OUR OCEANS AND THE IMPACTS OF PLASTIC DEBRIS

NEREIDA MARINE EDUCATION

May 2015

For years, people have been treating the oceans like giant garbage dumps, assuming that the oceans are so large that all debris would disappear. But in reality, it has not disappeared and now . . .

ONE OF THE MOST COMMON POLLUTANTS IN OUR OCEANS IS PLASTIC

and plastic in the oceans is one of the biggest issues facing our planet.

It threatens marine life at every level of the food chain – from whales to birds to the fish that end up on our plates.

MARINE DEBRIS, PARTICULARLY PLASTICS, IS NOW FOUND EVERYWHERE IN THE MARINE ENVIRONMENT.

- Throughout the entire world's oceans
  - from the ocean surface, through the water column, and down to the ocean floor
  - from the equator to polar regions.
- On beaches around the world
  - from populated regions to the shores of remote, uninhabited islands.

Out of 700 sea water samples from all over the world, only three were plastic free.

Algalita Marine Research Foundation, 2014

Background photo: Michelle Mech

WHAT IS PLASTIC

Plastic is the common term for a wide range of man-made, synthetic or semi-synthetic materials used in a huge and growing range of applications, including:

- packaging and food containers,
- cookware, plates, cups, cutlery,
- shopping bags,
- toothbrushes, combs,
- cases for computers, iPods, and cellphones, DVDs,
- toys, balloons, straws,
- clothes
- fishing gear,
- buildings, appliances,
- cars and car parts,
- pipes, and
- medical devices.

PLASTICS AND OIL

Most plastic is made from crude oil, a non-renewable resource.

8% of the world's oil is used for plastic production.

Imagine a water bottle filled ¼ full of oil – that's how much oil is used in bottle production, water processing and shipping of bottled water!

PLASTIC PRODUCTION

NURDLES

Before plastics are molded into the products we use, they are first produced as plastic resin pellets the size of rice grains – about 2-6 mm in diameter.

Nurdles are heated up, treated with other chemicals, stretched and moulded into plastic products.

Over 113 billion kilograms of these preproduction nurdles are produced and transported around the world every year.

PEOPLE USE A HUGE AMOUNT OF PLASTIC.

For example, approximately 500 billion plastic bags are used worldwide each year – that's 1 million bags every minute!

Almost 300 million tonnes of plastic is produced worldwide each year.

Half of this will be used just once and thrown away!

Photo courtesy Judith and Richard Lang

GLOBALLY, ONLY 3.5% OF PLASTIC IS RECYCLED IN ANY WAY!

"PLASTICS, LIKE DIAMONDS, ARE FOREVER"

Capt. Charles Moore, founder of the Algalita Marine Research Foundation

Plastic is lightweight, flexible, durable and inexpensive to produce. It can also be chemical resistant, moisture resistant, and very strong.

The problem is that the molecular bonds that give plastics their desirable qualities also make them resistant to natural breakdown.

