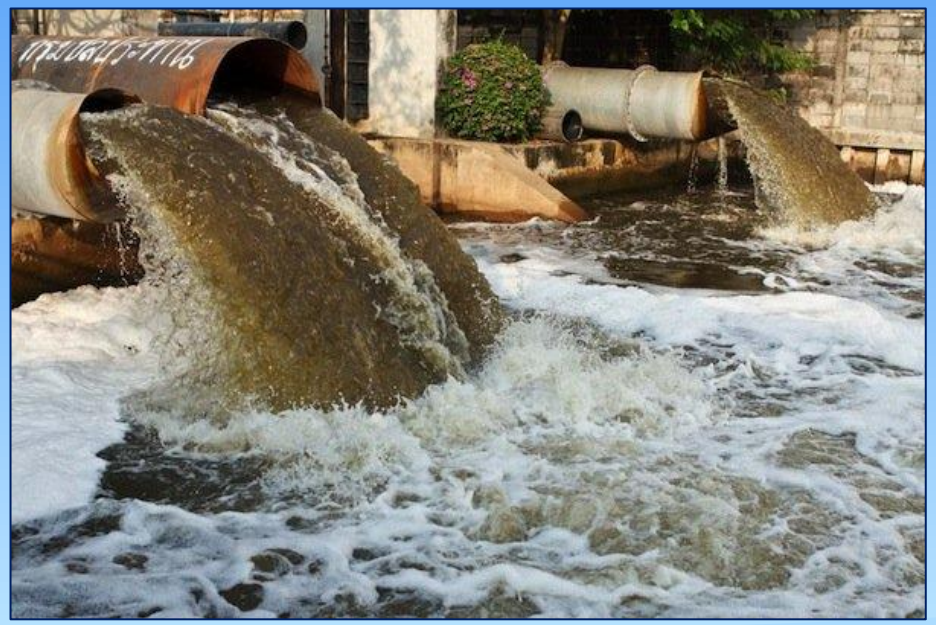
MARINE POLLUTION

NEREIDA MARINE EDUCATION

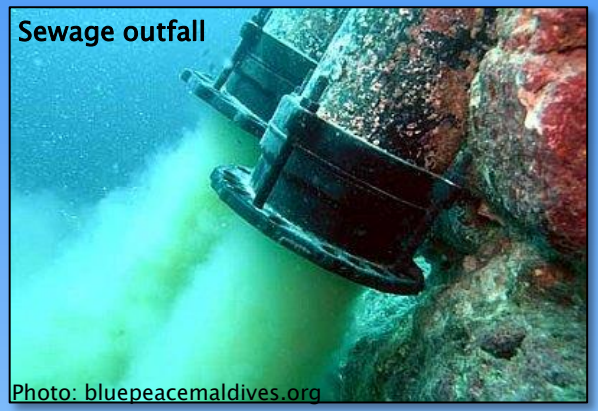


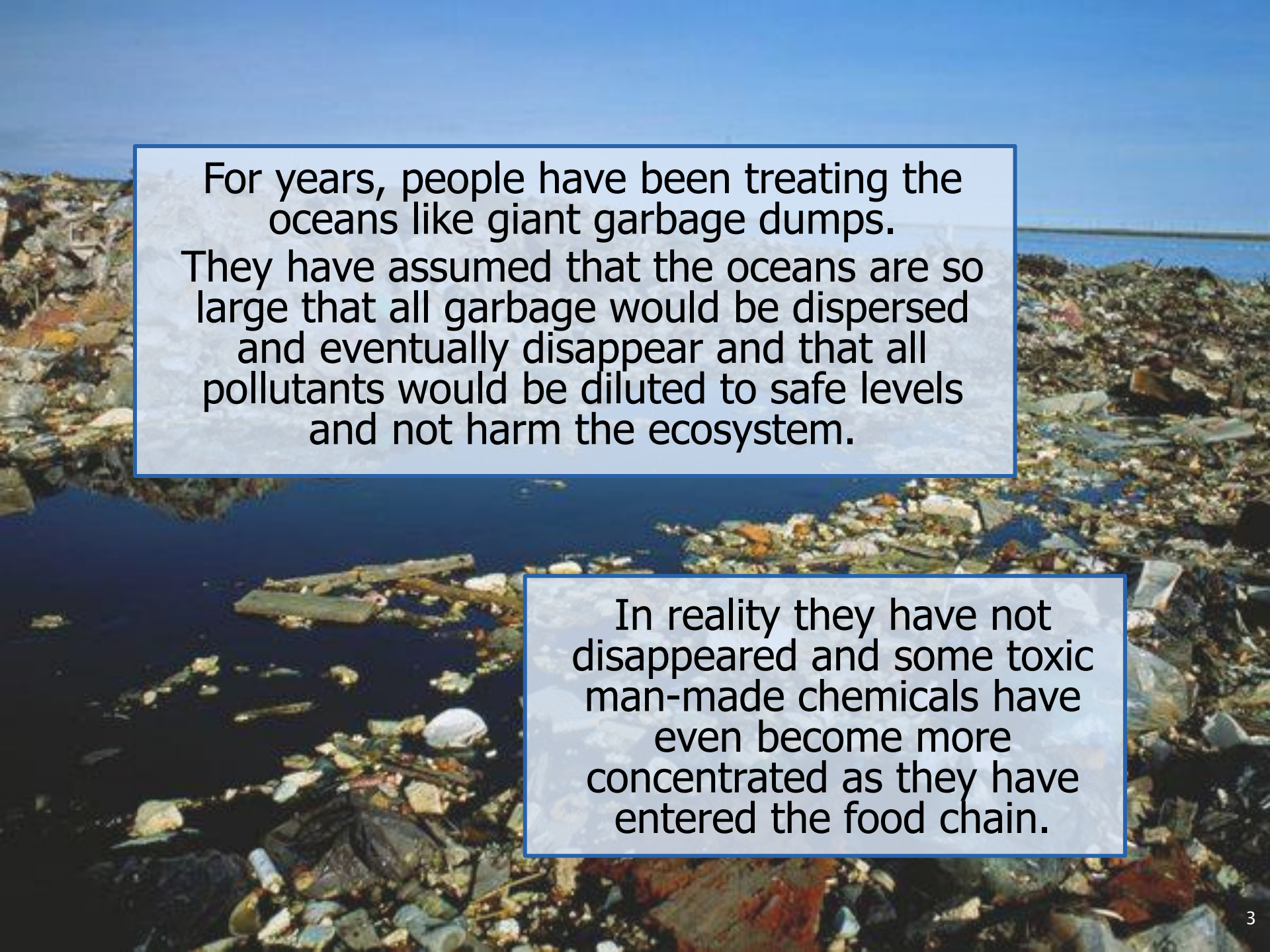
TOXIC WASTE

MAN-MADE OCEAN NOISE

May, 2015

1. TOXIC WASTE





For years, people have been treating the oceans like giant garbage dumps.

They have assumed that the oceans are so large that all garbage would be dispersed and eventually disappear and that all pollutants would be diluted to safe levels and not harm the ecosystem.

In reality they have not disappeared and some toxic man-made chemicals have even become more concentrated as they have entered the food chain.

TYPES OF MARINE POLLUTION

Marine pollutants of major concern are **toxic chemicals and heavy metals**, which can have a very harmful effect on marine life and humans.

Of toxic chemicals the ones of most concern are the ones that are not broken down by water.
These are called **POPs- Persistent Organic Pollutants**.

Of the over 63,000 chemicals thought to be in use worldwide about 4,500 fall into the category of POPs.

SOME COMMON EXAMPLES OF POPs ARE:

PBCs – used widely as coolant fluids in, for example, transformers, capacitors, and electric motors Banned internationally since 2004.

Dioxins and furans are released as by-products from waste incineration, the burning of fuels, the processing of metals, and paper manufacture.

PDBEs – since the 1970s, widely used as flame retardants in children's pygamas, furniture foam, carpets, wire insulation, and other products. Banned in some areas.

DDT – since 1940s, used as an insecticide. Internationally banned, but still used in some countries in food production and for malaria control.

SOME COMMON EXAMPLES OF HEAVY METALS

that are toxic or poisonous at low concentrations are:

- lead,
- mercury,
- copper,
- nickel, and
- arsenic.

For example, lead is found in:

Lures, jigs, and sinkers.

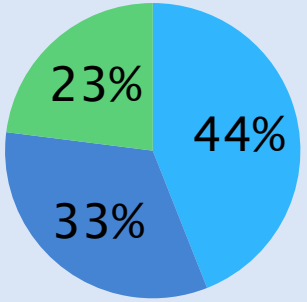
Antique toys (pre-1976)

Old house paint (pre-1978).

WHAT ARE THE SOURCES OF MARINE POLLUTION?

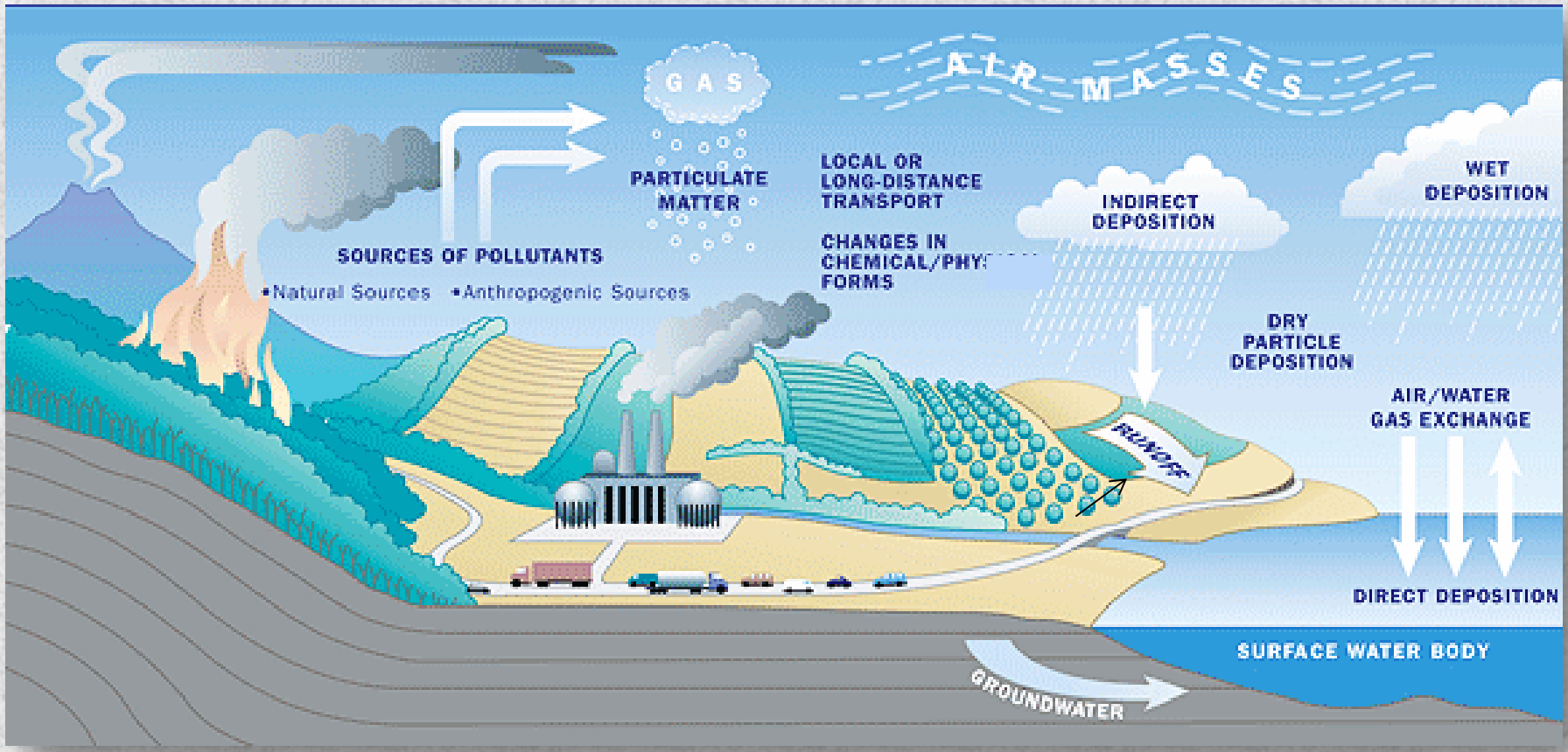
MARINE POLLUTION CAN ENTER THE OCEANS VIA:

- THE LAND (44%)
- THE AIR (33%)
- THE OCEAN (23%: ships and spills 12%, ocean dumping 10%, offshore mining 1%)



LAND-BASED MARINE POLLUTION

Almost 80% of marine pollution comes from land-based activities worldwide:
industry, agriculture, or domestic.



