DIVERSITY OF NATURAL SOUNDS IN THE OCEAN

DIVERSITY OF UNDERWATER SOUNDS

AIR

DEPTHS

100m

340m/s

1500m/s

THE SPEED OF SOUND IS ALMOST **4.4 TIMES FASTER UNDERWATER**
THAN IT IS IN THE AIR AND IT CAN TRAVEL 100 TIMES FURTHER.
THESE ATTRIBUTES VARY MOSTLY WITH DEPTHS, TEMPERATURE AND SALINITY.

1000m

SOFAR

minimal speed

maximal distance

COUSTEAU

SOUNDS OF
THE SILENT WORLD

WWW.COUSTEAU.ORG

CUSTODIAN OF THE SEAS
SINCE 1943

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.

Source : Discovery of Sounds in the Sea (D.O.S.I.T.S): http://www.dosits.org/science/soundsinthesea/commonsounds

DIVERSITY OF NATURAL SOUNDS IN THE OCEAN

ACOUSTIC POLLUTION

IN CERTAIN AREAS,
MARITIME TRAFFIC ALONE
INCREASES MARINE AMBIENT SOUND

BY 60%
COMPARED TO
THE NATURAL LEVEL

maritime transport

military ships

fishing

schools of fish

cetaceans

schools of shrimps

oil and gas offshore activities

On average, marine ambient sound ranges from about 20 to 80 decibels (1 µPa) with occasionally louder sounds, such as rain, underwater volcanoes, earthquakes, sea ice movement...
In the last decades, maritime traffic in certain areas has increased the ambient sound up to 12 dB above the natural level. Many other human activities, whether commercial or military, are important sources of sounds capable of disturbing marine life by generating intensities ranging up to 250 dB a meter away from the source (1 µPa).

COUSTEAU
SOUNDS OF
THE SILENT WORLD

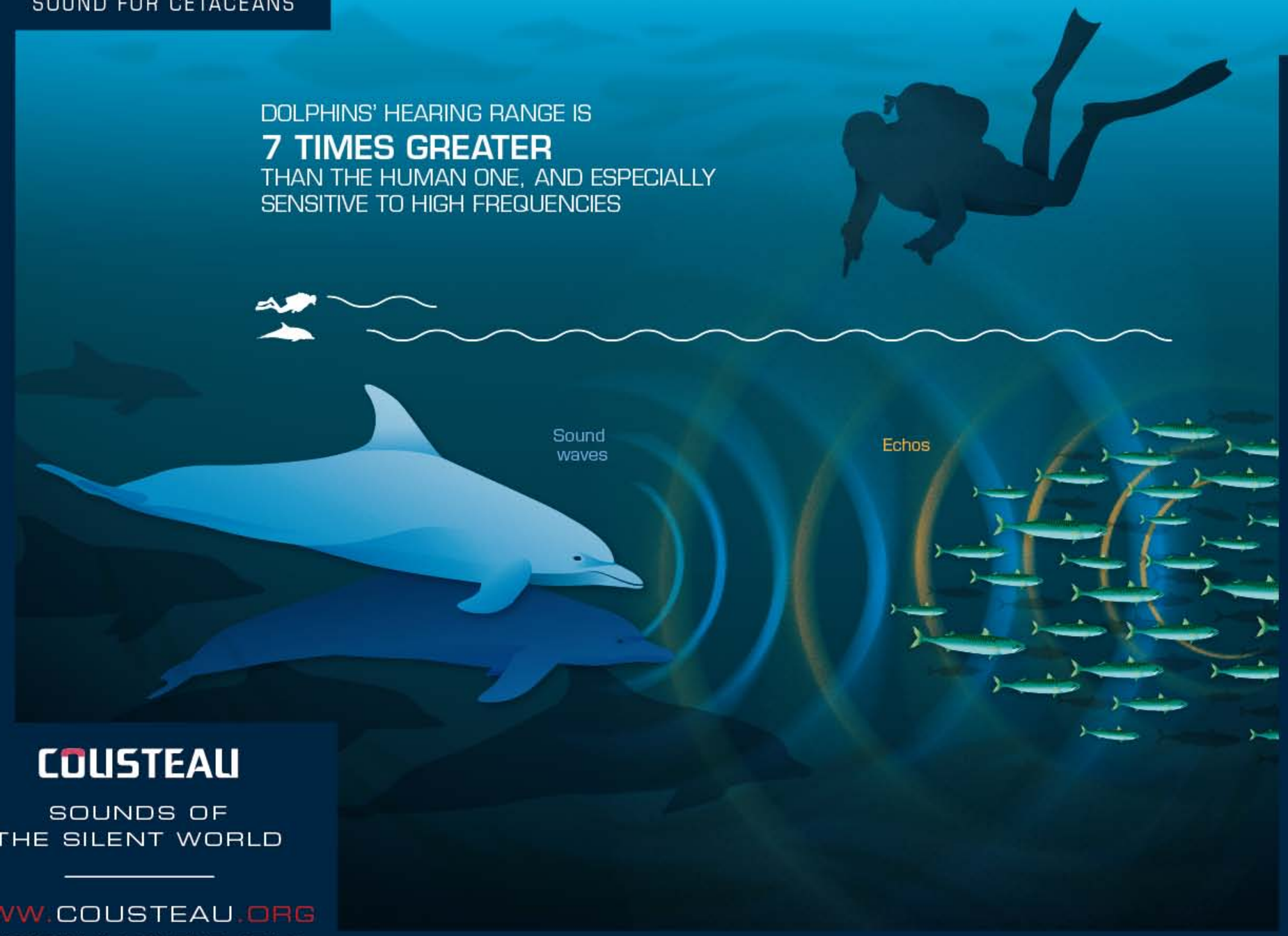
WWW.COUSTEAU.ORG
CUSTODIAN OF THE SEAS
SINCE 1943

