Mitigating the impact of the Navy Sonar on the cetacean populations of the Macaronesia

Proposal by

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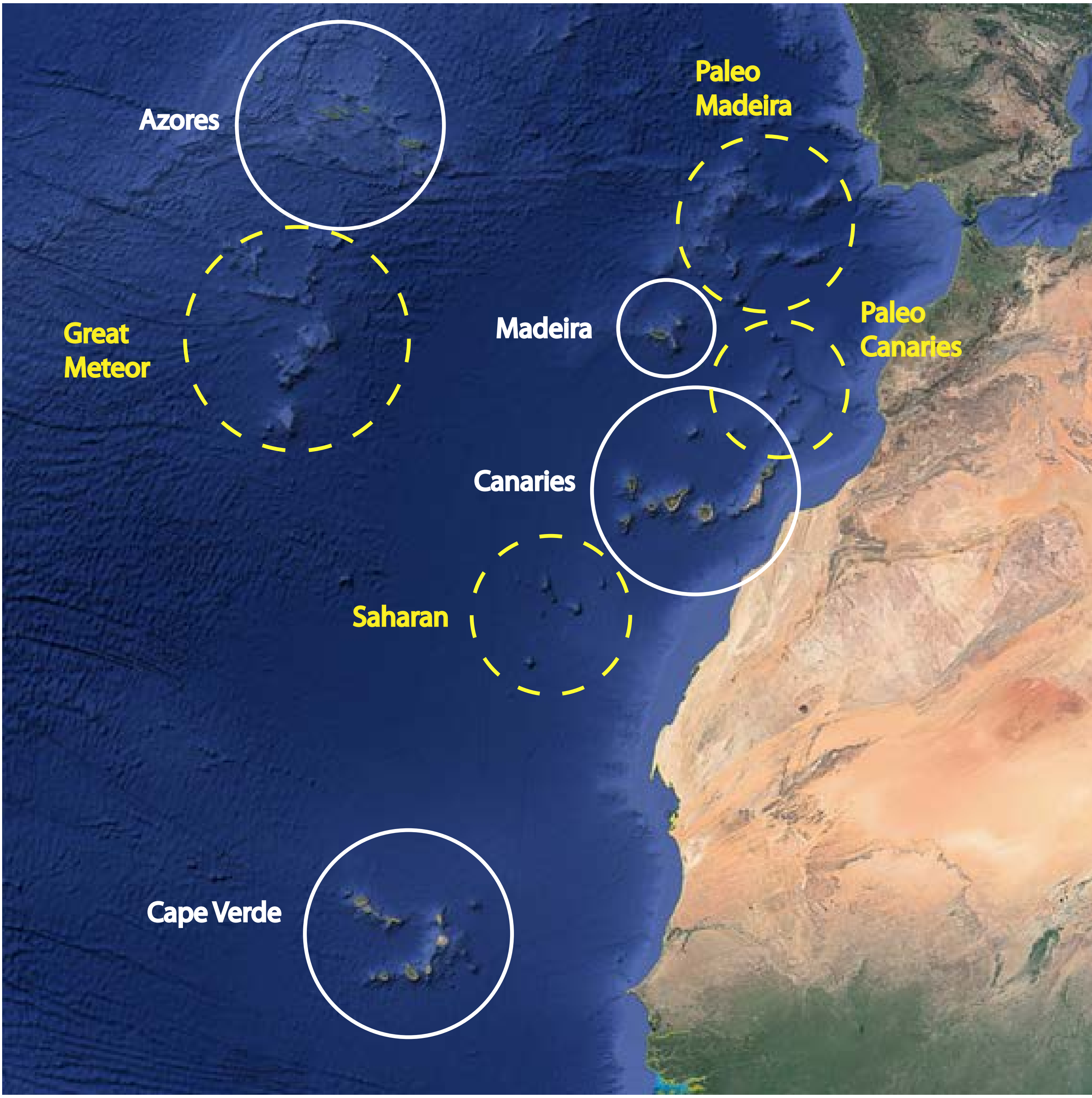


The Macaronesian biogeographic region with the actual emerged archipelagos
(white solid circles) and the paleo archipelagos (yellow dashed circles).

