White Paper

Control and reduction of anthropogenic noise in the Italian seas and mitigation of its effects

Workshop "Acoustic noise and its impact on cetaceans"

Istituto Nazionale di Fisica Nucleare – Laboratori Nazionali del Sud

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Introduction

The Associazione Italiana di Acustica (AIA) and the Istituto Nazionale di Fisica Nucleare (INFN) organized the workshop "Acoustic noise and its impact on cetaceans" in Catania on April 21 2017. The main purpose of the workshop was to focus on study and research activities on underwater noise and its effects on the life of cetaceans along the Italian coast. Physicists, biologists, engineers, geologists, naturalists of research institutes, universities, environmental organizations and associations have presented their activities in the framework of acoustic and environmental monitoring.

During the workshop, acoustic monitoring and modeling methodologies, new sensor development and related data analysis and results were discussed, thus demonstrating the presence of a huge variety of consolidated data and interesting scenarios for the future. The sharing of these works and projects paves the way to a positive implementation of the EU Marine Strategy Framework Directive. Based on the results of the workshop, this document aims at proposing coherent development actions in line with what has been done in the framework of the Marine Strategy Framework Directive 2008/56 / EC (MSFD, also known as Marine Strategy). Moreover, the "white paper" aims to support activities that are otherwise unsteady and unable to have a significant impact on the development of sustainable policies for commercial, touristic and industrial activities at sea. The sustainability of these policies is strongly dependent by the application of measures for the reduction of the main effects of anthropogenic activities on marine mammals. However, these effects are still poorly known and they are only partially monitored. An example of national monitoring effort is given by the marine mammals stranding National Database, managed by the University of Pavia and the Museum of Natural History of Milan on behalf of the Italian Ministry of the Environment and Territory Protection of the Sea (http://mammiferimarini.unipv.it).

In addition, a number of different activities managed by research institutes, Universities and private voluntary organizations give to our country (even if in absence of an organic monitoring and research plan) data of very high scientific value, fundamental to the definition of measures for protection of our seas and for a sustainable development of economy.

The high level of expertise and technologies available in Italy, together with the presence of highly qualified small and medium-sized companies, potentially put our country at a leading position in Europe in the measurement and mitigation of acoustic pollution at sea. The perspective is to move from a "pioneering" phase – in which leading Italian research institutes (INFN, INGV, CNR) and universities have been engaged in the construction of underwater observers and infrastructures of the highest technological level - to a new phase where to formalize a structure for a proper sharing and exploitation of the collected data and of the available scientific and technological skills.

To realize these goals, main aims are to achieve a link between the main national scientific bodies involved in this field of research (first of all CNR, INFN, INGV, OGS and Universities) and to coordinate and manage the huge quantity of data available. Indeed, underwater data are received from both cabled sites and mobile platforms with different standards and various bodies involved besides the main research institutes, such as the non-profit organizations involved in the study of the acoustic features of marine fauna, cetaceans and anthropic sources of noise. Such link must be managed with a coordinated and shared plan where the research bodies and universities should be providers of data, experiences and know-how.

From the workshop it stands out that research and monitoring activities will be necessary to define an action plan that will be as effective as the more efficient will be the coordination between national groups conducting research in the topics of noise measurement and of the effects of noise at sea. Such coordination will also be able to offer top-quality projects at European level.

The aim of the present document is:

- ***to give support to the monitoring plan of the underwater noise (11th descriptor of the Marine Strategy Framework Directive); for which the Italian Ministry of the Environment and the Protection of the Territory and the Sea (MATTM) hired CNR (Italian National Research Council) with the 2015/12/15 Memorandum of***

Understanding and CONISMA (National Interuniversity Consortium for Sea Sciences) by means of successive operating conventions (2015-2016);

- ***to propose to Italian authorities a guideline to start a systemic study on the effects of underwater noise, a phenomenon still to be understood in its dynamics, and to propose related actions to mitigate, and possibly eliminate, its negative effects on marine life in the Italian seas.***

The document is divided into four parts assembled in

1. **Why**
2. **How**
3. **How much, where and when**
4. **Opportunities and advantages for Italy**

1 - Why

Biological research showed that a great number of species, from mollusks to crustaceans from fish to marine mammals are able to produce and detect sounds.

Marine fauna has one of the main senses in acoustic perception, exploiting the characteristics of the medium in which it lives, where light slightly propagates whilst sound is efficiently transmitted. The seas, once relatively quiet environments where numerous species could use sound as a primary communication channel and make use of this with great efficiency, have quickly become extremely noisy. Anthropogenic sounds, just like natural ones, spread very effectively underwater, raising the level of global noise and then superimposing in an antagonistic way to the former. In particular, **two categories of anthropogenic sounds are capable of damaging marine life directly or indirectly: high intensity impulse sounds and persistent background noise.**

Impulse sounds are due to specific activities, mainly connected to military sphere (e.g. sonars and explosions) and industrial frame (mining exploration, construction of wind farms, works on the coast).