There are **3 WAYS THAT LAND-BASED POLLUTANTS ENTER THE MARINE ENVIRONMENT**:

- **Direct dumping** into ocean waters (often via rivers which carry the toxic pollutants into the oceans).
- **Land runoff**, primarily via rivers. Pollutants can seep into the ground, especially after a rain or flooding, and then stream into rivers and get carried into the ocean. (Floods also carry debris and other objects out to sea.)
- **Atmospheric fallout**, carried by air currents onto the oceans' surface.

Industrial waste dumped directly into the ocean

Runoff of fertilizers and other potential pollutants from unprotected farm field after heavy rain occurs

After a rainstorm, a river discharges sediment and nutrient-laden water to the sea

Photo: cc Malik Naumann, Marine Photobank

DIRECT DUMPING

Types of hazardous waste dumped directly into oceans include:

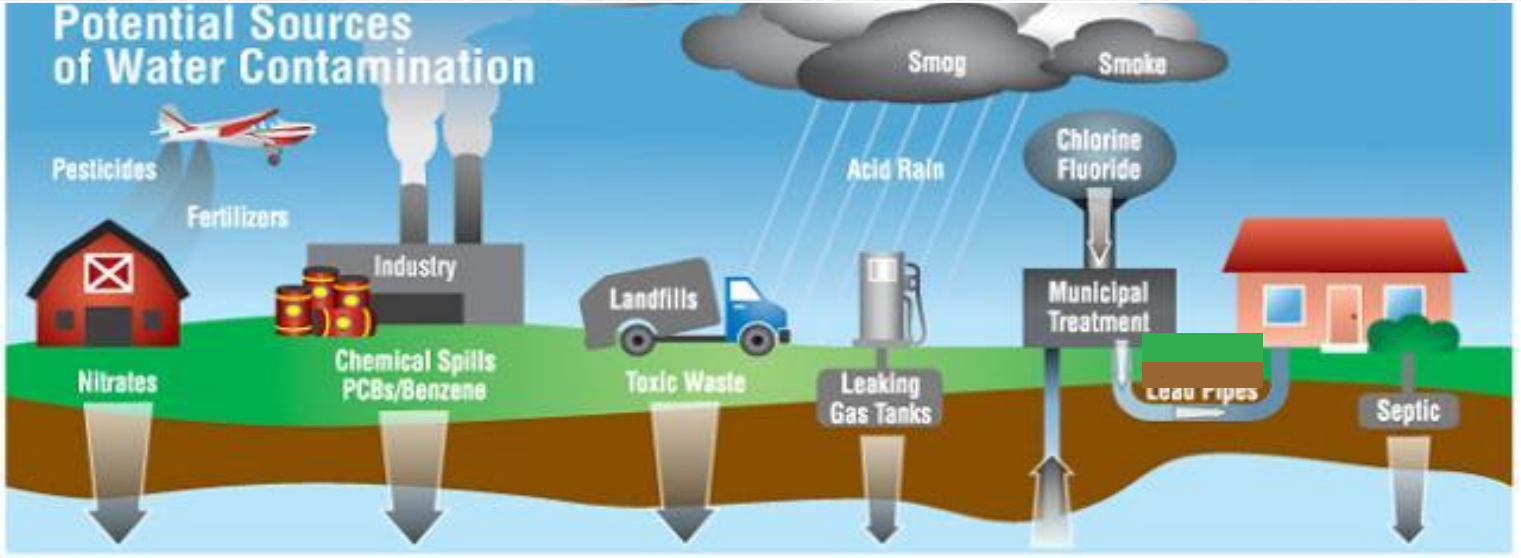
- Untreated or under-treated sewage (from toilets, bathing, dishwashing, laundry, etc.). Many cities around the world still have ineffective, little, or no sewage treatment.

- Industrial, chemical, and food processing wastes (e.g. pulp and paper production, chemical plants, metal and oil refineries).
- Coal and mineral mining waste (Each year, mining companies dump more than 180 million tonnes of hazardous mine waste into rivers, lakes, and oceans worldwide.)
- Radioactive waste from nuclear reprocessing plants (e.g. Since Japan's 2011 earthquake and tsunami, the Fukushima Daiichi nuclear power plant has been leaking hundreds of tons – up to 300 litres per minute – of contaminated underground water, containing radioactive strontium, into the ocean.
- Marine debris, in particular plastics because they leach toxins.

LAND RUNOFF

Runoff includes many sources, such as:

- landfills and dumps,
- farms and ranches – toxins from fertilizers, pesticides, herbicides, and animal waste (feedlots),
- construction of roads, buildings, channels, harbours
- mining,
- factories,
- oil production, oil pipeline leakages
- cars and trucks – automobile oil and grease from roads,
- and even our homes – toxic garbage, household items.



ATMOSPHERIC FALLOUT

Pollutants can be carried great distances in **the air** and then deposited on the ocean surfaces, often in the form of rain, snow, or mist.

Atmospheric sources of pollutants include:

- factory smokestacks, which can be far inland from any coastline – e.g. mercury and nitrogen from coal burning
- landfills and other areas – e.g. dust, plastic bags
- evaporation from inland water or land surfaces into the air

Pollutants can even be transported in this way to distant regions, like the Arctic and Antartica.

Photo coutesy of Ars Electronica on Flickr

OCEAN-BASED MARINE POLLUTION

Boats and ships can pollute oceans:

- Container ships lose an estimated 10,000 or more containers at sea each year (usually during storms).
- Discharge of waste and garbage from commercial ships (including cruise ships) is often intentional even though it is prohibited.
- Wastewater and bilge water from boats.
- Fishing-related debris, including lines, nets, pots, and lures, are lost accidentally or deliberately dumped into the ocean.
- Millions of litres of fuel are accidentally spilled from large and small boats, often the result of careless refuelling.

Aquaculture facilities can also be significant sources of pollution, including excess feed, fish waste, pharmaceuticals, and dead fish. (They can also result in the spread of parasites and diseases.)

OIL SPILLS

Millions of litres of oil can be spilled in major oil tanker accidents.

Recovering 10-15% of the oil spilled from major tanker accidents is considered successful.

The offshore oil and gas industry can also have accidental spills and also uses chemicals that are discharged directly into the marine environment.

Gulf Oil Spill
Photo: U.S. Coast Guard

THE RESULTS OF MARINE POLLUTION

FROM TOXIC WASTE

Algal bloom
Photo: T. Archer

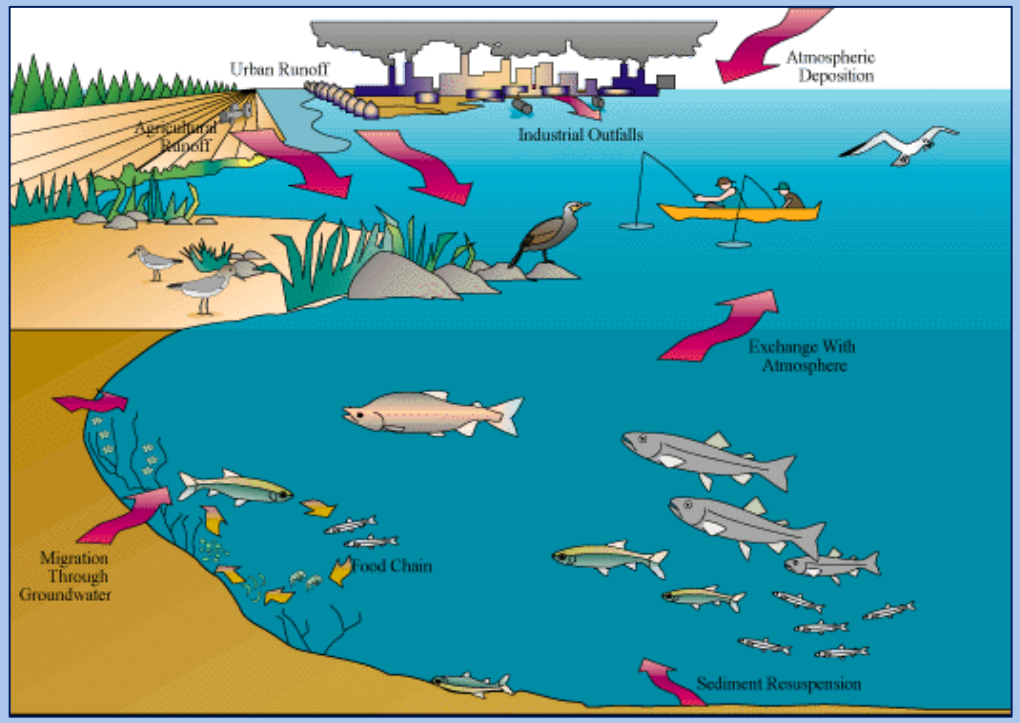
Agricultural runoff

Eutrophication

POPs (persistent organic pollutants), heavy metals, petroleum, and toxins from plastics all have devastating effects on marine life.

