THE DEATH OF CETACEANS THROUGH THE USE OF LFA SONAR IN NAVAL MILITARY MANOEUVRES

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Introduction

The appearance this summer of several cetaceans stranded on the coasts of the Canary Islands and the Azores while naval manoeuvres were being carried out has reopened the debate on the impact on cetaceans from the use of sonar and other acoustic pollution arising from these exercises.

This is not the first time this has happened in the Canary Islands, nor is this the only region in the world where the death of cetaceans has coincided with warship manoeuvres.

Despite the fact that the navies involved have repeatedly tried to deny their responsibility in these events, the fact is that both NATO and the US Navy have been aware of the cause of these deaths for years.

What is LFAS?

LFAS, or SURTASS LFAS, is the acronym for the high-precision SONAR system known as Surveillance Towed Array Sonar System, Low Frequency Active Sonar.

It is based on the use of high intensity sound waves (over 200 dB[i]) at low frequency (between 450 and 700 Hz[ii]) that can travel great distances underwater and detect objects hundreds of kilometres away[1]. Dozens of them are emitted in a matter of seconds (up to 250 within 4-5 seconds) and they hit objects and rebound to a receiver that interprets them and allows the object in question to be visualised. Sonar can also be used for a minute or more at a time at intervals of 10-15 minutes. This sound transmitter is suspended from the ship at a depth of around 50 metres.

However, it is known that NATO is continuing to experiment with systems at even lower frequency (50-150 Hz) and at a range of 230 dB, which would allow them greater reach and precision[2]. Mid-frequency sonar is also being used, sometimes in combination with LFAS, with similar harmful effects. For this reason, both mid and low frequency sonar have been appointed as the cause for cetacean strandings. But the potential impact of LFAS is higher due to its range, and that lower frequencies can interact with whales' sounds.

Sound travels 4.5 times faster in water than in air and the lower the frequency (Hz) the further it can travel (hundreds of kilometres). In addition, the intensity (dB) is more consistent. Frequencies below 1 kHz lose barely 0.04 dB per kilometre.

[i] dB = decibel, the measuring unit that defines the intensity of a sound wave. Loud fire alarms reach 105 dB.

[ii] Hz = Hertz, the measuring unit that defines the frequency or the number of cycles that a sound wave completes in one second.

What is it used for and what are NATO's plans?

The aim of this sonar system on warships is to be able to locate submarines with absolute precision (both nuclear and diesel-powered), including the most silent models and even with their engines switched off[3].

The objective of NATO, and particularly the US Navy, is to implement this system in their ships in order to cover 75%-80% of the world's oceans[4] which will have the result of acoustically polluting this vast tract of seawater. It is believed that with just a few ships positioned at strategic locations around the world, this whole area could be covered. This would thus replace the existing hydrophone system developed during the 1980s to trace the movements of Soviet submarines.

In the first year of implementation, the intention is to cover some 14 million square kilometres with LFA sonar.

Effects of LFAS on cetaceans

LFAS can have an effect on cetaceans at a distance of up to 100 kilometres. The resonance of the sonar causes vibrations in every cavity of their bodies: the windpipe, the jaws, cranial spaces (chests) and internal organs, with a greater impact on those that contain air[5]. They can give rise to haemorrhages of the lungs and ears and even destroy them.

Despite the continued denials and declarations from the US Navy, the US Government has known for years that mid-frequency sonar and LFAS cause very serious damage to living organisms, particularly those that are most sensitive to acoustic disturbances.

In 1997, the Marine Mammal Commission of the US Congress presented a report[6] which acknowledged the impact of LFAS. Amongst its conclusions were statements such as the effects of LFAS included "death by lung haemorrhage and other tissue trauma; total or partial loss of hearing; disruption of feeding, breeding habits and acoustic and sensory communication, and other vital behavioural changes"; it also stated that if these effects were severe or continuous they could lead to decreases in survival and productivity, with the consequent danger for the reproduction and survival of the species and the size of their populations.