Why Macaronesia?

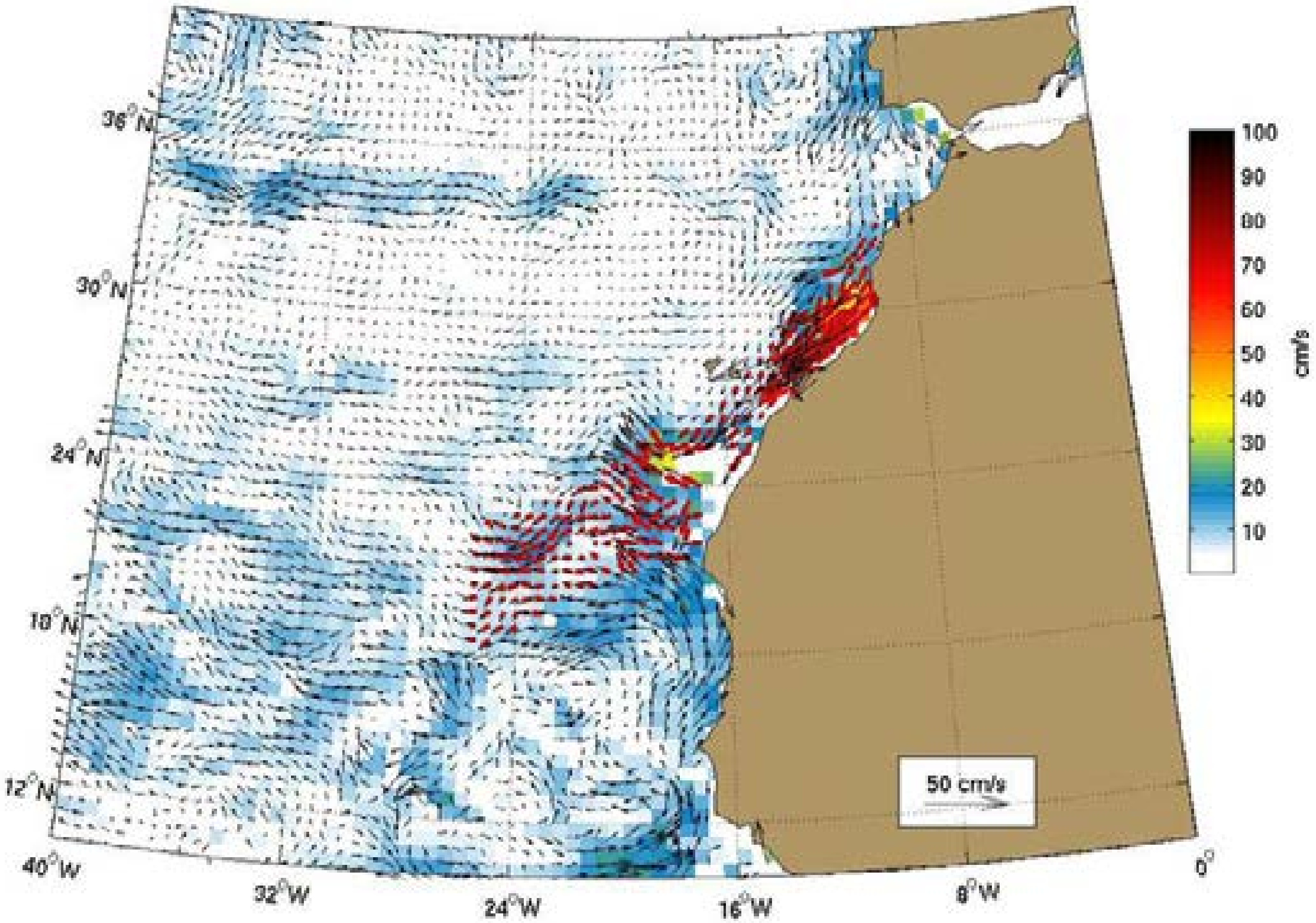
Because its biogeographic, climatic and oceanographic characteristics have created a cetacean hot-spot in the North Atlantic Ocean

