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Development of Regional Joint Master Program in Maritime Environmental Protection and Management - MEP&M -

Main pollutants in the environment and some tools for their analysis (Part 1)

**WP3. Capacity Building through staff training and equipment purchase .
Dev 3.4.2 KNOW-HOW TRANSFER TO TEACHING STAFF RELATED TO THE
MEP&M**

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20 December 2021**

Virtual meeting via Google-meet application

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Pollution from Maritime Transport



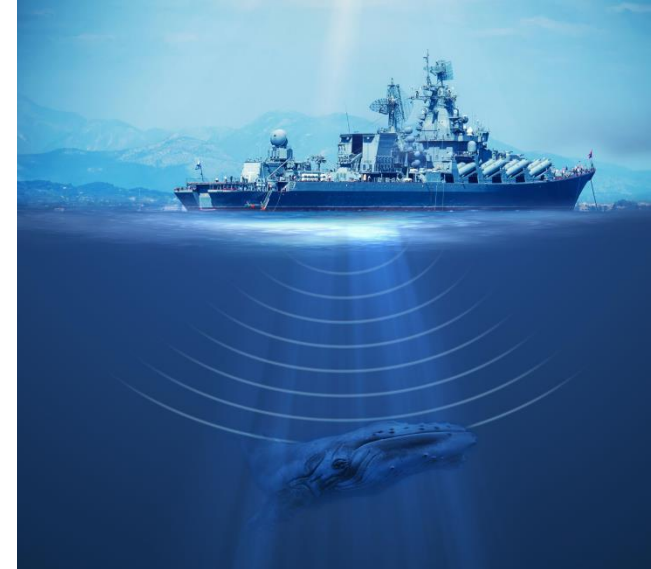
AIR POLLUTION

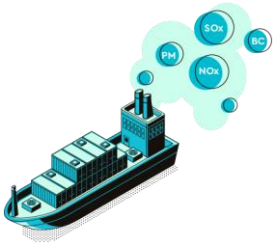


ACOUSTIC POLLUTION



WATER POLLUTION





Air pollution

Air pollution is the presence of substances in the atmosphere that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials.

Ships are responsible for more than 18 percent of some air pollutants.

DID YOU KNOW?

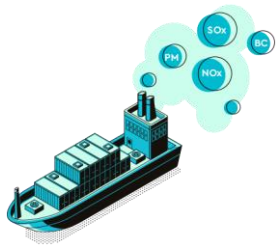
Cruise ships pollute more
than a million cars



The carbon
footprint per
person is worse
than flying

Air quality on the deck is as bad as
the world's most polluted cities





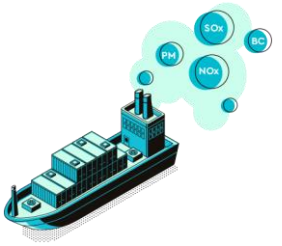
Air pollution

Air pollution from ships is generated by **DIESEL ENGINES** that burn fuel oil producing sulfur dioxide, nitrogen dioxide, carbon monoxide and dioxide, particulate material and hydrocarbons which again leads to the formation of aerosols and secondary chemicals reactions including formations of HCHO (formaldehyde),^lozone etc. in the atmosphere.

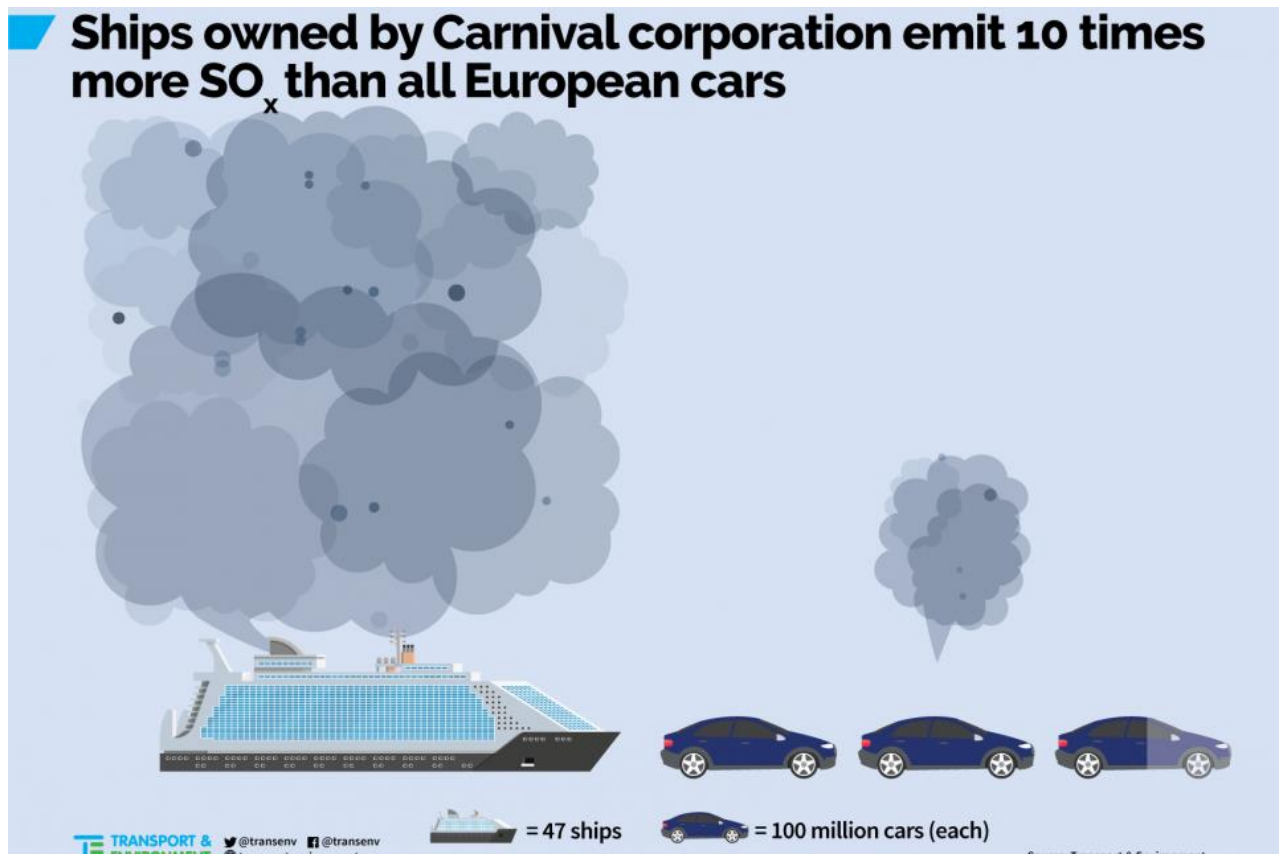


GREENHOUSE POLLUTANTS

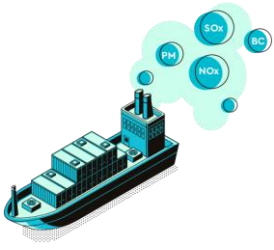
The two main pollutants from the ship's emission are Nitrogen oxides (**NO_x**) and Sulphur oxides (**SO_x**). These gases have adverse effects on the ozone layer in the troposphere area of the earth's atmosphere which results in the green house effect and global warming.



Air pollution



The top European cruise ship company emitted about 10x more sulphur oxide (SOX) in 2017 than did all of Europe's 260 million cars. Spain, Italy, and Greece suffered the most SOX air pollution.

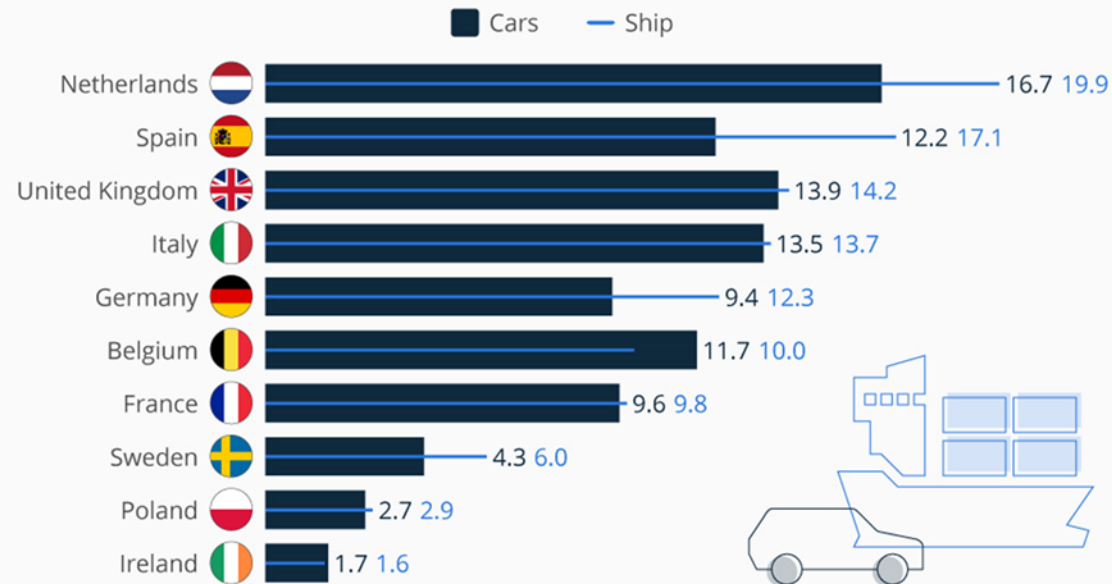


Air pollution

International Maritime Organization (IMO) estimates that carbon dioxide emissions from shipping were equal to 2.2% of the global human-made emissions in 2012 and expects them to rise 50 to 250 percent by 2050 if no action is taken.

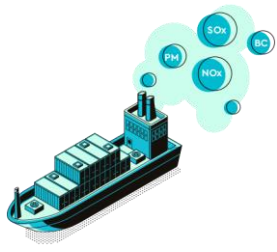
How Maritime Emissions Compare To Cars In Europe

CO₂ emissions from ships vs national car fleets in 2019 (million tons)

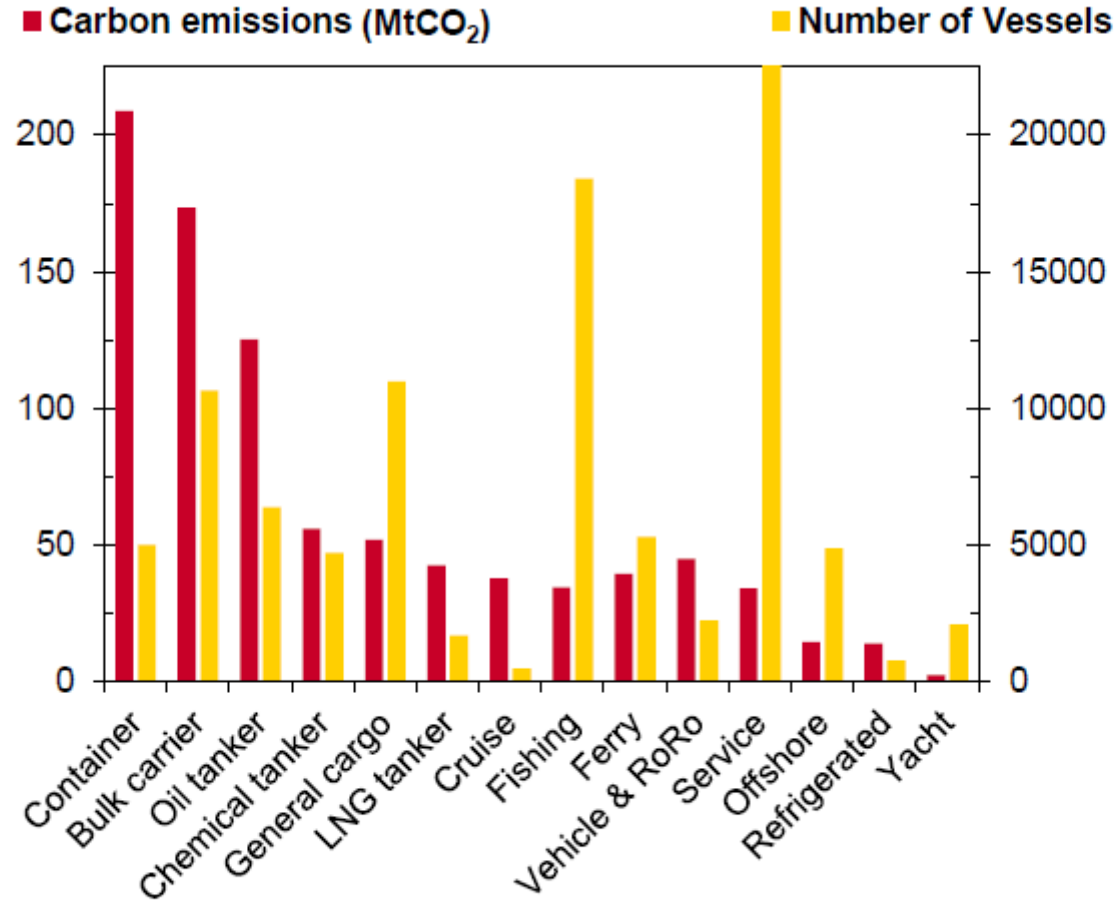


* Selected EU countries. Car fleet data is partial for Spain, UK, Germany, France, Sweden & Ireland and refers to major cities.
©StatistaCharts Source: Transport & Environment

