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Restore our ocean and waters

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## **Studies in Support to the Implementation of the Mission:**

**‘Studies to Support  
Communities of Actors to  
Achieve the EU Mission -  
Restore our Ocean and  
Waters Objectives’**

**CINEA/2023/OP/0012**



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**Studies in Support to the Implementation of the Mission:  
‘Studies to Support Communities of Actors to Achieve the  
EU Mission Restore our Ocean and Waters Objectives’ -  
CINEA/2023/OP/0012**

**Underwater Noise, Emissions and Marine Megafauna in Sicilian Waters”  
A consolidated report for the Mission Ocean TA project “Evaluation of  
the impact on cetaceans and sea turtles of conventionally powered  
hydrofoils connecting Sicily to the smaller islands and comparison with  
the new hybrid-powered models”**

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## 1 Introduction

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This feasibility study was developed for the Sicilian Region - Department of Land and Environment (beneficiary) in support to the project “Evaluation of the impact on cetaceans and sea turtles of conventionally powered hydrofoils connecting Sicily to the smaller islands and comparison with the new hybrid-powered models” from October 2024 to September 2025.

Following the handshake meeting held on 04/10/2024 the TA Plan (Appendix A) was refined, agreed upon the Mission Ocean and the beneficiary, and implemented. During the execution the plan was further updated to better align it with the needs of the Region as the project evolved.

The next chapters of the present document are structured as follows:

- Chapter 2 gives an overview of the TA provided
- Chapter 3 to 5 present the main findings of the feasibility study
- Chapter 6 and 7 describes Recommendations and Conclusions

In appendix, the following can be also found:

- Appendix A - TA Plan
- Appendix B - Overview hybrid ferries in operation
- Appendix C - Minutes of the interviews with the experts on marine biology/ecology
- Appendix D - Overview regulatory framework on maritime transport
- Appendix E - Summary TA Sicily Decarbonization

Also, the following Annexes have been attached (zip folders) to this report containing relevant documents:

- Annex I - Regulatory Framework Task
- Annex II - Impacts task

## 2 Overview of TA provided

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The purpose of this Technical Assistance is to set a common understanding and establish responsibilities of each of the parties in the process of technical assistance provided by Mission Ocean and Water Resources Support Facility to the Sicilian Region - Department of Land and Environment, within the “Evaluation of the impact on cetaceans and sea turtles of conventionally powered hydrofoils connecting Sicily to the smaller islands and comparison with the new hybrid-powered models”.

In terms of technical and economic/financial aspects - considering the knowledge of the current transport system to the minor islands and the different needs of the passengers moving to the closer islands (using RO-RO) compared to the needs for farer islands (Pantelleria, Linosa, Lampedusa, Ustica), the TA team supported the beneficiary to further refine the project concept and identify feasible solutions. This included research to identify suitable existing solutions and/or best cases already adopted across the Mediterranean and/or other Sea Basins.

In terms of regulatory aspects – the TA team proceeded with a desktop analysis of the regulatory and legal framework for the identified technology/ies (eventually hybrid vessels, which combine different propulsion systems like fuel cells and batteries) that is/are applicable to the specific Sicilian case.



In terms of operational aspects - the TA team conducted several interviews with relevant stakeholders to raise awareness about the interest of the Sicilian Region and to formulate recommendations, targeting the maritime community of Sicily on the impacts of underwater noise and emissions on marine species.

This report synthesizes findings from desktop research and expert testimony related to the impact of maritime transportation (vessels) on biodiversity and ecosystems, serving Sicily's minor islands, with emphasis on effects, particularly underwater noise impacts, on cetaceans and sea turtles (these species are considered sentinels, keystone, umbrella and flagship, for their role in the marine food web). The report also examines the availability of studies comparing effects from conventional vessels and new hybrid solutions. In addition, operational recommendations for awareness-raising within the Sicilian maritime community have also been developed.

Lampedusa and Ustica islands are indicated as representative samples (hotspots) for the whole Sicilian ecosystem, given the importance the local Marine Protected Areas and rescue centres have acquired over the years. The evidence base of our report consists of structured interviews and grey-literature leads, which have allowed the synthetic considerations reported hereinafter.

The Climazul advisory team, composed by Thanos Smanis, Anna Maria Urgeghe, Leonardo Manzari, has been further supported by Prof Franco Andaloro, as one of the most prominent Italian experts of marine ecology and biology, with a vast knowledge of the Sicilian ecosystem.

### 3 Vessel navigation impacts between the smaller Sicilian islands and the mainland on protected species and habitats

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#### 3.1 Desktop review

A comprehensive desktop review was conducted to consolidate existing scientific knowledge, policy frameworks, and technical developments relevant to passenger and vessel navigation and its ecological impacts. The review drew on peer-reviewed literature, international guidelines, technical reports, and EU regulatory documents, with particular attention to studies addressing underwater noise, vessel traffic patterns, and species-specific sensitivities. In addition, recent advances in ship design, propulsion technologies, and noise reduction measures were surveyed to contextualise technological innovations within broader ecological and institutional considerations (see also Appendix B). The findings of this review served to frame the interview discussions (Section 3.3) and ensure alignment with ongoing research and policy initiatives at both European and international levels.

##### 3.1.1 Common causes of damages provoked

The main causes of impact from maritime transport on living species in Sicilian waters can be summarised as follows:

- **Collisions:** represent the most serious and acute type of impact, frequently resulting in the death or severe injury of the individual involved and, more rarely, in damage to the vessel. This affects all protected species and is correlated with their ethology and behavioural variability, with the



probability of collision strongly influenced by species-specific behaviour, habitat conditions, and life-cycle stages (Schoeman SP. et al, 2020<sup>1</sup>; Vighi M. 2025<sup>2</sup>).