Macaronesia is a 4,5 million square kilometres biogeographical region comprising five oceanic archipelagos: the Azores (northern limit), Madeira, Selvagen (Savage Islands), Canaries and Cape Verde (southern limit). The climate of these archipelagos is driven by the trade winds and the Canary marine current, and it has strong similarities with the Atlantic coast of the Iberian Peninsula and the north-western fringes of Africa. The five archipelagos have in common a volcanic origin, a contrasting landscape and a gentle climate. These features, and their oceanic nature have created an ideal environment particularly rich in endemic species.

The Macaronesia is a biogeographic region, which means their archipelagos have common climatic, geological, ecological and biological characteristics. The name was proposed by Philip Barker Webb a botanist that initially included in the region just the Canary Islands, Madeira and the Salvagem islands, because their similar vegetation. In 1879 the German botanist Adolf Engler included also Azores, and in 1961 the Canadian ecologist Pierre Danserau completed the description with Cape Verde.

These archipelagos have great climatic affinities with the Atlantic coast of the Iberian peninsula and the North-Western African coast, specially from the western Sahara to the Gambia river estuary. The climate is determined by the trade winds, the ocean circulation (Canary Islands current) and its latitude, comprising the mild-humid oceanic climate in Azores and Madeira to the dry tropical climate in Cape Verde.

The actual distribution of the five archipelagos only shows the most recent geological history of the region, the last 27 million years, which is the age of its oldest archipelago the Salvagem. But the geological history of the Macaronesia is the result of more than 60 million years of evolution through the succession of several volcanic archipelagos now disappeared. These archipelagos emerged and grew to reach their maximum high. Then, after the volcanic activity ceased, the erosive processes and subsidence overcame to sink them below the sea level. As a result, besides the emerged archipelagos, other four seamount archipelagos (Palaeo-Canaries, Palaeo-Madeira, Great Meteor and Saharan) are scattered through the region, influencing the oceanography, the biological productivity and the marine biodiversity.



Ocean surface circulation evidences the Canary Current Large Marine Ecosystem.

From the marine perspective, the oceanic eco-region is mainly characterized by the Canary Current Large Marine Ecosystem (CCLME), which is one of the 4 major upwelling systems in the world. The CCLME extends from the Strait of Gibraltar (around 36°N 5°W) to Bissagos Islands in the South of Guinea-Bissau (around 11°N 16°W), embracing the coasts and Economic Exclusive Zones (EEZ) of Morocco, Western Sahara, Mauritania, Senegal, Gambia, Guinea-Bissau, Portugal(Azores and Madeira) and Spain (Canary Islands). Also Cape Verde and Guinea are under the area of influence of the Canary Current, and therefore are considered as part of the CCLME.

On average the CCLME has a primary production of 1.196 mgC m^{-2} d^{-1}, which means 8% of the primary production in the world ocean. Mesoscale features, such as eddies and upwelling filaments, transport cold waters offshore, therefore enlarging the area of influence of the upwelled waters into the ocean. This primary production is the support of many fisheries and also provides food to many cetacean species.

The Canary Islands are considered one of the world's biodiversity hotspots for cetaceans, with 30 species reported so far. The rest of the Macaronesian region has also very high cetacean biodiversity: Madeira 29 species, Azores 27 species and Cape Verde 24 species. The four archipelagos combined host 32 cetacean species, which means 84% of the cetaceans that can be found in the whole North Atlantic Ocean. This extraordinary biodiversity upholds the necessity to establish adequate protection for the cetacean populations, mitigating the threats derived from the human activities on the sea.

