

The Lessons of Ziphia:

A Case Study to Better Protect Marine Mammals from Anthropogenic Noise in the French Exclusive Economic Zone

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Françoise Gaill

"This story, drawn from diverse backgrounds, produces a mosaic of influences around a piece of writing. A piece of writing that, when read, prompts us to reflect and even to do something. Such a narrative can only lead to action, once these facts and insights have been made available."

François Frey

"Ziphia is 'the other,' non-human, who embodied her own experience of the Earth system, at the heart of the ocean. It took the combined power of a group of researchers to approach, assemble, and then share the traces left by the death of this beaked whale, in the invasive violence of human noise.

Its tragic end forces us to shift to the urgency of another consciousness and another relationship with the major ecological issues of our time, regardless of our commitments and responsibilities, because 'the other' is also each one of us."

Marie-Cécile Guillory

"I listened to the flow of intelligence focused on Zyphia, the future of her species, the future of ours, without ego battles, accepting the arrival of emotions and expressing them with delicacy, humour, and anger.

I heard each person explain their speciality in an understandable way without being overbearing, accepting their limitations and fragilities in relation to other disciplines. And I felt, through this very special work of humanity, that we were touching on a profound and complex reality of life; life within us and outside us, connected."

Sébastien Dutreuil

"Accustomed to working at the intersection of several disciplines, I was particularly struck by the diversity and, above all, the complementarity of the skills required for writing. This is one of the most successful examples of collective writing that I have had the opportunity to contribute to. This experience highlights the fact that when it comes to transforming collective relationships with the environment, there is no single privileged point of view!"

Chloé Le Cam

"As a student of ocean, atmospheric and climate sciences, as well as environmental political science, I was really happy to participate in this joint reflection. It gave me hope, proving to me that the natural sciences, humanities, academia and industry can overcome their differences and take action to protect marine life. I sincerely hope that this initiative will inspire others."

Agnès Michelot

"Discovering the ocean with those who have practical experience in such varied fields, through an immersive and integrated approach, was inspiring. The spiritual dimension of the ocean system was particularly striking for me. It revealed a different way of thinking about the world. The boundaries between the human and the non-human blurred, giving way to the living.

The constraints of access to the oceanic world also became apparent as the fields of science opened up. As a lawyer, I felt swept up in the Esprit de Velox adventure. The law in the service of the ocean as a matter of course..."

Anna Evans

"My experience of this collaborative work has been enlightening. Long convinced that global change can only be achieved with the involvement of a large number of individuals, I have devoted myself to educating the general public rather than pursuing the specialised research required by contemporary science. I have seen how many scientists need interdisciplinary exchanges to nourish their thinking and their hope in the scope of their work, and how much I still admire this effort of the human mind in its infinite quest to understand life.

This exercise has been extremely invigorating, and I hope it will inspire other professionals to share their discipline with other perspectives."

Gaëlle Rousseau

"The interdisciplinary working group immediately creates an atmosphere of goodwill, transparency and knowledge sharing on the subject of respect for life, which does not necessarily resonate immediately in my original environment, the world of Defence. Stepping outside my usual circles, meeting committed and passionate people, sharing knowledge and learning together allows me to then transfer this experience to my own environment."

Jérôme Spitz

"To address the consequences of climate change and biodiversity loss, a scientific understanding of the ocean that transcends disciplines is now essential.

Objectif Océan is a laboratory for the development and implementation of such a vision. This article is the result of an initial joint immersion by authors with different experiences who have converged and evolved their perspectives thanks to each other's insights."

Justine Réveillas

"There is nothing like a concrete and captivating case study to put into practice the knowledge acquired during several years of study and a highly enriching PhD on the theme of marine environment protection.

Contributing my legal perspective to this superb project was a real pleasure and allowed me to confront the reality on the ground and practise inter-disciplinarity, which is essential today when addressing the protection of the Ocean system."

Éric Baudin

"For a goal to be successful, there is no other approach than to give it a global scope. Seizing an expert vision will only lead to partial success, focused on that expertise, which we will seek to enrich by promoting co-benefits.

My contribution to this collaborative work has reinforced my conviction in a concrete way, through the publication of a paper that raises a problem and outlines solutions, that we are all part of the ocean ecosystem and that when no link in the chain is, a priori, left out, then it becomes possible to turn this whole into a virtuous circle."

Jean-François Bourillet

"Humanity is facing many changes. The ocean, Ziphia and all other inhabitants are a source of solutions. Preserving them also means preserving our chances. The originality of the proposals put forward by the co-authors, who come from a wide variety of backgrounds, is based on attentive listening and a multiplicity of viewpoints and analyses."

Sound Pollution and Biodiversity Loss

Our perception of the underwater world remains partial and biased by our sensory and technical equipment.

Until the early 20th century, the ocean was considered a «world of silence». During the two World Wars and the Cold War, knowledge of underwater sounds became a military concern. The invention of sonar by Paul Langevin in 1917 allowed for the discrimination, identification, and classification of oceanic sounds. For the first time, natural sounds were catalogued, including shrimp-pistol sounds, cetacean calls, and fish-frog noises (Camprubi & Hui, 2020). Our understanding of these soundscapes has advanced, alongside the increasing pressure from anthropogenic noise. However, our representations of the underwater environment remain partial and biased by our sensory and technological limitations (Uexküll, 2010).

