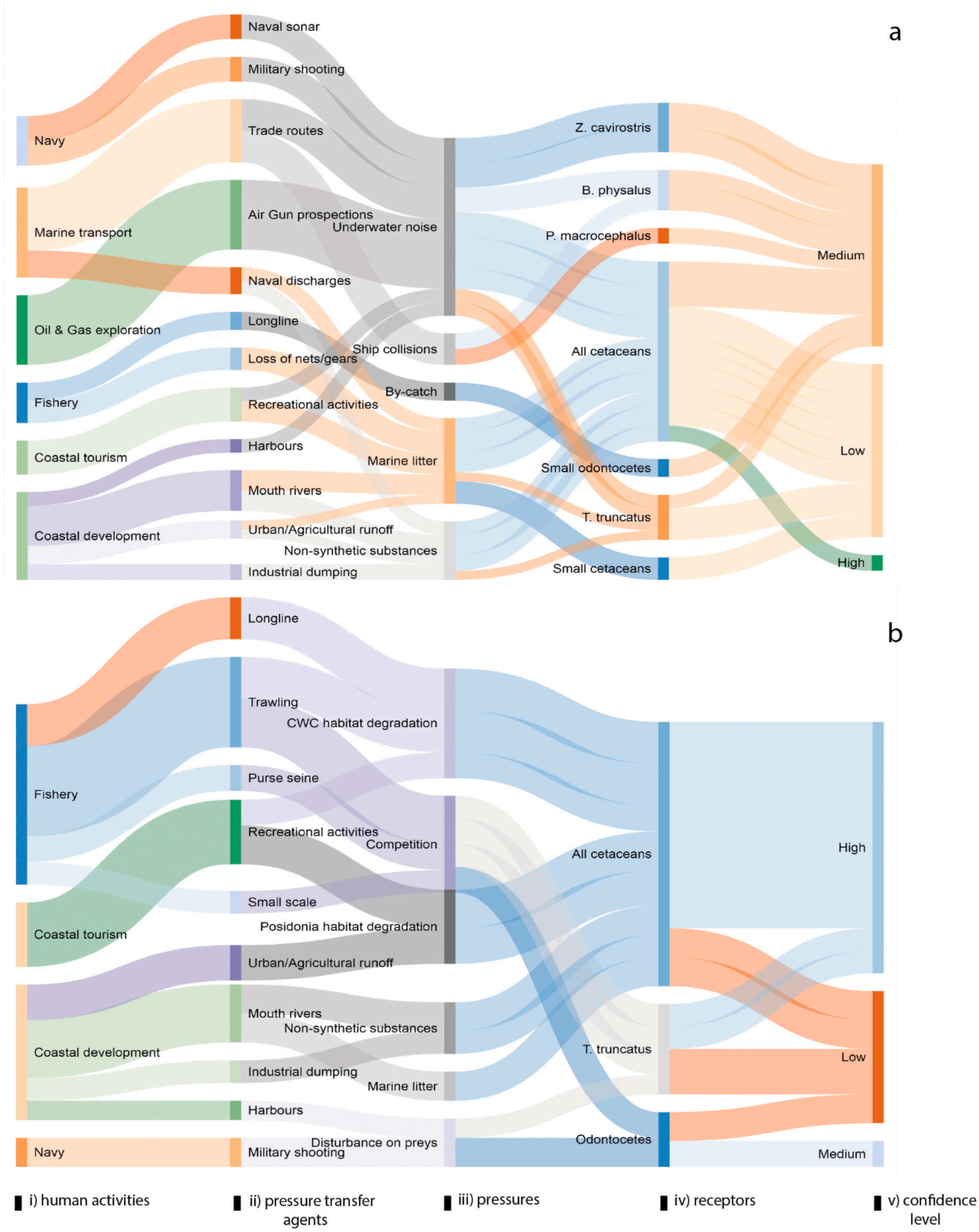

Fig. 4. Sankey diagrams describing the relationships between i) human activities, ii) pressure transfer agents, iii) pressures, iv) receptors (cetaceans described at species or at population levels), and v) confidence level, each corresponding to one node of the diagrams. The width of each band is proportional to the total pressure score derived by each cause-effect relationship chain 'human activities -> pressure transfer agent -> pressure -> receptor -> confidence level' (reported in Table S10). Bands merge with each other when cause-effect relationships share one of their nodes. Panel a) reports the cause-effect relationships related to direct pressures, while panel b) reports the ones of indirect pressures; http://sankeymatic.com/(accessed 12 July 2020).