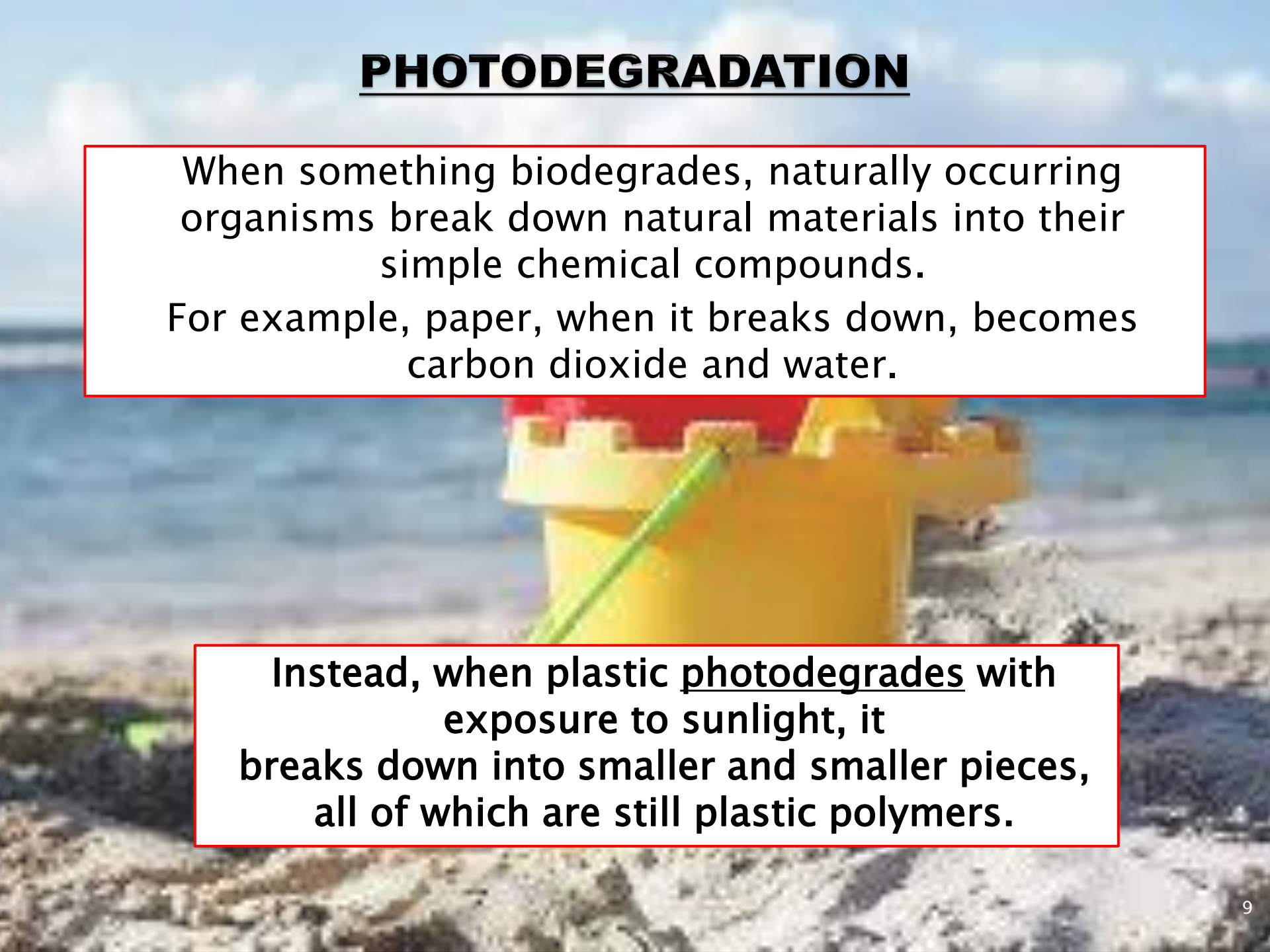
Therefore, PLASTIC DOES NOT BIODEGRADE ON ANY PRACTICAL TIME SCALE

- INSTEAD IT PHOTODEGRADES -

PHOTODEGRADATION

When something biodegrades, naturally occurring organisms break down natural materials into their simple chemical compounds.

For example, paper, when it breaks down, becomes carbon dioxide and water.



Instead, when plastic photodegrades with exposure to sunlight, it breaks down into smaller and smaller pieces, all of which are still plastic polymers.

Plastic can eventually be broken down to pieces the size of sand or even powder. **However, no matter how small the pieces, they are still plastic.**

The more plastic we produce, use, and discard, the more we have to live with.

"Except for a small amount that's been incinerated, every bit of plastic manufactured in the world for the last 50 years or so still remains. It's somewhere in the environment."

Anthony Andrady, senior research scientist

WE SEE PLASTIC THAT IS LABELLED BIODEGRADABLE, COMPOSTABLE, DEGRADABLE – WHAT DOES THAT REALLY MEAN?

Truly **biodegradable plastic** will biodegrade in natural environments (marine, fresh water, soil) or in active landfills. It is usually plant-based and derived from renewable raw materials such as corn starch, but it is not in wide use. There are standards for this plastic, but no regulations to enforce them, so over 50% of products that claim to be biodegradable actually aren't.

Compostable plastic will biodegrade only in compost, and in most cases, only in the controlled conditions of commercial compost facilities, not in home composts.