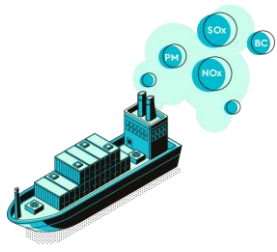




Air pollution



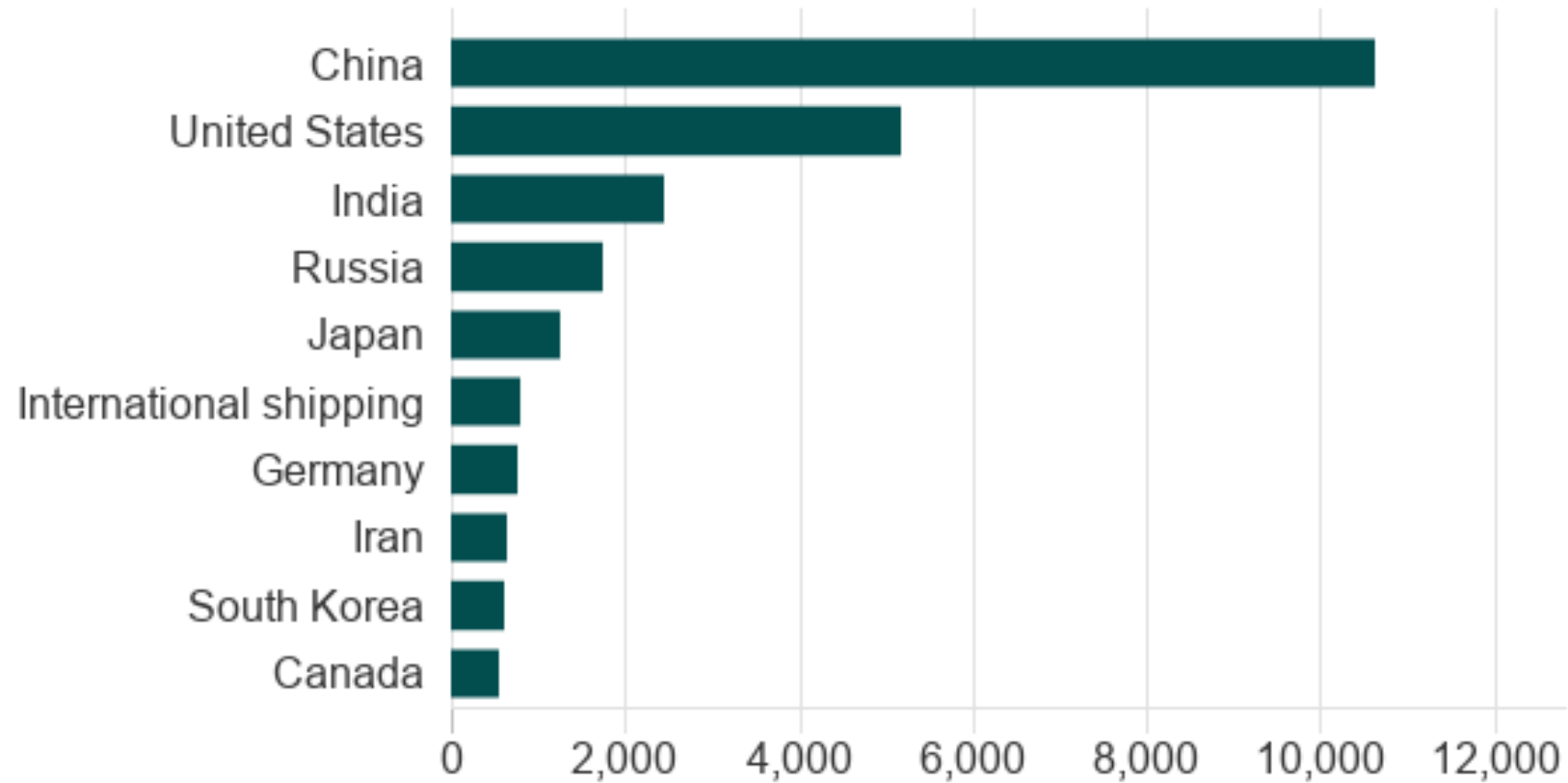
. Number of merchant ships and their carbon emissions, by category in 2017.



Air pollution

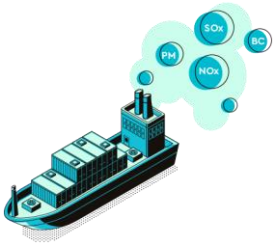
International shipping emissions compared to countries (2015)

■ Carbon dioxide emissions (million tonnes)



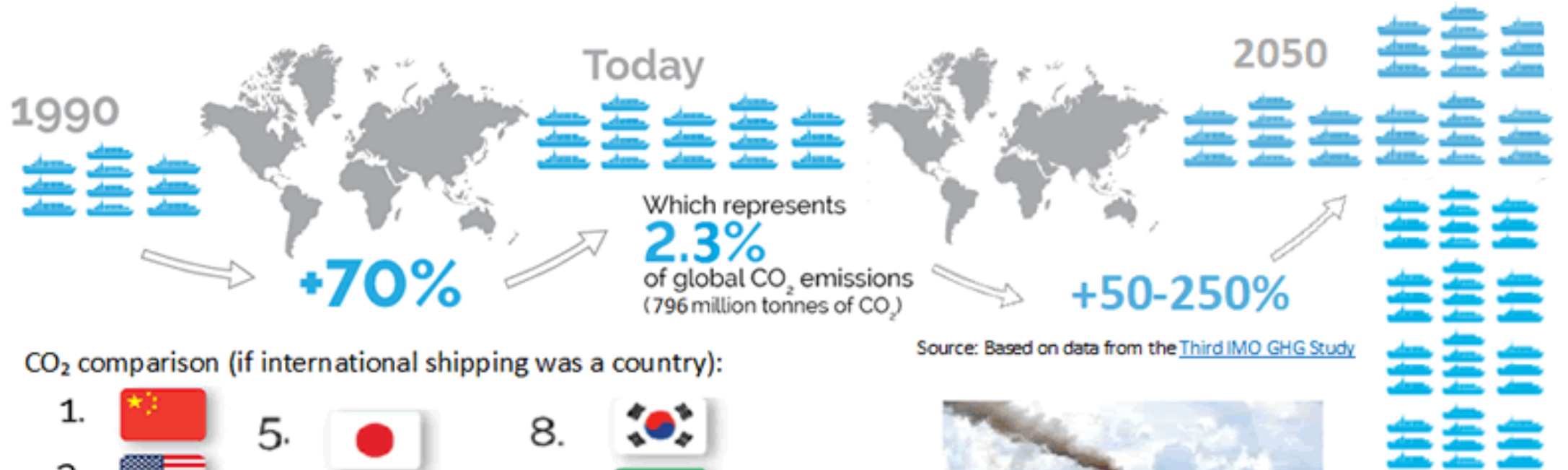
Sources: International Council on Clean Transportation, Netherlands Environmental Assessment Agency





Air pollution

International shipping emissions are the equivalent of Germany's and predicted to increase.

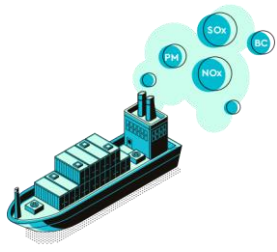


Source: Based on data from the [Third IMO GHG Study](#)

CO₂ comparison (if international shipping was a country):

- | | | |
|----|----|-----|
| 1. | 5. | 8. |
| 2. | 6. | 9. |
| 3. | 7. | 10. |
| 4. | | |

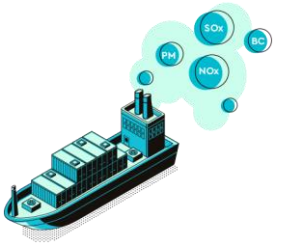




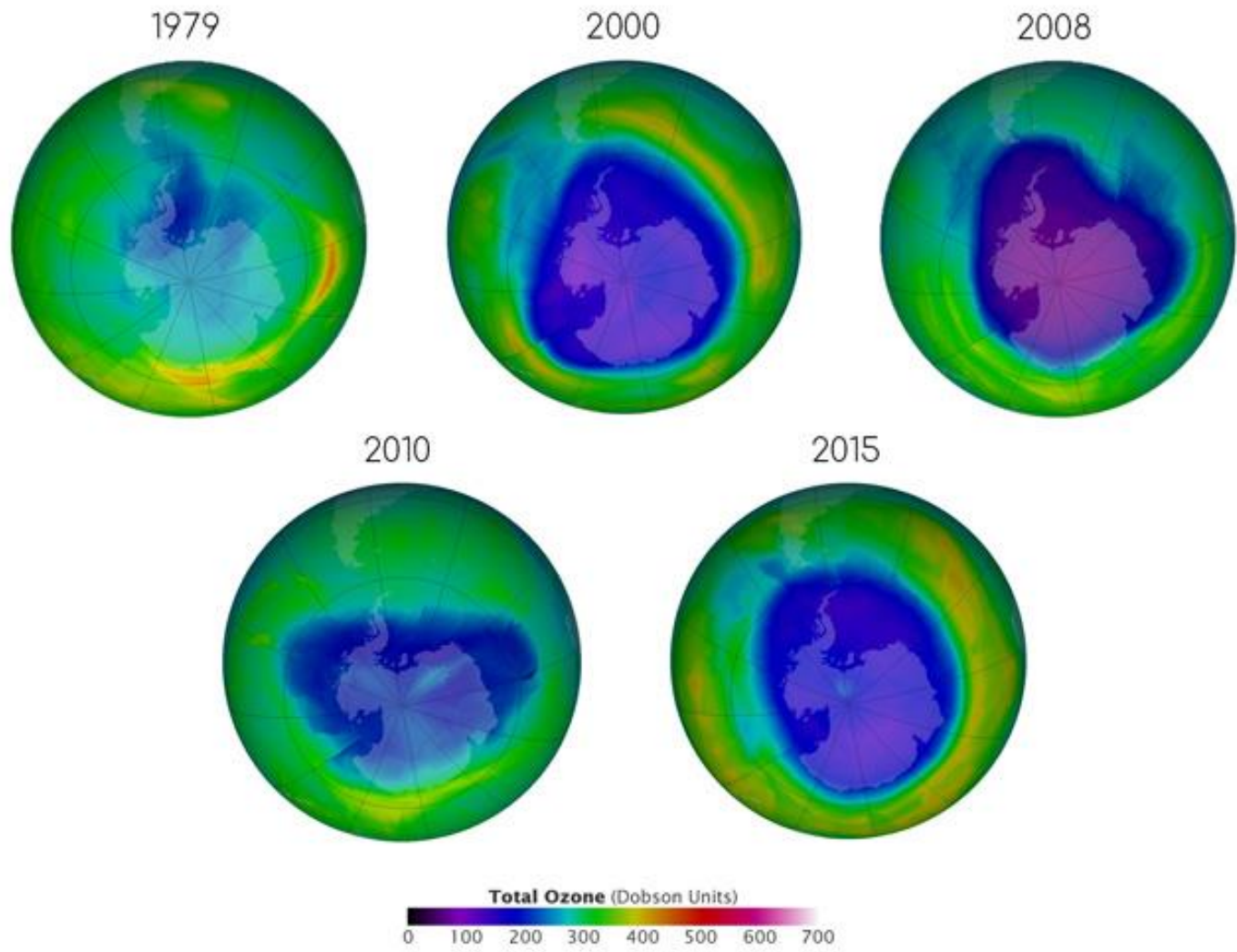
Air pollution

EFFECTS

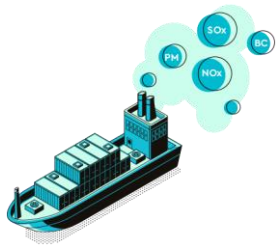
- EPA recognizes that these emissions from marine diesel engines damage the ozone layer, have adverse health effects associated with ambient concentrations of particulate matter and produce acid deposition, eutrophication and nitrification of water.
- Diesel exhaust has been classified by EPA as a likely human carcinogen. Thus, coastal cities like Marseille observe an increase in cancer cases which suggests a possible correlation.