2016; Kavanagh et al., 2019), particularly *Z. cavirostris* (Jepson et al., 2003; D'Amico et al., 2009; Podestà et al., 2016; Bernaldo de Quirós et al., 2019), *B. physalus* (Castellote et al., 2012) and *T. truncatus* (Jensen et al., 2009; Bearzi et al., 2012; Gonzalvo et al., 2014), with an average of medium confidence, i.e., there are no studies about this in the Gulf of Taranto, but evidence of the effects of underwater noise from the Ionian Sea (Carlucci et al., 2020b and references therein, and according to local expert knowledge; Table S10). Both the naval sonar from military activity and the air gun prospections from the oil and gas exploration present a total pressure score of 2.2 (Table S10), and are the main pressure transfer agents of underwater noise potentially leading to lethal injuries with spatial footprint up to 40 km (Parsons, 2017). Such lethal events are rare, while underwater noise leading to medium disturbance is more frequently produced (daily or seasonally) by military shooting activity, marine transport from the trade routes, and recreational activities (according to local expert knowledge).

The marine litter is the second pressure potentially affecting indiscriminately all cetaceans and specifically small cetaceans among which *T. truncatus*, followed by non-synthetic substances (total pressure score ranges of 0.8–2 and 0.8–1.8, respectively, Table S10). Five different pressure transfer agents contribute to the diffusion of litter, related to coastal development and tourism, fishery, and marine transport (according to local expert knowledge). Main sites source are the river mouths, beaches, and the areas where fishery may occur (Fig. 3b). Indeed, fishery is an important source of marine litter (Consoli et al., 2019). More lethal is the pressure generated by the loss of fishing gears at the individual level (Stelfox et al., 2016), and recreational activities on all cetaceans (Poeta et al., 2017), despite the frequency of their occurrences is unknown or low, as well as low or medium is the confidence level. From minor to medium disturbance is observed related to non-synthetic substances, mainly derived from land-based activities and naval discharges (Cardellicchio et al., 2000; Fossi et al., 2012, 2014; Jepson and Law, 2016). Also in this case, the level of confidence of such scoring is low.

Ship collisions and by-catch is very rare in the study area and these events are not directly observed by the local experts. Only in some cases, the presence of scars on the small odontocetes potentially attributable to collisions with pleasure boats is reported (Table S10). However, lethal effects due to the ship strikes at individual level, mainly on *B. physalus* and *P. macrocephalus*, are reported with medium confidence in the Mediterranean Sea (Panigada et al., 2006; Campana et al., 2015) and in the Atlantic and Pacific oceans (Jensen et al., 2004). Ship collisions, being a localized pressure, could occur over main traffic routes in the gulf (Fig. 3c).

Regarding the indirect pressures, competition derived by prey disturbance or depletion and habitats degradation are the strongest (total pressure score ranges of 1.4–1.8 and 1.6–2.6, respectively, Table S10). The footprint of fishery and navy exercise areas dedicated to military shooting activity is where cetaceans' prey competition or disturbance can origin (Fig. 3d). In this case, we specifically identified the areas interested by trawling in addition to the fishery grounds because of its renowned effect on the trophic food web (van Denderen et al., 2013; Carlucci et al., 2020c). Indeed, competition is mainly due to fishery activity that, through different pressure transfer agents, has been observed to lead to the prey depletion of odontocetes, and specifically of *T. truncatus* (Piroddi et al., 2010; Ricci et al., 2020b).