Stranded beaked whales in Fuerteventura.
Photo credit: IUSA.

Why the military sonar?

Because it has been linked to mass strandings of beaked whales and also to the death of many other cetacean species.

Over the past 20 years, there has been increasing concern that noise from human activities may affect wildlife. Recent work has explored how the anthropogenic sound affects marine life, including not only marine mammals, but also fish or even zooplankton. Concern ranges from effects such as shipping noise reducing the range over which whales can communicate to injury from intense sound.

These studies suggested that risk of injury from exposure to loud sound sources such as military sonars should be limited to tens of meters. It was therefore surprising when evidence mounted that atypical mass strandings of beaked whales (family Ziphiidae) have coincided with some naval exercises involving mid-frequency active (MFA) sonars, which operate in the 3–8 kHz frequency band. These strandings are the only known cases where exposure to anthropogenic underwater sound has been demonstrated to lead to the death of marine mammals.

Although the link between naval exercises and cetacean strandings had first been documented in the 1970s, the risks military sonar poses to cetaceans didn't receive much international attention until the highly-publicized mass stranding of Cuvier's beaked whales (*Ziphius cavirostris*), Blainville's beaked whales (*Mesoplodon densirostris*), and northern minke whales (*Balaenoptera acutorostrata*) in the Bahamas in 2000. This was the first time that the US Government determined a stranding to be the result of mid-frequency active sonar use.

In 2007, a US government-convened panel published guidelines for the level of noise at which injury occurs to cetaceans. They considered impulsive sound at levels of 230 dB re:1µPa peak pressure was an uppermost "safe" exposure limit for marine mammals, including beaked whales. The 2007 limit has since been adopted by many noise producers and managers as an absolute level at which injury impacts to cetaceans occur (for example, a European Union advisory group used these criteria for their advice on harmful sound levels in EU waters).

But this sound levels are referred to the appearance of direct physical damage on the cetaceans, the fact is that behavioral impacts occur at lower sources levels than noted above. There is a growing consensus that exposure to military sonar may trigger a behavioral reaction in beaked whales that may lead to lethal stranding, and that the behavioral reaction may also lead to injuries related to bubble growth through decompression as the whales alter their dive behavior.

Following the 2000 Bahamas mass stranding it was estimated that these whales were exposed to sound levels no higher than 160–170 dB re:1µPa, which would result in a much larger impact radius around the active sonar source. In a recent study on tagged Cuvier's beaked whales, the animals began to respond at received levels of 89 dB re 1 µPa by ceasing to beat their tail flukes. One animal stopped echolocating, ceased foraging, and swam rapidly away from the source at a received level of 98 dB re 1 µPa.