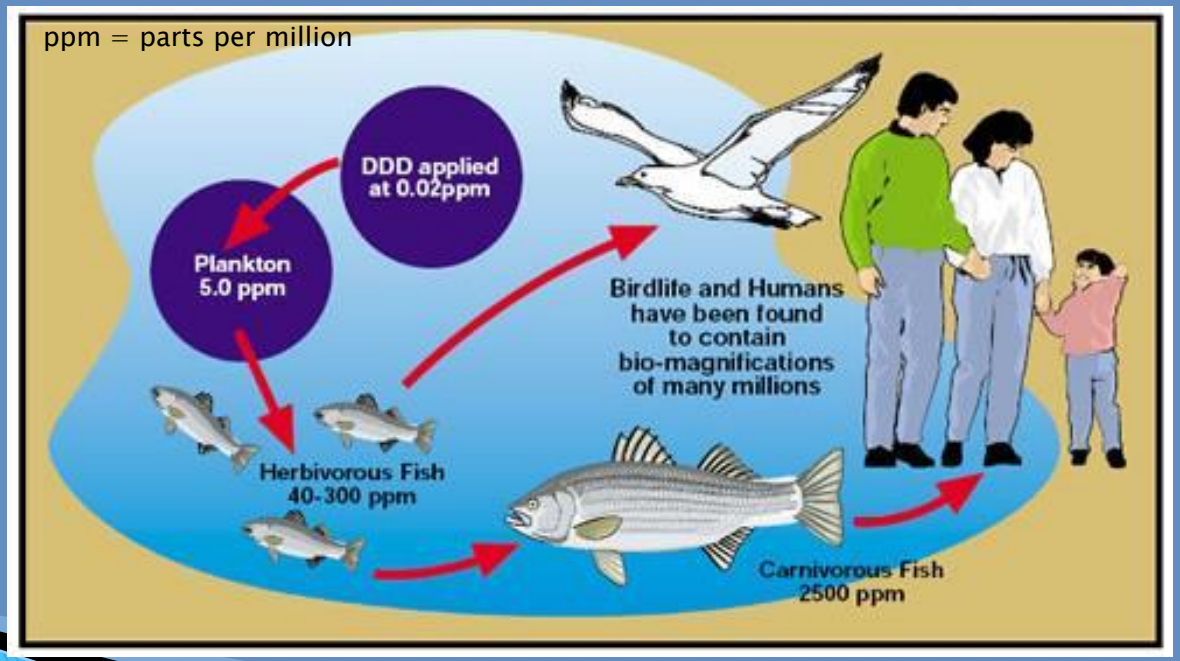
Such toxins can accumulate in the tissues of many species of aquatic life in a process called BIOACCUMULATION.

BIOACCUMULATION
is the progressive increase in the amount of a substance in an organism.



Most toxic chemicals cannot be excreted or broken down for use by organisms. Therefore, over time, with further intake of pollutants, the amount of toxic substance in an organism continues to increase.

Toxins that wash into the oceans and bioaccumulate in marine organisms low on the marine food chain are transferred to humans and marine mammals that are higher up in the marine food chain in a process called <u>BIOMAGNIFICATION.</u>

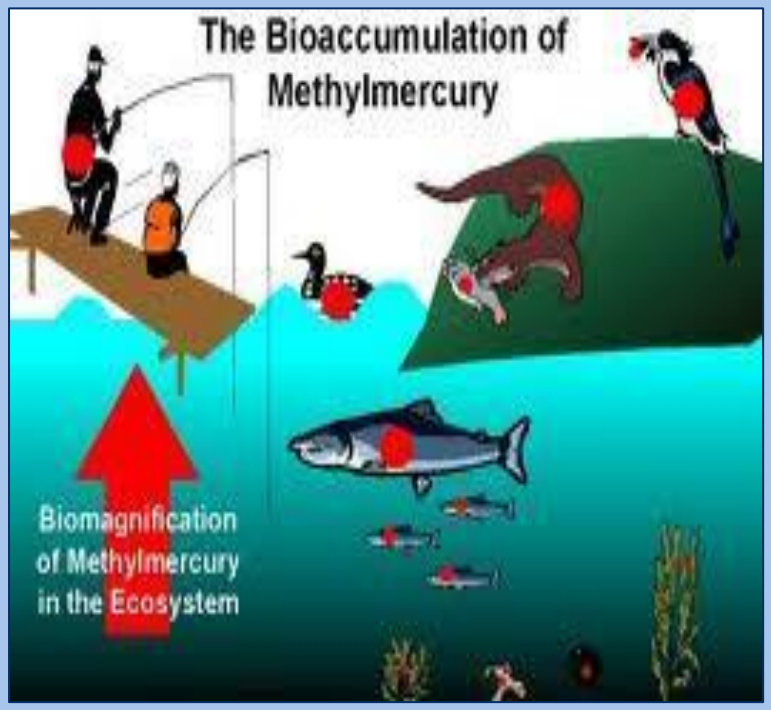


BIOMAGNIFICATION

is bioaccumulation occurring through several levels of a food chain and becoming more concentrated as it moves higher.

As a result, organisms at the top of the food chain generally suffer greater harm from a persistent toxin or pollutant than those at lower levels.

For example, mercury that enters the oceans is absorbed by plankton, which are eaten by small fish. Larger fish eat the small fish and accumulate the mercury into their bodies in higher and higher concentrations – passing it on to the animals and people that eat them.



BIOACCUMULATION AND BIOMAGNIFICATION, FOR EXAMPLE, IN WHALES

At the base of the ocean food web, POPs are absorbed by phytoplankton, then zooplankton and krill eat the photoplankton, consuming the POPs.

↓

In the Northeastern Pacific Ocean, herring eat the plankton, salmon eat the herring, and then Orca whales eat the salmon, or eat seals that have eaten the salmon.

↓

By the time these toxins have reached the whales, where they build up in their tissues, levels have increased significantly.

As a result, transient killer whales (Orcas) from the Northeastern Pacific are among the **most PCB contaminated marine mammals in the world**.

Animals higher up the food chain, such as SEALS, can have contamination levels millions of times higher than the water in which they live.

And POLAR BEARS, which feed mainly on marine mammals such as seals, beluga and narwhal, can have contamination levels up to 3 billion times higher than their environment.

Fortunately, with international agreements to ban PCBs, PCB levels in polar bears have drop substantially over recent years.

Photo courtesy of WWF

EFFECTS OF MARINE POLLUTION ON MARINE ANIMALS AND HUMANS

In certain kinds of fish, birds, and mammals, POPs are linked to declines, diseases, or abnormalities.


Harbour seal

MAN-MADE CHEMICALS CAN CAUSE SERIOUS HEALTH PROBLEMS.

MARINE POLLUTION – EFFECTS ON MARINE ANIMALS

MARINE MAMMALS

In marine mammals, POPs are known to cause:

- hormone disruption,
- reproductive failure, and
- immune deficiency

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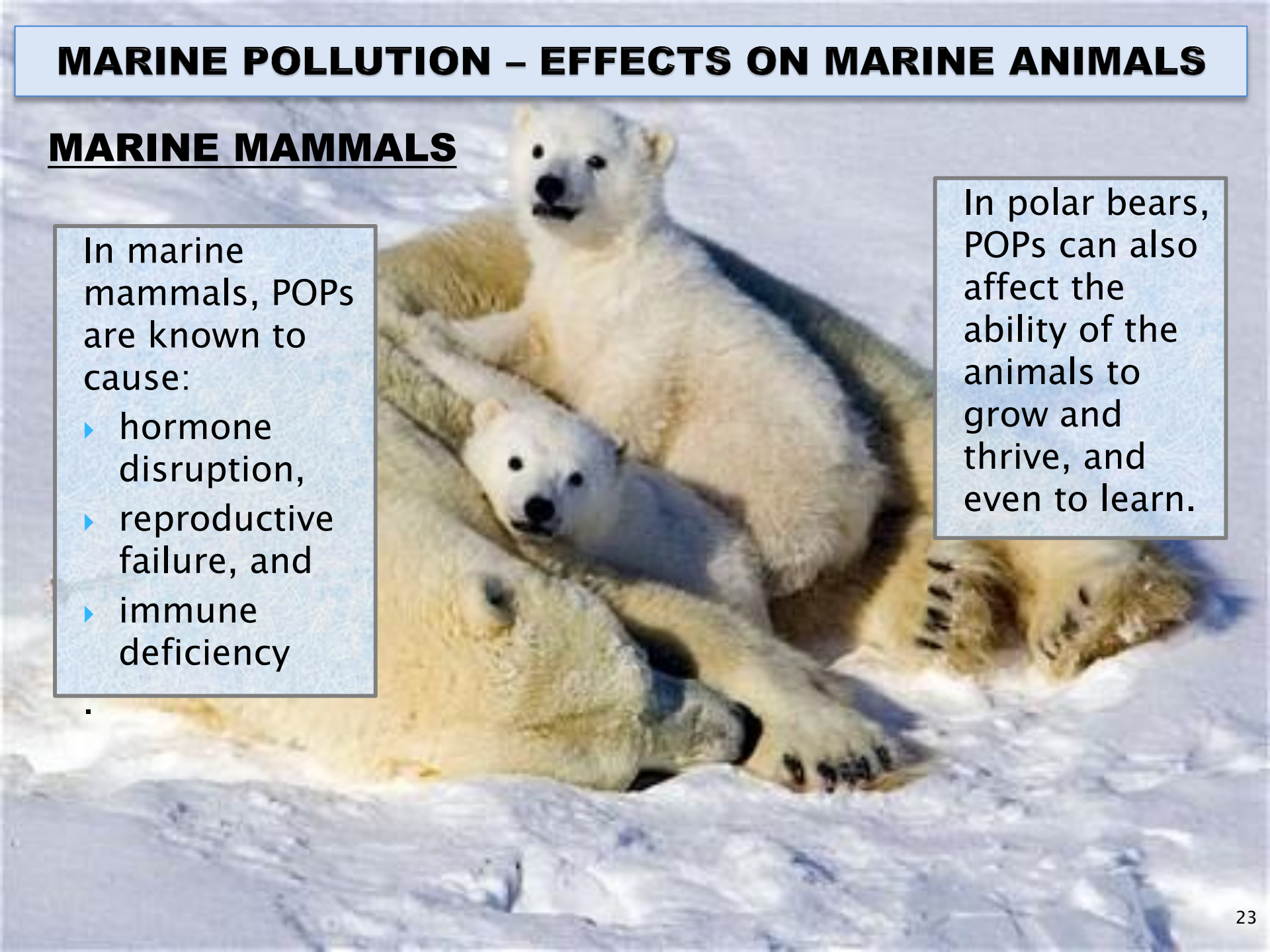
In polar bears, POPs can also affect the ability of the animals to grow and thrive, and even to learn.



In mammals, POPs can be transferred through the placenta and breast milk to developing offspring.

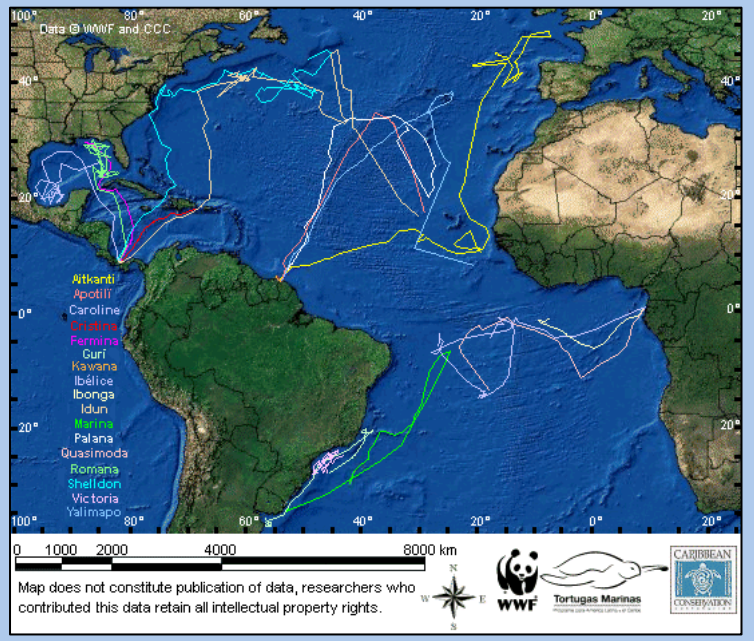
For example, in female dolphins, about 80% of toxic contaminants are passed to their first-born calf.