It also made reference to the disturbances that this type of acoustic pollution can cause in terms of changes to migratory routes, by avoiding traditional feeding and breeding grounds and other important habitats, as well as psychological damage and stress, making the animals more vulnerable to diseases such as viral, bacterial or parasitical attack. In short, it effects their distribution, their number and their survival.

An Environmental Impact Study carried out by the US Navy[7], as a result of accusations from numerous social collectives in manifesting their concerns about naval manoeuvres, showed that beaked whales "could be affected by these operations".

More recently, in 2001, one year after the loss of life in the Bahamas, the National Marine Fisheries Service (NMFS) and officials from the US Navy announced that, based on autopsies and other evidence from the beached animals, it was "highly probable" that this was due to sonar transmissions by the navy[8].

Where has this system been tested?

NATO has also carried out exercises of this kind in the waters of the Bahamas, the Azores and the Mediterranean[9]. For example, thanks to the declassification of secret NATO documents, we have been able to ascertain that between 1981 and 1996[10], warships carried out at least 11 experiments of this kind in the Mediterranean. And more recently, in the Ligurian Sea (which has been declared a Cetacean Sanctuary), five of these tests were carried out between 1999 and 2002[11] in experiments on the effects of this sonar on sperm whales and other cetaceans.

For many years now, NATO has shown a particular interest in understanding the endurance and resistance of cetaceans to sound waves, as well as having undertaken studies on the echolocation systems of cetaceans, especially beaked whales[12], as demonstrated by various declassified NATO reports. Curiously, it is highly likely that the results of these studies served to develop the LFA sonar that is now killing these cetaceans.

Some scientists have actually managed to detect the use of these sound waves in the course of their work, as was the case of some cetacean researchers in the Ligurian Sea who, while studying a group of long-finned pilot whales *(Globicephala melas)*[13]; detected a military sonar which disturbed the sleep of the crew on board the research vessel for a month; they could not pinpoint its origin, though they estimated it at 15 miles from their location. The sounds consisted of regular transmissions repeated every 41 seconds at about 4 kHz.

The US Navy has also carried out studies of this kind just off its own coasts, both in the Pacific (Hawaii and California) and the Atlantic (around the Bahamas).

Between 1996 and 1998, the navy tested their LFA sonar on the whales of Hawaii. Evidence showed that the cetaceans modified their migrations and movements, disappearing from the area and, in the case of humpback whales, they stopped singing. In the experiments carried out in Hawaii, 140 decibels were sufficient to make the whales abandon the area; although some researchers believe that more than 120 dB is enough to damage the health of these animals. According to the US Navy's own studies, LFA sonar can

generate sound waves of 140 decibels capable of travelling more than 300 miles[14].

In the case of humpback whales *(Megaptera novaeangliae)*[15] disturbances in their sexual behaviour has been noted at sound waves of 150 dB[16]; this same intensity can cause gray whales *(Eschrichtius robustus)*[17] to change their migratory routes, and finback whales *(Balaenoptera physalus)*, blue whales *(Balaenoptera musculus)*[18] and sperm whales *(Physeter macrocephalus)*[19] to change their feeding grounds or stop communicating[20]. But the resistance of cetaceans to sound waves can be very different depending on the species[21]. For example, it has been proved that beluga whales *(Delphinapterus leucas)* try to get away from focus of acoustic pollution even when this is 50 kilometres away from them[22].

In 1997, another experimental sonar trial took place off the coast of California close to the island of San José, ending up with the stranding of three whales and a sperm whale. According to scientists in the area, the sound waves from this experiment could be recorded along the whole length of the Californian coast[23].

In the Bahamas, a test known as Littoral Warfare Advanced Development (LWAD) ended up, in its first few hours, with the stranding of various beaked whales *(Ziphius cavirostris, Mesoplodon densirostris)* and subsequently even minke and rorqual whales *(Balaenoptera acutorostrata and Balaenoptera sp.)* and Atlantic spotted dolphins*(Stenella frontalis)*[24].