Vulnerable habitats degradation was considered as an indirect pressure impacting cetaceans at population level. In particular, CWC communities and *P. oceanica* meadows represent the main essential fish habitats in the gulf, which are able to support high biodiversity and ecosystem services provisioning (Costantino et al., 2010; D'Onghia et al., 2016; Capezzuto et al., 2018). Evidence of anthropogenic impacts affecting these habitats were detected in the study area (i.e., D'Onghia et al., 2017; Telesca et al., 2015). As for their ecological role, we considered the scoring of the pressures degrading these habitats proportional to the derived indirect pressure acting on cetaceans. Habitats degradation mainly derives from coastal tourism, fishery and coastal development through recreational activities, longline and trawling, and urban and agricultural runoffs, respectively (Fig. 4b) (Marbà et al., 2014; Ragnarsson et al., 2016).

Finally, non-synthetic substances and marine litter affecting cetaceans' preys, as well as preys' disturbance (mainly due to underwater noise) are reported to origin mainly from land-based activities and affecting all cetaceans with both high and low confidence, depending on the cause-effect relationship (see Simmonds and Nunny, 2002).

3.4. Recommendations for the management plan and monitoring program

The process of knowledge building and the risk-based analysis provided important outputs to manage pressures for cetaceans' conservation. These entail considerations on the likelihood of potential negative effects on cetaceans (documented in *sections 3.2* and *3.3*), and the different confidence levels we applied to the risk-based analysis.

Firstly, any management plan of the Gulf of Taranto supporting cetaceans' conservation would need to be framed within a precautionary approach. Undoubtedly, improved management measures should be put in place considering the best available knowledge documented here. Monitoring activities would be needed to increase knowledge on cetaceans and on the potential effects of the multiple human pressures for which there is no evidence yet. This acquired knowledge would be essential also to monitor the consequences of the existing and future management measures in the area in the long term. At present, databases on cetaceans' distribution and ecology are limited to a minority of the species (Fig. 2a–b), as well as limited in space (Fig. 2c) and time (spanning the temporal range of 2009–2016). Nevertheless, this shortage of knowledge should not postpone the action addressed towards cetaceans' protection in the area. On the contrary, it represents the reference baseline for the monitoring of management effectiveness. Cetaceans' populations currently seem to thrive in the Gulf of Taranto based on what has been visible and monitored in the last ten years, and in the absence of a comparison with data related to the past. These recommendations mean to support the preservation of this favorable condition in the long term.

As such, management measures need to target the full array of drivers of pressures in a coordinated manner. For instance, underwater noise is the major pressure in the gulf driven by multiple human activities in charge of different responsible authorities. Currently, the activities are managed individually through specific protocols to contain potential negative effects at a level to not affect cetaceans, as military (NURC, 2008) and seismic activities (ISPRA, 2012). Though rare and punctual, human activities contributing to underwater noise might overlap spatially and temporally and induce significant impacts over large spatial areas in the gulf. Moreover, the propagation of underwater noise in the deep is still unknown by narrowing our capability of effectively identifying all the impact zones (Madsen et al., 2006). This is especially critical in the Gulf of Taranto, where the complex geomorphology can influence sound dispersal. Interestingly, some activities that contribute less to overall underwater noise intensity may have relevant negative effects on cetaceans at the local scale. For instance, underwater noise deriving from pleasure boating and vessels in shallow water can cause disorientation and a reduction of communication capabilities in bottlenose dolphins in an area of 50 m (Jensen et al., 2009). This pressure should be carefully considered and managed in the Gulf of Taranto, because the increase of coastal tourism will drive the increase of pleasure boating. This trend calls for management measures addressed at avoiding the rise of the overall noise pressure. Ship collisions linked to the maritime transport sector emerged to be of potential concern. Collision risk on cetaceans should be carefully addressed in light of the forecasted increase of maritime traffic in the gulf – though data showed a significant decrease of maritime traffic due to the effects of COVID19 pandemic for the I semester 2020 (Tab. S7), in line with trends observed elsewhere, e.g., Northern Adriatic Sea, Italy

(Depellegrin et al., 2020). Some experiences have proved the manageable nature of this pressure by means, for instance, of traffic control schemes (e.g., Agardy et al., 2019) or controlled speed reduction (e.g., Constantine et al., 2015).