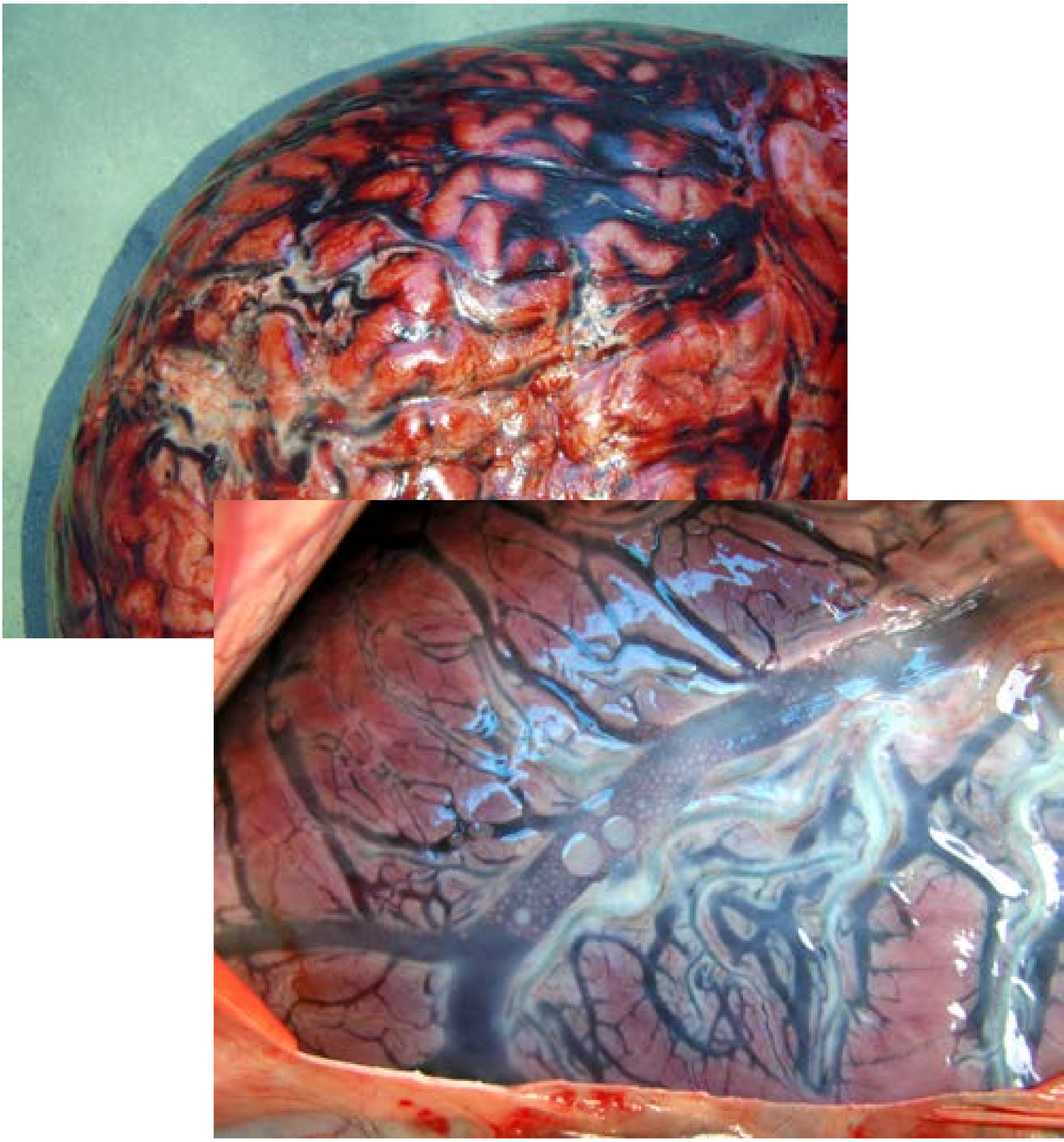
Beaked whale rescued during a naval exercise in Fuerteventura
Photo credit: Cabildo de Fuerteventura

The studies above document behavioral changes in beaked whales at relatively low levels of mid-frequency sonar exposure that can be expected to occur at distances many hundreds of miles from the sonar source. It should be noted, however, that the degree of responses by animals, and the received level of sound at which these responses occur, might be affected by the context in which the sound is received. For example, a mother and calf might be more sensitive than a solitary male; an animal that urgently needs to feed may show less of a behavioral change than one that is relatively well-fed; a young animal that is more vulnerable to predation might react more quickly to an intense noise than a larger adult; a habituated animal might respond at higher received levels than a naive animal; or a chronically stressed animal might responded differently to a non-stressed animal.

The negative effects of the Naval exercises do not seem limited to the beaked whales. Northern minke whales (*Balaenoptera acutorostrata*) had been noted previously to strand during military sonar-related beaked whale mass stranding events. But minke and blue whales may not be the only baleen whales that are vulnerable. Between 1982 and 2007, of 180 gray whale (*Eschrichtius robustus*) standings that occurred in California, 22% coincided in time and location with military exercises.