- **Liquid and gaseous pollution:** this can be distinguished between emergency and systemic causes. **Emergency pollution** arises from accidental spillage of hydrocarbons and other liquid contaminants due to collisions, sinkings, and vessel damage. Though rare, such events are particularly dangerous and capable of profoundly altering the ecology of affected areas, causing death by poisoning, or by covering or transferring contaminants into the food chain. **Systemic** pollution stems from the continuous release of combustion fumes and exhaust gases with intensity linked to the vessel type, engine age, and other factors (e.g. operational practices). It is systemic and often concentrated in port areas and on the incoming and outgoing routes from islands. In addition to the portion of fumes that lingers in the air and contributes to carbon dioxide emissions, a portion of the gases dissolves or deposits into marine waters, with direct and indirect impacts on marine life including primary production and higher trophic levels. All forms of marine pollution have a negative impact on marine organisms (Mearns A.J. et al., 2018<sup>3</sup>), especially on species at the top of the food chain such as marine mammals, large elasmobranchs, and marine reptiles, where bioaccumulation and biomagnification phenomena emphasize the effect of contaminants (Tanabe S., 2002<sup>4</sup>).
- **Underwater noise and electromagnetic pollution:** In the context of this report, the term noise refers specifically to underwater noise, which can significantly interfere with marine species by masking echolocation and communication, disrupting feeding and mating behaviour, increasing stress levels, and driving species to avoid critical habitats such as feeding or breeding grounds. It depends on a series of factors mainly linked to propulsion. Besides the type of engine, vessel design (displacement, planning, or foil-supported), propeller or water jet systems, hull-water displacement, and wake turbulence all contribute to noise signatures affecting marine life and protected species (see the behaviour of figurehead dolphins). There is a large literature on the disturbing effect exerted by the noise of boats on the behaviour of marine species, with variations by area and species, being able to also affect their health and well-being (Panigada S. et al., 2008<sup>5</sup>). In-depth studies have been conducted in the Pelagos Sanctuary for Mediterranean Marine Mammals (Maglio A. et al., 2015<sup>6</sup>).
- **Pollution from waste and biological discharges:** the release of anthropogenic waste into the sea by passenger transport vehicles should be excluded both by common sense and by the civic education of these vehicles as well as by the strict application of the law (Argüello G., 2019<sup>7</sup>) by transport service operators. Nonetheless, cases of improper disposal continue to occur (Dąbrowska J et al., 2021<sup>8</sup>). The impact of waste is part of the extensive literature describing the effect of marine

<sup>1</sup> Schoeman, R. P., Patterson-Abrolat, C., & Plön, S. (2020). A global review of vessel collisions with marine animals. *Frontiers in Marine Science*, 7, 292.

<sup>2</sup> Vighi, M. (2025). Vessel strikes as a pressure to marine biodiversity.

<sup>3</sup> Mearns, A. J., Reish, D. J., Bissell, M., Morrison, A. M., Rempel-Hester, M. A., Arthur, C., ... & Pryor, R. (2018). Effects of pollution on marine organisms. *Water Environment Research*, 90(10), 1206-1300.

<sup>4</sup> Tanabe, S. (2002). Contamination and toxic effects of persistent endocrine disruptors in marine mammals and birds. *Marine pollution bulletin*, 45(1-12), 69-77.

<sup>5</sup> Panigada, S., Pavan, G., Borg, J. A., Galil, B. S., & Vallini, C. (2008). Biodiversity impacts of ship movement, noise, grounding and anchoring. *Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures*, 9-56.

<sup>6</sup> Maglio, A., Soares, C., Bouzidi, M., Zabel, F., Souami, Y., & Pavan, G. (2015). Mapping shipping noise in the Pelagos Sanctuary (French part) through acoustic modelling to assess potential impacts on marine mammals. *Sci. Rep. Port-Cros Natl. Park*, 185, 167-185.

<sup>7</sup> Argüello, G. (2019). *Marine pollution, shipping waste and international law*. Routledge.

<sup>8</sup> Dąbrowska, J., Sobota, M., Świąder, M., Borowski, P., Moryl, A., Stodolak, R., ... & Kazak, J. K. (2021). Marine waste—sources, fate, risks, challenges and research needs. *International journal of environmental research and public health*, 18(2), 433.



litter on marine species, ranging from entanglement to ingestion for macro-waste and ingestion for micro- and nano-litter. As regards to liquid waste, the vessels are legally required to have closed waste and sewage tanks, though compliance is not universal. While the organic fraction of such discharges is generally less problematic, associated detergents, soaps, and cleaning agents can be harmful, as also observed in Italian waters (Fossi M.C. & Lauriano G., 2008<sup>9</sup>). Shipping has also been considered for many years to be a major source of marine waste (Golik A., 1997<sup>10</sup>), which constitutes one of the main causes of mortality for large marine vertebrates (Gagliani F., et al., 2014<sup>11</sup>).

### 3.1.2 Main marine species affected

The protected marine species that may be impacted by navigation to the smaller Sicilian islands include:

- **Marine mammals:** these are species that return to the surface to breathe and often swim on the surface, remaining exposed to the risk of collision. They also have acoustic systems that make them particularly sensitive to noise and electromagnetic waves.
- **Large cetaceans:** in the area of the smaller Sicilian islands the presence of sperm whales (Frantzis A et al. 2011<sup>12</sup>) has been frequently recorded since the 1950s (Bolognari A., 1950;1951<sup>13</sup>), especially in the southern Tyrrhenian Sea in both directions (Di Paola AI et al. 2025<sup>14</sup>) and in the Ionian Sea (Lewis T et al. 2007<sup>15</sup>). The fin whales (*Balaenoptera physalus*) are also reported, in the Strait of Sicily and in the Pelagie area in the spring months (Sciacca V. et al 2014<sup>16</sup>, Canese S. et al 2006<sup>17</sup>). Frequent collisions with vessels are reported in the literature (Laist DW. Et al, 2001<sup>18</sup>) and strategies have been developed to minimize their impacts (Wiley DN et al, 2011<sup>19</sup>), including speed limitations that have been implemented in some regions such as the North Sea (Laist DW et

<sup>9</sup> Fossi, M. C., & Lauriano, G. (2008). Impacts of shipping on the biodiversity of large marine vertebrates: persistent organic pollutants, sewage and debris. *Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures*, 95-116.

<sup>10</sup> Golik, A. (1997). Debris in the Mediterranean Sea: types, quantities, and behavior. *Marine debris: sources, impacts, and solutions*, 7-14.

<sup>11</sup> Galgani, F., Claro, F., Depledge, M., & Fossi, C. (2014). Monitoring the impact of litter in large vertebrates in the Mediterranean Sea within the European Marine Strategy Framework Directive (MSFD): Constraints, specificities and recommendations. *Marine environmental research*, 100, 3-9.

<sup>12</sup> Frantzis, A., Airoldi, S., Notarbartolo-di-Sciara, G., Johnson, C., & Mazzariol, S. (2011). *Inter-basin movements of Mediterranean sperm whales provide insight into their population structure and conservation. Deep-Sea Research Part I: Oceanographic Research Papers*, 58(4), 454-459.

<sup>13</sup> Bolognari, A. (1951). La migrazione del capodoglio nel Mediterraneo. *Italian Journal of Zoology*, 18(4-6), 253-256.

<sup>14</sup> Di Paola, A. I., Gelippi, M., & Blasi, M. F. (2025). *First Photo-Identification Study of the Sperm Whale (Physeter macrocephalus) in the Aeolian Archipelago and the Northern Coast of Sicily (Southern Tyrrhenian Sea, Italy)*. *Diversity*, 17(3), Article 147

<sup>15</sup> Lewis, T., Gillespie, D., Lacey, C., Matthews, J., Danbolt, M., Leaper, R., ... & Moscrop, A. (2007). Sperm whale abundance estimates from acoustic surveys of the Ionian Sea and Straits of Sicily in 2003. *Journal of the Marine Biological Association of the United Kingdom*, 87(1), 353-357.