We found high level of potential pressure linked to marine litter and non-synthetic substances in the area. Managing land-based human activities in the gulf will be essential to control related effects caused by land-based pressures linked to recreational, industrial and agricultural activities. To manage marine litter and contaminants the starting point should be controlling their production at the source (Cheshire et al., 2009). Nonetheless, steps have been already taken since sectoral management measures on ghost nets and on industrial dumping are in place (Table S3). The low confidence we possess to imply potential negative effects of the above mentioned land-based pressures indicates the need of a better understanding of the related cause-effects relationships thus orienting future studies in the area. We mentioned also threats coming from oil-spill phenomena, which have already occurred in the Gulf of Taranto (Crisafi et al., 2016), constituting a possible source of contamination in the area to be managed.

As for the indirect pressures, competition for preys' depletion and key habitats degradation are among the highest threats to cetaceans' well-being. A reduction in fishing effort in the area is foreseeable as the starting point to limit cetaceans' preys depletion, which can strongly affect the food-web of the gulf (Ricci et al., 2019). We emphasise the need to preserve the marine environment as a whole by acting for its good state, because its functioning is the key to achieve any conservation objectives. The indirect effects on cetaceans resulting from long-term depletion of cetaceans' preys and of the marine environment are not foreseeable at the moment. Despite the high confidence emerged from *section 3.3*, further monitoring studies and management measures are needed to prevent no-return situations of degradation with negative implications on cetaceans.

The establishment of an ABMT for conservation is here argued to be highly beneficial. We framed our understanding of the area starting from the knowledge required by both legally and non-legally binding initiatives for conservation (Table 1), and we found significant need to establish protection in the gulf. A dedicated MPA in the Gulf of Taranto will not control all sources of pressures, but it would reinforce the effort to protect cetaceans in synergy with other sectorial management measures (Geijer and Jones, 2015). Indeed, the designation of a protected area would help to lobby with other human activities to act towards conservation. Establishing the management mechanisms through an MPA responsible body can help in coordinating monitoring efforts towards consistent long-term data and information in the gulf. Furthermore, coordinating systematic monitoring activities on cetaceans would be essential to understand their distribution trends and their level of vulnerability to human pressures, in view of existing human activities' increasing trends and new uses demanding for space (e.g. whale watching, wind farms, oil extraction). In addition, improved monitoring efforts would be beneficial to inform climate change effects on cetaceans in the gulf, considering also the possible invasion of alien species (Lezzi et al., 2016). Advanced monitoring techniques (e.g. machine learning techniques, Maglietta et al., 2018; Reno et al., 2018) and predictive distribution models would be supported on a regular basis. The existing locals' engagement in conservation and monitoring activities provided by the local NGOs and research institutes through citizen science would be better supported by local and national authorities (Ricci et al., 2018).