Therefore, a plastic may be biodegradable in compost or landfill, but not biodegradable in the natural or marine environment and vice-versa.

Degradable , oxo-degradable or oxo-biodegradable plastic (commonly used for plastic bags) is typically conventional plastic with metal salts added to cause fragmentation, causing it to break down faster than normal plastic.

It takes years to fully degrade. In the meantime, the resulting fragments of plastic, which remain in the environment, can be more harmful as the fragments can more readily be transported by wind, precipitation, or flowing water onto soil or into marine habitats, where they can endanger more animals than would a single plastic bag. It cannot be recycled because the metal salts contaminate the recycling stream.

Even if a product is marine biodegradable, biodegradation occurs much slower in the ocean than on land.

HOW PLASTIC GETS INTO THE OCEANS

HOW PLASTICS GET INTO OUR OCEANS – FROM LAND SOURCES

Inland industrial and domestic litter can become marine debris if it gets into streams, rivers, gutters, or storm drains and makes its way into the oceans.

Photo courtesy of wellingtondany at Flickr

Litter on beaches such as discarded fishing gear, food packaging and beverage containers, cigarette butts, and plastic beach toys can be washed into the ocean at high tide.

Hurricanes, tsunamis, and floods carry plastic into the ocean.

EXAMPLES OF PLASTIC DEBRIS OFTEN FOUND LITTERED ON BEACHES

Discarded pieces of fishing lines or net

Styrofoam, in particular polystyrene foam, is especially bad for the environment because it readily breaks up into small pieces that are easily spread by wind and water

Disposible diapers

Plastic pop bottles, used to launch small fishing boats in Mexico

Mesh bags from beach toys and produce

Lengths of rope and string

PIECES FROM THESE AND OTHER PLASTIC ITEMS

Medical waste

MICROPLASTICS – VERY SMALL PLASTIC PARTICLES (5 mm or less) – are now found in increasing amounts in the world's oceans and marine sediments, on the shores of six continents and oceanic islands, and even in Arctic sea ice. Some of the highest accumulations occur thousands of miles from land.

They have also been found in marine organisms ranging from small invertebrates to large mammals.

Microplastics greatly outnumber larger plastic fragments and their size makes them virtually impossible to clean up once they get into the oceans or other environments. Sources include:

- **Larger plastic items**, which eventually degrade into microplastic pieces.
- **"Nurdles"**, which are often carelessly handled during production and transportation. An increasing amount are produced each year.


Beach covered in nurdles

OTHER SOURCES OF MICROPLASTICS:

- **Tiny plastic beads called 'scrubbers' or 'exfolients',** which are often in many cosmetics (such as facial cleansers, soaps and toothpaste) and household, boat, and industrial cleaning products – micro-fine polyethylene granules that go right down the drain, into the sewers, and into the rivers and oceans.

  For example, one facial scrub that was tested contained about 330,000 microbeads per tube.

- **Our synthetic clothing, blankets, bedding, towels,** which are releasing millions of tiny plastic fibres, less than a millimeter in size. Plastic-based garments, such as fleece clothing, can lose up to1,900 fibers per wash, which can go into the ocean from our wash water and into the cells of sea life.

Polyester is a plastic material synthesized from crude oil and natural gas

A 2011 study found that 85% of human-made materials found on shorelines are microfibres that match material used in synthetic clothing, with the greatest concentration near sewage outflows.

In a 2015 study, researchers calculated that

8 MILLION METRIC TONS OF PLASTIC ARE ENTERING THE OCEANS EVERY YEAR from 6.4 billion people living in 192 coastal countries (93% of the global population).

THAT'S OVER 21,000 TONS PER DAY!

8 million metric tons of plastic is equal to 15 grocery bags filled with plastic going into the ocean along every metre of coastline in the world.

On our current trajectory, by 2025, this amount could double!

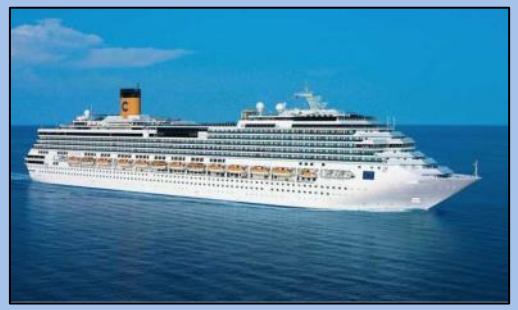
Major contributors are middle income countries with rapidly growing economies that have not developed sufficient waste management systems.