Air pollution



Destruction to the ozone layer (1979-2015)



Air pollution

EFFECTS

Sulphur dioxide (SO₂): Breathed in high concentrations, can cause problems in the respiratory tract. Mixed with water, can generate acid rain.

Nitrous oxides (NO_x): Apart from their effect on health (airways irritation, lung failure, etc.), it has a strong impact on water eutrophication.

Suspended particles: They are hazardous because of their tiny size, since they can reach the deepest areas of the respiratory system and, from there, the blood stream.

AIR POLLUTION

STRESS TO HEART STRESS TO LUNGS ASTHMA SHORTENED LIFE SPAN EYE IRRITATION HARM TO BLOOD

WHO IS MORE AFFECTED

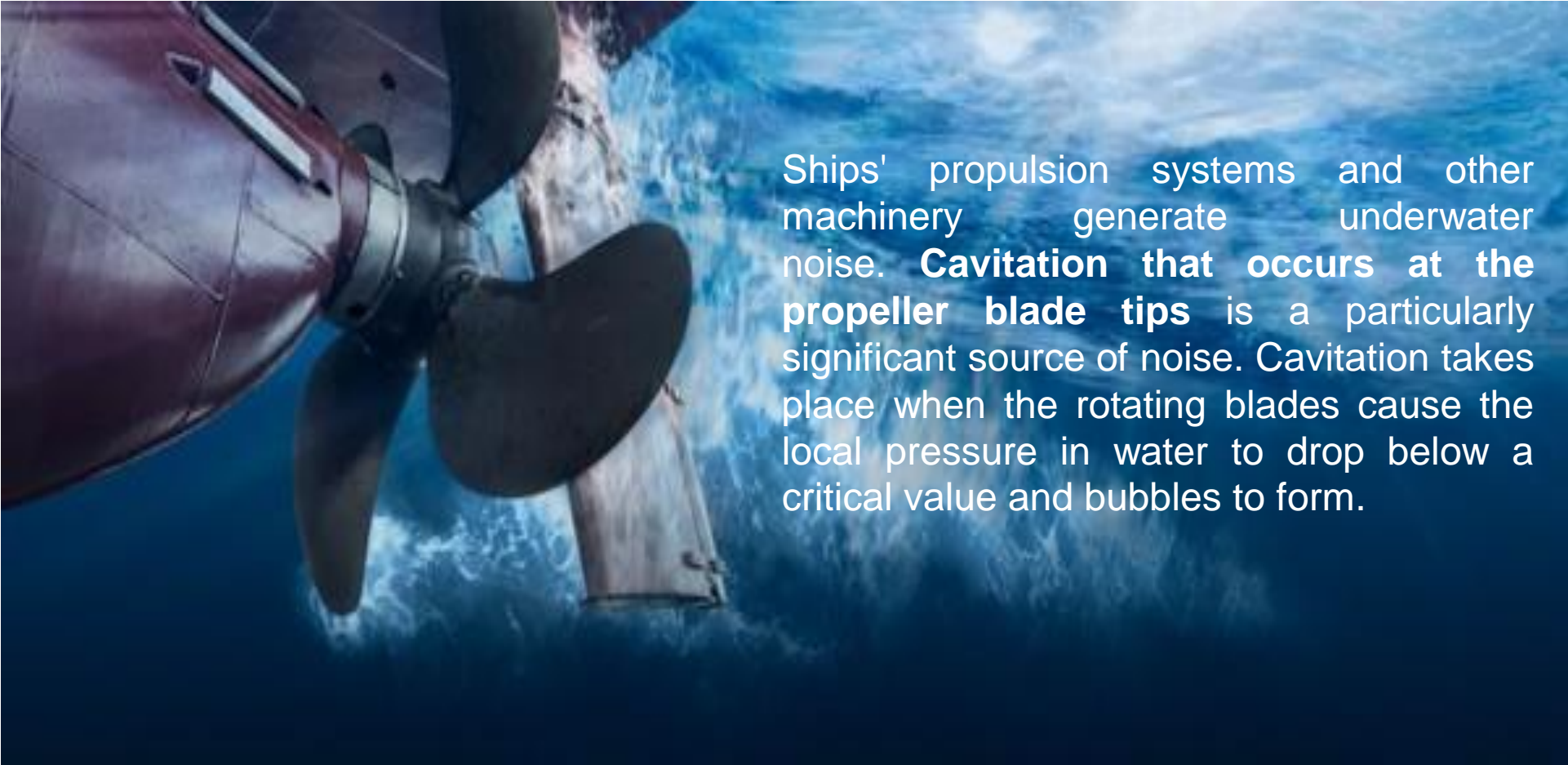
PEOPLE WITH HEART DISEASE PEOPLE WITH LUNG DISEASE PREGNANT WOMEN
CHILDREN UNDER 14 OUTDOOR WORKER ELDERLY PEOPLE

HOW TO PROTECT YOURSELF

RESEARCH POLLUTION LEVEL IN YOUR AREA AVOID HIGH TRAFFIC ROADS WORK OUT IN THE MORNING
AVOID SMOKING EAT FOOD FULL OF VITAMIN C AVOID EXERCISING OUTDOORS



Acoustic pollution



Ships' propulsion systems and other machinery generate underwater noise. **Cavitation that occurs at the propeller blade tips** is a particularly significant source of noise. Cavitation takes place when the rotating blades cause the local pressure in water to drop below a critical value and bubbles to form.



Acoustic pollution

SOURCES OF NOISE

While there are plenty of naturally occurring sounds in the ocean, an increase in commercial vessel traffic is the main reason for increased underwater noise.

Sound travels **4.5 TIMES FASTER** in water than in air.

WHERE VESSEL NOISE COMES FROM

- ENGINE AND ONBOARD MACHINERY
- DRAG FROM POOR HULL MAINTENANCE
- BOW/STERN THRUSTERS
- PROPELLER
- CAVITATION

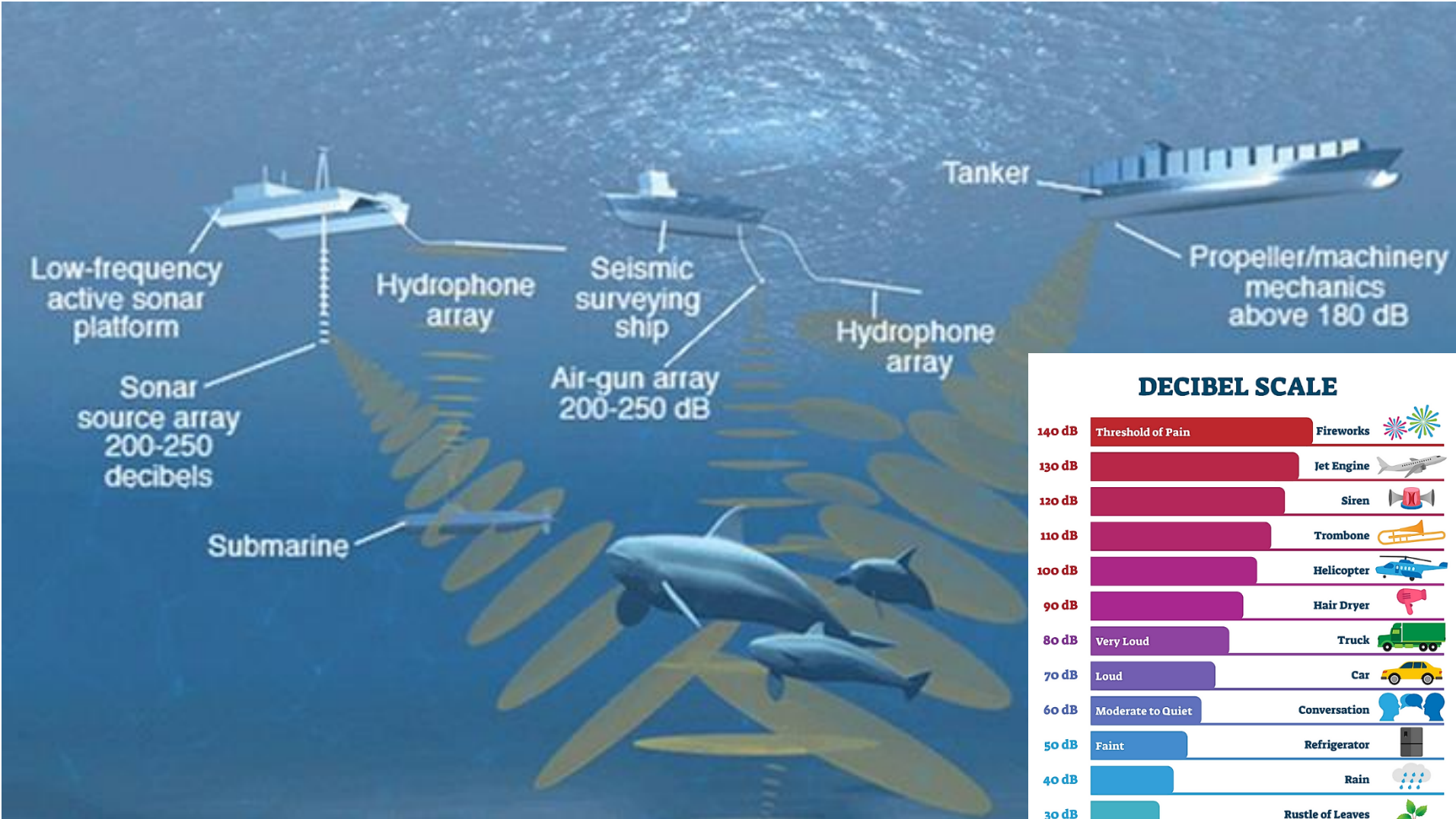
In the North Pacific Ocean, underwater noise has been **DOUBLING** in intensity **EVERY DECADE** for the past **60 YEARS**.

NOISE INCREASES WITH SPEED.

Most underwater noise from large vessels is caused by propeller cavitation.