Bottlenose dolphins in the Gulf of Mexico suffer damaged immune systems from the bio-accumulation of POPs within their bodies and, in oil spill areas, were found to be underweight, anemic, and showing signs of liver and lung diseases.

SEA TURTLES

Sea turtles' migration habits increase their exposure to marine pollution.

Fibropapillomatosis is a disease affecting sea turtles, predominantly Green sea turtles. It results in large white tumors growing on faces, flippers, and internal organs. The tumours can affect sight, swimming, swallowing, and internal system functions, and can be fatal. **Researchers studying Green sea turtles in Hawaii have linked this disease to nitrogen in the runoff of urban and farm pollution (eg. from fertilizers).**



For example, tracking of 17 Leatherback migration movements

MARINE BIRDS

Birds have played a major role in creating awareness of pollution problemas.

After World War I, DDT was widely used as a pesticide and washed into nearby waterways, where aquatic plants and fish absorbed it.

Bald eagles and other predatory birds such as Ospreys, Peregrine Falcons, and Pelicans, in turn, were poisoned with DDT when they ate the contaminated fish and the DDT and its relative toxins bio accumulated in their fatty tissues.

Photograph courtesy Gary M. Stolz/U.S. Fish and Wildlife Service

THE BIOACCUMULATION OF DDT

altered the birds' calcium metabolism. As a result, their eggs had shells so thin that they often collapsed under the weight of the adult bird during incubation or otherwise failed to hatch.

Bald Eagle eggs effected by DDT

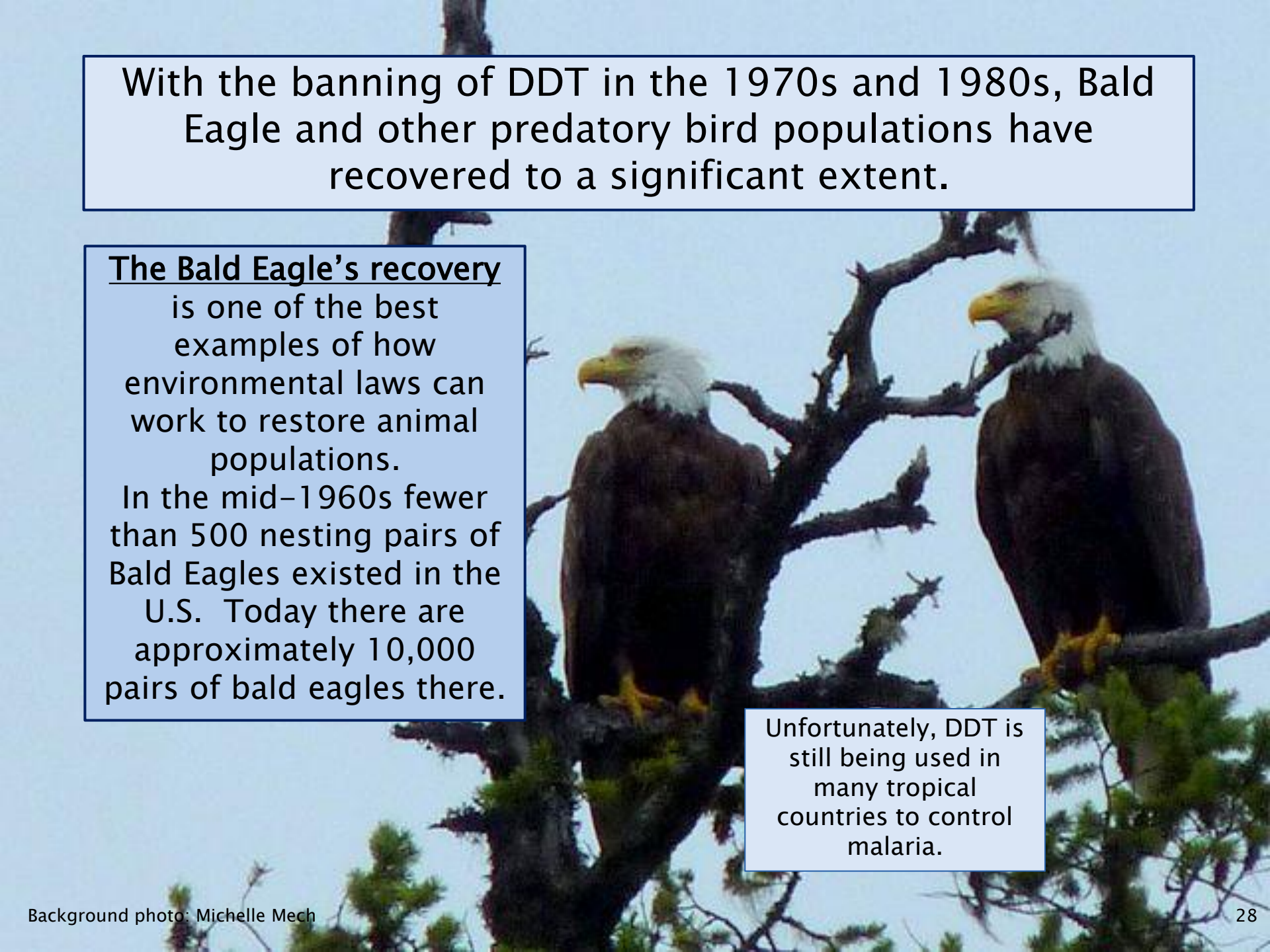
Osprey

This drastically reduced populations of Bald Eagles and other birds.

Background photo: Michelle Mech

With the banning of DDT in the 1970s and 1980s, Bald Eagle and other predatory bird populations have recovered to a significant extent.

The Bald Eagle's recovery is one of the best examples of how environmental laws can work to restore animal populations.
In the mid-1960s fewer than 500 nesting pairs of Bald Eagles existed in the U.S. Today there are approximately 10,000 pairs of bald eagles there.



Unfortunately, DDT is still being used in many tropical countries to control malaria.

Background photo: Michelle Mech

MARINE POLLUTION – EFFECTS ON HUMANS

HEAVY METALS

Exposure to heavy metals has been linked with:

- developmental retardation,
- various cancers,
- kidney damage,
- other adverse health effects, and
- even death in some instances of exposure to very high concentrations. (WRI)

For example:

- Lead can damage the brain, kidneys, and reproductive system and can cause birth defects.
- Mercury is a neurotoxin and if it enters the brain it can cause permanent brain damage.

POPs

Many POPs and other toxic chemicals are called '**endocrine disruptors**'. Endocrine (or hormone system) disruption in humans can cause:

- enlarged prostrates,
- cancer,
- heart disease,
- diabetes,
- thyroid disorder,
- ADHD,
- infertility,
- obesity,
- early puberty in girls,
- mental disorders.

POPs have also been linked to reproductive, developmental, behavioral, neurologic, and immunologic adverse health effects.

RESULTS OF OIL SPILLS

Oil spills can:

- contaminate shorelines and ocean sediment,
- cause the death of many animals,
- deteriorate water quality,
- cause commercial fishing closures, and
- impact tourism.

Oil contains PAHs (polycyclic aromatic hydrocarbons), which are toxic, very difficult to clean up, and last for years in the marine environment.

Less than 1% of oil soaked birds survive.

THE EXXON VALDEZ,

in 1989, ran aground in Alaska and spilled 41 million litres of oil. Only 3% of the oil was recovered.
Over 2,000 km of coastline was polluted and an estimated 2,800 sea otters, 250,000 birds, 1.9 million salmon, and 12.9 billion herring were killed.

20 years after the spill an estimated 75,000 litres of oil remained in the area, causing lingering effects on local marine life.

Cleaning the beach

Background photo: Exxon Valdez oil spill,
Courtesy of Chris Wilkins/AFP/Getty Images

THE GULF OF MEXICO OIL SPILL,

in 2010, released 880 million litres of oil into the ocean. Researchers estimate that 6,000 sea turtles, 26,000 dolphins and whales, 82,000 birds, and countless fish and invertebrates were harmed or killed.

Five years after the spill, Bottlenose dolphins and sea turtles are dying in record numbers and other marine animal are still being affected. For example, since the spill began, approximately 1,000 bottlenose dolphins have been found dead in the northern Gulf of Mexico.

The 2.5 million litres of toxic dispersants used to break up the oil in the Gulf oil spill may have worse long-term human and ecological impacts than the oil itself.

Gulf of Mexico oil spill

Photo: Joel Sartore, National Geographic

Background photo courtesy of Boston.com

VICTIMS OF OIL SPILLS

Oiled whales and sea otters

Oil soaked sea turtle

RESULTS OF MARINE POLLUTION - EUTROPHICATION

The release or runoff of sewage and toxic waste, in particular from agricultural fertilizers and manure, into coastal waterways can lead to outbreaks of harmful algal bloom which poison other marine life.

This is known as **EUTROPHICATION.**

Depleted oxygen levels are the most common cause of fish kills.
Photo: Michelle Mech

This can also deplete oxygen and help to **cause 'dead zones' - marine areas where oxygen levels are so low that most marine life cannot survive, and either die or leave the area.** Habitats that would normally be teeming with life become, essentially, biological deserts.

DEAD ZONES

Though dead zones can occur naturally, increasing human population and demand for resources and development are causing increases in their size and number.

They are occurring primarily near inhabited coastlines.

In January 2011, 534 (WRI) dead zones were counted worldwide – caused by climate change, overfishing, and marine pollution. contaminación marina.

22,000 square kilometer dead zone in the northern Gulf of Mexico in the United States near the Mississippi river. The light blue is the water with low oxygen levels due to excessive nutrients from agricultural activities and other runoff brought to the sea. Image: Robert Simmon, NASA

2. NOISE – THE OCEAN-BASED POLLUTION WE DON'T SEE

- CAUSED BY MAN-MADE ACTIVITIES ON OR IN THE OCEAN

UNDERWATER SOUND AND MARINE ANIMALS

When people think about ocean pollution, they often forget or are unaware of the fact that man-made noise is also disturbing marine life in our oceans.

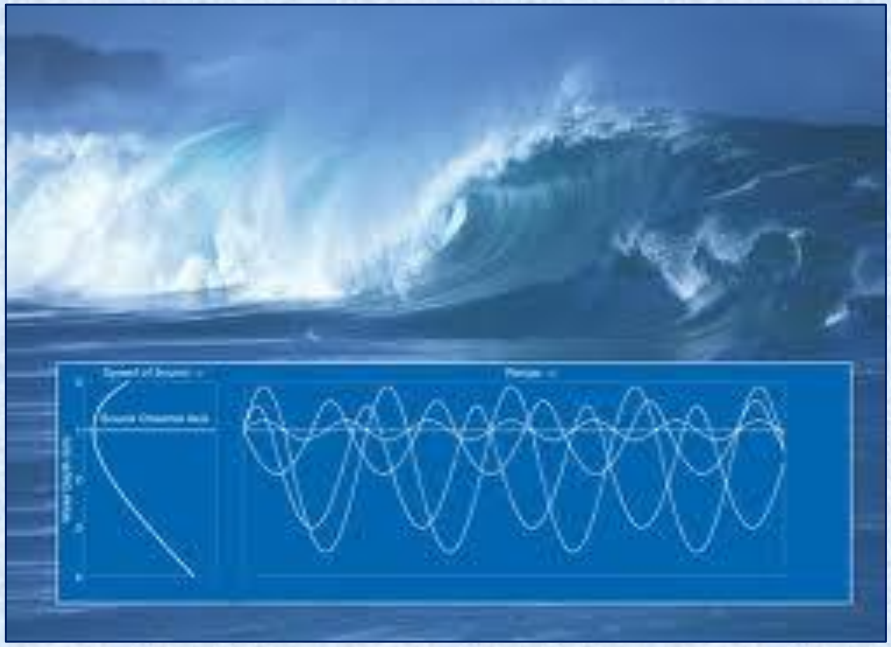
UNDERWATER SOUND

Sound travels almost 5 times faster in water than in air.

