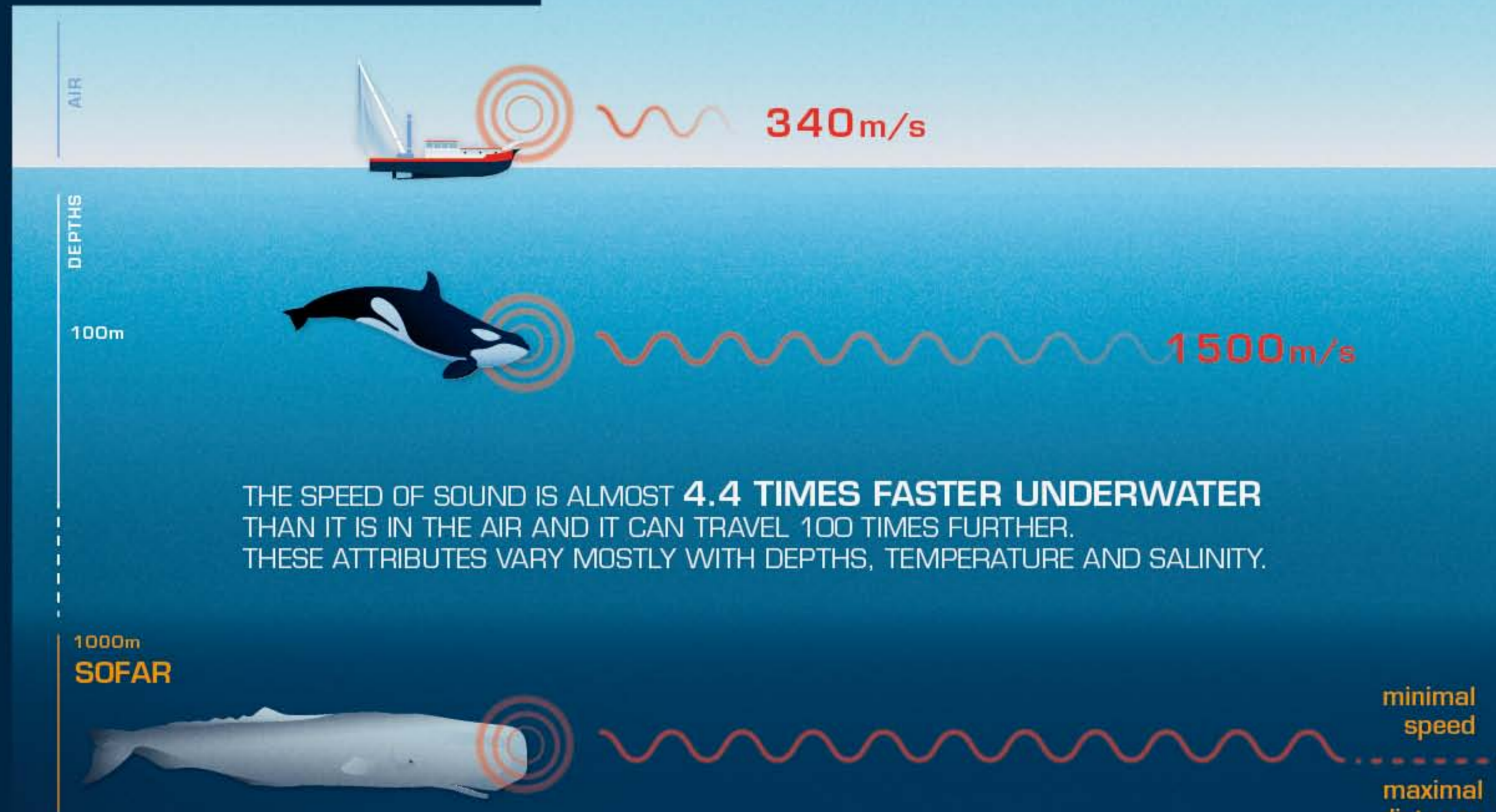


DIVERSITY OF NATURAL SOUNDS IN THE OCEAN

DIVERSITY OF UNDERWATER SOUNDS



Sounds travels at an average speed of 1500 meters per second (m/s) in seawater and only 340 m/s in air. However, in seawater each 1° C rise increases sound speed by 4.5m/s, a rise by one unit of salinity increases it by 1.3 m/s, and at a depth of 1000 m speed increases by 16 m/s. At this depth, there is a layer of water called SOFAR (Sonar Fixing and Ranging Channel) in which the speed of propagation is minimal. However, it channels sound waves in the same way optic fibre channels light and some whales use it to communicate over large distances that reach thousands of kilometres. Studies suggest that in an acidified Ocean, sound must travel twice as far to lose its intensity, especially for low frequency sounds. The impacts of climate change – increases in temperature, salinity and acidity – may therefore change the way sound spreads in the Ocean.