While the polar bear has become a symbol of climate change, whales are often used as ambassadors for the fragile oceanic space, increasingly disrupted by conflicting human objectives: biodiversity protection versus commercial, recreational, academic, or military activities in shared zones.

The death of a Cuvier's beaked whale (Ziphius cavirostris) found on February 2, 2021, on the commune of Ars-en-Ré (Charente-Maritime, France), likely due to anthropogenic noise, invites us to shift our perspective from an isolated incident to the reality of an interconnected oceanic system, with multiple actors, both humans and non-humans. This case is not isolated, but Europe has been slow to implement effective protection against underwater noise pollution.

As part of the Objectif Océan research programme (Box 1), we formed a working group from various relevant disciplines to investigate the death of the Cuvier's beaked whale, which we named Ziphia. This approach allowed us to explore the multiple human and non-human issues associated with anthropogenic underwater noise, to question the concept of marine protected areas (MPAs), and to propose new avenues for the protection of marine life, as well as develop recommendations for the preservation of marine mammals, advocating for responsibility across all societal sectors.

Investigate the death of the Cuvier's beaked whale, which we have named Ziphia.

Objectif Océan and the Esprit de Velox Vessel.

The group formed to study the Ziphia case is part of the responsible research and innovation program, Objectif Océan. This initiative is led by the Esprit de Velox association, which includes a hundred individual and institutional members from civil society, research, education, industry, and the maritime world. It contributes to the United Nations Decade of Ocean Science for Sustainable Development (2021-2030).

Esprit de Velox aims to evolve oceanographic campaigns by:

- *Creating an inclusive «third place» for collective intelligence, facilitated by researchers in the broadest sense, through roundtables, conferences, and workshops.*
- *Developing Esprit de Velox, a discreet, bio-inspired, energy-autonomous, and environmentally low-impact vessel capable of hosting long-term research teams. The vessel will facilitate the convergence of diverse experiences and foster a new dialogue with the ocean. The goal is to embark the first research team in 2027 (www.espritdevelox.org).*

The workshop on the Ziphia case underscores the importance of long-term thinking, the need for a «base camp,» and the recognition of the unforeseen outcomes arising from the diversity of perspectives. Over an 18-month period, the group underwent a transformation in the research process itself. After a series of collective sessions fueled by personal contributions and a residency (November 21-24, 2021), each contributor not only developed a shared, enhanced vision of the subject but also evolved their personal practice within their respective field.

By striving to perceive and anticipate the oceanic transformations that concern us all, integrating a multiplicity of human and non-human perspectives, the Objectif Océan programme is fostering the emergence of an «oceanethology.»

The Ziphia Case

Although strandings of beaked whales are relatively rare, they occur regularly along the French Atlantic coast (Meheust et al., 2021). After five strandings in the first half of 2020, a sixth carcass washed ashore on February 2, 2021, at Ars-en-Ré (Fig. 1).

Sound travels five times faster in water than in air.

The necropsy of this mature female revealed injuries consistent with traumatic death caused by the direct impact of an impulsive shock on the cetacean (Fig. 2).

Hearing is as crucial for cetaceans as vision is for humans: light barely penetrates more than 200 meters underwater. Sound, on the other hand, travels five times faster in water than in air and, depending on the frequency and characteristics of the environment, can travel up to several thousand kilometers from its source. For cetaceans, hearing is the most important sense to perceive their environment, locate their prey, and communicate with their peers (Fig. 3).

This species produces sounds in the range of 20 kHz to 80 kHz.

Cetaceans with teeth, such as the Cuvier's beaked whale, perceive a frequency range from 100 Hz to 100 kHz (20 Hz to 20 kHz for humans). This species produces sounds in the 20 kHz-80 kHz range. Among the expertise developed and shared by the members of the working group, intuitive animal communication (Evans, 2010; Evans & Kaiser, 2017) seeks to create bridges for direct dialogue between humans and other species by balancing intuition and logic. It enables us to perceive how these social beings use sound to interact with their environment, their peers, and other species (communication, feeding, reproduction, learning of young...).

Perceive how these social beings use sound to interact with their environment.

This emphasis on intuition, defined by Henri Bergson (1934) as «the sympathy by which one transports oneself into the interior of an object to coincide with what it has that is unique and, therefore, inexpressible,» allowed us to place the whale at the center of our group and «give it a voice.»