Acoustic pollution



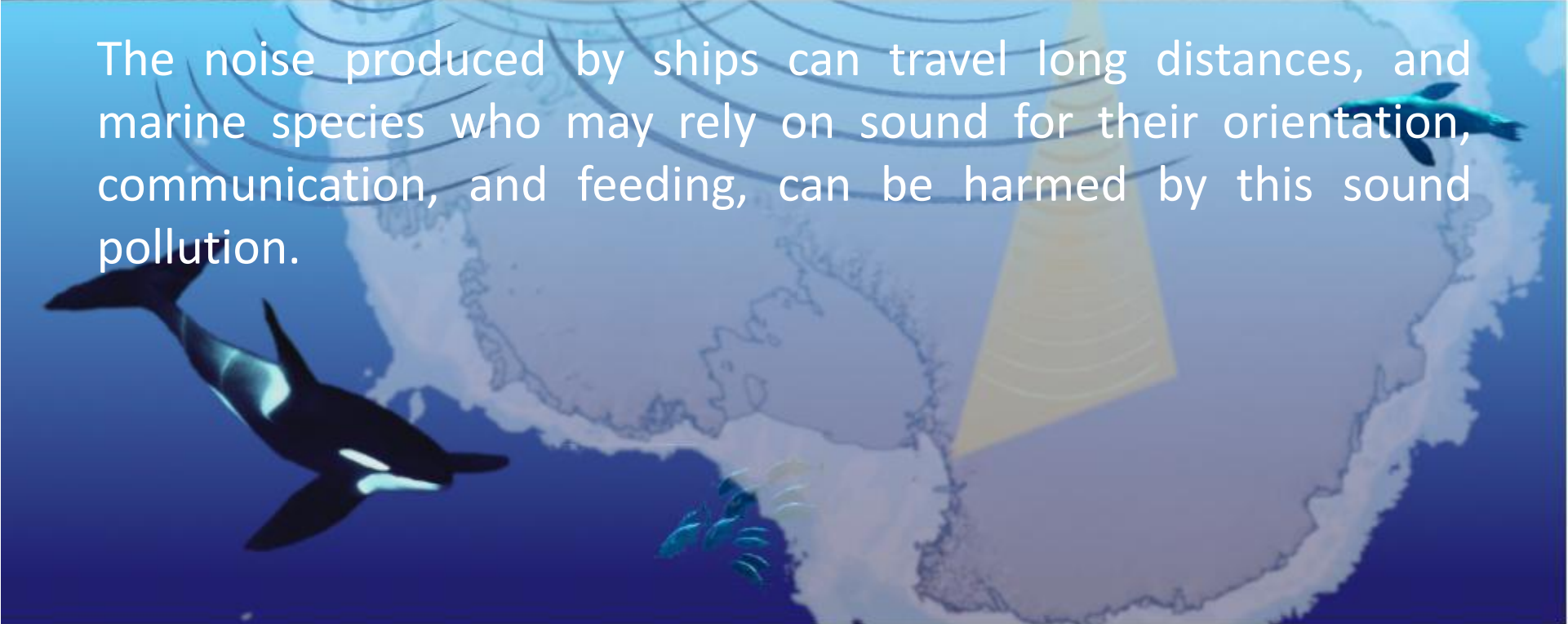
SAFE EXPOSURE LIMIT 85 db FOR 8 HOURS A DAY (HUMAN HEALTH)



Acoustic pollution



The noise produced by ships can travel long distances, and marine species who may rely on sound for their orientation, communication, and feeding, can be harmed by this sound pollution.





Acoustic pollution

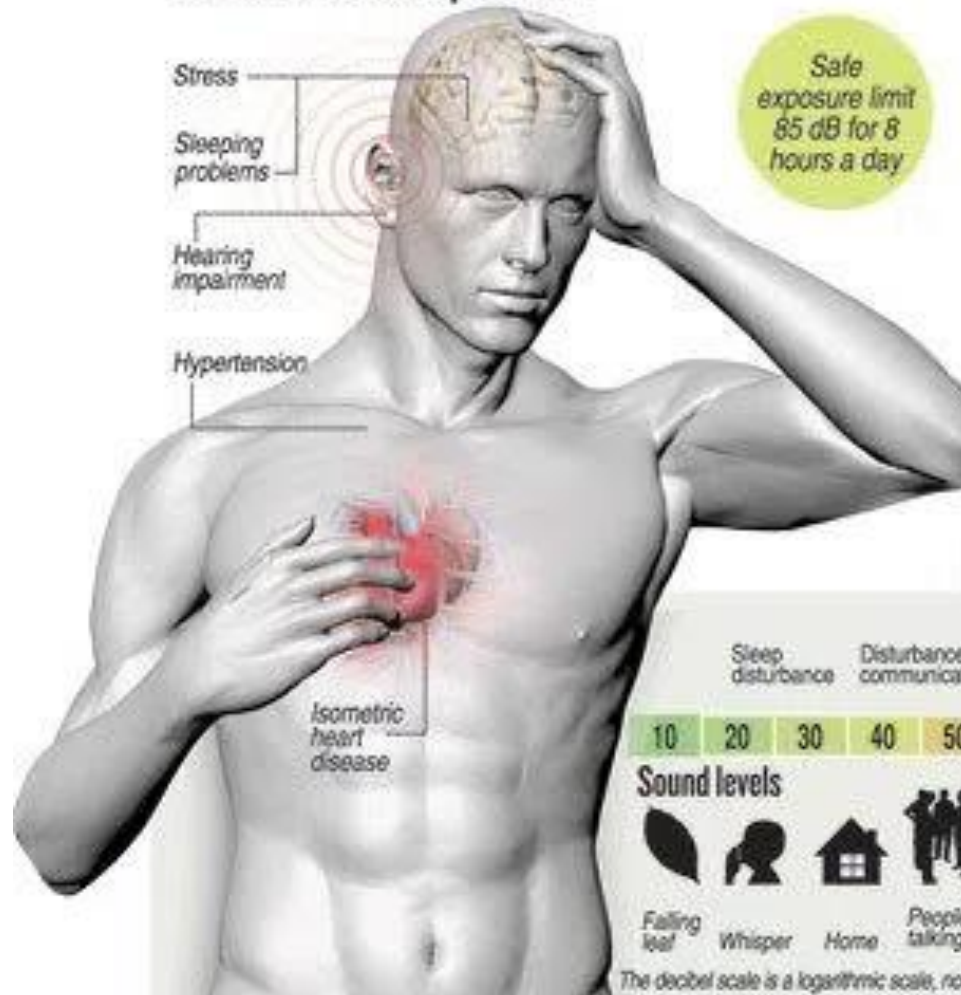
- Whales make sounds to find each other in the immense ocean, while some also use acoustics to navigate and find food.
- Pinnipeds, such as seals and sea lions, also use sound for communication in their marine environment. These sounds may damage animal hearing, reduce their communication space and disturb their natural behaviours.





Acoustic pollution

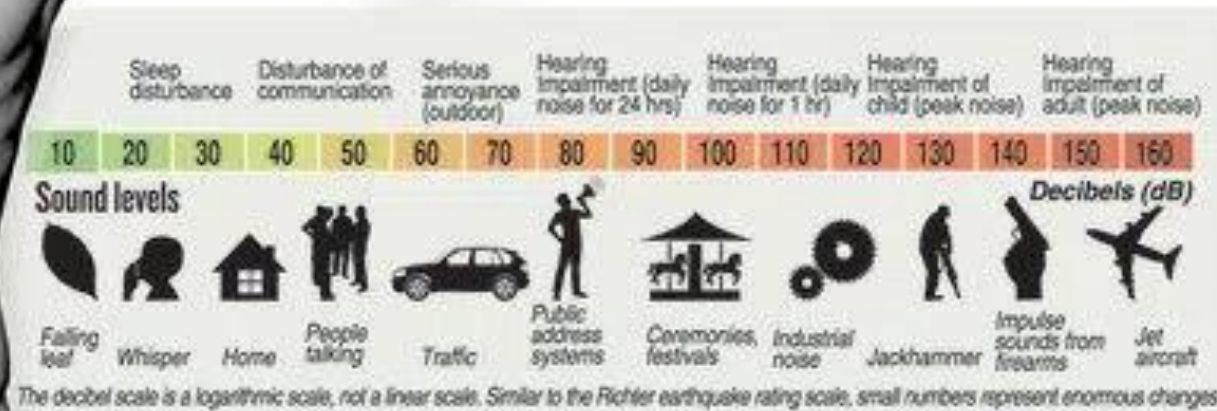
Effects of noise pollution



Effects of Noise on Health

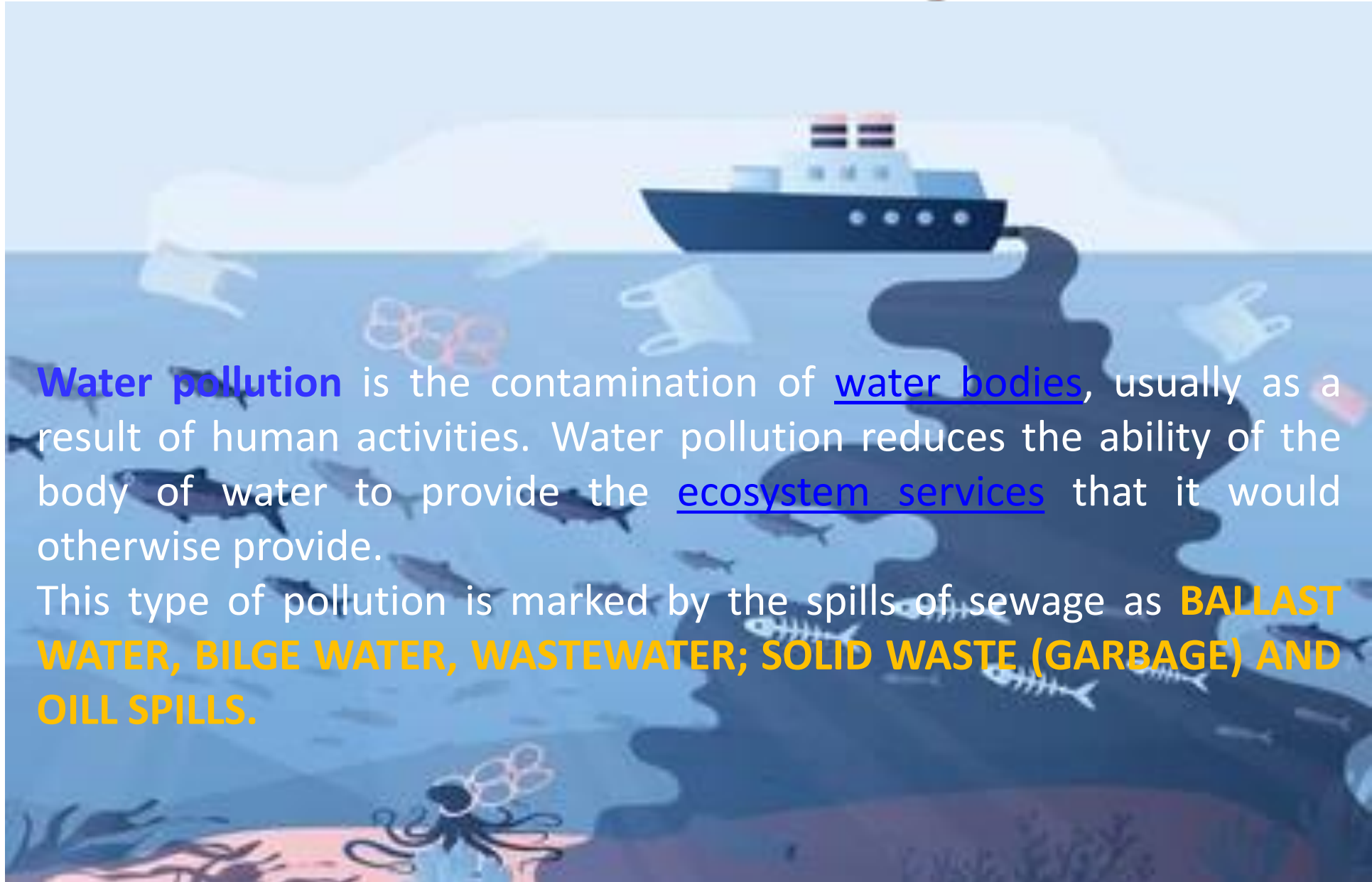
Noise pollution can cause

- Annoyance and Aggression,
- Hypertension,
- High Stress Levels,
- Tinnitus,
- Hearing loss,
- Sleep disturbances,
- Forgetfulness,
- Severe Depression
- Panic Attacks.