<sup>16</sup> Sciacca, V., Caruso, F., Beranzoli, L., Chierici, F., De Domenico, E., Embriaco, D., ... & Riccobene, G. (2015). Annual acoustic presence of fin whale (*Balaenoptera physalus*) offshore eastern Sicily, central Mediterranean Sea. *PLoS one*, 10(11), e0141838.

<sup>17</sup> Canese, S., Cardinali, A., Fortuna, C. M., Giusti, M., Lauriano, G., Salvati, E., & Greco, S. (2006). The first identified winter feeding ground of fin whales (*Balaenoptera physalus*) in the Mediterranean Sea. *Journal of the Marine Biological Association of the United Kingdom*, 86(4), 903-907.

<sup>18</sup> Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S., & Podestà, M. (2001). *Collisions Between Ships and Whales*. *Marine Mammal Science*, 17(1), 35-75.

<sup>19</sup> Wiley, D. N., Thompson, M., Pace III, R. M., & Levenson, J. (2011). Modelling speed restrictions to mitigate lethal collisions between ships and whales in the Stellwagen Bank National Marine Sanctuary, USA. *Biological Conservation*, 144(9), 2377-2381.



al, 2014<sup>20</sup>). In the Mediterranean, collisions with vessels remains a significant risk for whales (Panigada S. et al. 2006<sup>21</sup>), as highlighted by a review (Espada R et al, 2024<sup>22</sup>).

- **Delphinids:** the species present in the area of interest as reported by ISPRA 2012 under the MSFD framework are the Common dolphin (*Delphinus delphi*) a deep-sea species common in all Sicilian seas; the Stenella (*Stenella coeruleoalba*) a species confused with the common dolphin, (more coastal and equally common); the Bottlenose dolphin (*Tursiops truncatus*) of larger size but very common; Risso's dolphin (*Grampus griseus*) has been reported in all Sicilian seas but is uncommon; Pilot whale, present in Sicily both in the Tyrrhenian Sea and in the Strait of Sicily but not particularly frequent; reports of Beluga (*Delphinapterus leucas*) and Killer Whale (*Horcynus orca*) are limited to one controversial report in Sicilian seas and two historical reports respectively (Notarbartolo di Sciara, 1987<sup>23</sup>). Maritime traffic generates noise that disturbs these species (David L, 2002<sup>24</sup>), while accidental mortality of dolphins is mainly linked to fishing with pelagic driftnets, which is now legally prohibited although still practiced illegally in some instances. Interference between dolphins and vessels is mainly linked to electromagnetic disturbance and noise (Jensen et al 2009<sup>25</sup>; Campana I et al 2015<sup>26</sup>).
- **Mediterranean Monk Seal (*Monachus monachus*):** the Mediterranean monk seal was historically present along the coasts of continental Italy until the middle of the last century and along the coasts of Sicily, Sardinia and the smaller islands until the mid-1970s and the end of the 1980s (Aguilar, 1999)<sup>27</sup>. Despite the disappearance of a stable resident population in the territory, in recent decades there have been sightings of single specimens in some coastal locations, located in the most remote and insular areas of Italy. These sightings have often been attributed to wandering, non-resident specimens along the Italian coasts (RAC/SPA 1998; 2005; 2024<sup>28</sup>; ISPRA, 2024). In the Sicilian area, the presence of the monk seal has been repeatedly reported in the Egadi Islands and one specimen was identified through camera trap in a cave in Marettimo (Bundone L. et al., 2019<sup>29</sup>).
- **Reptiles:** Three of the six turtle species recorded in the Mediterranean are present in the area: loggerhead turtle (*Caretta caretta*), leatherback turtle (*Dermochelys coriacea*), and green turtle (*Chelonia mydas*). *Caretta caretta* is by far the most common, with over 100 nests recorded annually over the past decade.; the others must be considered occasional. The injured or dead specimens found are almost all linked to collisions with boats, the ingestion of plastic, and capture on longlines for hooking of large pelagic fish, but also due to trawling and entanglement in gillnets (Russo G. et

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<sup>20</sup> Laist, D. W., Knowlton, A. R., & Pendleton, D. (2014). Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. *Endangered Species Research*, 23(2), 133-147.

<sup>21</sup> Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A., & Weinrich, M. T. (2006). *Mediterranean fin whales at risk from fatal ship strikes*. *Marine Pollution Bulletin*, 52, 1287-1298.

<sup>22</sup> Espada, R., Camacho-Sánchez, A., Olaya-Ponzone, L., Martín-Moreno, E., Patón, D., & García-Gómez, J. C. (2024). *Fin Whale Balaenoptera physalus Historical Sightings and Strandings, Ship Strikes, Breeding Areas and Other Threats in the Mediterranean Sea: A Review (1624-2023)*. *Environments*, 11(6), Article 104.

<sup>23</sup> Notarbartolo-di-Sciara, G. (1987). Killer whale, *Orcinus orca*, in the Mediterranean Sea. *Marine Mammal Science*, 3(4), 356-360.

<sup>24</sup> David, L. (2002). Disturbance to Mediterranean cetaceans caused by vessel traffic. *Cetaceans of the Mediterranean and Black Seas: State of knowledge and conservation strategies. Report to the ACCOBAMS Secretariat, Monaco*.

<sup>25</sup> Jensen, F. H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M., & Madsen, P. T. (2009). *Vessel noise effects on delphinid communication*. *Marine Ecology Progress Series*, 395:161-175.

<sup>26</sup> Campana, I., Crosti, R., Angeletti, D., Carosso, L., David, L., Di-Méglio, N., ... & Arcangeli, A. (2015). Cetacean response to summer maritime traffic in the Western Mediterranean Sea. *Marine Environmental Research*, 109, 1-8.

<sup>27</sup> Aguilar, A. (1999). *Status of Mediterranean monk seal populations*. RAC-SPA / UNEP, Aloès Editions, Tunis. 1-60 pp

<sup>28</sup> <https://www.rac-spa.org/node/2520>

<sup>29</sup> Bundone, L., Panou, A., & Molinaroli, E. (2019). On sightings of (vagrant?) monk seals, *Monachus monachus*, in the Mediterranean Basin and their importance for the conservation of the species. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 29(4), 554-563.



al., 2003<sup>30</sup>; Casale P., 2010<sup>31</sup>). In Sicily, injured animals can be handed over to wildlife recovery centres or to the Sicilian Zooprohylactic Institute, which is the responsible regional body.

- **Elasmobranchs:** In the Mediterranean, 21 species of sharks and rays (elasmobranchs) are protected under the GFCM Recommendation - GFCM/36/2012/3 of the General Fisheries Commission for the Mediterranean. This recommendation aims to protect the shark and ray species listed in Annex II of the Protocol to the Barcelona Convention on Specially Protected Areas and Biological Diversity in the Mediterranean. Under this rule, binding for all GFCM Member States, these species cannot be “retained on board, transhipped, landed, transferred, stored, sold, displayed, or offered for sale,” but “must be released unharmed and alive whenever possible,” and States must ensure “high levels of protection from fishing activities.” Today many species of sharks and rays are at risk due to indirect or direct fishing for finning and therefore fishing is the main cause of death for elasmobranchs. Navigation also represents a significant cause of death for pelagic and nektonic species among which the most exposed to collisions is the whale shark (*Rhincodon thypus*) (Womersley, F. C. et al. 2022<sup>32</sup>).
- **Seabirds:** Numerous species of seabirds are abundant in the areas around Sicily and the smaller Sicilian islands as emerges from the ISPRA study conducted within the MFSD (ISPRA 2025; SNPA 2020). The impact of shipping on seabirds has been extensively studied (Schwemmer P. et al, 2011<sup>33</sup>) and is closely linked to the speed of nautical vessels.