The following species, other than beaked whales, have stranded coincident with naval exercises: dwarf sperm whales (*Kogia sima*); pygmy sperm whales (*K. breviceps*); short-finned pilot whales (*Globicephala macrorhynchus*); long-finned pilot whales (*G. melas*); pygmy killer whales (*Feresa attenuata*); and several dolphin species (S*tenella attenuata* and *S. coeruleoalba*). Another species that could be added (although not stranding as such), is the melon-headed whale (*Peponocephala electra*), which was recorded entering unusually shallow waters in response to sonar exposure.

Even sperm whales (*Physeter macrocephalus*) have been documented responding to sonar. Avoidance behavior, interruption of foraging and/or resting behavior, and an increase in social sound production in response to 1–2 kHz active sonar has been reported. In recent years, more dolphin species have been found during mass stranding events coincident with naval exercises. In June 2008, a mass stranding of common dolphins (*Delphinus delphis*) was associated with a naval exercise in Falmouth Bay, UK and at least 26 of these animals died. The researchers who evaluated the standing event determined "naval activity to be the most probable cause of the Falmouth Bay [mass stranding event]" . One of the largest dolphin stranding events to date, however, occurred 6–7 March 2009 on Gaddani Beach on the Balochistan coast of Pakistan, 50 km northwest of Karachi, when a mass stranding of 200–250 pan-tropical spotted dolphins (*Stenella attenuata*) occurred on the second day of a multi-national naval exercise. This event was the largest (atypical) mass stranding recorded of this species by an order of magnitude. It seems highly likely that this unusual mass mortality was also caused by naval exercises.



Gas embolism and haemorrhages present in brains from stranded beaked whales
Photo credit: IUSA.

As a consequence, there is a substantive and growing body of corroborating evidence to suggest that a wide range of whale, dolphin and porpoise species can be impacted by sound produced during military activities. The risk active sonar poses is not limited to beaked whales only. In fact, there may be more individuals of non-beaked whale species that have stranded coincident with military exercises than beaked whales. In addition, the level of sound at which impacts can occur is generally lower than previously believed.

The unusual "bubble" lesions discovered in several of the beaked whales that stranded during military exercises near the Canary Islands were similar to those found in cases of decompression sickness. It was subsequently postulated that these whales might have unusually high levels of dissolved nitrogen in their blood and that rapid ascent as a result of behavioral changes triggered by exposure to sonar sounds might cause "bends"-like lesions. The bubble lesions might therefore arise if animals are forced to or near the surface for an extended period, or into very shallow water. In short, the studies suggest that the lesions may result "from an abnormal behavioral response to sonar", possibly as the result of beaked whales exhibiting an "anti-predator" avoidance response when exposed to sonar noise.

The above mentioned evidence, plus the fact that all the 14 cetacean species known to be negatively affected by Naval exercises except one (*Eschrichtius robustus*, which is not distributed in the Atlantic Ocean) are present in the Macaronesia, demonstrate the importance to protect the wild populations of cetaceans in the Macaronesia from the mid-frequency active (MFA) sonar.

European Cetacean Society

Resolution on the need to regulate sonar mitigation
Adopted in Istanbul, Turkey on 4th March 2009

There is sufficient evidence that active sonar exposure even at relatively low levels can have significant impacts on some cetacean species. Beaked whales in particular are vulnerable to serious impacts including mortality from exposure to mid-frequency active sonar (1–10 kHz). Here we reaffirm the ECS 2003 Statement of Concern on Marine Mammals and Sound. The development of knowledge since this ECS 2003 resolution was adopted under-scores the need for urgent action on sonar mitigation.

Current mitigation efforts are generally untested and insufficient for beaked whales. Recently available data includes further evidence on the causal link between sonar and beaked whale mass-strandings. This includes spatio-temporal coincidence between naval exercises and mortalities and a consistent pathology on necropsied whales, pointing to an acoustic source as primary cause of death/stranding.