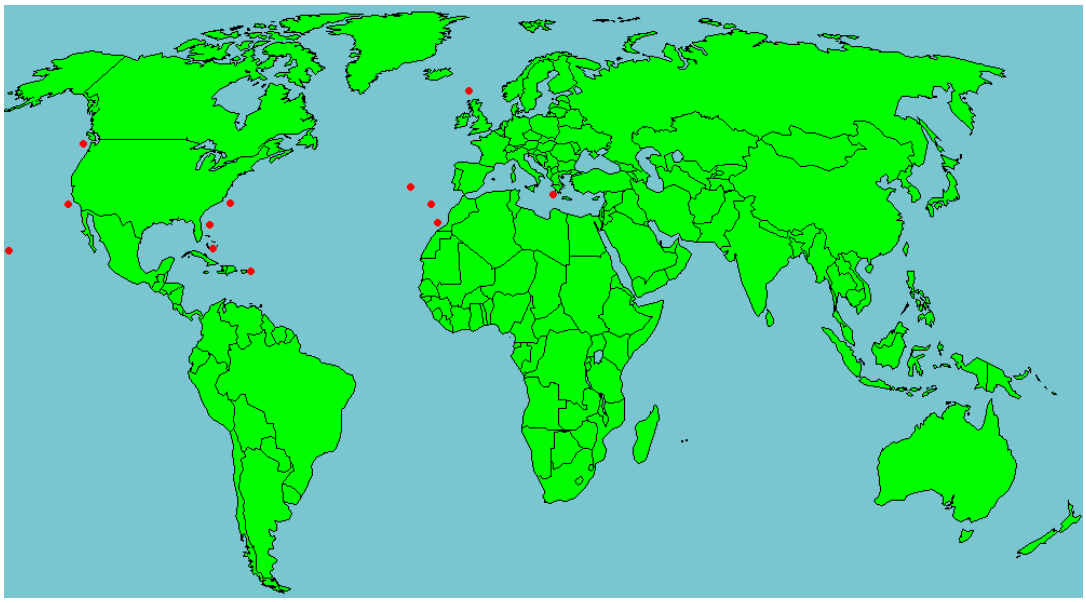
It is believed that these experiments are also taking place in the Caribbean, where various beaked whale strandings have occurred, without any further investigation, and in northern Europe, specifically around north-east Scotland and the Hebrides[25], which, along with the east of Lanzarote, is one of the most important habitats for the beaked whale in the North Atlantic. Military manoeuvres in this zone have been classified by various scientists as a serious threat to cetaceans[26].

Coinciding with the presence of six NATO warships in the zone in 2000, a dead whale appeared on the Scottish coast. They may also have been related with eight beached cetaceans whose autopsies showed damage data very similar to the dead beaked whales found in the Canary Islands during the 2002 manoeuvres. And this could also be the reason behind the scarcity of cetaceans while the naval exercises were being carried out, a fact that coincides with observations made in many places where these kinds of manoeuvres have taken place.

Given the ambitious plans of NATO and the US Navy, we cannot rule out the possibility that many more zones have been used for these kinds of tests and that at least some of the strandings for which no explanation has been found can be traced back to these experiments.

Stranding of cetaceans following naval military manoeuvres

	1985-1989					1990-1999					2000-204				
	85	86	87	88	89	91	96	97	98	99	00	01	02	03	04
Azores															X
Bahamas											X				
California							X	X		X			X		
Canary Is.	X	X		X	X	X							X		X
US Atlantic			X						X		X	X			
Greece							X								
Hawaii									X						
Hebrides											X				
Virgin Is.									X	X					
Madeira											X				
Vieques									X				X		
Washington														X	



Species affected

The majority of animals that found stranded on beaches, victims of NATO's naval manoeuvres, tend to be cetaceans from the beaked or bottlenose families of the *Ziphius* and *Mesoplodon* genus. These animals tend to measure between 4 and 12 metres long (i.e., they are medium-sized cetaceans, between dolphins and large whales).

The most common species found in these strandings are Cuvier's beaked whale *(Ziphius cavirostris)*, Gervais' beaked whale *(Mesoplodon europaeus)* and Blainville's beaked whale *(Mesoplodon densirostris)*, although other beaked whales such as True's beaked whale *(Mesoplodon mirus)*, Sowerby's beaked whale *(Mesoplodon bidens)* and even the northern bottlenose whale *(Hyperodon ampullatus)* have also been found beached.