Water pollution



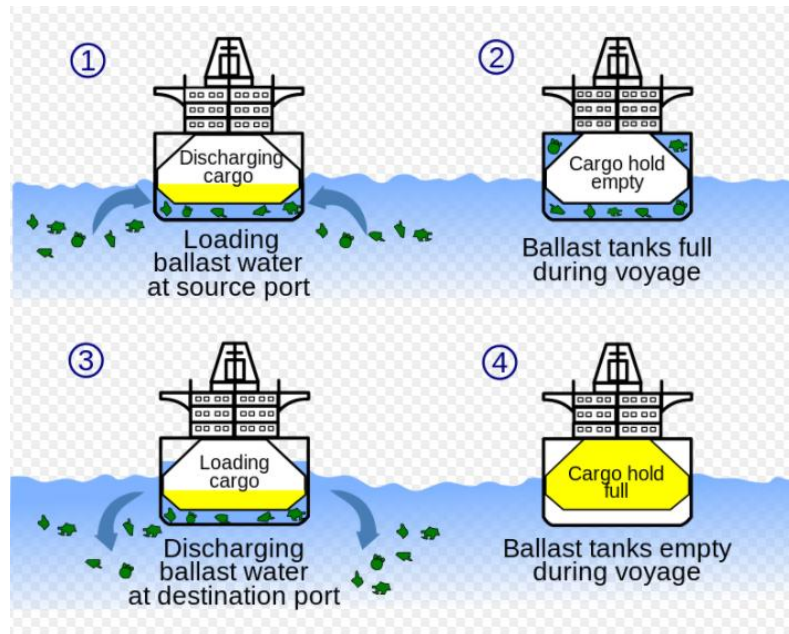
Water pollution is the contamination of water bodies, usually as a result of human activities. Water pollution reduces the ability of the body of water to provide the ecosystem services that it would otherwise provide.

This type of pollution is marked by the spills of sewage as **BALLAST WATER, BILGE WATER, WASTEWATER; SOLID WASTE (GARBAGE) AND OIL SPILLS.**



Water pollution

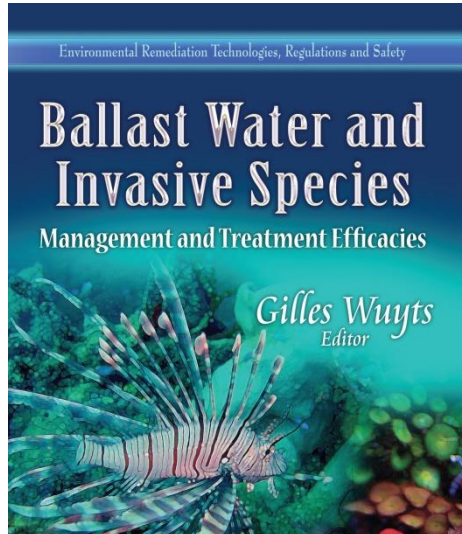
BALLAST WATER discharges. Cruise ships, large tankers, and bulk cargo carriers use a lot of ballast water, which is often taken on in the coastal waters in one region after ships discharge wastewater or unload cargo, and discharged at the next port of call, wherever more cargo is loaded.






Water pollution

Ballast water discharge typically contains a variety of biological materials, including plants, animals, microorganisms... These materials often include exotic species that can cause extensive ecological and economic damage to aquatic ecosystems along with serious human health problems.



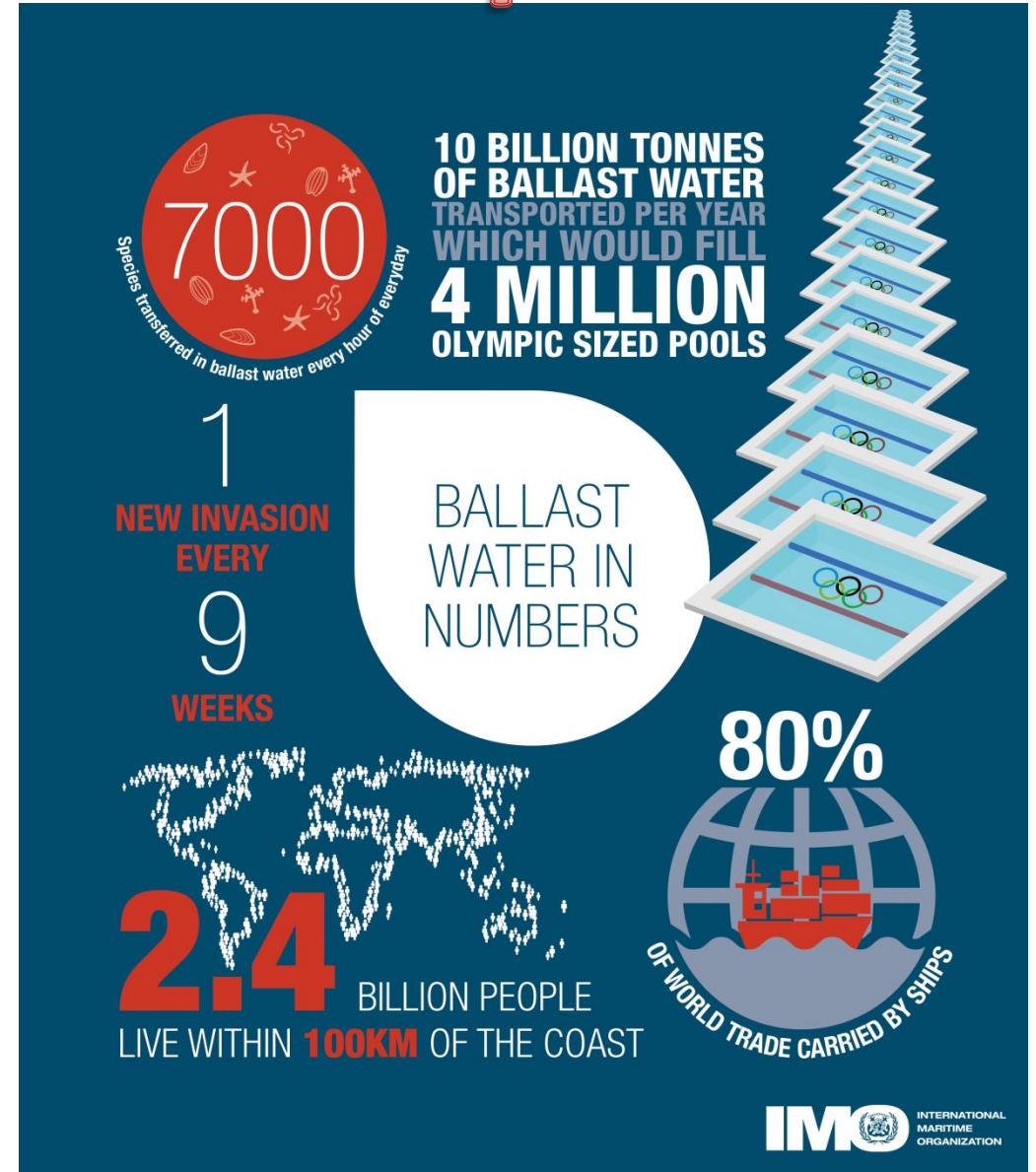
Guidelines for the control and management of ships' ballast water

to minimize the transfer of harmful aquatic organisms and pathogens



INTERNATIONAL MARITIME ORGANIZATION

Water pollution



7000 Species transferred in ballast water every hour of everyday


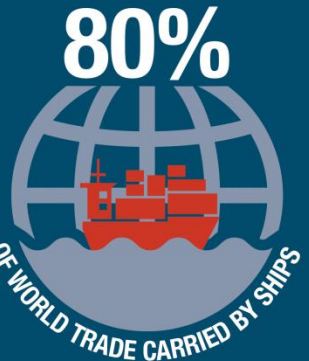

10 BILLION TONNES OF BALLAST WATER TRANSPORTED PER YEAR WHICH WOULD FILL 4 MILLION OLYMPIC SIZED POOLS

1 NEW INVASION EVERY 9 WEEKS

BALLAST WATER IN NUMBERS

2.4 BILLION PEOPLE LIVE WITHIN **100KM** OF THE COAST

80% OF WORLD TRADE CARRIED BY SHIPS

INTERNATIONAL MARITIME ORGANIZATION



Water pollution

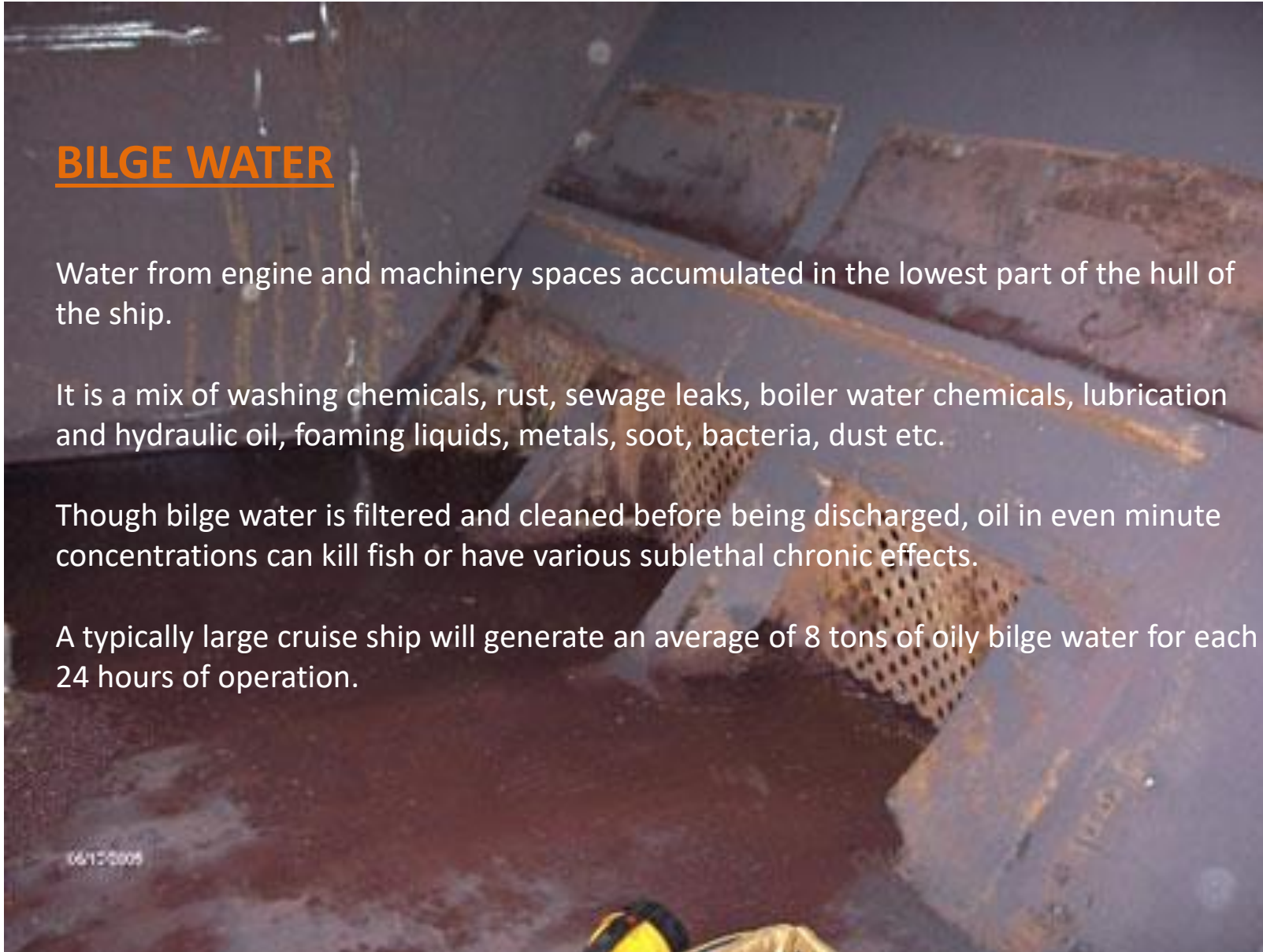
BILGE WATER

Water from engine and machinery spaces accumulated in the lowest part of the hull of the ship.

It is a mix of washing chemicals, rust, sewage leaks, boiler water chemicals, lubrication and hydraulic oil, foaming liquids, metals, soot, bacteria, dust etc.