Plastic debris from the ocean that was washed ashore by high waves at high tide in only one day on a 70 m stretch of beach on the north coast of the Dominican Republic

HOW PLASTICS GET INTO OUR OCEANS - FROM OCEAN SOURCES

- Rubbish from <u>LARGE VESSELS, LIKE CRUISE AND CARGO SHIPS, AND RECREATIONAL BOATS</u> – such as daily solid waste, bags, food packaging, plastic containers, fishing gear.

It is estimated that up to 10,000 shipping containers may fall from cargo ships annually.

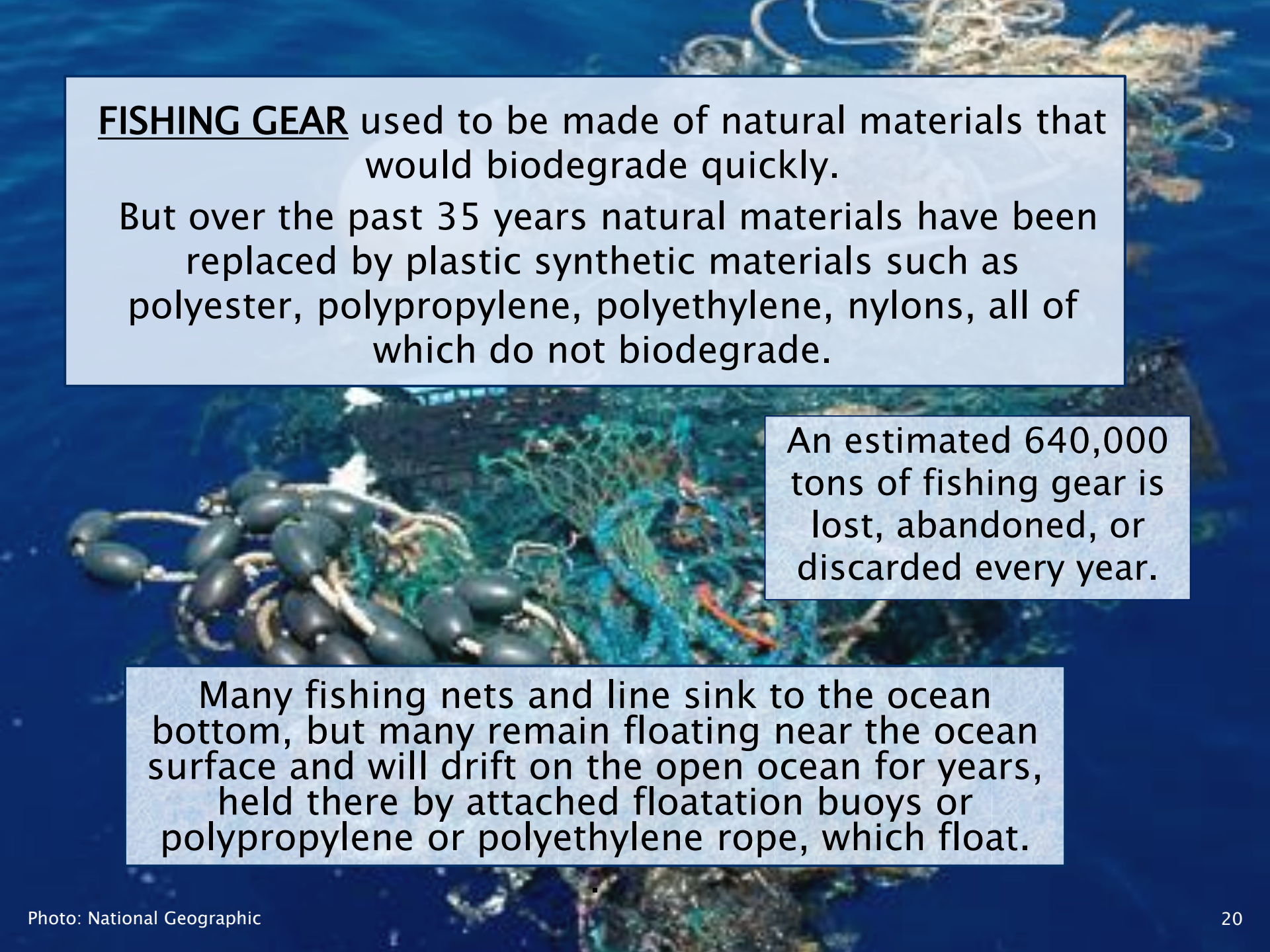


- <u>COMMERCIAL FISHERMEN</u> may fail to retrieve fishing gear or discard fishing gear or rubbish overboard, including nets, lines and ropes, bait boxes and bags, strapping bands, floats, plastic bottles, and general garbage.

An estimated18% of marine plastic debris is from the fishing industry.

- Waste from <u>OFFSHORE OIL AND GAS PLATFORMS</u> .

There are no global estimates for at-sea sources of plastic.



FISHING GEAR used to be made of natural materials that would biodegrade quickly.

But over the past 35 years natural materials have been replaced by plastic synthetic materials such as polyester, polypropylene, polyethylene, nylons, all of which do not biodegrade.

An estimated 640,000 tons of fishing gear is lost, abandoned, or discarded every year.