Fig. 2. *Massive thoracic hemorrhage observed during the dissection.*
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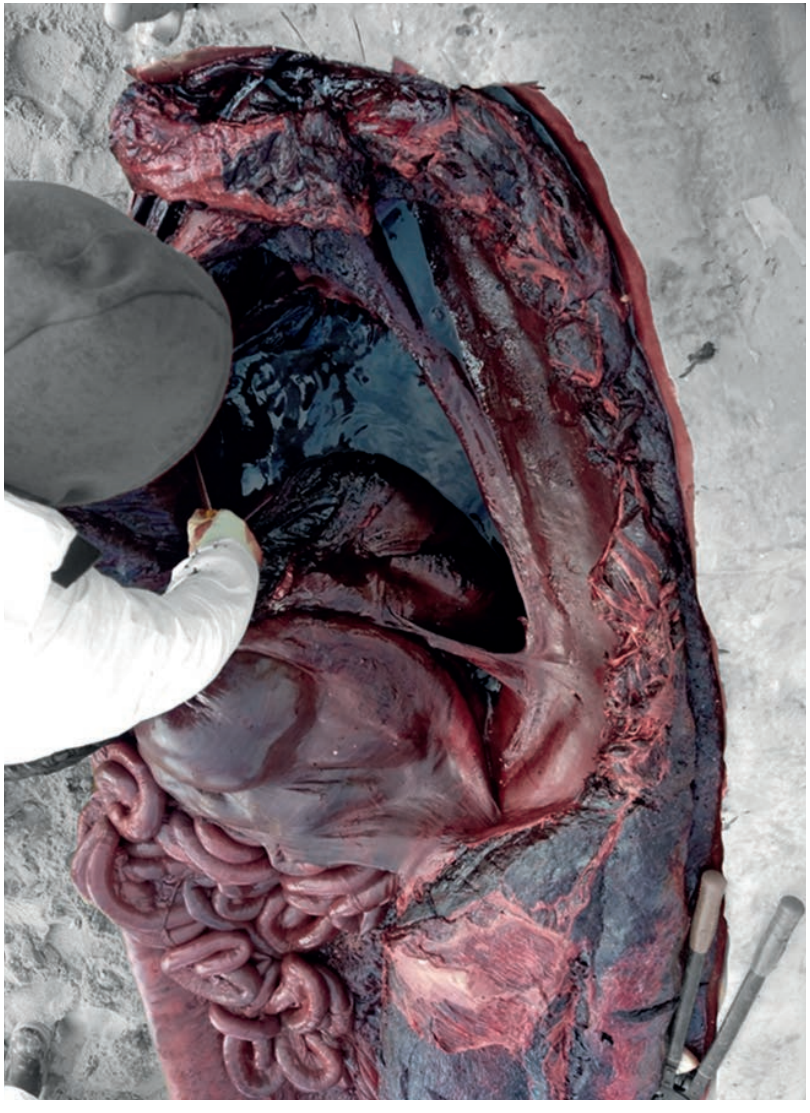


Fig. 1. *Ziphia, Cuvier's beaked whale, stranded on February 2, 2021.*
© Pelagis Observatory.



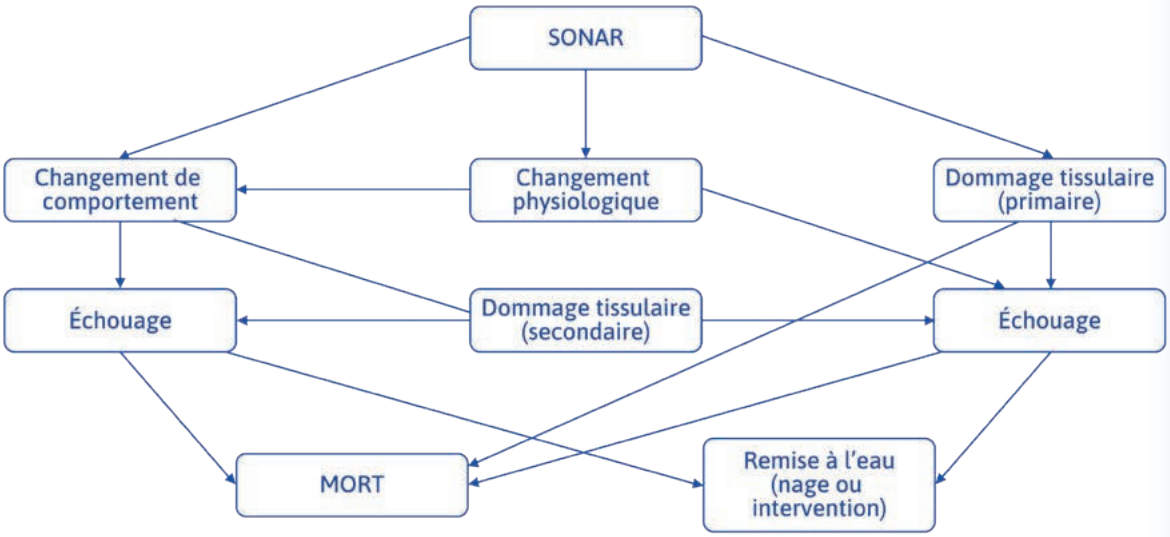


Fig. 4. *Potential mechanisms by which cetaceans are affected by sonar (source: authors based on Cox et al., 2006).*

Indeed, noise from human activities can, depending on its characteristics (power, intensity, frequency, duration...), create a wide range of harmful impacts: disturbance, physiological stress, habitat loss, masking of communications, temporary or permanent damage, and even death (Parsons et al., 2008; Tyack et al., 2011; Cox et al., 2006; Fig. 4).

Impulse noise is considered the main suspect in the Ziphia case.