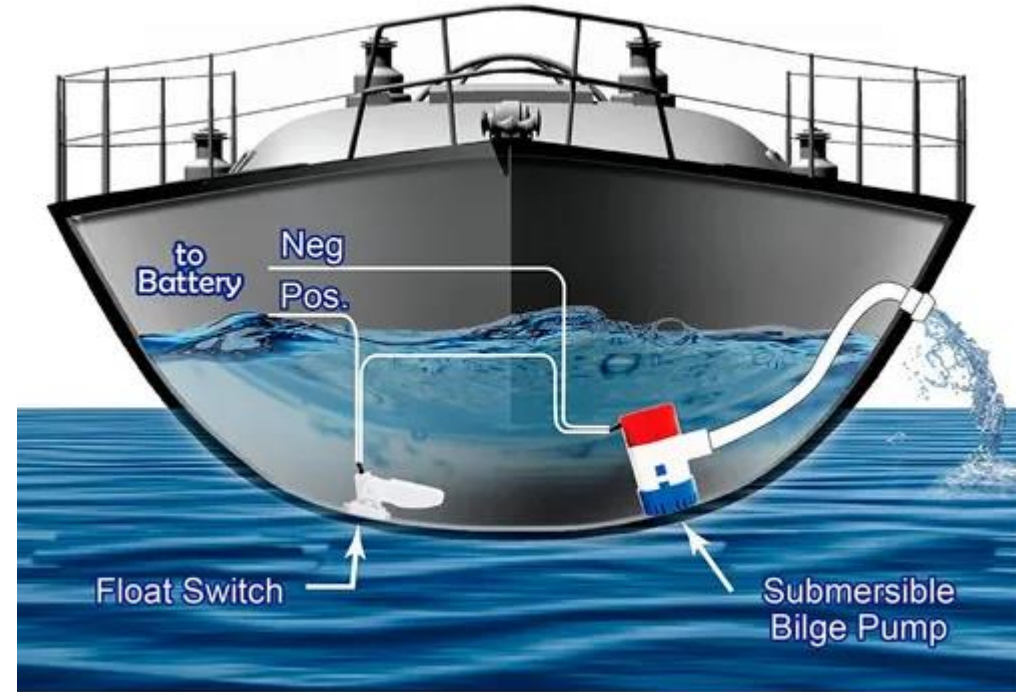
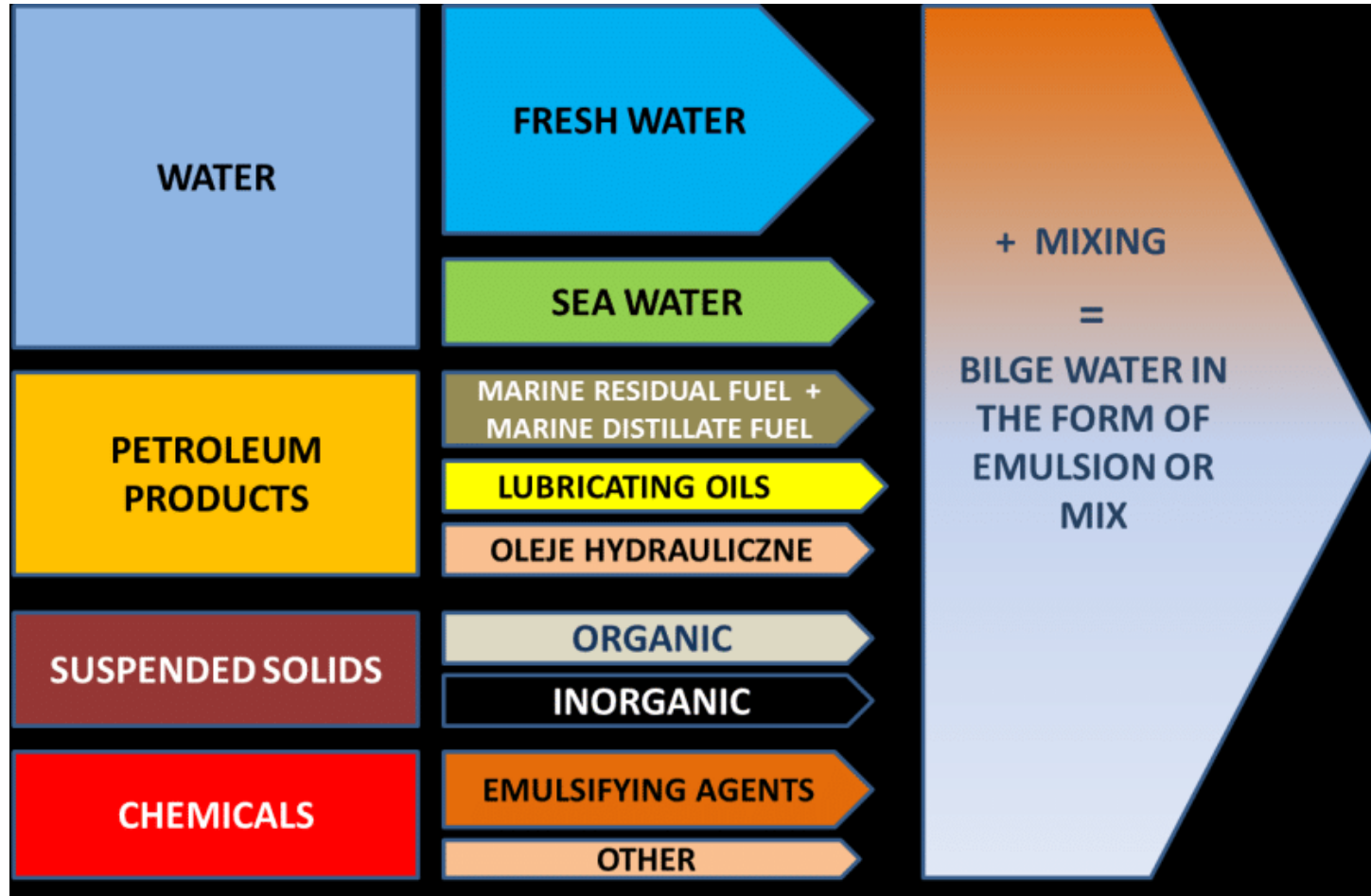
Though bilge water is filtered and cleaned before being discharged, oil in even minute concentrations can kill fish or have various sublethal chronic effects.

A typically large cruise ship will generate an average of 8 tons of oily bilge water for each 24 hours of operation.





Water pollution





Water pollution



WASTE WATER

Waterborne waste generated from a variety of processes on board.

The cruise line industry dumps 970,000 litres (255,000 US gal) of **greywater** and 110,000 liters (30,000 US gal) of **blackwater** into the sea every day.



Water pollution

BLACKWATER is the wastewater from toilets and medical facilities, which can contain harmful pathogens and harmful nutrients.

Discharges of untreated or inadequately treated blackwater can cause bacterial and viral contamination of fish and shellfish producing risks to public health.

Nutrients promote algal blooms which consumes oxygen and can lead to destruction of the aquatic life.

A large cruise ship (3,000 passengers and crew) generates an estimated 55,000 to 110,000 liters per day of blackwater waste.





Water pollution

GREYWATER is wastewater from the sinks, showers, galleys, laundry and cleaning activities aboard a ship. It can contain a variety of pollutant substances, including fecal coliforms, detergents, oil, metals, organic compounds, PAHs, nutrients etc.

Greywater has potential to cause adverse environmental effects because of concentrations of nutrients and other oxygen demanding materials.

Greywater is the largest source wastewater generated by cruise ships (90 to 95 percent of the total). Estimates of greywater range from 110 to 320 liters per day per person, or 330,000 to 960,000 liters per day for a 3,000-person cruise ship.





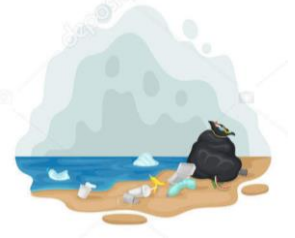
Water pollution

SOLID WASTE



Solid waste generated on a ship includes paper, glass, steel and plastics: **MARINE DEBRIS**.

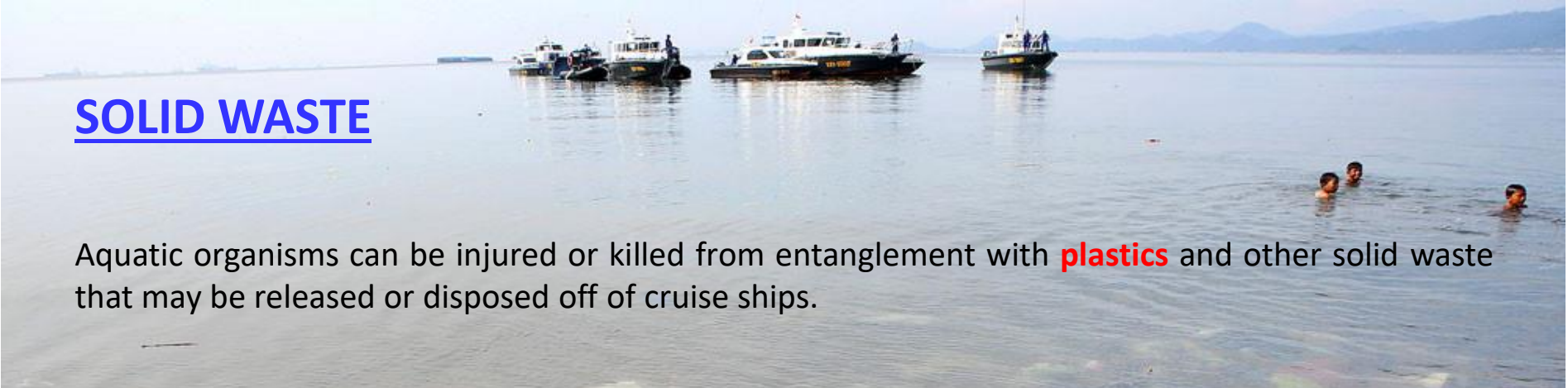
About 8 tons of solid waste are generated during a one-week cruise.



Water pollution

SOLID WASTE

Aquatic organisms can be injured or killed from entanglement with **plastics** and other solid waste that may be released or disposed off of cruise ships.





Water pollution

OIL SPILLS

Most commonly associated with ship pollution are OIL SPILLS

Oil spills are rare but have devastating effects. Toxic to marine life, PAHs, the components in the crude, are very difficult to clean up, and last for years in the sediment and marine environment.