It also travels further.

High intensity sound in the oceans can travel for thousands of miles.

Sound waves in the water are also louder.



WHY SOUND IS SO IMPORTANT TO MARINE ANIMALS

The ocean is a world of sound.
Underwater, vision is only useful for short distances.
Since sound can be heard for hundreds, even thousands of kilometers, it is as important to most marine animals as sight is to humans.

From invertebrate larvae to the largest animals on the planet, the detection and recognition of underwater sound is crucial.

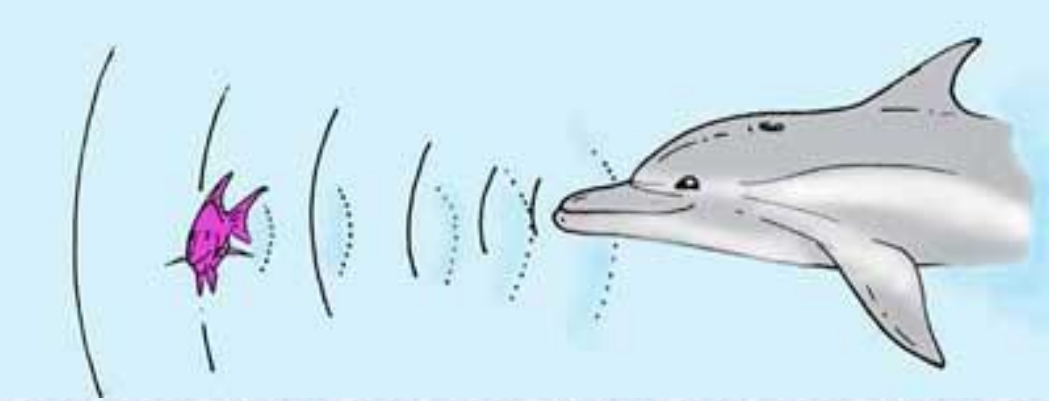
Marine animals rely on their hearing for everyday functions:

- finding food,
- detecting and avoiding predators and other dangers,
- communicating and transmitting warnings,
- establishing territories,
- navigation,
- finding mates that are often widely spread out,
- mother-offspring bonding
- staying in contact with their youth or their group members, and
- sensing changes in water conditions.

THE USE OF UNDERWATER SOUND IS PARTICULARLY IMPORTANT TO MARINE ANIMALS

Many marine mammals use some type of echolocations. Toothed whales, in particular, (including all dolphins and porpoises) have highly specialised echolocation abilities.

They emit pulses of sound that travel and reflect back off objects. The returning echoes give the animal an "image". In this way they "see" the world around them.



Man-made sound waves can drown out the sound waves that these animals make and use to survive.

THREE MAJOR SOURCES OF MAN-MADE OCEAN NOISES ARE:

- SURFACE OCEAN TRAFFIC
- MILITARY SONAR
- SEISMIC AIR GUNS

} SOME OF THE LOUDEST NOISES EVER PUT INTO THE OCEANS

1. SURFACE OCEAN TRAFFIC

The most visible causes of ocean noise come from motorboats, especially large commercial ships (cargo vessels, bulk carriers, container ships, oil tankers).

The over 230 cruise ships operating worldwide also contribute to noise pollution in the oceans.

Commercial ships have been increasing in both number and size. In January 2011, there were 103,392 seagoing commercial ships in service, with over double the total shipping capacity of 1980.

As a result, commercial ships are producing increasing ocean noise.

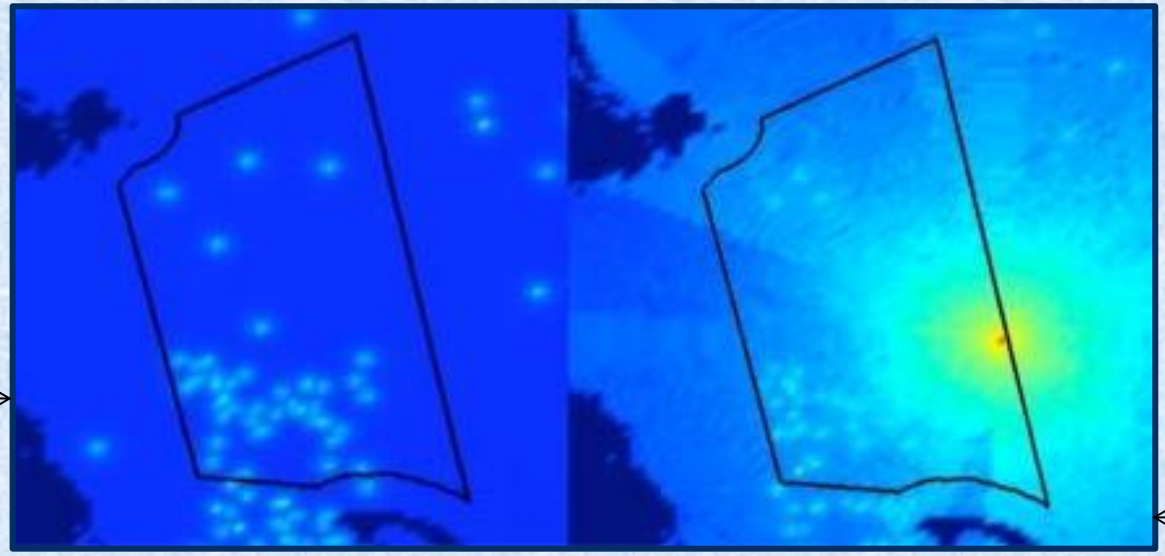
Background photo: Michelle Mech

In many areas, **SMALLER VESSELS SUCH AS FERRIES, FISHING VESSELS, AND RECREATIONAL WATERCRAFT**, may be the major source of man-made ocean noise.

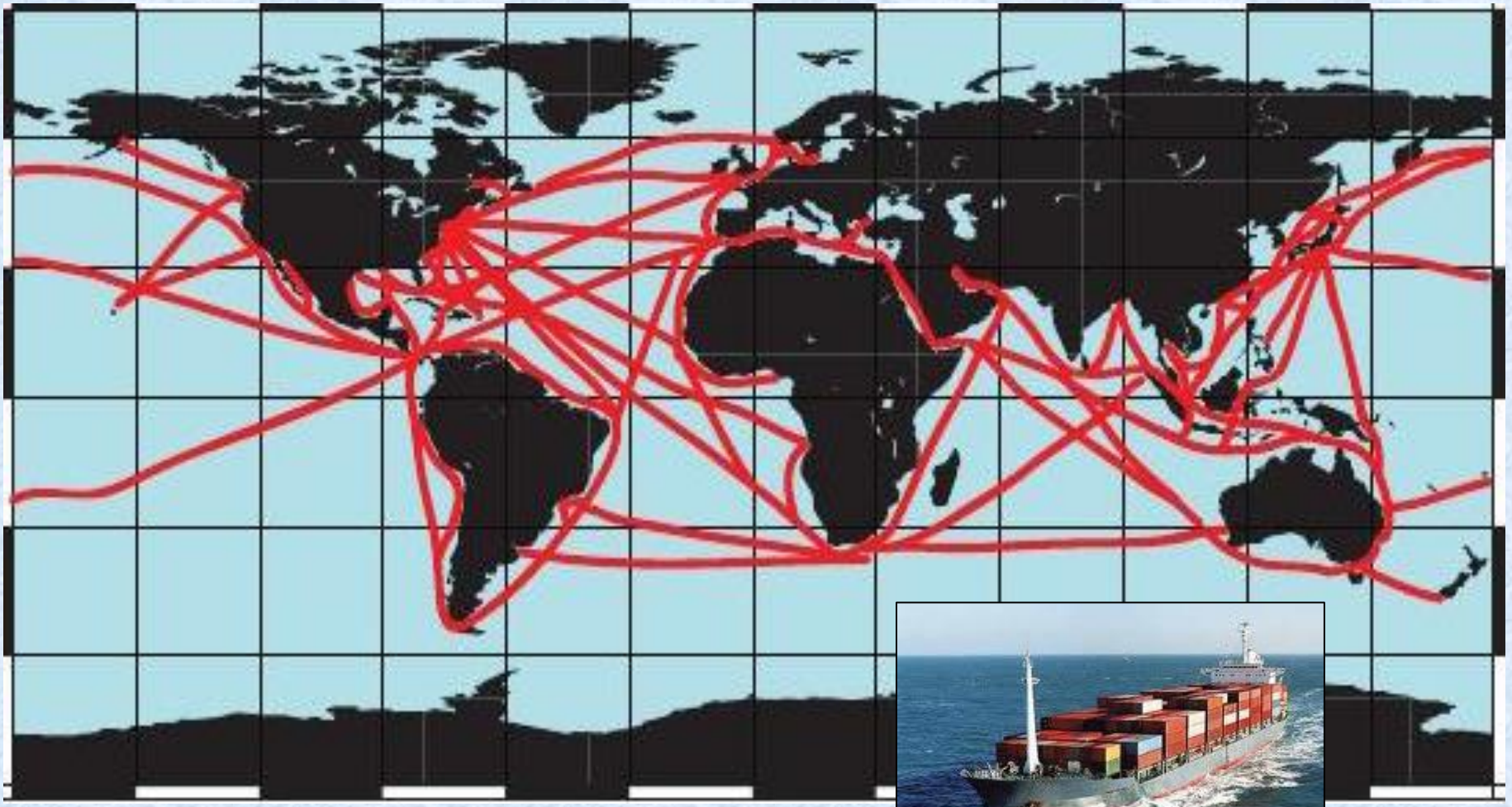
We should remember this if we are in a small boat or jet ski that can disrupt marine animals and whenever possible be careful not to get close to them.

The acoustic scene in the waters outside Boston Harbor – Each pale blue dot represents the sound energy from a calling North Atlantic right whale.

The whales calling without commercial ship noise



The large colourful area radiating from the red dot is noise from a commercial ship. The ship's noise drowns out the whales' vocalizations over a wide area.



Major commercial shipping lanes of the world's oceans

Baleen whales, seals, sea lions, walruses, and fish are the ocean animals most affected by the acoustic energy generated from large commercial vessels.