Other species that have also suffered damage as a result of these manoeuvres are the Atlantic northern right whale *(Eubalaena glacialis)*, humpback whales *(Megaptera novaeagliae)*, common rorquals *(Balaenoptera physalus),* minke whales *(Balaenoptera acutorostrata)*, sperm whales *(Physeter macrocephalus)* and other, lesser-sized, creatures such as the Atlantic spotted dolphin *(Stenella frontalis)*, the pygmy sperm whale *(Kogia breviceps)*, or the common porpoise *(Phocoena phocoena)*[27]. It cannot be ruled out that many other cetaceans may also have been affected by LFA sonar, as well as a multitude of marine organisms that do not tend to wash up on the shore after their death[28]. Laboratory experiments have demonstrated that 57% of trout exposed to sound waves at 170 dB died.

In the case of the Cuvier's beaked whale *(Ziphius cavirostris)*, it was proved that the use of sonar with a wavelength of 290 Hz at a distance of just 500 metres caused vertigo and disorientation in the animal, while the LFA sonar used regularly in NATO's military naval manoeuvres tend to use an intensity twice as high. It has also been proved that sounds of just 150 dB are enough to seriously damage a cetacean, while the LFA sonar exceeds 200 dB.

It is believed that for every 10 points that the decibel scale increases, the intensity of sound is multiplied tenfold. The US Navy is aware of the impact of its experiments on marine life thanks to numerous studies[29] and recognises that frequencies above 180 decibels have potentially damaging effects on cetaceans[30]. The LFA sonar tends to use frequencies of 220 decibels (i.e., 10,000 times higher than those regarded as dangerous to cetaceans) but can reach as high as 240 dB[31], or what would be the same as an intensity 10 million times higher than the decibels necessary to cause serious damage[32] and 10 billion times higher than those that cause disturbances.

Effects on humans

It is believed that these experiments may also have resulted in human victims. In Hawaii, a diver who was snorkelling while an LFAS experiment was going on in 1998 had to be hospitalised with acute trauma symptoms. Another diver also had to be treated in 1999 during the course of one of these tests. Earlier, also in Hawaii, a professional diver was accidentally exposed to LFA sonar from a warship 100 miles away (166 kilometres), causing disorientation and vibrations in the lungs[33]. Scientists have concluded that diving close to zones where these experiments are being carried out could put the diver at serious risk[34]. Experiments carried out by the US Navy on its own divers were able to corroborate the effect of sonar, resulting in the hospitalisation of some of the people affected.

According to experiments carried out on its own personnel, the US Navy concluded that many divers subjected to frequencies of 140-148 decibels suffer from a strong aversion to sound. A level of 157 decibels would cause at least 20% of divers to leave the water. And at 160 decibels, the effects on the lungs could cause "a considerable reduction in the vestibular function". We should add to this the fact that the human ear cannot stand sounds above 160 dB, that

short exposures to 140 dB can result in death, and that remaining in a place where 120 dB are being emitted for more than seven minutes can cause serious and permanent damage to hearing.

Some important events

In May 1996, 12 Cuvier's beaked whales beached themselves on the Greek coast of the Gulf of Kyparissiakos following military manoeuvres in that part of the Mediterranean. One whale had died from the shock waves that its body had been subjected to, despite being 25 kilometres away from the LFA sonar (at 150 dB). NATO had been experimenting with sonar that generated sound to an intensity of 230 dB in frequencies that ranged between 250 Hz and 3 kHz[35]. The investigator[36] of these deaths concluded that the possibility of the deaths being attributable to causes other than the military manoeuvres was 0.07%, and that death had been caused by acoustic disturbance.

In June 2000, the stranding of 16 cetaceans from four different species (nine of which died) across a perimeter of 200 km in the Bahamas took place after six US Navy ships used sonar at medium frequency (2.8-3.5 kHz and 235 dB). Following the autopsies, it was corroborated that all the animals had suffered haemorrhages in their inner ears and some of them also had eye haemorrhages. The investigators[37] concluded that this damage was due to the sonar used during the manoeuvres.