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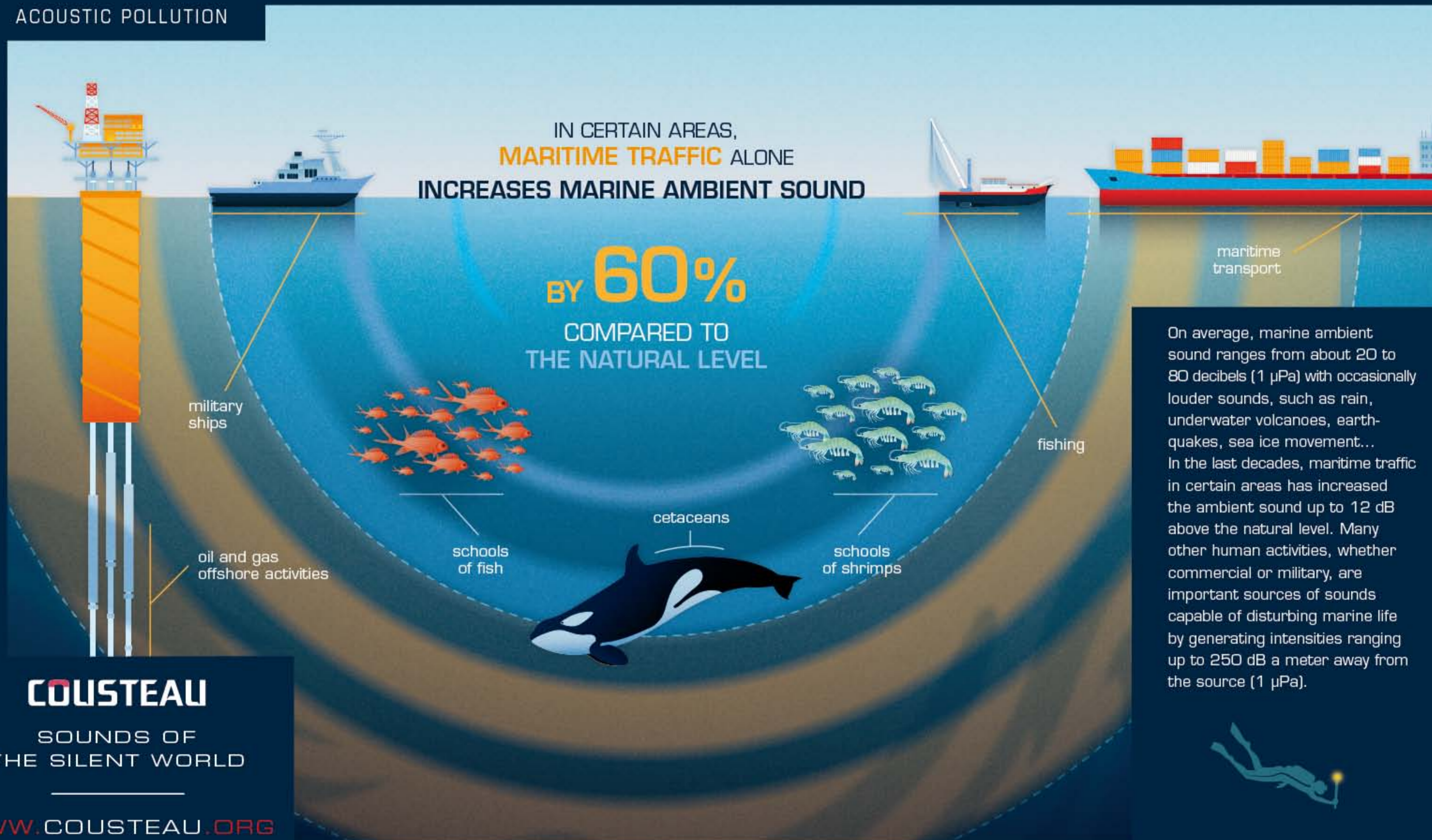
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ACOUSTIC POLLUTION