Water pollution

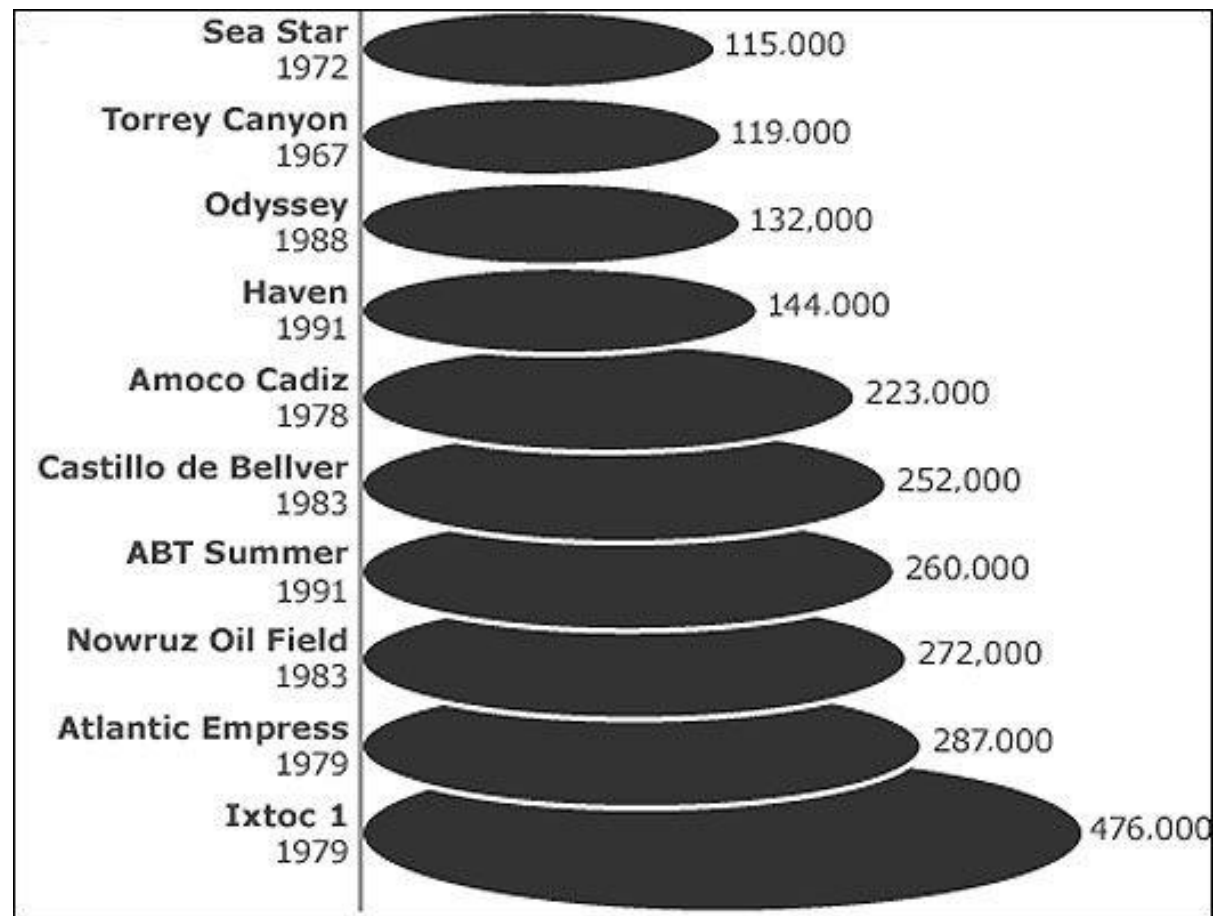
The 10 largest oil spills in history



Exxon Valdez (1989, Alaska)
37000 tons of crude



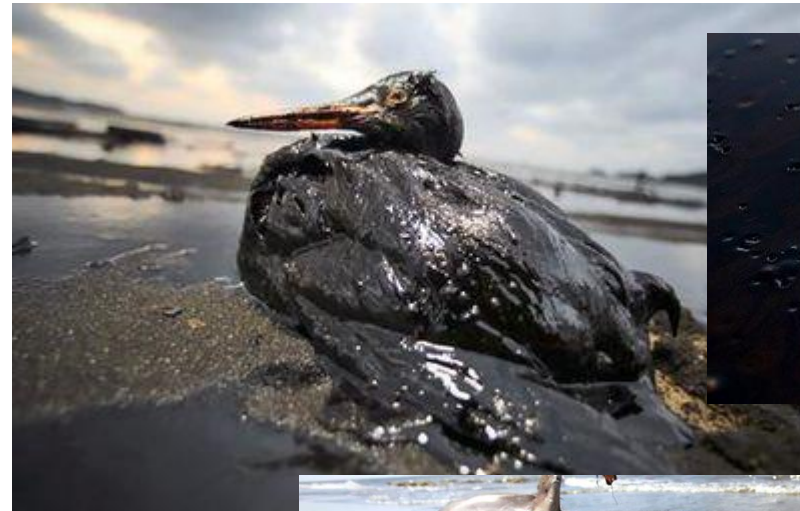
Prestige (2002, Spain)
20000 tons of crude





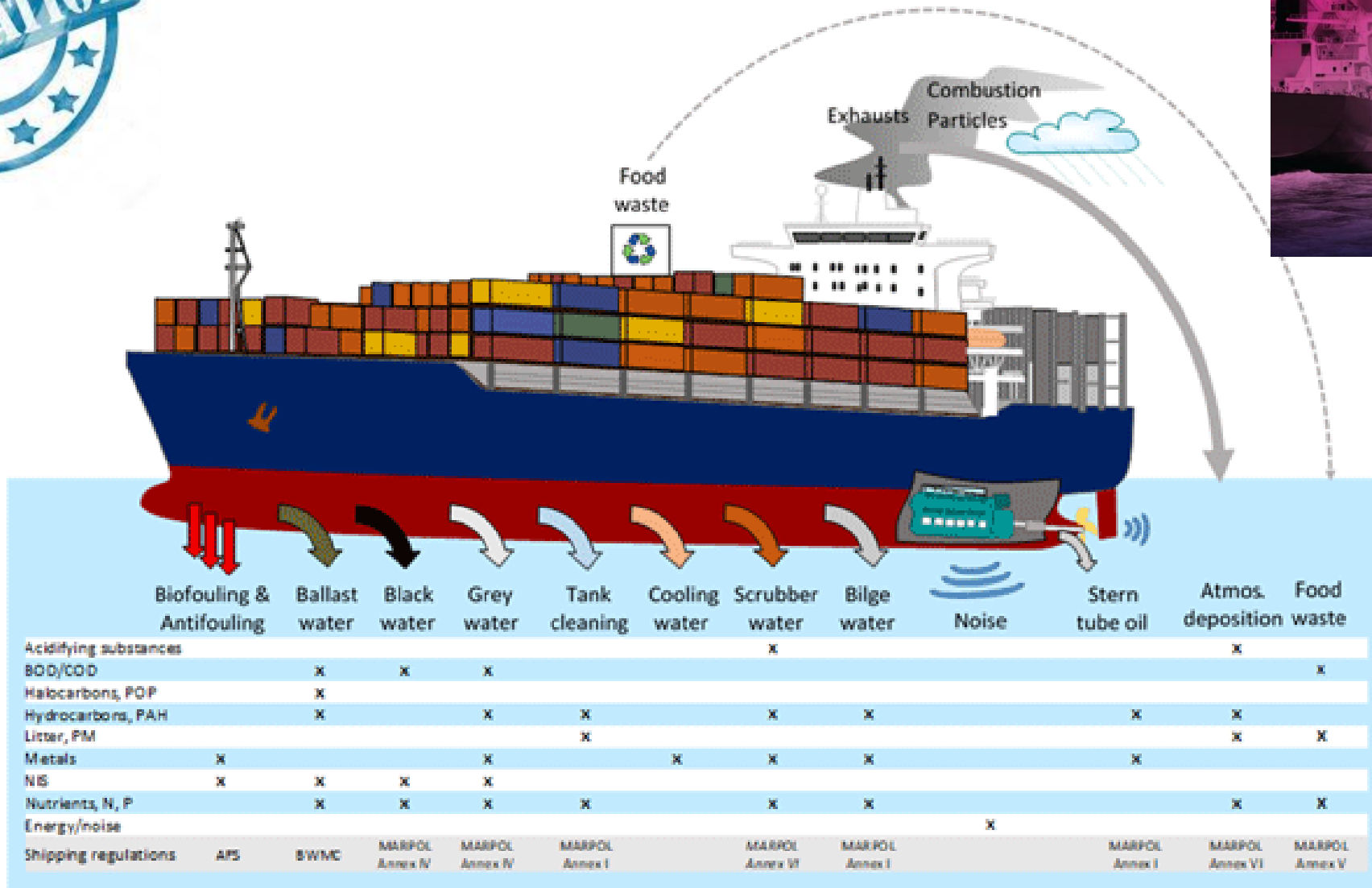
Water pollution

Marine species exposed to PAHs can exhibit developmental problems, susceptibility to disease, and abnormal reproductive cycles.



REGULATION



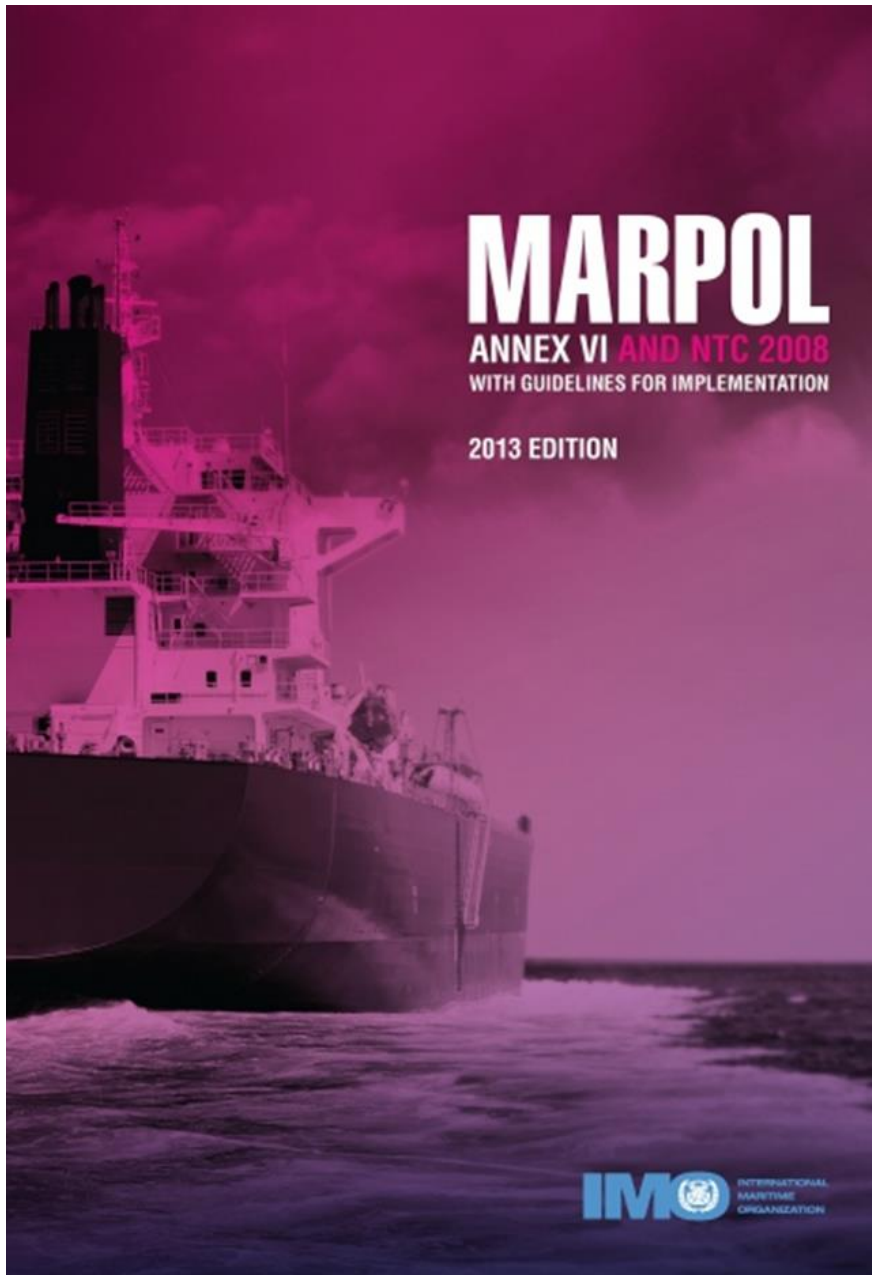


REGULATION FOR AIR POLLUTION (ANNEX IV)