4. Discussion and conclusions

The Gulf of Taranto falls within several criteria for site selection related to all the initiatives addressing cetaceans' conservation in the Mediterranean Sea, both at national and regional level (i.e. SAC, SPAMI, IMMA, EBSA, CCH). However, none of these areas has been designated and implemented, yet. The gulf presents persistent population of cetaceans that find key areas for their life history phases (Carlucci et al., 2017). A key argument for the conservation values in the Gulf of Taranto is the presence of different haplotypes of striped dolphins, which appear phylogenetically separated from other Mediterranean and Atlantic counterparts. Avoiding genetic erosion by conserving this area is of deem importance (Ciccarese et al., 2019). Several deep-sea (submarine canyon and CWC banks), shallow (seagrass meadows and coralligenous outcrops), and pelagic (upwelling sites) habitats create favorable conditions for the support of high biological diversity and thriving cetacean's communities in the Northern Ionian Sea. For instance, the Amendolara Shoal may represent a site of priority for conservation for the presence of the bioconstructor *Dendrophyllia cornigera* (Chimienti et al., 2019; Castellan et al., 2019) listed as Vulnerable in the IUCN Red List. Further studies are needed to deepen the knowledge on cetaceans interacting with CWC reefs (Henry and Roberts, 2017). All these habitats are recognized as biodiversity hotspots of priority for conservation, as well as fragile and sensitive to both local anthropogenic and climate-induced impacts. Likely, for all these reasons, during the first phase of the SPAMIs network implementation by UNEP MAP RAC/SPA (2008–2009), the Gulf of Taranto, together with Santa Maria di Leuca, was identified as an area deserving the inclusion in the SPAMI List (Portman et al., 2013). Unfortunately, the area today is not on that list and is barely covered by small coastal ABMTs targeting conservation of seabed habitats (e.g., *Posidonia oceanica*), and by the Fishery Protected Area (FRA) of Santa Maria di Leuca. No conservation measures are in act to specifically protect cetaceans within these ABMTs. The EBSA of the Southern Adriatic covers a very small neighbor portion of the Northern Ionian Sea in its eastern side, but it is not legally binding.

Despite the poor conservation effort targeting cetaceans in the area, the Gulf of Taranto is subjected to diverse and widespread human pressures. When approaching management for conservation, considering pressures' footprint can support their control and reduction (Elliott et al., 2020), even if knowledge on habitat suitability of target species is incomplete. This can be an effective way to operationalize a precautionary approach to conservation especially for highly mobile species. Marine conservation has been traditionally approached starting from conservation targets, such us benthic habitats (Ceccherelli et al., 2006) or sessile organisms (Breen et al., 2015), and from specific ABMTs to preserve coastal and marine areas, such as MPAs (Notarbartolo di Sciara, 2008). Here, we did start from considering all the ABMTs that can be designated to protect cetaceans in the Gulf of Taranto, both at national and regional level, to build the relevant knowledge and inform the analysis, but we did not necessarily conclude for a specific conservation ABMT. Indeed, several of the selection criteria listed in the official documents of conservation instruments were found to be satisfied by the characteristics of the marine area and the present cetaceans' populations. As a result, the entire Gulf of Taranto can be indicated as an area suitable for the establishment of diverse legally and non-legally binding protection areas. Indeed, cetaceans are potentially spread in the full area of the gulf, and for the presence of the acknowledged important habitats, it might deserve to be protected as a whole. The establishment of large marine protected areas targeting highly mobile species has increased with time (Wilhelm et al., 2014), even though conservation effectiveness of such areas is still uncertain (Ban et al., 2017; White et al., 2017). On the other hand, smaller MPAs effectiveness can be doubtful due to their limited size that contrasts the migratory nature of most cetacean populations (Notarbartolo di Sciara, 2008). The Pelagos Sanctuary for marine mammals' protection, the only Mediterranean international MPA, was criticized for not covering the entire areal of species inhabiting the Corsican-Ligurian-Provençal Sea, and so excluding important habitats for their conservation (Druon et al., 2012; Agardy et al., 2019). Nonetheless, when reliable information is available, the establishment of an MPA in identified specific areas, where highly mobile species are stationary for relevant periods corresponding to important life stages (e.g. breeding, feeding), might be beneficial (Breen et al., 2015). A persistent cetacean area has been defined in the Gulf of Taranto, which could be considered as an area with potential to be designated as a cetacean conservation area.

Here we argue that the Gulf of Taranto is eligible for the establishment of an ABMT, for instance a Specially Protected Area of Mediterranean Importance (SPAMI) in accordance to the SPA/BD Protocol (Carlucci et al., 2018b,c; Maglietta et al., 2018). Nonetheless, any ABMT aiming at preserving cetaceans will have necessarily to consider how to manage pressures also coming from the surrounding areas (i.e., underwater noise). The conservation effectiveness of MPAs is subjected to their capacity to control pressures driven by human activities inside and outside their boundaries (Mazaris et al., 2019; Claudet et al., 2020). Menegon et al. (2018) have shown how an Apulia MPA was potentially subjected to pressures deriving from outside its boundary.