Many fishing nets and line sink to the ocean bottom, but many remain floating near the ocean surface and will drift on the open ocean for years, held there by attached floatation buoys or polypropylene or polyethylene rope, which float.

Photo: National Geographic

WHAT HAPPENS TO PLASTICS IN THE OCEANS?

PHOTODEGRADATION AND FRAGMENTATION

Since the ocean water keeps plastic cooled, plastic takes much longer to photodegrade in the ocean than it does on the land.

The deeper the plastic sinks, the longer it takes to photodegrade.

Plastic breaks down into smaller pieces as a result of:

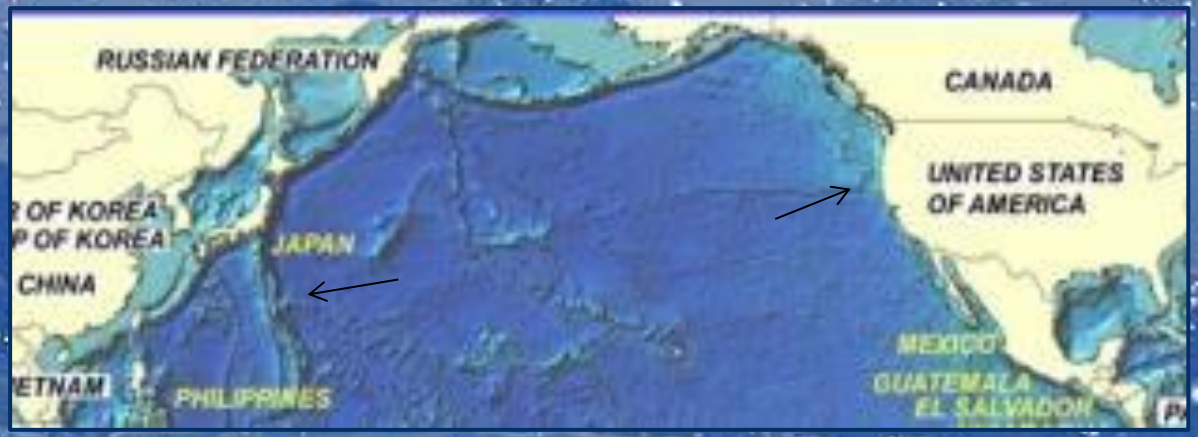
- weathering, which can cause surface embrittlement and cracking,
- wave and sand action in the ocean, and
- grinding from rocks, sand, and waves on beaches.

FLOATING PLASTIC

In the ocean, much of the plastic debris floats and can travel on currents for thousands of kilometers. Thus it is found floating on all the world's oceans.

An example is the debris from the Japan earthquake and resulting 7-metre tsunami in March 2011. Ocean debris can move at 11 to 32 km a day and a substantial amount of the estimated 1.5 million tonnes of this debris washed up on the west coasts of Canada and the U.S. from 2012 to 2015. The items included boats, fishing floats, soccer balls, even a Harley-Davidson motor-cycle.