Impulsive noise is considered the main suspect in the Ziphia case. Short and intense, it propagates either in all directions (explosion) or in a directional manner (sonar). The intensity of the sound perceived corresponds to a pressure variation relative to a reference pressure, expressed in decibels. Pile driving, explosions, military sonars, and certain seismic sources (academic or oil-related) are typical examples of such noises. High-intensity sound emissions seem to specifically alter the behavior of diving whales, causing them to lose spatial orientation and leading to rapid ascents to the surface and/or to shallower, coastal areas (Cox et al., 2006; Parsons et al., 2008; Ketten, 2014). They also represent a risk of temporary or permanent auditory damage and can cause the formation of gas bubbles, hemorrhages in vital organs, potentially lethal to the animal in the short or medium term (Cox et al., 2006; Parsons et al., 2008). These sounds can also lead to changes in heart rate and blood pressure, hypoxia, or even blood cavitation and organ rupture (Cox et al., 2006).



Fig. 3. *Photograph by Nicolas Floc'h of Ziphia's habitat, Lampaul Canyon, Bay of Biscay, -864 m, marine snow, rocky shelf, Chereef oceanographic mission, in Paysages productifs, Initium Maris, Deep Sea.*

"For this mission of eleven dives between -700 and -1,800 meters, I use a wide-angle lens, unlike the scientists who prefer tight shots. I strap my camera to the French oceanographic fleet's underwater robot, HROV Ariane, as if it were the bumper of a car. I benefit from Ariane's «headlights,» which illuminate the landscapes. Down there, it's like Mars or the Moon, but inhabited by solitary fish and thousands of species. Along the water column, in the substrate of the samples collected, what surprises me in the detail of my images is the sheer abundance of life."

In Ariane's «headlights»
Deep landscapes in marine snow
Stirred by organisms in the night of their hyperbaric lives
Mapped in «clicks»
In memory of a whale...
Nicolas Floc'h, 2021

Why this accident?

For several decades, mass strandings of beaked whales have been reported worldwide, and linked to high-intensity emissions produced by certain industrial, scientific, or military activities. As a result, in each case of beaked whale mortality, the co-occurrence of such activities is systematically investigated (Ketten, 2014).

Investigations have revealed a regular association between these deaths and the presence of military vessels.

Investigations have revealed a regular association between these mortalities and the presence of military ships, particularly those using high-power low- and mid-frequency sonars (Filadelfo et al., 2009). For example, the risks associated with the use of these sonars were acknowledged by the U.S. Navy in 2001. Following a mass stranding of 17 cetaceans in the Bahamas in March 2000, including beaked whale species (Schrope, 2002; Ketten, 2014), a U.S. Navy anti-submarine exercise was held responsible. The lawsuit brought forward, detailed in Joshua Horwitz's War of the Whales (2015), garnered significant attention. Similar events have also been reported in Europe. Unfortunately, our case study is not the most recent. In fact, 12 whales stranded on the northern and southern coasts of Cyprus between February 9 and 13, 2023. None survived. Specialists from Istanbul University produced a preliminary report indicating acoustic trauma (Basat, 2023).

The examination of Ziphia allowed for an estimate of its death occurring between January 5 and 10, 2021. A backward modeling of the corpse's trajectory from the coast to the probable site of death (Fig. 5) was carried out using an inverse drift model (Peltier & Ridoux, 2015): the likely path of the carcass leads to a high probability of death occurring at the Natura 2000 site «Mers Celtiques - Talus du golfe de Gascogne». This site is protected under two directives: the Habitats Directive (Fauna, Flora) and the Birds Directive. The first is awaiting the adoption of its objectives document (Docob), while the latter does not specifically target cetaceans. In the immediate vicinity (50 km) and during the considered period (January 4–8, 2021), a military vessel was conducting tests under the management of Naval Group, within a designated exercise and firing zone (Zonex) assigned by the Atlantic maritime prefecture (Fig. 5) within the Natura 2000 area.

The examination of Ziphia allowed for an estimate of its death occurring between January 5 and 10, 2021