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SOUND FOR CETACEANS

DOLPHINS' HEARING RANGE IS
7 TIMES GREATER
THAN THE HUMAN ONE, AND ESPECIALLY
SENSITIVE TO HIGH FREQUENCIES



Sound waves

Echos



The human hearing range lies between 20 Hz and 20 KHz. That of the common bottlenose dolphin (*Tursiops truncatus*) ranges between 10 KHz and 150 KHz. Due to the superior diffusion of sound underwater compared to light, for many marine species sound is more important than sight for both communication and the perception of their surroundings. Over the past 70 million years, the evolution of cetaceans has led them to develop subtle and complex systems of detection and communication, which can be greatly affected by anthropogenic noise pollution. To the sensitive ears of the killer whale (*Orcinus orca*), any sound superior to 135 dB is painful: the sounds emitted by airguns during seismic prospecting range around 240 dB. Severe biological and behavioral impacts have also been observed on Cetaceans.



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SOUND FOR OTHER MARINE SPECIES

SEAHORSES PRODUCE CLICKS DURING THEIR COURTSHIP PROCESS,
WHICH AVERAGE 100 DB AND 350 HZ BY RUBBING BONES IN THEIR SKULL TOGETHER.



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WHEN FACED WITH A THREAT,
THE SOUNDS THEY PRODUCE ARE

THREE TIMES LOUDER!

Seahorses vibrate to produce a "growl" at 115 dB and 115 Hz, which corresponds to a threefold increase in loudness ! This serves to stun their predator enough to allow them to escape the danger. The production and perception of sound plays an essential role in the life of numerous marine animal species, and is a determining factor in their capacity to orient themselves, feed, reproduce and escape predators. There are over 800 known species of fish that are capable of producing sounds. Fish can produce sounds by vocalisation to attract a mate, or to deter a predator or a competitor. Other sounds are produced involuntarily while swimming, by drumming muscles on the swim bladder, by rubbing parts of their bodies together or by changing the speed and direction of their swimming.



IMPACTS OF ACOUSTIC POLLUTION ON MARINE LIFE

MARINE MAMMALS

IN SOME COASTAL WATERS,
ACOUSTIC POLLUTION DECREASES THE DISTANCE OVER
WHICH WHALES CAN HEAR ONE ANOTHER...

...BY **85%**



Several species of whales have adjusted their communication calls, suggesting they are "raising their voices" in order to be heard. There remains some uncertainty over the effects of noise exposure on marine animals, but a growing literature of scientific studies establishes that man-made sounds may injure marine mammals, disrupting their behaviour. A joint report of NOAA and the US Navy (2001) first established that sonars used by the Navy's ships were the most plausible cause of the beaching of 16 whales in the Bahamas in March 2000.

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Sources : Bioacoustic Research Program, Cornell University. USA.
IFAW Report (2008). Ocean Noise : Turn it down.
NOAA & US Navy (2001). Joint Interim Report Bahamas Marine Mammal Stranding Event of 15-16 March 2000.



IMPACTS OF ACOUSTIC POLLUTION ON MARINE LIFE

INVERTEBRATES

EXPOSING SEA HARES TO SHIP NOISE SIMULATIONS...

...INCREASES MORTALITY
OF EMBRYOS BY

21%

...AND OF LARVAE
BY

22%

Exposure of the sea hare (*Navanax inermis*) to intense noise causes injury and death, even at low levels. This effect is also witnessed in other vulnerable species. This stress, in early development stages, has a strong influence on population dynamics, leading to detrimental consequences for the animals' immune systems and reproductive success.

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IMPACTS OF ACOUSTIC POLLUTION ON MARINE LIFE

FISH

FOR THE AMDON DAMSELFISH,
THE STRESS GENERATED BY SHIP MOTOR NOISE...



Noise in the marine environment has the potential to impact fish demography. Stress generated by noise has a direct impact on the survival rate of prey fish species, by affecting their behavioural response and physiology. Ambon damselfish (*Pomacentrus amboinensis*), when stressed by motorboat noise, responded less often and less rapidly to simulated predatory strikes.

...**DOUBLES** THE LIKELINESS OF
BEING CAPTURED BY A PREDATOR

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