### 3.2 Sicilian research ecosystem on marine resources

Sicily hosts a diverse and well-structured research and monitoring network dedicated to marine resources, biodiversity conservation, and the management of human-ecosystem interactions. This ecosystem of institutions includes national research bodies based in the Region, universities, specialized laboratories, and non-governmental organisations. Together, they provide complementary expertise in ecological monitoring, pathology and rescue, oceanographic and fisheries research, and public awareness.

The main actors are listed below:

- Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)
- Istituto Zooprofilattico Sperimentale della Sicilia (IZS Sicilia) (Palermo, Catania, Barcellona Pozzo di Gotto) including the Regional centre of Recovery for Sea Turtles
- Consiglio Nazionale delle Ricerche - Istituto per lo Studio degli Impatti Antropici e Sostenibilità in Ambiente Marino (CNR IAS) - Based in Palermo, Capo Granitola, Castellammare del Golfo;
- Istituto Nazionale Fisica Nucleare (INFN) - Laboratori Nazionali del Sud (Catania)
- Universities of Palermo, Catania and Messina;
- Stazione Zoologica Nazionale (SZN) Anton Dohrn in Messina;
- Oceanographic and Experimental Geophysics Institute (OGS), in Milazzo and Panarea;
- WWF and MAREVIVO local turtles' rescue centre in Agrigento, Trapani and Milazzo;
- Lampedusa Sea Turtle First Aid centre.

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<sup>30</sup> Russo, G., Di Bella, C., Loria, G. R., Insacco, G., Palazzo, P., Violani, C., & Zava, B. (2003). Notes on the influence of human activities on sea chelonians in Sicilian waters. *Ibex Journal of Mountain Studies*, 7, 37-41.

<sup>31</sup> Casale, P. (Ed.). (2010). *Sea turtles in the Mediterranean: distribution, threats and conservation priorities*. IUCN.

<sup>32</sup> Womersley, F. C., Humphries, N. E., Queiroz, N., Vedor, M., da Costa, I., Furtado, M., ... & Sims, D. W. (2022). Global collision-risk hotspots of marine traffic and the world's largest fish, the whale shark. *Proceedings of the National Academy of Sciences*, 119(20), e2117440119.

<sup>33</sup> Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V., & Garthe, S. (2011). *Effects of ship traffic on seabirds in offshore waters: implications for marine conservation and spatial planning*. *Ecological Applications*, 21(5) 1851-1860.



### 3.3 Expert interviews

Following a desktop research and review, as part of the study, a series of targeted expert interviews were carried out during the summer period to gather multidisciplinary insights into the ecological, technological, and institutional dimensions of passenger and vessel navigation and its effects on marine ecosystems. The objective of these interviews was to collect qualitative evidence, professional experience, and sectoral perspectives to complement scientific literature and monitoring data. The minutes of the interviews are in Appendix C.

The discussions covered a wide spectrum of topics, ranging from species sensitivities, ecosystem responses, and pathology evidence to practical aspects of monitoring frameworks, and data accessibility. Input was also obtained on technological innovations in ship design, propulsion systems, and hydrofoil architectures, with a focus on their potential to mitigate radiated noise. In parallel, the interviews provided valuable information on institutional practices, stranding networks, and the role of marine protected areas in mediating impacts.

The following list presents the interviews conducted, in chronological order, with details of the experts and their respective areas of contribution:

- 1) **Dr. Giusi Buscaino**, Researcher, CNR IAS - Interview on species sensitivities, seasonal patterns, vessel spectral signatures, ecosystem effects, and monitoring recommendations.
- 2) **Dr. Guido Pietroluongo**, University of Padua; Cetacean Strandings Emergency Response Team (CERT); Banca Tessuti Mammiferi Marini del Mediterraneo (BTMMM) - Interview on pathology evidence, strandings databases, and displacement as a dominant chronic effect.
- 3) **Dr. Daniela Freggi**, Director, Wildlife and Sea Turtle Rescue centre Agrigento; Head, Lampedusa Sea Turtle First Aid; President, Associazione Caretta caretta - Interview on biomass trends near shipping lanes, monitoring needs, MPA mediation, and propulsion innovation.
- 4) **Barbara Amerio**, AMER Yachts (shipbuilder) - Interview on CETENA radiated-noise studies across propulsion architectures.
- 5) **Dr. Salvatore Dara**, Director, IZS Sicilia, with team members **Roberto Puleio** (DVM, Histopathology and Immunohistochemistry Lab.), **Guido Ruggiero Loria**, and **Giorgia Schirò** - Interview on institutional surveillance, turtle caseload, data access, and collision sources.
- 6) **Prof. Gianluca Sarà**, University of Palermo, Laboratory of Ecology, Department of Earth and Marine Sciences; National Coordinator, PhD School in Biodiversity; Green Card Talent Fellow, Ocean University of China, Qingdao; NBFC - National Biodiversity Future Centre; National Co-Coordinator, Spoke 1 Sea, Italian Cluster 6 Team in Europe - Interview on time-space scaling, hydrophone/DAS networks, collaborations, and funding mechanisms.
- 7) **Richard Forest**, SEAir (hydrofoil systems engineering and manufacturing) - Interview on noise reduction potential in new-generation hybrid hydrofoil vessels.

### 3.4 Considerations about main impacts on the targeted species

The evidence collected through literature review and expert interviews highlights some key impacts of maritime traffic on marine species. These impacts are differentiated across taxonomic groups, reflecting distinct sensitivities to noise frequency bands, behavioural patterns, and exposure contexts.

Some main considerations may be resumed as follows:

- Biomass reduction has been consistently observed in areas with heavy vessel traffic.



- Resident populations of striped dolphins and bottlenose dolphins are documented in the areas between Porto Empedocle, Linosa and Lampedusa, which is served daily by 2 ferries and 2 fast ferries, but also in an area crossed by numerous cargo ships, especially during the high season.
- Sea turtles and big marine vertebrates are subjected to cumulative risks from vessel strikes, bycatch and habitat disturbance.
- Traditional impacts, as noise, collisions, marine litter, oil spills, tar residues, remain significant stressors.

The empiric experiences reported by the interviewed researchers and specialists agree on the clear distinction in responses to underwater noise between sea turtles and mammals/cetaceans, given their different sensitivity to frequency bands. Sea turtles are most responsive to low frequencies. Mysticete whales are affected by higher, but still low-kHz, frequencies. Dolphins, by contrast, are mainly sensitive to very high frequencies.