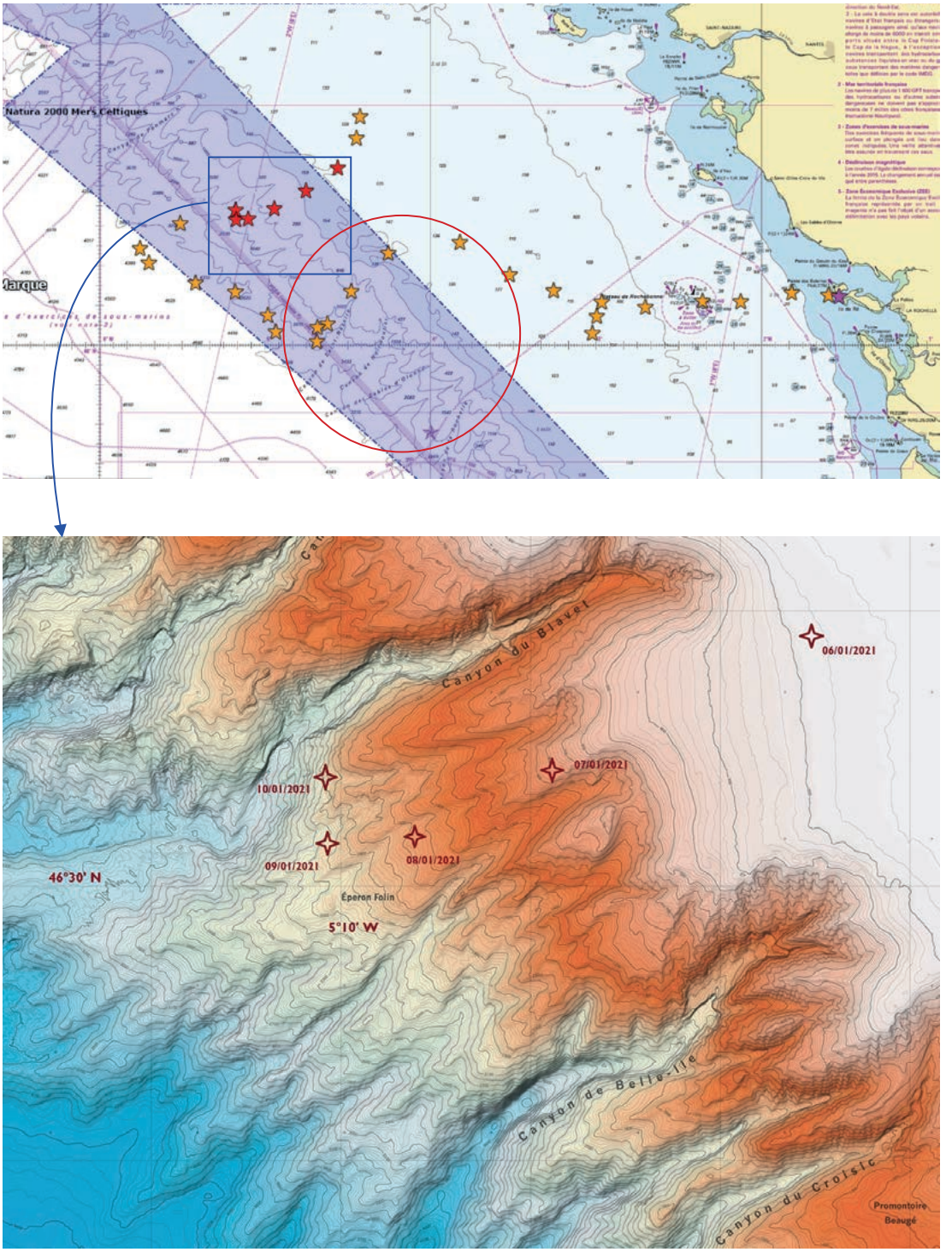


Fig. 5. *Reconstruction of the carcass drift (one mark per average daily position) from the stranding site (pink octagon) to the time of death (red capsules, period from January 5 to 10). Vessel presence zone (red circle). Credits: SHOM maps and enlargement on detailed bathymetric survey (Bourillet et al., 2012).*

No direct evidence allows us to designate the vessel's activity as the cause of the accident. However, Naval Group has taken up the issue with the support of our interdisciplinary working group in order to improve the processes for conducting pulse sonar tests on its combat vessels.

The environmental regulatory framework has changed little.

While anthropogenic sound pressures are intensifying, the environmental regulatory framework has evolved little and remains often ineffective. In maritime law, the 1982 United Nations Convention on the Law of the Sea (UNCLOS) imposes an obligation on states to prevent, reduce, and control marine pollution (art. 194), which indirectly includes sound pollution as «energy» introduced into the marine environment. International bodies (e.g., the International Maritime Organization, the OSPAR Convention) have issued recommendations. The European Marine Strategy Framework Directive (MSFD) provides that: «the introduction of energy, including underwater sound sources, should occur at levels that do not harm the marine environment.» In France, the MSFD is transposed into the environmental code and applies only to mainland France. This code imposes an ecological perspective in the planning of maritime space but excludes activities whose «sole purpose is defense or national security» (art. L 219-5-1).

Although France has a wide variety of MPAs defined by the environmental code (art. L. 334-1 and following), the vast majority of those in French Atlantic waters are not or are poorly regulated (Claudet et al., 2021). Regarding sound pressures, any civilian vessel navigating in an MPA is supposed to comply with its regulations, when they exist, and obtain the approval of the competent local authority if necessary. A guide from the Ministry of the Environment (Terrier et al., 2020) recommends various procedures to reduce or offset the impacts of anthropogenic underwater sounds, but these measures are neither mandatory nor applied consistently by the French administration. Ziphia was operating at the time of its death in an area covered by two MPAs. However, none of them impose any constraints on noise, while the continental shelf represents a preferred habitat for many sensitive cetacean species. Currently, this area is still assigned to military exercises (Zonex). The regulatory gaps and lack of field monitoring reduce the effectiveness of MPAs, which then become mere «paper parks» (Féral, 2011; De Santo, 2018).