In addition, abundance estimations of local populations of beaked whales indicate that populations are small and that the reproductive rate of some beaked whales may be low. Small, sometimes isolated, populations with reduced recruitment rate are vulnerable to human impacts as they may have a limited capability to recover after trauma.

This means that there is the potential for unsustainable impacts on beaked whales to occur in relatively short time periods. The advances in our understanding of behavioural reactions of beaked whales to sonar indicate that required mitigation ranges are larger than practical mitigation ranges in many cases.

In consequence, regulation of standardised mitigation protocols, including practical measures recently available, becomes a priority. Mitigation should be applied by all countries using military sonar in the three stages of sonar exercises: before (the planning phase), during and after sonar use. As sonar may have transboundary effects, mitigation procedures need regulatory support at both international and national levels.

Thus, the European Cetacean Society requests competent authorities to urgently adopt and enforce regulations for effective mitigation.

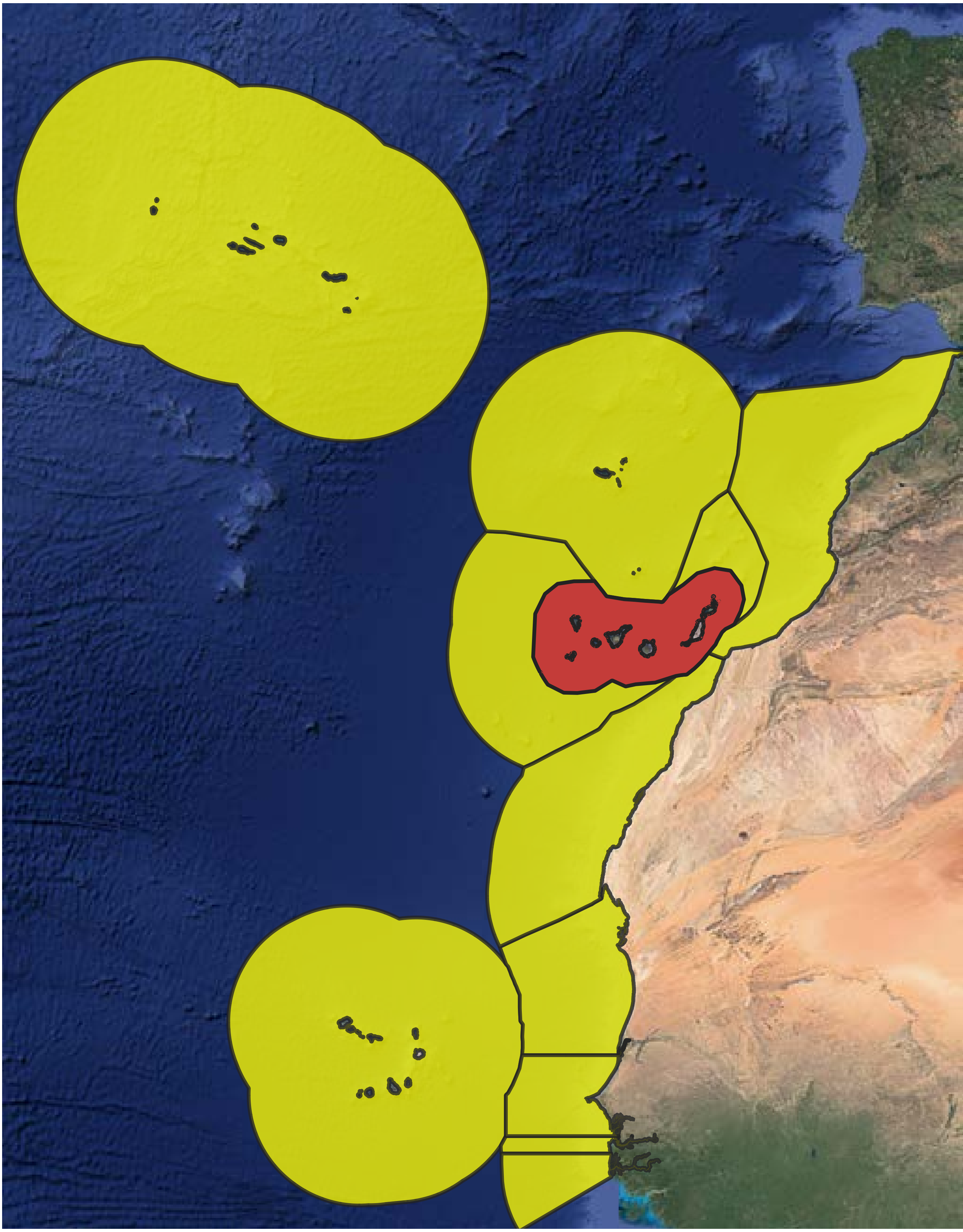
Is there any effective way to protect the cetaceans?