Source : Chao Peng et al (2015). Noise in the sea and its impacts on marine organisms, Int. J. Environ. Res. Hildebrand (2009). Anthropogenic and natural sources of ambient noise in the ocean. Marine Ecology Progress Series, vol 395.

DIVERSITY OF NATURAL SOUNDS IN THE OCEAN

SOUND FOR CETACEANS

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



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.

COUSTEAU

SOUNDS OF
THE SILENT WORLD

WWW.COUSTEAU.ORG

CUSTODIAN OF THE SEAS
SINCE 1943

Source : Fabre Julie (2014). La communication accoustique chez le dauphin et l'impact de la pollution sonore. Thèse de Doctorat Vétérinaire, Faculté de Médecine de Créteil. IFAW Report (2008). Ocean Noise : Turn it down.

DIVERSITY OF NATURAL SOUNDS IN THE OCEAN

SOUND FOR OTHER MARINE SPECIES

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 à 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.

COUSTEAU

SOUNDS OF
THE SILENT WORLD

WWW.COUSTEAU.ORG

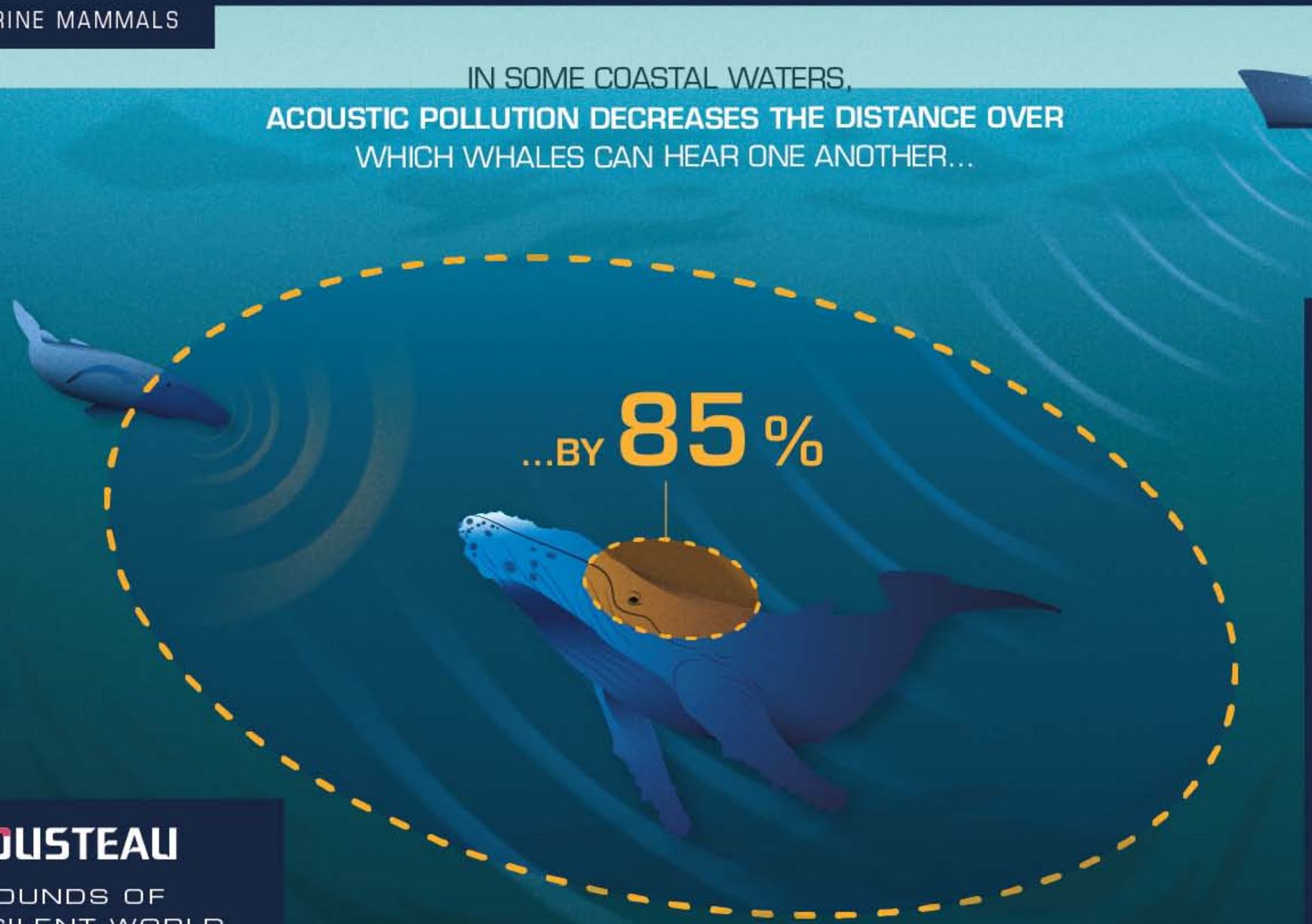
CUSTODIAN OF THE SEAS
SINCE 1943