Furthermore, in France's exclusive economic zone (EEZ), some offshore activities require a work permit from the maritime prefecture. This applies to any French or foreign vessel: scientific work or submarine cable reconnaissance follows the marine scientific research decree; exploration or exploitation of fossil mineral or energy resources follows the mining code, which refers to the environmental code. In the case of military training exercises, which concern us here, the French Navy designates Zonex. Any vessel, military or civilian, must therefore declare its work intentions to the maritime prefecture. Permits are granted to avoid conflicting use of the area, without considering the environmental impact of the vessels and their activities. However, the maritime prefect, a senior naval officer, is currently responsible for combating all forms of sea pollution: «military activities are increasingly oriented towards environmental protection and redefined as not to be carried out against the imperatives linked to this protection» (Touzot, 2018). In this case, the vessel operating in the area did not apply a noise reduction protocol, as no noise restrictions are imposed either in the MPA or the EEZ. However, it is important to clarify and remind that anyone conducting activities at sea, especially civilian vessels, is required to respect the general obligation to protect the marine environment imposed by international maritime law.

In this case, the vessel operating in the area did not apply a noise reduction protocol.

Proposals for Practical Improvements by the Working Group

Accountability for Users of Underwater Sound Equipment

Some organizations producing underwater sounds follow their own protocol. The French Research Institute for Exploitation of the Sea (Ifremer) has been applying a protection protocol since 2011 (Ducatel et al., 2019). This protocol includes a risk assessment upfront, preventive measures, and, if necessary, the cessation of activities during operations (Box 2). It is regularly updated to incorporate new knowledge or fill gaps.

A ship should always combine the rules of its company with the laws of the coastal state.

In the military sector, some navies and companies have noise reduction protocols in place. Coastal states have also established procedures. A ship should systematically combine the rules of its company with the legislation of the coastal state to take into account the most stringent requirements of either. Based on the work of the Objectif Océan programme and discussions within the working group, Naval Group consulted its in-house experts and modified its testing procedures using active sonar (which can be used, for example, to detect the presence of submarines) to reduce the impact of these activities on marine mammals (Box 3).

More generally, in the French EEZ, we recommend that all entities conducting activities that generate impulse noise (offshore construction sites, ships, drones, etc.) be required to follow a protocol. At a minimum, the guidelines issued by the Ministry of the Environment (Terrier et al., 2020) or Ifremer (Ducatel et al., 2019) should be followed. To this end, we recommend incorporating the provisions of the former into the Environmental Code or a ministerial decree.

Box 2

Summary of Ifremer's Protection Protocol.

Before each offshore campaign, Ifremer establishes a specific protocol for each piece of equipment, taking into account the IUCN Red List species present in the area, the status and regulations of the zone (MPAs, regulations of the coastal state, etc.). It specifies time slots outside of migration or reproduction periods, emission levels not to exceed, alert and exclusion zones, and whether independent marine mammal observers (MMOs) must be on board.

During the campaign, each equipment use starts with a pre-shot observation/listening to ensure no animals are present, followed by a gradual increase in power. Visual or acoustic monitoring (24/7) is provided by the MMOs. The MMOs have authority over the mission leader and commander to stop operations if the exclusion zone is violated. Operations can resume after the animals' absence is confirmed, with another gradual increase in power.

Class 1 equipment (source volume over 500 in3) follows the protocol. This protocol does not apply to class 2 equipment (source volume under 500 in3), unless required by the coastal state or specific regulations.

In the military domain, some navies or companies also have noise reduction protocols. Coastal states have also established procedures. A vessel should systematically combine the rules of its company and the coastal state legislation to account for the strictest constraints.

Inspired by the works of the Objectif Océan programme and discussions within the working group, Naval Group consulted its internal experts and modified its testing procedures for active sonars (used to detect submarines, for example) to reduce the impact of these activities on marine mammals (Box 3).

Box 3

Improvements to Naval Group's Active Sonar Testing Procedures.

- *Additional environmental specifications for programmes involving active sonars:*
  - *Selection of Zonex outside marine protected areas (MPAs) and preferred habitats of marine mammals.*
  - *Visual monitoring (by a watchstander on the bridge) 30 minutes before the scheduled start of testing.*
  - *Continuous acoustic monitoring via an acoustic recognition software operated by a trained operator capable of identifying biological sounds.*
  - *A 30-minute gradual increase in sonar power at the start. In case a marine mammal is spotted, the decision to halt the test remains under the responsibility of the vessel's authority, as per Naval Group's client.*
- *Proposal for a more inclusive procedure considering all noise pollutants from all vectors (drones, antennas, propellers...) and associated measures to be implemented.*
- *Stakeholder engagement:*
  - *Consultation with the supplier to present the recommended measures.*
  - *Consultation with the Navy and the Directorate General of Armaments to share the procedures.*

More generally, within the French EEZ, we recommend that any entity conducting activities generating impulsive noise (offshore construction, vessels, drones, etc.) should be required to follow a protocol. At a minimum, the Ministry of the Environment's guide (Terrier et al., 2020) or Ifremer's guide (Ducatel et al., 2019) should be applied. We recommend incorporating the provisions of the former into the environmental code or into a ministerial decree.