Photo: U.S. Navy/AFLO/ZUMA Press



Background photo Zora McGinnis

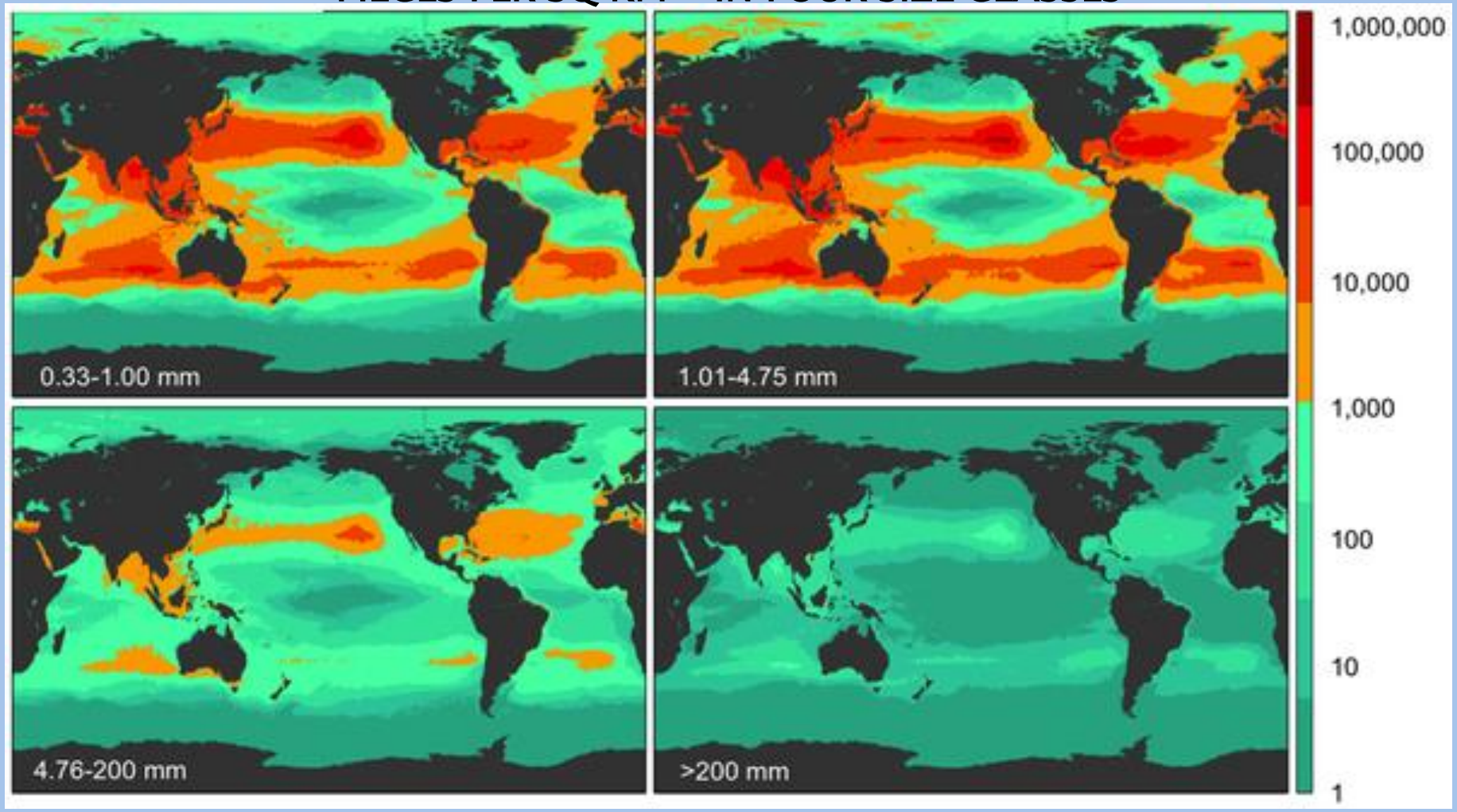
In a 2014 study, it was estimated that AT LEAST 5.25 TRILLION PLASTIC PARTICLES, WEIGHING 269,000 METRIC TONS ARE CURRENTLY FLOATING AT SEA and that:

- 92% is comprised of small fragments (0.33–4.75 mm).
- Of larger items (>200mm), foamed polystyrene items were the most frequently observed.
- During fragmentation plastics are lost from the sea surface.