These distinctions make it important to evaluate not only the intensity of noise emissions but also their frequency distribution, since vessel types are characterized by different spectral signatures: ferries radiate high-level, low-frequency noise, while hydrofoils emit comparatively lower levels but with a stronger high-frequency component.

Beyond noise, other traditional stressors remain significant. Collisions, marine litter, oil spills, and tar residues all contribute to cumulative pressures on marine species, amplifying the effects of maritime transport and biomass reductions have been documented in heavily trafficked areas, underscoring the ecological weight of these combined impacts.

For marine turtles, the frequency of vessel passages, whether single, repeated in the medium term, or sustained in the long term, is one of the most important determinants of impact. Turtles, which often drift at the surface carried by currents, are particularly vulnerable to collisions. Variations in geomagnetic fields can also contribute to strandings. Data from IZS Sicily record approximately 250 collisions annually, with over 70 assistance interventions; each intervention is systematically documented. While strandings have shown a relative decline, incidents linked to collisions, ingestion of marine litter, and fishing-hook injuries are increasing. Similarly, the Lampedusa Sea Turtle Rescue Centre reports 100-150 interventions per year, a rise partly associated with growing turtle populations resulting from improved nest protection and monitoring.

For cetaceans and other marine mammals, the dominant stressor is underwater noise, which has behavioural, physiological, biochemical, and even genetic consequences. Chronic or repeated exposure displaces animals from high-quality foraging areas, altering diets in the medium term and disrupting social cohesion. In whales, acoustic interference can reduce communication ranges by up to 50%, affecting orientation, migratory routes, and access to breeding grounds over scales of ~100 km. While some strandings are attributed directly to collisions, pathology analyses suggest that habitat displacement linked to anthropogenic activity is a more pervasive, chronic effect.

No vessel-specific impact analyses exist for Italy or Sicily for the target species of this report, although extensive studies are available from France and Spain, particularly on cetaceans.

Seasonality shapes both species' presence (e.g., whales in February-April; turtles nearshore during June-August spawning) and vessel traffic intensity (notably during the tourist high season). However, sedentary colonies demonstrate that boat passages exert pressure even during periods of reduced tourist activity, underlining the importance of establishing reliable baseline data. In the Sicilian channel between Porto Empedocle, Linosa, and Lampedusa, where two ships and three fast ferries operate regularly in peak season, significant information is available on the social structures of resident striped



and bottlenose dolphin populations and this could be used to further studies. Interesting, pathology and rescue networks report that private leisure craft, rather than scheduled transport or fisheries, are now the dominant source of turtle collisions and, by extension, small cetacean injuries nearshore. This shifts the priority for awareness campaigns and enforcement measures toward the recreational boating sector, while scheduled transport operators should still be engaged on routing and speed reduction in sensitive areas.

While cetaceans show some resilience to acoustic disturbance, this does not mitigate impacts on more vulnerable taxa. For example, invertebrates, whose mobility is determined by waves and currents, are fully exposed to localised maritime noise, while many fish species rely on a single acoustic channel for mate attraction or territorial defence. If this frequency is masked, reproduction can be severely disrupted. Given the interconnectedness of marine ecosystems, such disruptions propagate along the entire food chain. Studies should take into consideration also other marine species apart from the sentinel ones.

A useful reference in this context is the study conducted by Professor Gianluca Sarà's team (University of Palermo) and the IAS-CNR Capo Granitola team, which examined the impact of vessel noise (from ferries, hydrofoils, and catamarans) on bluefin tuna migration routes in the Mediterranean Sea<sup>34</sup>.

## 4 Difference in impacts between hybrid and traditional propulsion vessels

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To date, there are no specific studies that refer to the latest generation of hybrid catamarans or hydrofoils and the difference in underwater noise compared to those with traditional propulsion.

However, the TA team has conducted research on relevant data sources and ongoing projects that may provide insights and has developed considerations based on literature review and expert interviews (see Section 3.3).

### 4.1 Potentially useful data sources & undergoing projects

There is extensive literature focused on the impacts of noise on both vertebrate and invertebrate marine species.

Additionally, in the Sicilian area, research institutes are collecting data about noise and marine species. In Eastern Sicily, network of hydrophones (extending from Messina to Siracusa) is already active, monitoring the movements of marine species, vessel passages, and other acoustic signals.

Using DAS Technology, University of Palermo is coordinating the largest Italian project on marine ecosystem, which investigates animal behavioural responses to noise, including social interactions. Three PhD researchers in Catania are working specifically on these aspects. Similar networks are active in Northern Sardinia (Prof La Manna), Castellammare del Golfo, Catania etc.

There is also an ongoing collaboration with the University of Cambridge on modelling species movements, including migration routes

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<sup>34</sup> Sarà, Gianluca & Dean, J. & D'Amato, D. & Buscaino, Giuseppa & Oliveri, A & Genovese, Simona & Ferro, S. & Buffa, Gaspare & Lo Martire, Marco & Mazzola, Salvatore. (2007). Effect of boat noise on the behaviour of bluefin tuna *Thunnus thynnus* in the Mediterranean Sea. *Marine Ecology Progress Series*. 331. 243-253. 10.3354/meps331243.



Some specific examples of data collected at regional level are presented below:

- IZS collects data about strandings, collisions, contaminations provoked by hydrocarbons, rescues in favour of mammals, as well as for turtles;
- Historical passive acoustic recordings in the Marine Protected Area in Lampedusa (Capo Grecale) (IAS-CNR Capo Granitola);
- Systematic surveys of turtle nests in Lampedusa;
- Acoustic surveys of turtle nests in 2023 and 2025 in Linosa, close to the principal pier of the island;
- Monitoring of routes in the Gulf of Naples (port front);
- INFN-LNS project in the south-eastern Ionian Sea, 100 km off the coast of Catania (3000 m deep);
- Monitoring sites for seismic and volcanological purposes (e.g. INGV in Panarea).

On a wider geographical scope, other sources of data, particularly on monitoring cetaceans are:

- The Stranding Database of University of Pavia since 1985, managed by CIBRA of the University of Pavia, the Civic Museum of Natural History of Milan, with the Universities of Genoa, Teramo and Siena;
- The National Reference Centre for Diagnostic Investigations on Stranded Marine Mammals (C.Re.Di.Ma.) Since 2015 the C.Re.Di.Ma. collaborates directly with other bodies of the National Strandings Network, in particular with the Cetacean Stranding Emergency Response Team (CERT) and the Mediterranean Marine Mammal Tissue Bank<sup>35</sup> of the University of Padua, the Strandings Database<sup>36</sup>;
- ACCOBAMS Survey Initiative (ASI) project that is establishing an integrated, collaborative, coordinated monitoring system for the status of cetacean populations at the whole ACCOBAMS area level, with the final aim to strengthen the conservation efforts and governance for cetacean species;
- Pelagos (only relevant to Italy-France- Principality of Monaco shared waters) and other Italian regions.