In 2002, in the Canary Islands, at least 27 whales from three different species (of which 14 died) appeared stranded on the beaches of Fuerteventura following NATO naval manoeuvres. Studies[38] highlighted the fact that the cetaceans had suffered injuries similar to a powerful decompression process, like that experienced by some divers, which causes the air to expand suddenly, compressing the body, introducing air bubbles into the bloodstream and producing an embolism. These injuries were very similar to those discovered by British investigators in various cetaceans that have been found dead on their coasts in the last few years[39]. Previously, between 1985 and 1991, the Canary Islands had already been witness to episodes similar to this one[40].

Also in September 2002, various beaked whales and a dolphin were found dead on the coast of the Gulf of California in the vicinity of the island of San José after the R/V *Maurice Ewing* had passed through, having carried out experiments with sonar at 220 dB[41].

The reason behind other mass strandings is unknown, though they could well be due to these kinds of activities, such as the case of the sperm whales throughout the North Sea in the 1990s[42]; the appearance of dozens of cetaceans from numerous species between Madeira, the Canaries and the Azores in 1998; the frequent strandings of such social creatures as pilot whales and false killer whales in Australian waters and the incident in July 2002 on the coast of Massachusetts with the beaching of some 50 creatures[43].

In some of the cases of massive strandings of cetaceans, the reason has been attributed to persecution by predators or injury to the dominant male and there are even theories on disturbances in the magnetic field that guides these animals on their transoceanic travels. But in many other cases, the reasons are unknown.

Recently, in 2003, another stranding incident took place on the coast of the state of Washington, when a dozen porpoises *(Phocoena phocoena)* ran aground on the coast, coinciding with the manoeuvres of a warship. Preliminary analyses[44] do not seem to be able to find a relationship between the incident and the presence of the warship, although this possibility is not being ruled out, given that during the presence of the ship in state waters, many researchers reported abnormal behaviour in the cetaceans in this zone, such as killer whales and porpoises.

Other effects of naval manoeuvres on cetaceans

It is not just sonar that can seriously affect or kill cetaceans; other sounds emitted during military manoeuvres can also have a serious impact on them[45]. For example, communications between submarines tend to use high frequencies of 5-11 kHz but at a high intensity (180-200 db); shots from the batteries of naval warships can exceed 270 dB. Likewise, explosions can cause the death of numerous cetaceans, which was confirmed during wars that involved the use of torpedoes[46]. Not to mention the use of sonar to detect mines, or just the acoustic pollution from regular maritime traffic.

Why the Canary Islands?

Given the number of incidents that have occurred and the number and diversity of species affected, it is evident that the Canary Islands has been the most greatly affected area in the world in terms of these events.

As indicated by the various investigators, the eastern zone of the Canary Islands, between Fuerteventura and Morocco, seems to be a particularly important feeding zone for these species of beaked whale. The volcanic configuration of the Canary Islands means that a feature of this part of the Atlantic are areas that plunge very quickly from emerging land to vast ocean depths of more than 3,000 metres. This zone is home to channels and canyons that could potentially be used by “enemy” submarines. These characteristics are shared with another European area which is also extremely important for beaked whales and where voices have also been raised to denounce NATO’s naval exercises - the Hebrides.

Is it possible that NATO wants to test the effectiveness of its LFA sonar in deep-sea channels and canyons?
Is it believed that the waters of the Canary Islands form a channel that makes the military defences of NATO countries more vulnerable?

It would be expedient for the various NATO navies to abandon their ambitious project, which will turn the oceans of the world in to a dead sea through acoustic pollution, and seek other sonar systems that do not cause damage to cetaceans (such as passive sonars), and for them to make public all the reports on the zones in which they have been experimenting with this system and the effects it has caused. For example, in the Mediterranean, where the declassification of secret documents has allowed us to discover that this sea has been extensively used for these ends, there are areas of high ecological value and enormous importance to beaked whales, such as the Genoa Canyon and the Almeria Canyon, which could be seriously threatened by these sonar systems.

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