Background noise is linked to the presence of hundreds of thousands of boats regularly under way all over the seas of the world. Every boat produces a low frequency noise that spreads for tens of kilometers, overlapped with all the other environmental sounds. The result is that many seas have become very noisy places for the intense and continuous naval traffic.

Studies on *impulsive sounds* have been performed and the related mitigation procedures are already in place, although the dynamic of the effects is far from being fully understood. The scale of impulsive noise effects on the marine life ranges from the **disturbance** (signal masking, habitat removal) caused by low intensity noise to the **death** for barotrauma, to temporary or permanent hearing damage, as suggested by surveys on stranded cetaceans.

The *background noise* analysis presents even greater difficulties. The deleterious effects of exposure to continuous noise have been well documented in humans and in other terrestrial species. It causes stress increase, physiological weakening, difficulty communicating with the conspecifics and impossibility to detect preys or predators. It is reasonable to assume that the same effects affect all marine organisms that use sound as a privileged sense, but this needs further investigations at different levels. The observation of **short-term and long-term noise effects caused by naval traffic** at species level, population and ecosystems requires **large-scale (tens of years) monitoring** that provide **historical data series that can describe how ecosystems respond to this pressure over time** (e.g. variations in the distribution and use of habitats for marine mammals).

As illustrated, institutions account **submarine anthropogenic noise to be a real polluting source** with impacts both at the level of individuals and of the populations.

The Marine Strategy Framework Directive **2008/56/C** inserts "submarine noise produced by humans" within the definition of "pollution" (Art 3 point 8) and it is inserted in the list of pressures (Descriptor 11) to be analyzed and monitored (Table 2 of Annex III) for the purpose of determining

the good ecological status of marine environments (Annex I, point 11) and the preparation of protection strategies. In addition, the Marine Strategy Directive is expected to achieve by 2020 the "**Good Environmental Status**", a balance that will enable marine and maritime activities to be carried out in environmentally sustainable conditions.

Pollution laws, however, face a huge cross-border challenge: the diffusion of underwater noise, in fact, as well as the movement of marine fauna, goes beyond the limits of the national waters of each country, making even more difficult the definition and the application of shared rules on noise and acoustic pollution.

The Marine Strategy Directive and the Maritime Spatial Planning Directive (adopted by the European Parliament and the Council in 2014) are geared towards **the effective management of maritime activities and the sustainable use of marine and coastal resources at international level, pointing to individual countries the way forward.**

2 - How

European Maritime Directives and Planning of Maritime Space provide that **public administrations must evaluate the effects on marine fauna** when evaluating new activities and infrastructures to be realized at sea (wind farms, pipelines and oil pipelines, geophysical prospecting, exploitation mining and oil, etc.). This preventive assessment activity needs guidelines that are not always available or are only partially suited to the purpose, because the lack of basic knowledge on the actual diffusion and impact of environmental noise. **It is therefore necessary that the National Environmental Protection System (SNPA)** - born following the issuance of the Italian Law 28-06-2016, n. 132, "Istituzione del Sistema Nazionale a rete per la Protezione dell'Ambiente e disciplina dell'Istituto Superiore per la Protezione e la ricerca Ambientale" (Establishment of the National Network for the Protection of the Environment and discipline of the Superior Institute for Environmental Protection and Research) - **prepares these guidelines by promoting research projects and experiments to develop and test reference documents**. For this purpose, it will be necessary to consider the UNEP/CMS/COP12/Doc.24.2.2 "Marine Noise" resolution with indications and guidelines for the impact assessment of activities generating noise at sea.

Another key sector that accompanies the binding preventive opinions is environmental monitoring for the definition of Good Environmental Status and the verification, through targeted controls, of the requirements made at the authorization stage. These SNPA-specific activities must have in the development and implementation of the Marine Strategy Directive, coordinated by the Italian Ministry of the Environment, the implementation of the Noise Monitoring Plan.

A key step in this direction is the creation, from the existing infrastructures, of a national network of underwater acoustic observatories (land connected, autonomous and recoverable), which enable the long-term and real time measurement and monitoring of acoustic noise as well as of biological data. This network would be supported by a suitable group of scientists responsible for the correct planning of collection campaigns and their data analysis.

The network can also provide data to compare with models, and it will be a tool to control the thresholds of noise and the presence of unmodified or unexpected sources. The same network will provide data on the presence of acoustically identifiable marine species, thus improving knowledge on the distribution, seasonal presence and, for some species, population composition and habitat use. The infrastructure data will converge into a national database.