EU Projects and Units that are studying or have studied the problem include (*but may be not limited to*):

- HORIZON SATURN project<sup>37</sup>;
- HORIZON LOWNOISER project<sup>38</sup>
- Sustainable Blue Economy Partnership BluEcho project<sup>39</sup>;
- PNRR ITINERIS<sup>40</sup> - project (coordinated by Professor Pappalardo, CNR) to create the first Italian portal that groups together information from monitoring sites;
- Joint Research Unit EMSO marine observation fixed sites<sup>41</sup>;
- Study conducted by Professor Gianluca Sarà's team and the IAS-CNR Capo Granitola team on the impact of noise emissions from vessels (ferries, hydrofoil, catamarans) on bluefin tuna routes in the Mediterranean Sea<sup>42</sup>;
- Tank studies conducted by CNR - IAS on various fish and crustacean species;

<sup>35</sup> <http://www.marinemammals.eu/>

<sup>36</sup> <http://mammiferimarini.unipv.it/>

<sup>37</sup> <https://www.saturnh2020.eu/>

<sup>38</sup> <https://cordis.europa.eu/project/id/101192302>

<sup>39</sup> <https://bluepartnership.eu/projects/science-policy-assessing-impacts-and-developing-solutions-ship-traffic-and-offshore-wind>

<sup>40</sup> <https://itineris.cnr.it/>

<sup>41</sup> <https://emso.eu/>

<sup>42</sup> Sarà, Gianluca & Dean, J. & D'Amato, D. & Buscaino, Giuseppa & Oliveri, A & Genovese, Simona & Ferro, S. & Buffa, Gaspare & Lo Martire, Marco & Mazzola, Salvatore. (2007). Effect of boat noise on the behaviour of bluefin tuna *Thunnus thynnus* in the Mediterranean Sea. *Marine Ecology Progress Series*. 331. 243-253. 10.3354/meps331243.



- Studies conducted in dolphinariums.

## 4.2 Considerations about technologies and vessels used for connection with smaller islands

Regular maritime transport with minor islands in Sicily, is currently carried out through ferries, fast ferries with hydrofoil technology, catamarans. The required decarbonization process has already implied the adoption of bi-fuel or hybrid vessels, both in the shuttle service across the Strait of Messina and in the connection with minor islands.

Caronte&Tourist was the first operator to adopt LNG powered ships in Italy, starting with Elio. The company currently operates 3 ships using alternative fuels (LNG), including the NEREA bi-fuel ship that connects Sicily with minor islands. Liberty Lines has placed an order for 9 new hybrid fast ferries (some of them already delivered) to carry out the service.

In parallel, the Regione Sicilia has also commissioned one hybrid ferry to Fincantieri, to be put at disposal of an appointed shipowner, to carry out the service with Pantelleria, Lampedusa and Linosa. Furthermore, the regional government has acquired full competence from the central government, on the subject of its regular public transport to and from minor islands, implying a complete autonomy to implement and speed up the sustainable transport system.

In the framework of this technical assistance, the TA team conducted research to identify suitable existing hybrid vessel solutions and/or best practices already implemented across the Mediterranean and other sea basins. Regarding regulatory aspects, the TA team also carried out a desktop analysis of the regulatory and legal framework applicable to the identified technologies (e.g., hybrid vessels combining different propulsion systems such as fuel cells and batteries) in the context of the Sicilian case. The results of these TA tasks are provided in Appendices B, D, and E, which have been produced and shared with the Sicily Region.

As for a more detailed analysis of the technical aspects of the vessels, it is essential to differentiate between the **acoustic** and **emissions** profiles.

Hydrofoils are already in the “**high-frequency, high-noise**” corner relative to conventional ferries. Hybridization changes the propulsion duty cycle; under electric or low-load hybrid modes reductions in tonal components associated with combustion and gear-line harmonics at low-mid frequencies is expected, alongside decreased cavitation incidence at optimized set-points, although the net benefit still requires in-situ demonstration. At present, no peer-reviewed studies specifically addressing the acoustic performance of the latest hybrid catamarans or hydrofoils in the central Mediterranean have been published, underscoring the need for controlled measurements along Sicilian routes.

In terms of **emissions**, hybrid vessels should reduce CO<sub>2</sub> per leg when a non-trivial fraction of hoteling, manoeuvring and low-speed segments can be electrified, with additional gains if shore power and charging draw on low-carbon electricity. Real-world deltas will depend on battery capacity, load factor, sea state and operational practices; a fair comparison should express results in terms of gCO<sub>2</sub> per passenger-kilometre and per tonne-nautical-mile across a seasonal cycle. No route-specific CO<sub>2</sub> datasets for Sicilian hydrofoils or hybrids were identified during expert interviews; establishing the need for baseline data collection as part of the recommended measurement protocol below.

With respect to **materials and quieting technologies**, shipyard experience indicates that propulsion architecture and driveline choices significantly affect radiated noise and onboard vibration.



A recent CETENA-AMER Yachts<sup>43</sup> study, comparing conventional shaft-line (e.g., Caterpillar) with IPS pod systems across displacement and planing monohulls, was made available to the scientific community and can inform hypotheses about radiated-noise mechanisms relevant to high-speed craft. While these findings are not hydrofoil-specific, they support the importance of testing hybrid craft with optimized propulsors and isolation to minimize cavitation and structure-borne components.

## 5 Feasibility of dedicated Mission Ocean funded projects and relevant suggestions

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Interviews with veterinarians, marine biologists, ecologists, shipyard executives and regional authorities converge on four core findings.

- 1. Knowledge Gaps on Hydrofoil Impacts.** To our knowledge, no scientific study was published that specifically addresses the effects of hydrofoil vessels on the indicated species, nor a comparison among newly hybrid powered hydrofoil vessels and conventional ones. Underwater noise from fast craft interacts with species-specific hearing sensitivities and movement patterns. Conventional ferries tend to generate intense low-frequency noise, while hydrofoils concentrate energy at higher frequencies, with different implications for whales, dolphins and turtles. Documented impacts span behavioural displacement from foraging grounds, constrained communication ranges in whales, and stress-linked physiological responses. Evidence specific to the latest hybrid high-speed craft is still limited, making acoustic measurements along Sicilian routes a priority.
- 2. Emission reduction potential.** CO<sub>2</sub> and pollutant emissions from conventional craft are materially higher on a per-voyage basis than what is technically achievable with hybridization, but the realized benefit depends on duty cycle, operational set-points and grid electricity provenance.
- 3. Fragmentation of Monitoring Systems.** There is a wide spectrum of databases, monitoring and rescue systems datas, analysis and statistics on the impact of human activities on the investigated species and beyond. However, these resources are largely siloed, mostly pursuing single and different goals (geological, meteorological, maritime surveillance and safety, climate change, etc.) and are not integrated in a uniform system, missing a whole picture. Similar gaps in coordination are also evident among research institutions.
- 4. Collision Risk Profile.** Collision risk in Sicilian waters is driven largely by private leisure craft rather than scheduled ferries or hydrofoils, which implies that awareness and compliance measures must target the wider maritime community, not only operators of scheduled services.