Improve Protection within MPAs (All Legal Categories Combined)

For the specific case of the «Mers Celtiques - Talus du golfe de Gascogne» area, it is urgent that the objectives document (Docob) be adopted, in accordance with the FR5302015 data standard form from the National Museum of Natural History, which targets cetaceans including Ziphius cavirostris. More generally, it seems essential to strengthen the relevance of MPAs regarding anthropogenic noise, whether ambient or impulsive, by banning exercises involving military sonars. Additionally, any activity generating impulsive noise should be better monitored and controlled, for example, by requiring the operator to provide a risk assessment to the MPA management council for prior authorization. These measures should be extended to deep waters of MPAs to cover ecosystems from the surface to the seabed.

Any activity that generates impulsive noise should be better catalogued and controlled.

We also recommend deploying passive acoustic sensors at certain deep-sea marine observatories located in offshore MPAs to improve our understanding of underwater soundscapes and better justify decisions related to anthropogenic noise at sea. We call for better coordination between defense activities, sustainable development, and integrated maritime policy at maritime prefectures to ensure operational coherence in these measures. Finally, the regulations applicable to each MPA should be easily accessible, like the Nav&Co app, which allows users to learn about the regulations in force in each zone and discover marine biodiversity (SHOM and OFB, 2022).

The regulations applicable to each MPA must be easily accessible.

Track Life and Analyze Risks

It is urgent to go beyond analyzing the impact on hearing alone.

The impact of sound on an animal depends on the nature of the emitted noise, the noise perceived by the animal (species-specific audiogram), and the source-animal distance (Lurton et al., 2007; Southall et al., 2007; Lurton, 2016). Although experts have defined metrics for evaluating perceived noise (National Marine Fisheries Service, 2016), the challenge lies in setting alert levels and thresholds from which species groups are likely to experience temporary or permanent hearing loss. These thresholds are slowly but steadily updated (National Marine Fisheries Service, 2018; Southall et al., 2019).

However, it is urgent to move beyond the analysis of hearing impacts alone. Observed mortality in beaked whales may be due to physiological stress or tissue injuries for which no thresholds are known. Furthermore, the European Marine Board's inventory of knowledge and proposals on anthropogenic underwater noise emphasizes the importance of prioritizing the study of sound effects and the thresholds for temporary and permanent damage it causes across the entire trophic network, not just on marine mammals (Thomsen et al., 2021).

In view of these uncertainties, it seems necessary to apply the precautionary principle.

Thus, the lack of knowledge regarding the impacts of impulsive noise on cetaceans and marine life in general contributes to the difficulty in establishing consistent exposure thresholds. Additional research efforts are needed to protect marine life effectively. In the face of these uncertainties, the precautionary principle should be adhered to. While risk reduction measures for marine life vary across legislations, they should all include risk analysis – with or without preventive measures – ongoing monitoring, and permanent control.

Towards a Systemic Framework of Thought

Anthropogenic noise disrupts organisms at all trophic levels. Its propagation over long distances and the multiplicity of affected habitats make it difficult to document its effects, whether immediate or long-term. Understanding the impact of noise on the Ocean requires a holistic approach that embraces its complexity; we need to «learn to think like the Ocean» (Box 4).

Depending on historical or regional contexts, the ocean has been the subject of various representations: a political and geostrategic space for the reconfiguration of empires at the beginning of the modern era (Mancke, 1999); a naval chessboard for military and commercial circulation; an inexhaustible reserve of fishery, energy, and mineral resources; or a discreet receptacle for nuclear waste, plastics, or CO2 (Hamblin, 2013). Military patronage led to the development of geophysical knowledge and the construction of an oceanic vision (Doel, 2003; Turchetti & Roberts, 2014; Edwards, 2010; Hamblin, 2005): forecasting wave heights for landings; mapping the seafloor, studying currents, temperatures, and salinities for submarine navigation, etc. (Hamblin, 2005). The importance of physics distanced ocean sciences from life sciences (Doel, 2003): oceanographers are not asked to concern themselves with living organisms (Oreskes, 2021). When Navy-funded oceanographers developed acoustic tomography techniques, they did not consider their (real) impacts on cetaceans and societies: «protecting the environment» was not part of their mission (Oreskes, 2021), and the military culture of secrecy prevented any collaboration.

Understanding the impact of noise on the ocean requires a holistic approach that embraces its complexity.

Cold war physical sciences and scientific advances also helped document the global evolution of the environment (climate change, depletion of the stratospheric ozone, etc.) and gave birth to «Earth system sciences» and the polymorphic concept of the Anthropocene (Gemenne et al., 2021; Torre-Schaub et al., 2022). This recent framework leads us to conceive of Earth—as well as living beings, the climate, material cycles, and soil—as a system of interconnected entities that support its habitability. The ideal of «mastery over nature» is replaced, in such an interconnected system, by uncertainty in the face of our own paradoxes, which complicate the overlap of MPAs and military exercise zones, national security and environmental protection.