This does not include the massive amount of plastic that sinks (extremely difficult to determine because of the huge depths of the ocean), washes up on beaches and seashores, or has been ingested by organisms.

Examples of high levels of plastic debris:	
Off the west coast of Canada	Up to 9,200 particles per sq metre
Off the coast of Australian	Up to 40,000 pieces per sq km
On the seabed in the Arctic, near Norway	7,710 items per sq km 67% of the litter affects sea life in some way.

MODEL RESULTS FOR GLOBAL COUNT DENSITY OF FLOATING PLASTIC – PIECES PER SQ KM – IN FOUR SIZE CLASSES



Measured at 1571 stations from 680 net tows and 891 visual survey transects for each of four plastic size classes.
Eriksen M, Lebreton LCM, Carson HS, Thiel M, Moore CJ, et al. (2014) Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. PLoS ONE 9(12): e111913. doi:10.1371/journal.pone.0111913

SINKING AND SUSPENDED PLASTIC

It is estimated that 70% or more of plastics sink. With very little light and much lower temperatures at the bottom of the ocean, **it is unlikely that plastic will photodegrade into smaller pieces once it has sunk to the seafloor.** This debris accumulates on the bottom of the ocean and can kill the marine life found there.

Some plastics, such as plastic shopping bags and fragmented styrofoam, neither float on the surface or totally sink to the bottom of the ocean. They remain suspended and freely drifting in the ocean at water depths of up to 2000 meters.

OCEAN GYRES

Our oceans are made up of complex networks of currents that circulate water around the world. Large systems of these currents, coupled with wind and the earth's rotation, form circulating currents called gyres, which are formed in each hemisphere.

These areas are also referred to as ocean convergence zones. They produce areas of abundant nutrients, attracting marine life across the food web.

There are 5 major ocean gyres: the Indian, the North Pacific, the South Pacific, the North Atlantic, and the South Atlantic.

Several smaller gyres or convergence zones occur in the sub-polar regions and in major tropical zones.

Background photo: Michelle Mech

The circular ocean currents or gyres draw hundreds of tonnes of plastic into their centre, so plastic tends to accumulate there, creating a "plastic soup".

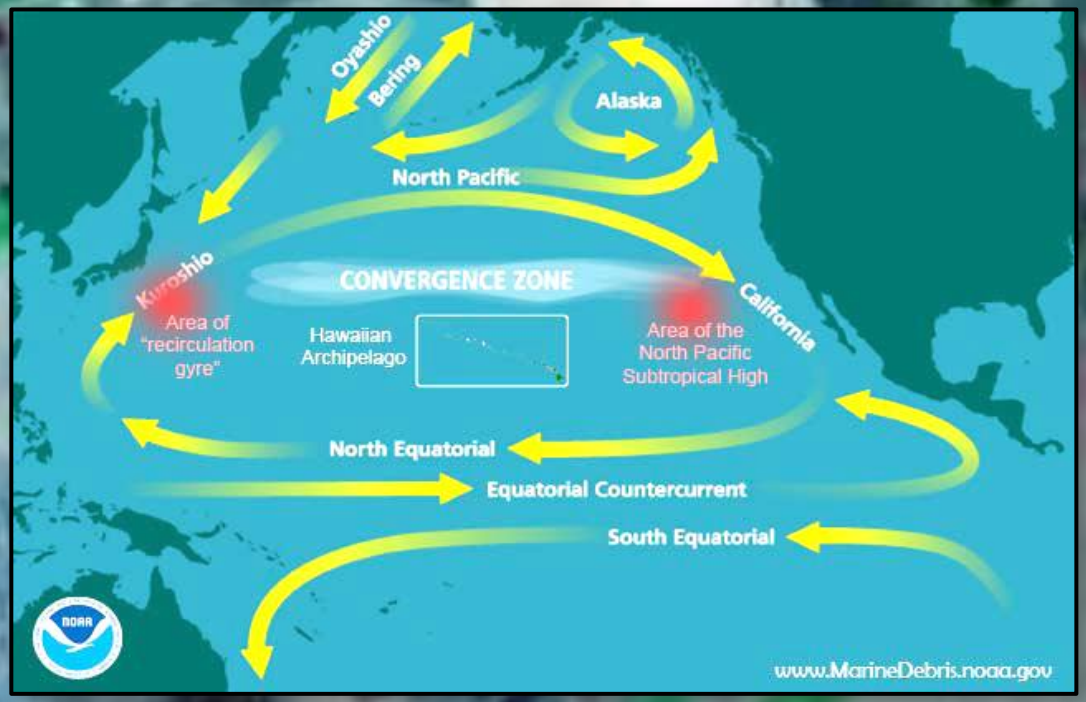
While the "plastic soup" in the gyres is not concentrated – meaning you wouldn't be able to see it from the air – once you get in the water, it can't be missed – thousands of small pieces of plastic waiting to be ingested by the many marine animals found there.