Mitigation measures based on visual observers have revealed to be inefficient, the only effective measure is the establishment of a moratorium in the use of the sonar in the most critical areas.

Recent reviews of mitigation measures to minimize impacts of high intensity sound sources, for both seismic surveys conducted during oil and gas development and military activities, have been critical of the standard methods (which tend to rely on visual observers) as being inadequate, concluding that they cannot prevent cetaceans from being affected by sound. An effective method to protect the cetaceans from the behavioural changes triggered by exposure to sonar sounds would reduce the appearance of the unusual "bubble" lesions described in beaked whales.

In September 2002, fourteen beaked whales from three different species stranded in the Canary Islands during an anti-submarine warfare exercise in the area. In July 2004, at least four beaked whales died after an international naval exercise. Four other mass strandings, all associated with naval activity, struck the islands in the years before. This situation motivated a non-binding resolution of the European Parliament in 2004 (B6-0089/2004), calling its Member States to adopt a moratorium on the deployment of high-intensity active naval sonars until a global assessment of their cumulative environmental impact on marine mammals, fish and other marine life was completed. The same resolution also recommended the Member States to immediately restrict the use of high-intensity active naval sonars in waters falling under their jurisdiction.

Following this recommendation, the Spanish government passed a moratorium on naval sonar in the Canary Islands in November 2004, banning its use within 50 nautical miles of its jurisdictional waters. During the 14 years that have passed since the moratorium was put in place, there have been no atypical mass strandings in the Canary Islands, probing its effectiveness as a mitigation measure.



Macaronesian region showing in yellow the Economic Exclusive Zones (EEZs) and in red the current MFA military sonar moratorium area.

What is next?

In order to protect one of the most important areas for the cetaceans in the North Atlantic, all the countries and regions of the Macaronesia must be encouraged to adopt the mid-frequency active (MFA) sonar moratorium on their EEZs in order to extend the positive effects that the moratorium had on the cetacean populations of the Canary Islands.

Madeira and Azores and the Canary Islands, as EU territories are directly concerned by the B6-0089/2004 resolution of the European Parliament and their willingness to set up a MFA sonar moratorium in their EZZs would mean the protection of over 40% of the Macaronesian Region.

Expanding the MFA sonar moratorium to all the rest of the countries in the region would mean an effective protection of over 3,5 Million square kilometres, which represents 85% of this biodiversity hotspot for cetaceans.

Region	EEZ (Km^2)	Current MFA sonar moratorium (Km^2)
Azores	959.784	
Canary Islands	446.558	200.000
Cape Verde	804.694	
Gambia	23.184	
Madeira	453.008	
Mauritania	173.728	
Morocco (Atlantic)	233.836	
Senegal	158.936	
Western-Sahara	284.730	
TOTAL	**3.538.458**	**200.000**

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