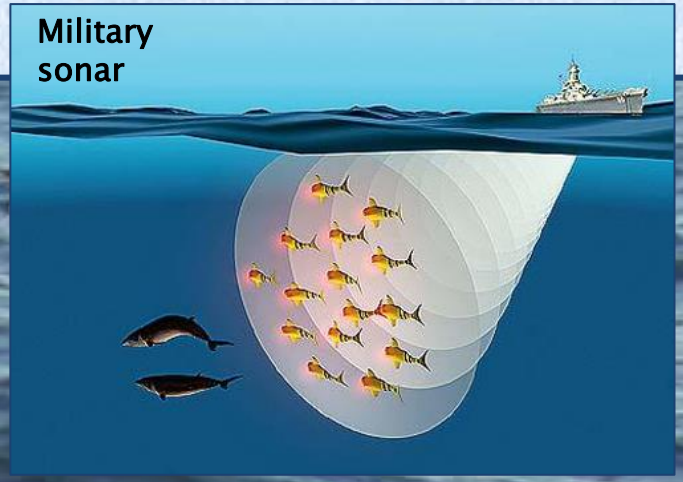
Source: Marine Mammals and Noise, A report to Congress from the Marine Mammal Commission, 2007

2. MILITARY ACTIVE SONAR

ACTIVE SONAR systems are used by the U.S. and other navies:

- **Mid-frequency active sonar** has been used for many years to detect submarines and is widely deployed (on approximately 300 ships).
- **The newer, low-frequency active (LFA) sonar** sends out loud sounds at low frequencies. It is used for long range detection and is currently operational on only a few ships.

The U.S. Navy and NATO are planning to deploy LFA sonar across 70% of the world's oceans.



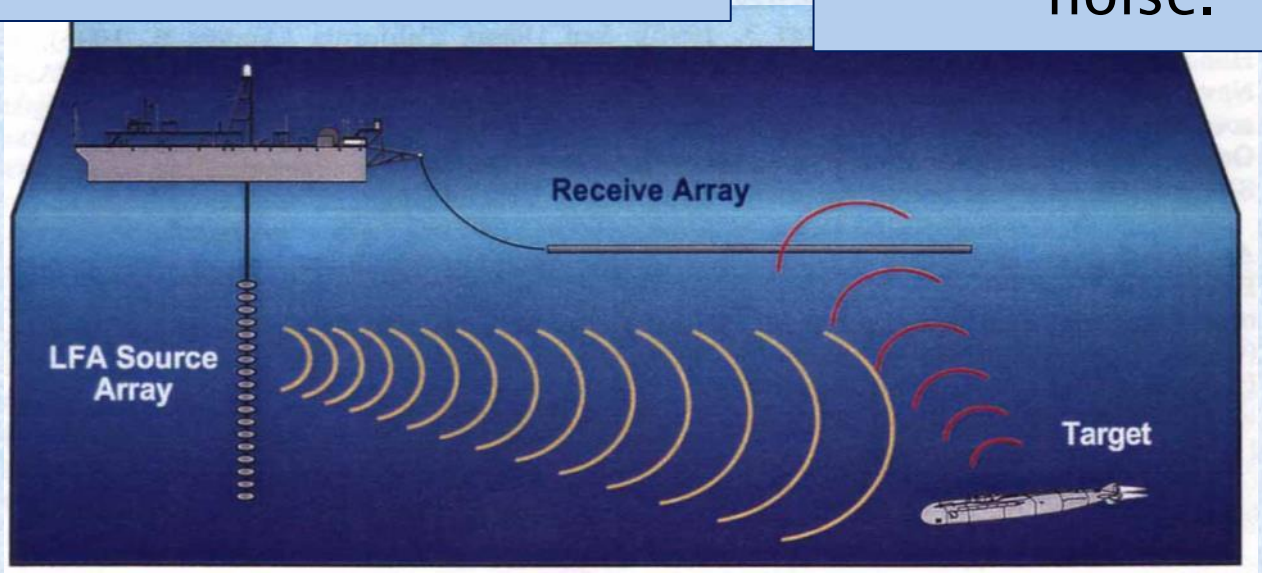
Low-frequency sound travels further than mid-frequency sound.

Background photo: Michelle Mech

MILITARY ACTIVE SONAR emits intense sound waves that sweep across the ocean like a floodlight, revealing objects in their path.

These sound waves can be as loud as a rocket blasting off.

A single LFA sonar source is capable of flooding thousands of square kilometers of ocean with intense levels of noise.



U.S. Sonar system

3. SEISMIC SURVEYS

SEISMIC SURVEYS are used:

- by academic geologists to study the seabed and underlying geology and,
- more frequently, by the offshore oil and gas industry to find and monitor oil and gas deposits beneath the seafloor.

As the search for offshore oil has increased over recent years, so has the use of seismic surveys.

In 2011, there were 163 seismic survey vessels in the world.

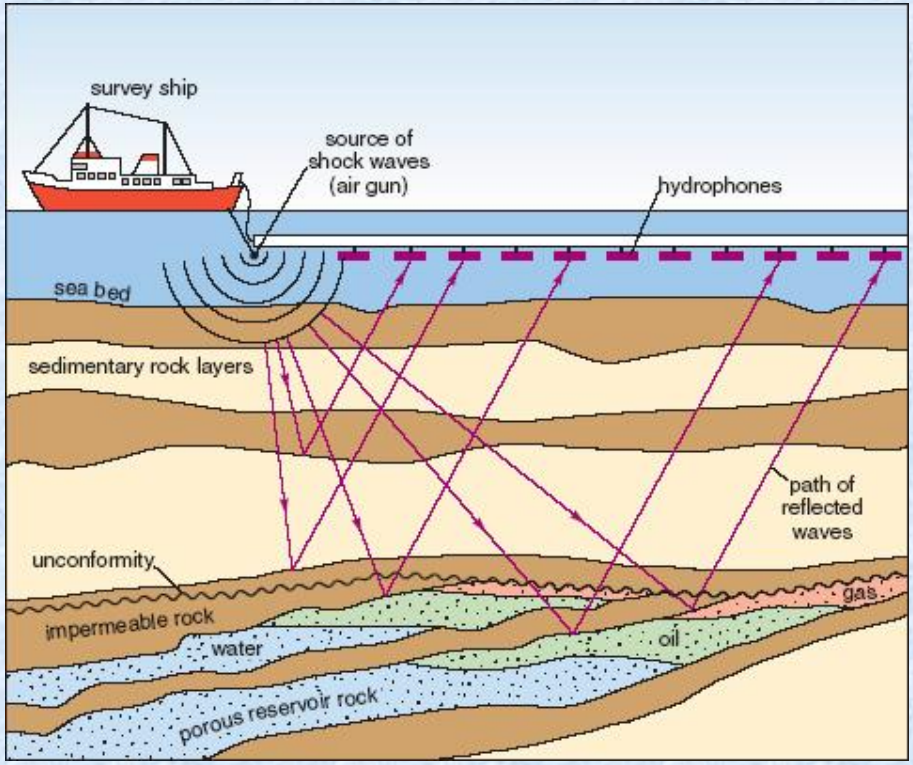
Offshore drilling platform

Today, offshore exploration and production activity contribute roughly **30%** of the world's oil and gas output.

SEISMIC SURVEY SHIPS travelling at 4.5-5 knots (about 9 km/hr) typically tow an array of 12-48+ air guns which generate powerful sound waves by firing off explosive blasts of pressurized air bubbles to produce intense, brief sound pulses every 10-12 seconds.

As many as 16 "streamers"of hydrophones, as long as 10 km, are towed 5-10 meters underwater, 50-150 meters apart.

HYDROPHONES listen for echoes, which provide images of layers of sediment, rock, and hydrocarbons up to 40 km below the ocean floor.



Source: http://openlearn.open.ac.uk/mod/resource/view.php?id=172129)

SEISMIC SURVEYS typically last about 2-3 weeks and cover a range of 500-1000 kilometers, raising noise levels up to 100 times higher. They primarily use high energy, low frequency sound waves because they are the sound waves that can penetrate deep into the ocean floor.

These sound waves can be as loud, or even louder than, the sound intensity produced by a jackhammer, which can damage human ears in as little as 15 seconds.

For marine mammals nearby, the noise is literally deafening.

A seismic ship shooting a survey. To either side of the ship's wake is an air-gun array. Each array contains 4 strings of air guns.

Major areas of oil and gas exploration and production in the world's oceans

The 102 meter long seismic survey ship *Ramform Sovereign* has a maximum towable footprint of 10.4 sq km – an area equivalent to 830 soccer pitches.

Source: Marine Mammals and Noise, A report to Congress from the Marine Mammal Commission, 2007

OTHER SOURCES OF MARINE NOISE POLLUTION

EXPLOSIVES are used in:

- Construction and removal of unwanted structures, e.g. offshore oil and gas drilling platforms, harbours
- Blast fishing
- Military warfare and practice

Explosives cause extremely high noise levels in a wide range of frequencies as well as pressure waves. These have caused the injury and/or death of many marine mammals, sea turtles, and fish.

MARINE CONSTRUCTION AND INDUSTRIAL ACTIVITIES also produce noise pollution. These activities include:

- pile driving,
- dredging,
- cable laying,
- drilling

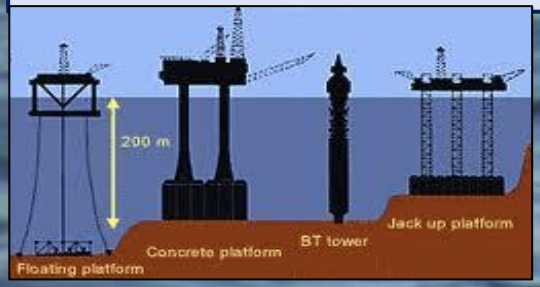


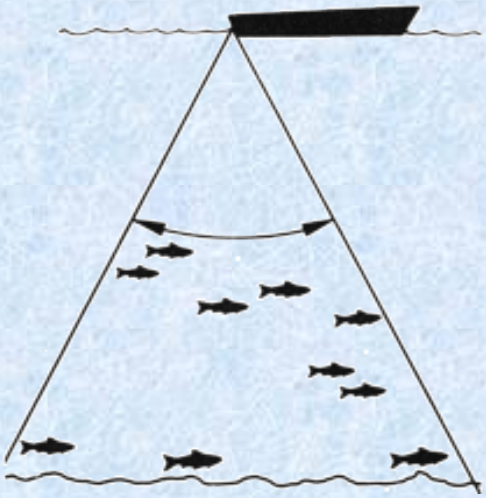

Photo courtesy St-Adrews.ac.uk

Once a company finds oil, it constructs drilling platforms and then drilling operations and offshore oil production contribute more underwater noise.