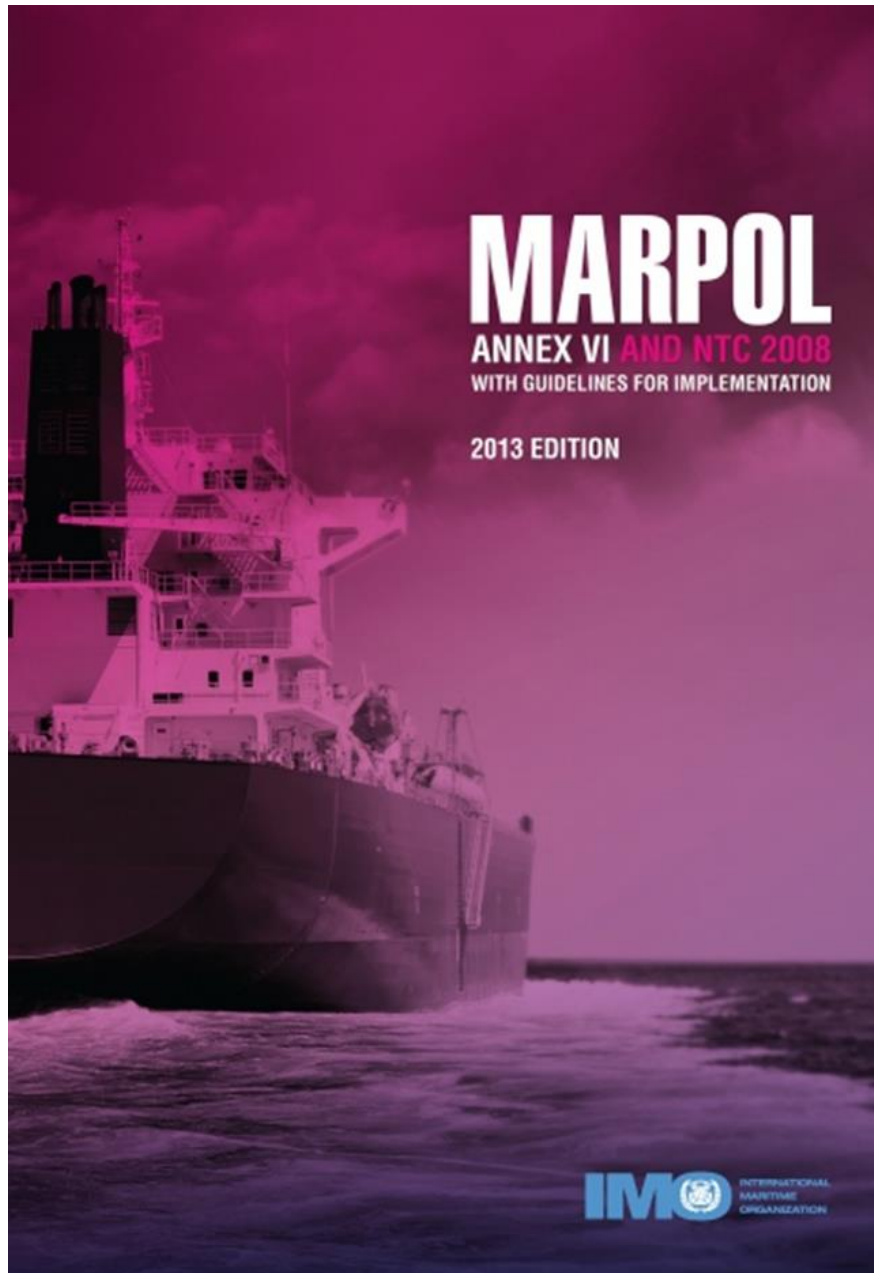
MARPOL Annex VI, first adopted in 1997, limits the main air pollutants contained in ships exhaust gas, including sulphur oxides (SO_x) and nitrous oxides (NO_x), regulates shipboard incineration, and the emissions of volatile organic compounds (VOC) from tankers.

On 2005, the Marine Environment Protection Committee agreed to revise MARPOL Annex VI with the aim of significantly strengthening the emission limits in light of technological improvements and implementation experience.

Under the revised MARPOL Annex VI, the global sulphur limit will be reduced from current 3.50% to 0.50%, effective from 1 January 2020, subject to a feasibility review to be completed no later than 2018. Progressive reductions in NO_x emissions from marine diesel engines installed on ships are also included.



REGULATION FOR BILGE WATER POLLUTION (ANNEX I)



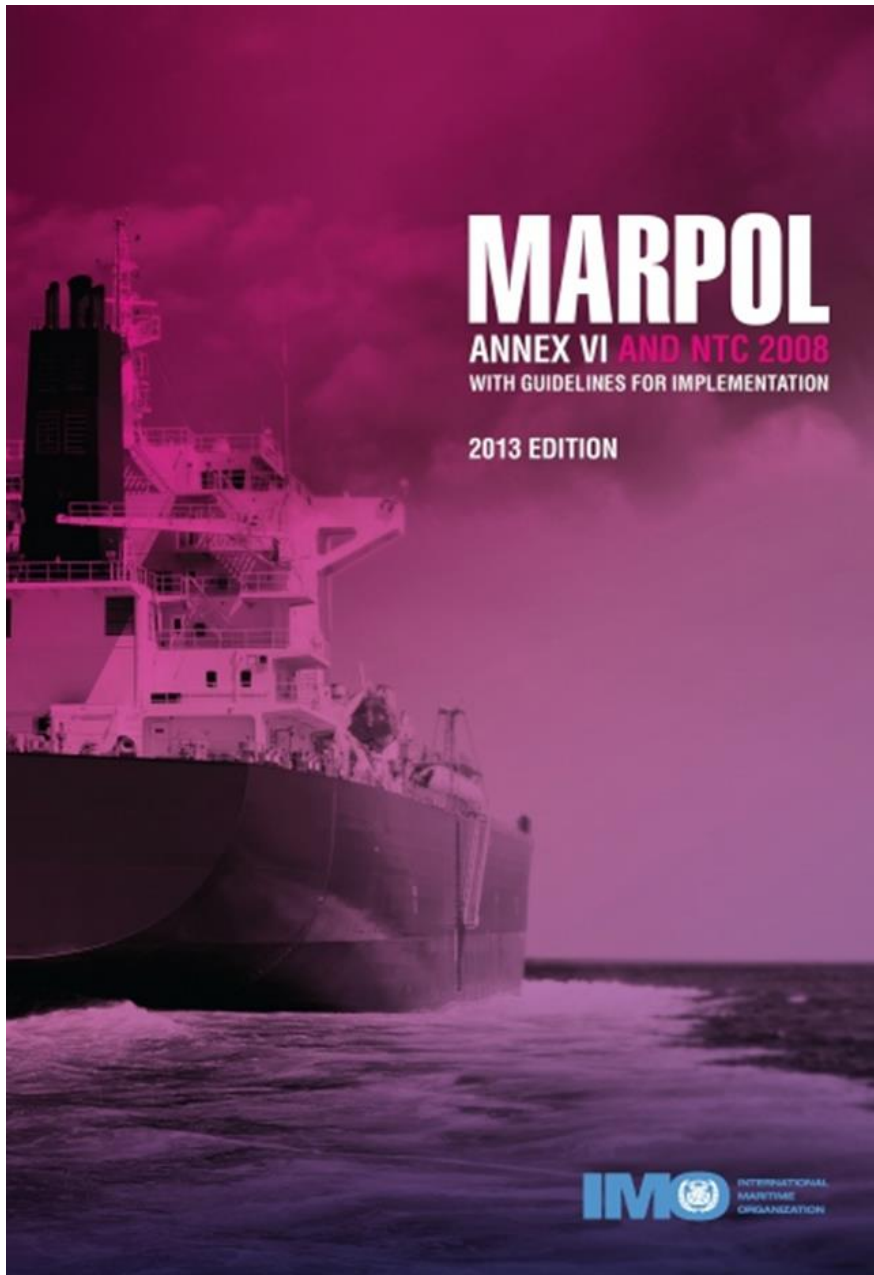
As far as operational oil pollution is concerned, the many innovations introduced by MARPOL on allowable **discharges of bilge water through the oily water separator (with the well-known 15ppm standard), or oily waters from the cargo tanks, through the oil discharge and monitoring system,** have contributed greatly to a noticeable decrease in the pollution of the world's seas, though it is fair to recognize that a greater effort to impose compliance must be carried out.

REGULATION FOR WASTEWATER POLLUTION (ANNEX IV)

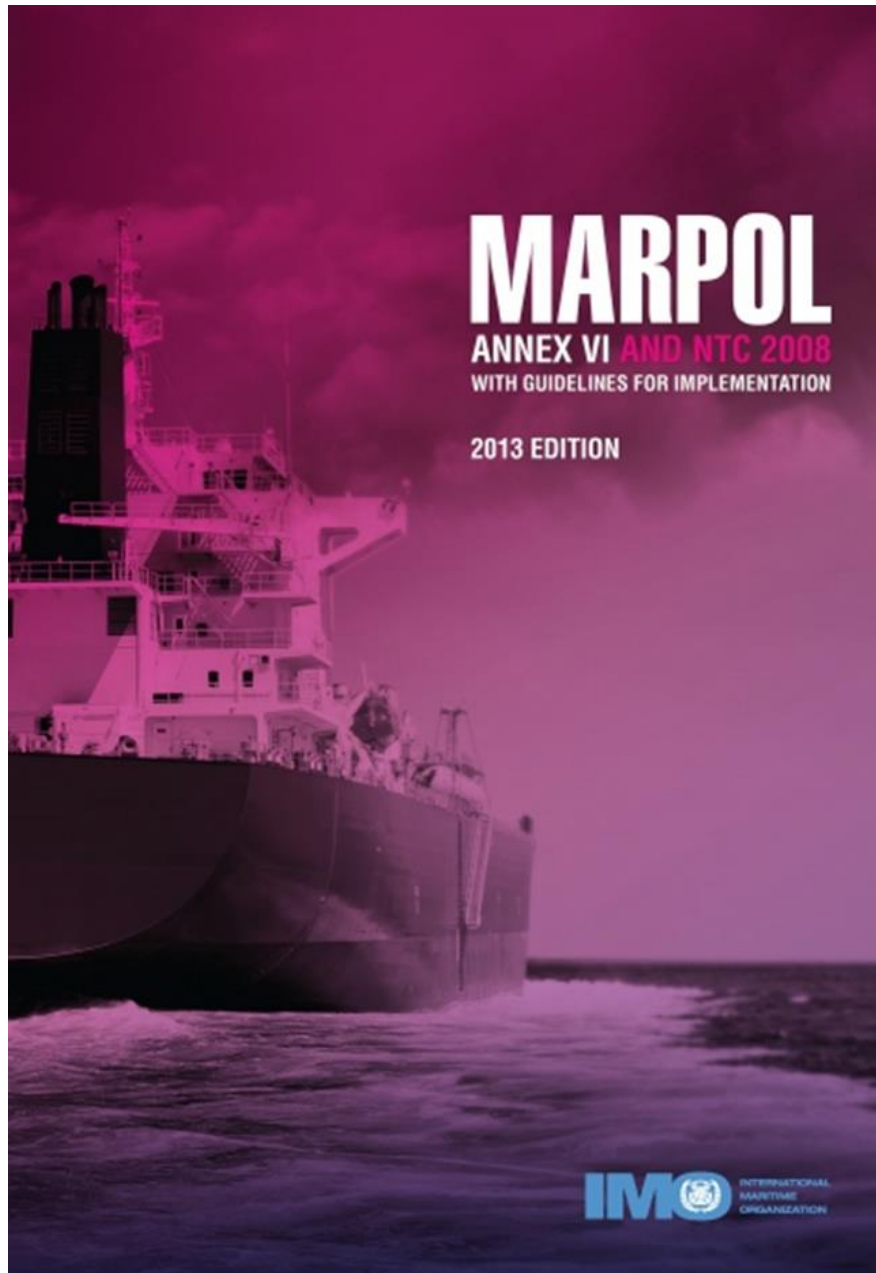
Annex IV contains a set of regulations regarding the discharge of sewage into the sea from ships, including regulations regarding the ships' equipment and systems for the control of sewage discharge, the provision of port reception facilities for sewage, and requirements for survey and certification.

The revised Annex applies to ships, engaged in international voyages, of 400 gross tonnage and above or which are certified to carry more than 15 persons. The Annex requires ships to be equipped with either an approved sewage treatment plant or an approved sewage comminuting and disinfecting system or a sewage holding tank.

The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land.



REGULATION FOR SOLID WASTE (ANNEX V)



MARPOL Annex V seeks to eliminate and reduce the amount of garbage being discharged into the sea from ships

MARPOL Annex V generally prohibits the discharge of all garbage into the sea, except as provided otherwise in regulations 4, 5, and 6 of the Annex, which are related to food waste, cargo residues, cleaning agents and additives and animal carcasses.

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¡GRACIAS! Thank you
Faleminderit Hvala.

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