The implementation of the monitoring network will also enable the identification of *quiet areas* of biological relevance (e.g. Nature 2000 sites) and of areas particularly vulnerable to acoustic pollution (because they are subject to other sources of pollution or peculiar propagation conditions of the sound or presence of endangered species). Such areas could provide a *pilot case* to test the effectiveness of protection standards and strategies, such as restrictions on human activities temporarily restricted to migration and reproduction periods, as is already the case in other parts of the world.

3 - How much, where and when

The adoption of a strictly conservative limit to minimize the effect of extensive noise on all Italian seas **is difficult to apply**, especially in areas close to commercial ports or commercial shipping lines. Hence, the main task of research is to provide data on the **eco-sustainability of the noise level of anthropogenic origin** and its periodicities, and to **highlight risks and vulnerabilities in terms of geographical areas, times, species and ecosystems in general.** The complexity of such studies, particularly with regard to the background noise, requires an experimental approach and the use of statistical and forecasting methodologies. Offshore observations require a large deployment of media, resources and new technologies. A systematic effort must therefore be immediately planned, organized and conducted to assess the effect of noise on the Italian seas. Research activities should address three main areas:

1) Qualitative and quantitative description of acoustic noise in the Italian seas

The establishment of a marine sound and associated information registry could be the system that provides all the necessary information on the three legal pillars known as rights, restrictions, and responsibilities related to human activities in marine environment.

Effective compilation of the registry requires as realistic data as possible on the number and location of the sources. For this purpose, it is necessary to synchronize and harmonize databases providing information on the presence of commercial, military, fishing and recreational boats and craft and their activities. Data from AIS (Automatic Identification System) stations can be enriched with data obtained from different technologies, such as cameras, radar or satellite images.

In parallel, reliable models on source emission will have to be built. Based on the characteristics of the same source, these models should be able to predict the acoustic emission and its propagation with sufficient accuracy. The characterization of the sources can be validated with acoustic recordings and with direct measurements for the assessment of the noise of propellers and engines and impulse sources such as *air-guns*, metal cylinders that generate compressed air impulses used in geophysical explorations for purposes of scientific research and mining exploration.

This will allow to realize a database of typical emission for different source types, increasing the statistical validity of the sample, enriching and improving their classification, validating existing models, and providing, if necessary, specific noise reduction measures.

The registry will provide input for the production of **detailed noise maps, depending on the location, depth, time, frequency and periodicity of the noise**. Maps will be provided with statistical information such as combined average values on the water column in specific areas, percentages exceeding certain thresholds, and so on.

The production of reliable acoustic maps also requires the consolidation of sound propagation patterns, which depend on the physical characteristics of propagation medium, water column, bathymetric profiles and surface conditions. It is essential to **create a software tool shared by the Italian scientific community and certified by the competent Ministries**, which uses reliable, certified and up-to-date databases.

2) Maps of the presence of marine fauna.

Such maps should include data on spatial and temporal distribution in terms of species, number of individuals and *habitat use* of marine fauna, cetaceans in particular. In this regard, information from various sources, including the National Database on marine mammal stranding, should be supplemented; the stranding Database provides a continually updated picture of the marine mammal stranding occurring on Italian coasts for various causes (interactions with fisheries, collisions, pollution, noise, etc.) and information from observational surveys on the presence of different species at sea.

3) Impact of acoustic noise on species, individuals and population

The impact should be quantified and evaluated at the behavioral (e.g. abandonment by the species of critical habitats) and physiological level in order to define qualitative standards to protect both

individuals and populations. For these assessments, it is necessary to have solid knowledge of the ecology of the different species that can be generated only by long series of observational data at sea. Indeed, despite the availability of relatively long time series in some areas of the Italian seas, the assessment of the impacts of underwater noise is still largely missing, with the exception of a few studies.

The outcomes of the proposed activities will make possible the implementation of **maps defining the areas of vulnerability and the impact of acoustic noise on the ecosystem. These actions will moreover provide the legislator and the control and protection authorities with a comprehensive and reliable tool for**:

- the assessment of the environmental risks of sea activities;
- the definition of operational mitigation actions (eg constraints to specific sources, navigation, speed, number or size of ships in a certain area)
- the identification of the technological developments necessary to minimize at the design level the acoustic impact of fleets and marine equipment
- compliance with the relevant Community directives

4 - Opportunities and advantages for Italy

Thanks to the particular geographical location of Italy, Italian seas are one of the main sources of economic wealth in terms of trade, fishing, tourism, natural resources and ecosystem services. The Italian seas are a privileged corridor not only for sea trade but also for marine fauna. Although often underestimated, noise is one of the main sources of pressure on the environment and hence on the natural resources of our seas.