Building on these synthetic considerations and drawing on the interviewed experts input, and advisory team experiences a set of suggestions may be provided. In general, it has emerged that Sicily, with its wide and complete marine ecosystem and unique geography, could represent a hotspot, becoming a forefront model of preservation & research area of the Mediterranean. This would involve piloting a sustainable coexistence between maritime transport and marine biodiversity practice, supported by the integration of scientific monitoring, innovative technologies and active community participation.

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<sup>43</sup> Becchi, P., De Angelis, E., & Firenze, E. (2020, July 17). CETENA-AMER Yachts — Rumore irradiato in mare. Unpublished technical report (CETENA / AMER Yachts). [no public link available]



This configuration aligns closely with the objectives of the Horizon EU Mission “Restore Our Oceans and Waters” and could serve as a strong basis for a project proposal to be potentially submitted under this programme.

## 6 Main recommendations

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### 6.1 Main suggested actions for sustainable maritime transport and ecosystem protection

Even though cetaceans and sea turtles serve as sentinel species of the whole marine food chain, interventions by policy makers aimed at ensuring sustainable maritime transport, should investigate impacts on all marine species, given their ecological interdependence. As an example, **invertebrates are largely sessile or limited in mobility, making them particularly vulnerable to localised increases in underwater noise**, with little or no possibility of avoidance. Fish species often depend on a single acoustic channel for key behaviours such as reproduction or territorial defence. When these **frequency bands** are masked by anthropogenic noise this result in potentially severe disruptions to population dynamics.

In order to provide a comprehensive and integrated assessment, it would be important to encourage the different research and monitoring systems to converge towards **a uniform and coordinated detection across all Sicilian waters** and coasts of transport routes, collisions, noise, oil spills and tar leakages, marine litter, bilge waters, waste and biological discharges, alongside the established geological, meteorological, maritime surveillance and safety, climate change monitoring.

Currently available technologies, methods and applications, including manned and unmanned, satellite, surface, underwater, AI, digital, etc., allow near-complete surveillance of the marine environment. Acoustic monitoring, aerial surveys, rescue/stranding data may be therefore combined with this purpose. This would also foster the rich and diversified landscape of research institutions and intervention centres to operate within a common ecosystem.

For this purpose, the existing network of hydrophones from Messina to Siracusa, coordinated by the University of Palermo and using DAS Technology, could represent a replicable model. Similarly, the PNRR ITINERIS project, coordinated by Professor Pappalardo, CNR, aims to create the first Italian portal that aggregates data from different monitoring sites, contributing to **a unified and interoperable information system and network**.

Within a similar contest, the identification, definition, regulation, implementation and monitoring of dedicated transport lanes on each route would facilitate the implementation of protective measures, such as speed reduction, adoption of alternative fuels, and temporary deactivation of hydrofoil planning, particularly needed to preserve sensitive areas.

In areas where repeated vessel passages overlap with feeding grounds or nursery areas, **reduced-speed “quiet transits” and minor route micro-adjustments** can reduce acoustic exposure and collision risk, particularly during February-April (whales) and June-August (turtles). Coordination with **Coast Guard** sectors and **MPA managers** is essential to ensure feasibility and compliance. Emerging



Mediterranean guidance on speed management (e.g., ACCOBAMS<sup>44</sup> analyses) can be adapted to the Sicilian context.

Hybrid vessels should **prioritize electric or low-RPM hybrid operation** in approaches, departures and near-MPA segments, with dynamic set-points tied to biologically sensitive waypoints. Along the same transport lanes, comparative measurements and studies among the different categories of vessels (i.e. for passenger, vehicle and goods transport) and relevant propulsion systems should be conducted to detect and evaluate the main effects.

Pilot studies in representative corridors, such as Porto Empedocle-Linosa/Lampedusa, Ustica-Palermo, could be performed and combine bottom-mounted and drifting hydrophones co-registered with AIS, speed-over-ground and engine load, while performing repeated crossings with a conventional hydrofoil and a hybrid counterpart at matched schedules and meteorological windows. Acoustic monitoring metrics should include broadband SPL, third-octave levels, tonal/cavitation signatures and received levels within 50 Hz-100 kHz to cover turtle-whale-dolphin bands. Biological responses should be tracked via photo-ID, passive acoustic detections and systematic surface sightings from MPA platforms and trained volunteers. CO<sub>2</sub> accounting should follow an operations log capturing energy/power by phase (port manoeuvring, acceleration, cruise, approach) and produce gCO<sub>2</sub> per passenger-km and per tonne-nm, with sensitivity tests for different hybrid set-points.

ISPRA's FLT-Med and LIFE Conceptu Maris deliverables offer corridor-level datasets intersecting ferries and megafauna that may be cross-referenced with Sicilian routes. ACCOBAMS<sup>44</sup> and Pelagos<sup>45</sup> documents provide templates for speed management and noise hotspot analysis that can be adapted to a Sicilian PSSA-style approach if pursued by the Region.

In this vision, **local fishery communities**, as custodians of millenary knowledge and sustainable models, could be active players in drafting action plans, contributing to the implementation of research and assessment activities. They could evolve into environmental stewards and co-managers of maritime and coastal spaces. This recognition of their importance (for the relevant territories) could be concretely expressed through welfare services and benefits, exclusive and jointly regulated catch rights, fostering stewardship rather than just orienting them towards questionable forms of fishing-tourism.

This **strong governance**, supported by stable **monitoring** infrastructure, would also facilitate the introduction and enforcement of severe guidelines for private leisure boats and charter fleets, both within harbour, marinas and port areas, as well as in open waters, as the most effective way to mitigate impacts on the ecosystem. Mandatory briefings, speed advisories, approach-distance reminders and a one-tap reporting apps represent practical interventions that are likely to deliver disproportionate benefits.

Moreover, it should be highlighted that also harbours and ports represent very polluted and overturned maritime areas, acoustically and chemically transformed yet understudied, that may deserve a specific environmental attention.

Finally, in addition to the co-financing of feasibility studies and pilot actions through EU frameworks such as LIFE, S3, Horizon Mission Restore Our Oceans and Waters, Horizon Europe, Interreg MED, Interreg

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<sup>44</sup> ACCOBAMS Secretariat. (2020). Overview of noise hot spots — ACCOBAMS area (Part: Mediterranean). MOP6.Doc28Rev1  
ACCOBAMS Secretariat. (2022). CCH identification process. MOP8.Doc30

ACCOBAMS Secretariat. (2024). Analysis of maritime traffic speed in 2023 in the NW Mediterranean (PSSA). SC16.Doc18.