In this study, we focused on the cause-effect relationships between the human activities present in the Gulf of Taranto and the cetacean species health through an EB-MSP approach, to identify those activities that drive these cause-effects chains. Our analysis has also helped in defining pressures and related effects to support the effectiveness of a future ABMT for conservation, independently from its typology. The identified human activities (e.g., maritime transport, fishery, coastal tourism) are managed under specific sectoral policies and related governance systems that need to be coordinated towards a common objective of conservation of species and habitats, beyond the designation of an ABTM. We report as an example the Particularly Sensitive Sea Areas (IMO, 1991), which are designated by the International Maritime Organization to manage international shipping on areas that are environmentally or culturally sensitive to its impacts (Geijer and Jones, 2015). The here proposed EB-MSP approach aims at supporting the synergy between the establishment of a future ABMT and a coordinated sectoral management approach for the achievement of conservation objectives. The ABMT would support the negotiation with the maritime sectors and responsible authorities to manage human activities to control and reduce pressures, by providing a recognition of conservation values and needs in the Gulf of Taranto. This would also be beneficial for all species and habitats that have not been the focus of our analysis but are of conservation priority and present in the gulf, such as the sea turtle *Caretta caretta* and the coralligenous outcrops that have been recognized to be under threat in the area (Casale and Margaritoulis, 2010; Cirelli et al., 2018; Pisto et al., 2019; Bevilacqua et al., 2018). Such an approach would support a greater resilience of habitats to climate changes, which lead to their degradation by indirectly impacting cetaceans because of the alteration of primary production dynamics and preys' availability (Simmonds and Eliott, 2009). In this study, it emerged also that identifying the drivers of change by reconstructing the cause-effect relationships is especially relevant for land-based activities and potential sources of pressures, such as marine litter. Land-sea continuum is important in the context of the Gulf of Taranto, because of the geomorphological characteristics of the area. The presence of the submarine canyon system Taranto Valley increases the level of threat derived from any source of pollution, also of terrestrial origin, for the role canyons play as conveyor belts of sediment and debris in the deep sea (Fernandez-Arcaya et al., 2017). The presence of submarine canyons has been already identified as a priority to be considered for the setting of appropriate EB-MSP strategy in deep-sea areas (Manea et al., 2020) to control potential drivers of impacts between coastal and off-shore marine ecosystems (Popova et al., 2019), and between shallow and deep ecosystems (Levin et al., 2018).

Finally, though the governance framework reconstructed here is particularly complicated by the presence of multi-level responsibilities, the Gulf of Taranto is a Historical Bay, fully under the responsibility of Italy. This fact can facilitate coordination between multiple responsible authorities towards a common vision for the gulf. The implementation of a multi-sectoral portfolio of management measures rooted within the EB-MSP approach combined with the designation of an ABMT should be considered in the Italian marine spatial plan for the Ionian-Central Mediterranean maritime area. We stress the need to recognize the multiple co-benefits delivered by boosting marine conservation implementation together with EB-MSP measures in the Gulf of Taranto for the effective protection of the marine environment and the cetaceans, and the sustainable use of marine resources and space.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvman.2021.112240.

Credit author statement

RC: Conceptualization, Data curation, Investigation, Writing – review & editing, Supervision; EM: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft; Writing – review & editing, Visualization; PR: Conceptualization, Data curation, Investigation, Writing – review & editing; GC: Data curation, Investigation, Writing – review & editing, Visualization; CF: Data curation, Writing – review & editing; RM: Data curation, Writing – review & editing; EG: Conceptualization, Methodology, Investigation, Formal analysis, Writing – review & editing, Supervision.

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