The implementation of a systemic and synergic plan for the research and sound monitoring of the Italian seas represents a unique opportunity for the adoption and development of innovative methods for the sustainability of marine resources. This plan applies to both the economic and the environmental stages, as well as it represents an opportunity for developing knowledge in a discipline whose dynamics are still only partially understood.

A classic example of anthropic pressure lays in the competition between dolphins and fishing activities, aggravated in recent years by over-fishing and by the reduction of trophic resources available. Dolphins are perceived as a threat by fishermen. There is no doubt that better knowledge of the distribution and ecology of these cetaceans and the rationalization of anthropic pressures can lead to an improvement in fisheries and support policies for small artisanal fishing.

The activities proposed in this document also foreseen the creation of new specialized professional figures with new technical, scientific and managerial skills (see blue carreers "EASME / EMFF / 2016 / 1.2.1.2") distributed on the territory. From a medium to long-term perspective, these figures are indispensable to ensure effective the application of protection and conservation measures at both at the national and at the international level, where Italy could play a top-player role.

The definition of a common operational platform will certainly lead to the development of collaborations among research, academia, organizations and industry areas. This could lead to new and different visions of maritime transport, both in terms of energy saving and in the design of new propellers, with an immediate relapse also on sport and tourist navigation and a potential remodeling of harbor activities or of the same harbors.

These activities may also have implications for updating MSFD descriptors, with consequences that are not conceivable at this time.

From a research point of view, it should be emphasized that noise measurement and monitoring have many interdisciplinary aspects, as the sources from which they are generated are many and diversified: natural, geophysical, physical, biological and anthropic sources (for research, navigation, fishing and military activities). Precisely, interdisciplinarity will allow the integration of several experts who will thus be able to share, disseminate and hence enrich the common body of knowledge.

Proponents

Name	Surname	Affiliation	Date
Giorgio	Riccobene	INFN-LNS	03/08/2017
Giorgio	Bellia	Univ. Catania, INFN-LNS, CONISMA	03/08/2017
Paolo	Favali	INGV	03/08/2017
Francesco	Filiciotto	CNR-IAMC	03/08/2017
Gaetano	Licitra	ARPAT	03/08/2017
Claudio	Fossati	CIBRA, Univ. Pavia	03/08/2017
Gianni	Pavan	CIBRA, Univ. Pavia, CONISMA	03/08/2017
Angelo	Camerlenghi	INOGS	03/08/2017
Giuseppa	Buscaino	CNR-IAMC	03/08/2017
Elena	Papale	CNR-IAMC	03/08/2017
Rosario	Grammauta	CNR-IAMC	03/08/2017
Vincenzo	Maccarrone	CNR-IAMC	03/08/2017
Gabriella	La Manna	MareTerra Onlus	03/08/2017
Tomaso	Gaggero	Univ. Genova	03/08/2017
Salvatore	Mazzola	CNR-IAMC	03/08/2017
Enrico	Rizzuto	Univ. Napoli	03/08/2017
Michele	Viviani	Univ. Genova	03/08/2017
Caterina	Lanfredi	Tethys Research Institute	03/08/2017
Maria Grazia	Attanasi	WWF Sicilia	03/08/2017
Daniela Silvia	Pace	Oceano Mare Delphis	03/08/2017
Sabina	Airoldi	Tethys Research Institute	03/08/2017
Clara	Monaco	Ketos	03/08/2017
Salvatore	Viola	INFN-LNS	03/08/2017
Virginia	Sciacca	E-Conscience	03/08/2017
Francesco	Caruso	Whoods Hole Institute (US)	03/08/2017
Alessio	Maglio	Sinay (F)	03/08/2017
Elena	Bonaccorsi	FeelLand	03/08/2017
Sara	Pulvirenti	INFN-LNS	03/08/2017
Giuseppina	Larosa	INFN-LNS	03/08/2017
Laura	Beranzoli	INGV	03/08/2017
Mauro	Taiuti	Univ. Genova	04/08/2017
Salvatore	Mellea	Fondazione Michelagnoli - Taranto	04/08/2017
Riccardo	Reitano	Univ. Catania	07/08/2017
Massimiliano	Rosso	Fondazione CIMA	13/08/2017
Aurelie	Moulins	Fondazione CIMA	13/08/2017
Paola	Tepsich	Fondazione CIMA	13/08/2017
Emilio	De Domenico	Univ. di Messina	18/08/2017
Maria	De Francesco	Univ. di Messina	18/08/2017
Nunziacarla	Spanò	Univ. di Messina	18/08/2017
Gioele	Capillo	Univ. di Messina	18/08/2017
Giuliana	Pellegrino	Ketos	23/08/2917
Alessandra	Casale	Univ. Genova	23/08/2917