<sup>45</sup> Pelagos Sanctuary. (2024). Intermediate report — Call 2. Pelagos CST16 Inf05



Italy-Malta, Italy-Tunisia, the **funding** of an ambitious medium-long term project could be ensured through the activation of an offset mechanism, where public and private funds could be blended (i.e. Public Private Partnerships - PPPs). Such a mechanism would allocate a specific percentage of the planned private and/or public investments affecting maritime spaces and coastal zones of Sicily to support the initiative, protecting the marine ecosystem and fostering sustainable maritime transport.

## 6.2 Suggested propulsion systems for fleets ensuring the connection with smaller islands

With regards to the propulsion of passenger, goods, vehicles' transport vessels, up to date, the following recommendations can be made for Regione Sicilia:

- Adoption of hybrid ferries equipped with low-noise, low-emission propulsion systems. Options include LNG (as transitional alternative fuel) or wind-assisted technologies (Flettner rotors or wing sails) used during navigation, and recharging batteries/hydrogen fuel cells to be used when taxing in port areas or while moored at berth;
- Within major port areas, the development of Onshore Power Supply (OPS) systems and LNG bunkering infrastructure, with relevant supply chain logistics designed to progressively substitute fossil LNG with the bio-LNG. These infrastructures could also be concentrated in the main hub-ports, while the adoption of (self-propelled or pulled by tugs) barges (both for LNG and electrification) would represent a versatile solution for smaller ports or berths with limited available sufficient surface;
- Where feasible, OPS systems should be implemented also inside smaller islands' berths, also including through off-shore/floating/barge solutions with electrical recharge from renewable energy sources.

Progressive building-up of the hydrogen supply chain, connecting the production of grey and green resource with the port-hubs, through a brand-new distribution network. In the interim, road transport by truck could provide an effective temporary solution until dedicated infrastructure is in place.

## 6.3 Recommendations for dissemination and stakeholders' engagement

The engagement with the Coast Guard, fishery communities and cooperatives, shipyards, port authorities/harbour masters, MPAs, dive/whale-watch operators, yacht marinas, charter companies and recreational skippers, leisure boats shipowners, NGOs, civil society organisations, on a seasonal as well as on a medium-long term basis, will require a bridging effort with the research & study activities. This approach is consistent with **the role of MPAs and the Fisheries Local Action Groups (FLAGs) as of "cultural intermediaries"**, extending far beyond simple dissemination and divulgation actions. Their interventions would be much more related with **educational and training programmes, ocean literacy optimization**, and building up of **skills** and specialisations which could not be replicated elsewhere.

Sicily may already count on a significant **synergic network of MPAs and FLAGs**, as well as on a multitude of initiatives exploiting and optimizing the liaison of its **territories and communities with economic operators, tourists, investors. Youth sensibilisation** at schools, training new environmental guards, supporting professional upgrades or diversifications to ensure the required skills to such a transition will be fundamental. The planification of a dedicated needs assessment, followed by a detailed calendar of actions could represent an additional opportunity for sustainable development for Sicily.

An awareness-raising campaign could be of high added value for Sicily's maritime community. Key recommended actions and steps may include:

### 1. Core messages and campaigns should focus on the following:



- “Quiet transits”: **high-speed crafts** generate distinct acoustic energy that can **reduce whale communication ranges and displace animals** from feeding grounds; slowing down near hotspots provides measurably benefits.
  - “Citizen science”: most turtle **collisions** involve leisure craft—**Reduce speed** in flagged zones; avoid approaching or circling; report sightings and strandings via the MPA/IZS channels, using apps.
  - “New technologies”: **hybridisation reduces noise** and CO<sub>2</sub> in port approaches and near MPAs when operated in electric/low-RPM modes.
  - “Ports upgrades”: shore power and quiet-zone signage in port forelands support resident dolphins year-round.
- 2. Awareness raising ideas that could be implemented:**
- Co-branded marina packs with QR-coded maps of seasonal hotspots and “quiet corridor” segments; pre-departure briefings for scheduled services and charter fleets; VHF channel inserts and electronic “Notice to Mariners” during peak seasons; dockside signage and fuel-dock prompts; integration with citizen-science platforms coordinated by MPAs and rescue centres; and joint Coast Guard-MPA patrol days focused on education-first engagement.
  - A “Blue Crossing—Sicily” seal could be awarded to operators complying with speed, routing and hybrid-mode pledges on specified legs.
- 3. Main actors to be involved**
- **MPAs** lead place-based engagement and curate sightings; the **Coast Guard** ensures compliance and coordinates advisories; operator consortia and shipyards co-design operational pledges and host technical demos; **IZS Sicilia and the Lampedusa Rescue Centre** triage reports and publish seasonal bulletins; **universities/CNR** integrate monitoring streams and evaluate outcomes; **NGOs** (e.g., Legambiente) extend outreach beyond ports and into schools and tourism networks.
- 4. Monitoring, Evaluation and Transparency actions**
- Define a simple scorecard per season: reported sightings and compliance interactions; monitor vessel speeds inside quiet corridors from AIS; number of operators adopting hybrid quiet-mode protocols; turtle collision reports; and acoustic levels at fixed hydrophones before/after campaign onset.
  - Publish results in an open seasonal note via the ITINERIS-style portal to normalize transparent learning.

## 7 Conclusion

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In the Sicilian seascape—crowded, biodiverse and economically vital, the question is not whether underwater noise and emissions matter, but how quickly and coherently improved practices can be monitored, measured, mitigated, and mainstreamed. The interviews assembled here point to a pragmatic pathway: test and prove the acoustic and CO<sub>2</sub> benefits of hybrid hydrofoils on real routes; run “quiet transit” operations through sensitive segments; bring MPAs, fishers and leisure skippers into the monitoring tent; and institutionalise what works via licensing, signage and seasonal advisories. Done together, Sicily can connect its islands more cleanly and quietly while safeguarding the region’s biodiversity.



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## Appendixes (attached in zipped folder)

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- Appendix A - TA Plan
- Appendix B - Overview hybrid ferries in operation
- Appendix C - Minutes of the interviews with the experts on marine biology/ecology
- Appendix D - Overview regulatory framework on maritime transport
- Appendix E - Summary TA Sicily Decarbonization



## Annexes (attached in zipped folder)

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### Annex I - Regulatory Framework Task

- EEC\_3577.92\_Principle freedom maritime transport
- Decreto approvazione\_PSM 0924
- MinInfraTrasp\_2024\_Piani dello Spazio Marittimo

### Annex II - Impacts task

- Effects of boat noise on the behaviour of bluefin tuna
- Overview of the Noise Hotspots in the ACCOBAMS Area - Part Mediterranean Sea
- ACCOBAMS - Cetacean Critical Habitat Identification Process
- Analysis of Maritime Traffic Speed in the North-West Mediterranean PPSA: Establish a Baseline to Monitor Progress in Complying with IMO Recommendations for Speed in the PPSA
- Assessment of the Distribution of Maritime Traffic and Anthropogenic Underwater Noise in Pelagos Sanctuary
- CETENA-AMER Yachts - Rumore irradiato in mare