Source : Anderson (2009). The functions of sound production in the lined seahorse, *Hippocampus erectus*, and effects of loud ambient noise on its behavior and physiology in captive environments", Dissertation Abstracts International, Volume: 73. Oliveira et al. (2014). Sounds produced by the longsnout seahorse: a study of their structure and functions." Journal of Zoology 294.

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...



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.

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.

COUSTEAU

SOUNDS OF
THE SILENT WORLD

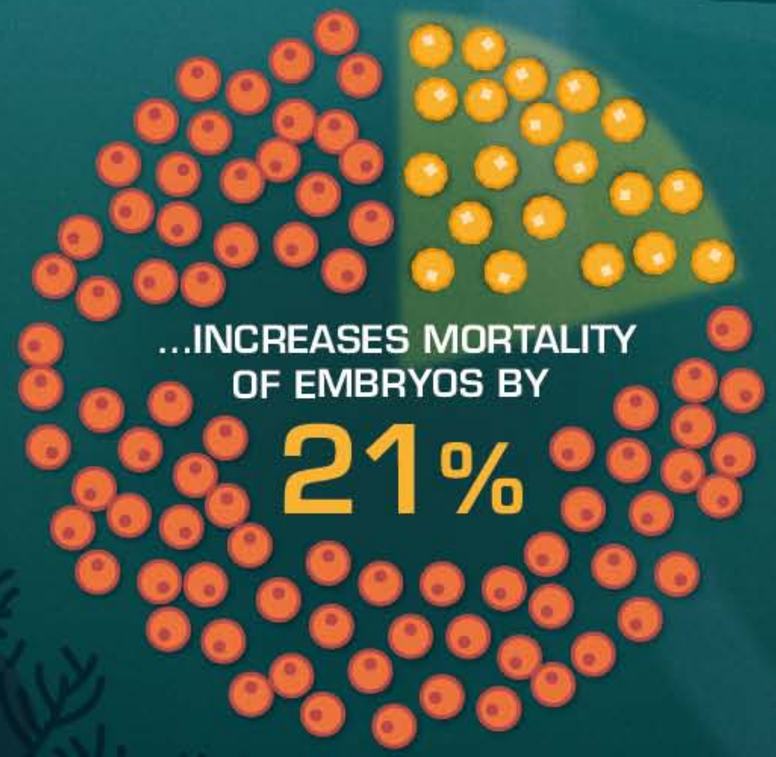
WWW.COUSTEAU.ORG

CUSTODIAN OF THE SEAS
SINCE 1943

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.

COUSTEAU

SOUNDS OF THE SILENT WORLD

WWW.COUSTEAU.ORG

CUSTODIAN OF THE SEAS SINCE 1943

Source : Nedelec et al (2014). Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate. Scientific Reports. 4 : 5891.

IMPACTS OF ACOUSTIC POLLUTION ON MARINE LIFE

FISH

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

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

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.

Source : Simpson et al (2016). Anthropogenic noise increases fish mortality by predation. Nat Commun.

COUSTEAU

SOUNDS OF
THE SILENT WORLD

WWW.COUSTEAU.ORG

CUSTODIAN OF THE SEAS
SINCE 1943