Learning to think like the Ocean

«I live on the Île de Ré, on the Atlantic West Coast of France. Every stranding is heartbreaking and evokes a terrible feeling of powerlessness. When Ziphia was found at the Pointe de Grignon, I felt the need to react: I formed a collective of researchers contacted through the emerging network of the Esprit de Velox programme. Pluri-, inter-, and transdisciplinarity are no longer the issue (Berkowitz et al., 2019). I am a sailor, an engineer, a human... a multifaceted individual who knows enough about the complexity of the environment to understand that alone, I am unable to answer the questions that arose in me when facing that great body lying on the sand. Ecological, philosophical, technical, biological, legal questions... I also needed to metabolize the event, to digest the anger, the sadness, the fear in the face of the fragility of the thin habitable layer in which we live, and which is now tearing apart. The contribution of artists and representatives of other «regimes of truth» (Latour, 2012) appeared essential to me. They are other multiples, present with different perspectives, who take over when scientific rationality fails.

The Ocean is composed of interacting parts supporting an autonomous system that exceeds them. To understand its functioning and its responses to current threats, we attempt to mimic it in the very process of understanding by recreating a «biocenosis» of thought. The different parts of the same problem interact through their specialists. The absence of hierarchy and good management of ego allow the emergence of what in us links, «self-organizes,» and balances to form a global, functional, and exhaustive thought.

Each representative of a practice or discipline accepts a cognitive discomfort related to their gaps in other fields, the necessity of making their language intelligible, and the destabilization of their representations when non-scientific contributions throw the group into moments of questioning and empathy. Each individual then identifies with non-human life and feels what escapes their own thinking. Strong common values and the desire to participate in a process of perpetual reorganization of methods and roles enable «resonance» to emerge, «when the subject and the world touch and mutually transform each other» (Rosa, 2018). Like in the Ocean, a coexistence and co-evolutions, often mutually beneficial, unfold. We then find our place at the heart of the pulse of life and, as Aldo Leopold listened to the secret opinion of the mountain, we hear the «world singing.»

François Frey,
President of the Esprit de Velox programme

Are these two objectives to be opposed? The recognition of the interdependence of Earth's system elements forces us to adopt a way of thinking that embraces the complexity of the oceanic environment, thus broadening our view of defense missions that often omit environmental law and consider themselves exempt from contributing to the protection of life.

It seems essential to weigh up the major national security issues.

It is essential to weigh the major issues of national security. The concept of «ecosystem service,» although anthropocentric and supporting a form of commodification of nature (Maris, 2014; Prévost et al., 2016), highlights our dependencies. For example, more than 40% of the global population depends on fisheries products for food (FAO, 2020). The destruction of marine habitat by any actor thus affects all peoples: the concept of territorial defense could therefore consider the cumulative impact of elements such as climate (migration flows), mobility of essential resources (fishing), the globality of pollution (radioactivity, persistence of chemical products...), on the security of a population. However, while ocean sciences are traditionally interdisciplinary, they are still today attached to their «silos.» To think and act in a common complex environment, we need synergies and collective dynamics involving a diversity of actors: NGOs, scientists, industry, citizens, and the military, so that all protagonists, including Defense responsible for our security, grasp the stakes and adjust their practices, at least in times of peace. The ecosystemic collapse we are experiencing calls for a reconsideration of the purpose, content, and actors involved in the very idea of defense.

The destruction of marine habitats by one actor affects all peoples.

Conclusion: Protect and Transmit

While anthropogenic sounds and their propagation in the water are identifiable, their impacts on biocenoses remain poorly understood, as do the thresholds beyond which these sounds become a pressure on different marine species. This results in a lack of precise, well-reasoned, and harmonized regulations in international, European, or French law. Thus, the MPA in which Ziphia was found applies no restrictions regarding underwater noise. However, recent research on the impact of anthropogenic sounds on marine life shows how pressing and systemic this issue is (Bonnel et al., 2022). Given the growing interconnection of ocean uses, it becomes essential to subject all sound producers to a preventive protocol in the French EEZ, a protocol that would be strengthened in MPAs by requiring mandatory authorization, without waiting for scientific confirmation that could be established by recording soundscapes in certain MPAs.

If we revise our priorities, focusing on the long term and our responsibility.

Ziphia's death illustrates the current inability of various sectors of our society to embrace the complexity of the oceanic environment; let us hope that the lessons learned will drive us towards a solution. By progressively articulating the diversity of approaches, in order to find new ways to frame problems and discover new solutions, our working group moves forward, experimenting, in understanding this complexity. It seems necessary to support the different communities interacting with the Ocean in their exchanges so that the diversity of sensitivities to the oceanic environment evolves into a complementarity of perspectives, knowledge, skills, and resources: this is what the Objectif Océan programme is striving to achieve. If we revise our priorities, focusing on the long term and our responsibility to safeguard what sustains life that underpins human existence, we will be able to pass on, as a legacy, an Ocean that is both alive and sustainable, far beyond the symbol of the whale.

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On February 2, 2021, a Cuvier's beaked whale (Ziphius cavirostris) stranded on Île de Ré (Northeast Atlantic, France). Preliminary analyses suggested that the animal's death was likely caused by anthropogenic noise, produced near an area where a military vessel was conducting tests within a marine protected area. This event marked the beginning of an investigation into the origins of the incident and highlighted the complexity of the relationship between ocean life and human activities. It also served as a foundation for a broader collaborative reflection, integrating various disciplines to rethink ocean knowledge production, the legal frameworks regulating marine space use and protection, and our anthropological relationship with the ocean.

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