THE NAVY also produces other man-made noises in its training activities, which include:

- anti-submarine warfare exercises;
- gunnery, missile and bombing exercises; and
- extensive testing for new weapons

Weapons test: 450 kg MK-83 bombs dropped in the Atlantic test range.
United States Navy Photo by Vernon Pugh



OTHER TYPES OF SONAR SYSTEMS

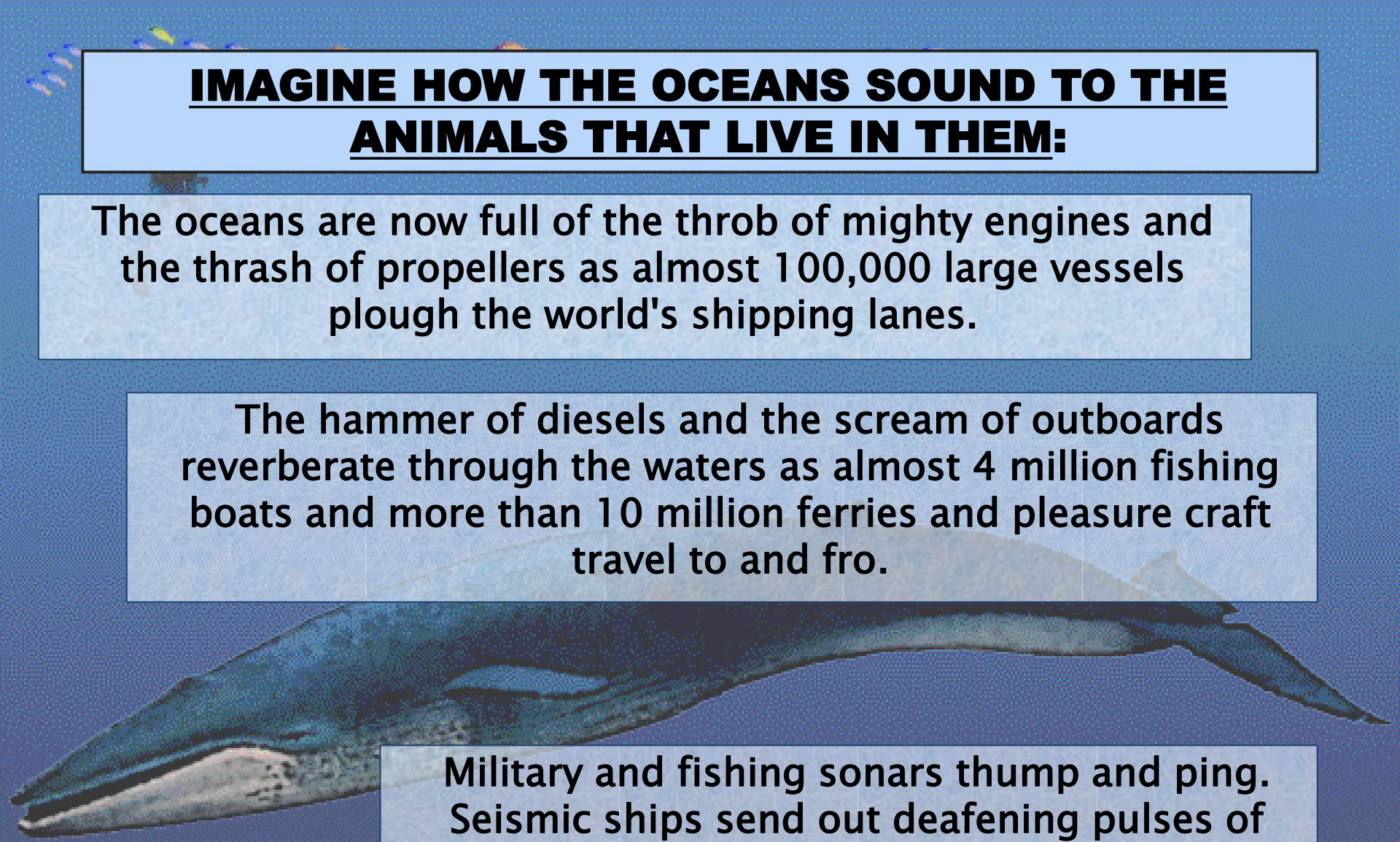
are used by nearly all of the 90,000 vessels in the world's commercial fishing fleet and by many of the millions of small boats owned globally.

They are commonly used for finding fish, depth sounding, and locating submerged objects.

IMAGINE HOW THE OCEANS SOUND TO THE ANIMALS THAT LIVE IN THEM:

The oceans are now full of the throb of mighty engines and the thrash of propellers as almost 100,000 large vessels plough the world's shipping lanes.

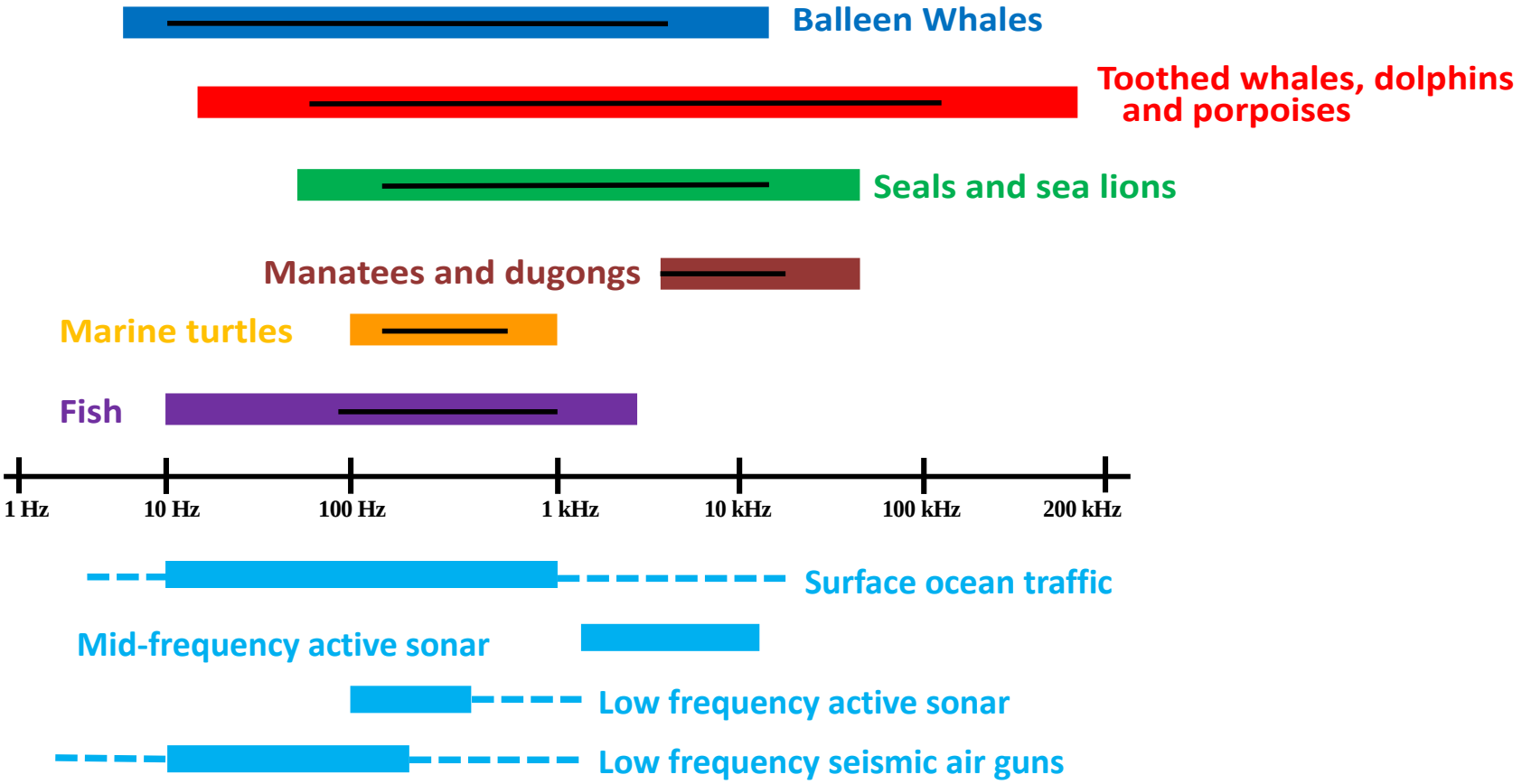
The hammer of diesels and the scream of outboards reverberate through the waters as almost 4 million fishing boats and more than 10 million ferries and pleasure craft travel to and fro.



Military and fishing sonars thump and ping. Seismic ships send out deafening pulses of sound. And drills and dredges grind away on the ocean floor.

FREQUENCY RELATIONSHIPS BETWEEN MARINE ANIMAL SOUNDS AND MAJOR MAN-MADE NOISE

Marine animals utilise and hear underwater sound in different ways and are "tuned" to different frequency bands. Baleen whales, most fishes, sea turtles, and invertebrates hear best at lower frequencies, while dolphins and porpoises can hear higher frequencies, into ranges above human hearing (20 Hz to 20 kHz). The sounds from man-made noise are often in the same frequency ranges.



The frequency of sound waves is measured in the number of pulses or cycles per second, or hertz (hz). Information on these frequency ranges varies significantly.

For marine animals, the black lines denote most cited or highest sensitivity.
For man-made noises, the solid lines denote most cited or most occuring.

RESULTS OF EXPOSURE TO MAN-MADE OCEAN NOISE

The noise that is now in our oceans poses a significant and sometimes lethal threat to whales, dolphins, seal lions, seals, sea turtles, and other marine wildlife.

It is stressing marine life and disrupting the basic biology of the oceans.

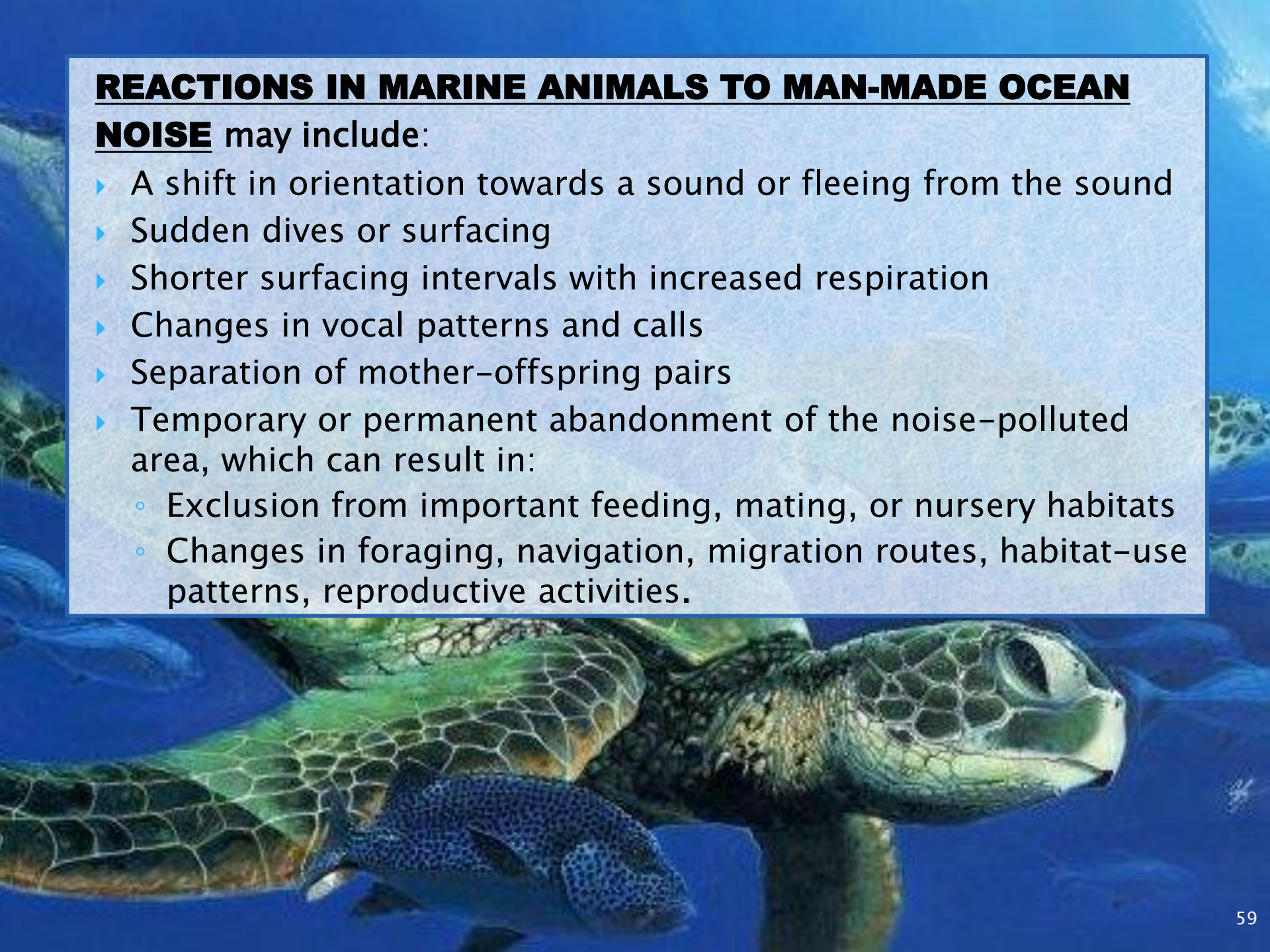
MASKING

Just as it can be difficult to hear someone talking at a loud party or to have a conversation in a noisy restaurant, elevated noise levels in the ocean can interfere with marine animals' ability to hear important sounds.

This type of acoustic interference is called **MASKING.**

Acoustic masking by man-made ocean noise:

- is likely having an increasing impact on animals' access to acoustic information that is essential for communication, orientation, sensing dangers such as oncoming ships, and other important activities,
- is of particularly high concern for marine animals that use low frequencies, such as baleen whales, sea turtles, and most fish.



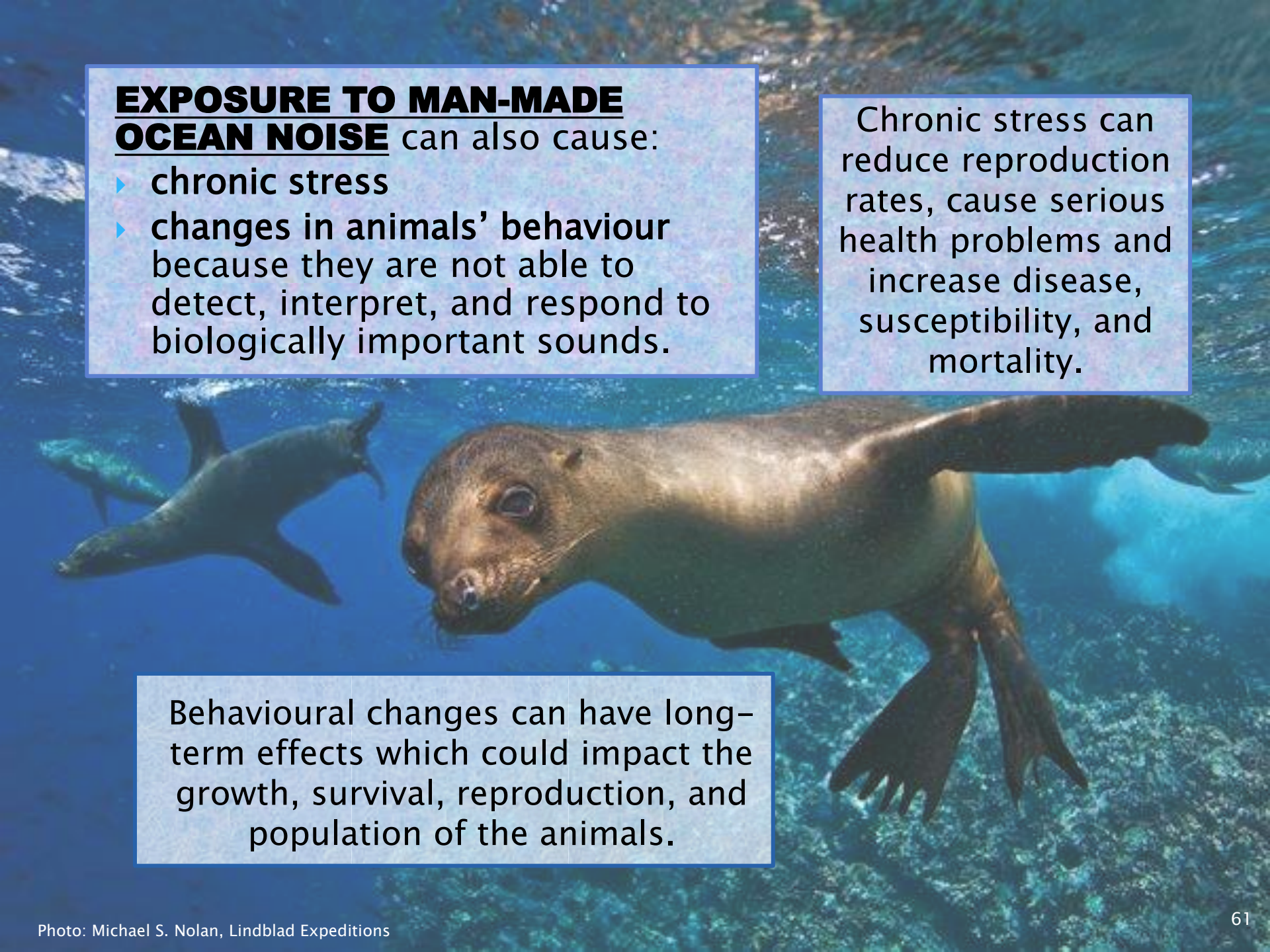
REACTIONS IN MARINE ANIMALS TO MAN-MADE OCEAN NOISE may include:

- A shift in orientation towards a sound or fleeing from the sound
- Sudden dives or surfacing
- Shorter surfacing intervals with increased respiration
- Changes in vocal patterns and calls
- Separation of mother-offspring pairs
- Temporary or permanent abandonment of the noise-polluted area, which can result in:
  - Exclusion from important feeding, mating, or nursery habitats
  - Changes in foraging, navigation, migration routes, habitat-use patterns, reproductive activities.

EXPOSURE TO NOISE

Exposure to intense, man-made noise has caused:

- Physical damage to tissues and organs of marine animals, which can lead to mortality,
- Permanent or temporary loss of hearing in marine mammals and fish or reduction in their hearing capability, which can:
  - increase an animal's vulnerability to predation,
  - reduce its foraging efficiency, or
  - impede its communication,
- Other auditory damage (e.g. sensory hair cells).



EXPOSURE TO MAN-MADE OCEAN NOISE can also cause:

- **chronic stress**
- **changes in animals' behaviour** because they are not able to detect, interpret, and respond to biologically important sounds.

Chronic stress can reduce reproduction rates, cause serious health problems and increase disease, susceptibility, and mortality.

Behavioural changes can have long-term effects which could impact the growth, survival, reproduction, and population of the animals.

Photo: Michael S. Nolan, Lindblad Expeditions

FOR WHALES, man-made noises are drowning out the calls of mates, calves, and other pods that these mammals depend on. Calls and songs of many whales can be heard over several hundreds of kilometers or more.

Photo: Michelle Mech

Avoidance behaviour in **SEA TURTLES** can result in significant changes in their distribution and the possibility of being displaced from their preferred feeding habitat.

Noise pollution has also damaged the auditory systems of **CEPHALOPODS** such as octopus, squid, cuttlefish.

In FISH, man-made noise can:

- Damage swim bladders, tissue, eyes, tiny hairs in the ears and tissue in the auditory system,
- Cause declines in fisheries when fish temporarily or permanently change their habitat,
- Kill fish eggs and reduce growth rates for fry,
- Disrupt schooling structures in fish and scare away the prey species of many marine animals.

NOISE POLLUTION IS CAUSING WHALES AND OTHER MARINE ANIMALS TO BEACH THEMSELVES ON BEACHES THROUGHOUT THE WORLD.

Dead Pilot Whale
Photo: New Zealand Department of Conservation

POTENTIAL BEACHINGS AND INJURIES FROM ACTIVE SONAR

Mass strandings and deaths have occurred in areas where U.S. and other navies have conducted exercises using Military Active Sonar.

"The Navy wants to use sound waves millions of times more intense than is save for divers."

Jean-Michel Cousteau

Photo credit iStockphoto

Almost 200 beached Pilot whales off the east coast of Australia – thought to be caused by military sonar.

IN MARINE ANIMALS, MILITARY ACTIVE SONAR HAS CAUSED tissue damage and bleeding around the ears, eyes, and brain and large bubbles or holes in their organs.

These symptoms indicate decompression sickness – the illness that can kill scuba divers who surface too quickly from deep water.

TOOTHED WHALES, including dolphins and porpoises, possess a special fat-filled organ called a melon near their brains that acts as an "acoustic lens" to direct the animal's sound waves.

Intense military sonar can cause this special organ to begin bleeding and eventually lead to the animal's death.

WHY DOES SONAR CAUSE DECOMPRESSION SICKNESS AND OFTEN BEACHINGS?

To escape the incredibly loud, scary, painful noise and the damaging effects of powerful sonar pulses, marine mammals panic and flee or surface too quickly. Some of them dive repeatedly and rapidly. **Some become disoriented and beach themselves.**

EXAMPLES OF BEACHINGS RELATED TO ACTIVE SONAR

LOCATION	AFTER ACTIVE SONAR TESTING
Since sonar began, globally	There have been 41 cases of mass strandings of Cuvier's beaked whales. There were none before then.
Canary Islands	21 whale strandings linked to U.S. Navy maneuvers.
2000, Bahamas	17 whales stranded themselves (8 of them died) and the population of beaked whales in that region disappeared.
2005, U.S. east coast	At least 34 whales of three species strand. Tissue scans showed hemhorrhaging.
2008, England	At least 60 short-beaked common dolphins stranded.
2010, Scotland	Mass beaching of 33 pilot whales.
2011 study	Kidneys of 21 stranded dolphins contained gas bubbles.

BEAKED WHALES, toothed whales that have elongated beaks, seem to be more acoustically sensitive to active sonar than other species.

POTENTIAL BEACHINGS AND INJURIES FROM SEISMIC SURVEYS

SEISMIC AIR GUNS have:

- Caused whale strandings and displaced whales from critical habitats for feeding and resting.
- Caused mass strandings of giant squid, suffering massive internal injuries and badly damaged ears.
- Caused severe damage to the ears of fish.
- Caused catch rates to plummet, in some cases over large areas of the ocean, threatening fishing industries. Reduced catch rates of 40-80% near seismic surveys have been reported.

Background photo: Michelle Mech

EXAMPLES OF BEACHINGS RELATED TO SEISMIC SURVEYS

LOCATION	AFTER SEISMIC TESTING
2002, Gulf of California	2 Cuvier's beaked whales strand.
2008, Madagascar, Exxon survey	Mass stranding of at least one hundred melon-headed whales
2009, coast of Tasmania, Australia	Multi-species stranding of 189 pilot whales and 10 dolphins. 140 of the whales & 4 of the dolphins died. In the previous weeks, Tasmania had experienced about 540 beachings.
2012, Northern Peruvian coast	Nearly 900 long-beaked dolphins and black porpoises washed ashore. The animals examined had bubbles in their organs and tissues, emphysema, and their middle ears were bleeding and fractured. They likely died from decompression sickness caused by rapid ascent after being scared.

SEISMIC EXPLORATION may be one of the greatest threats to whales and dolphins.

This leaves us with the question – does our need for new oil supplies take precedence over ocean animals' needs for acoustic space in the seas?

Humpback whale beached off the coast of Colima, Mexico, possibly due to noise pollution. It was later rescued.
Humpback whales are particularly sensitive to oceanic noise pollution.

MARINE POLLUTION

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