Like degraded plastic confetti, it is now spread across 2/3rds of the surface – thinly distributed and extremely impractical to clean up at sea.

Plastic soup

The gyre closest to North America is the North Pacific Gyre.

It spans an area estimated to be over twice the size of the Unites States – because gyres are constantly moving, shifting with seasonal weather, and changing in shape and size, at times it can be smaller and at times it actually extends from Japan to San Francisco.



North Pacific Gyre diagram
Image: NOAA

Background photo courtesy: www.hopeforgaia.com

THE NORTH PACIFIC GYRE is also called the Great Pacific Garbage Patch as it has a very high level of plastic particulate suspended in the upper water column.
In this Gyre:

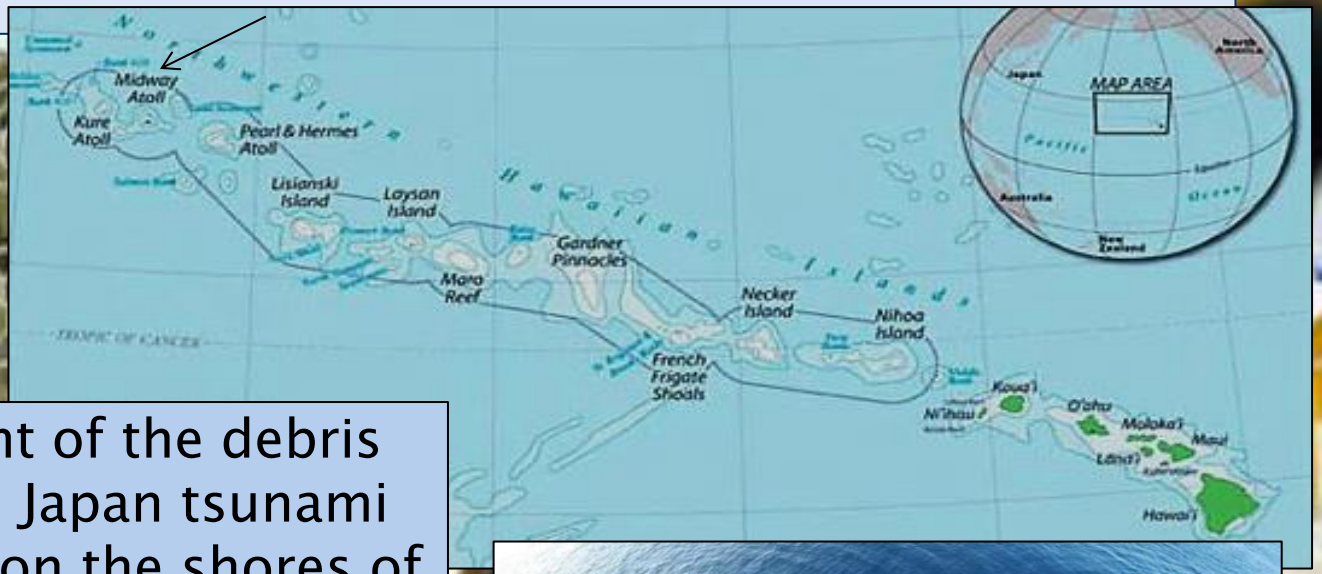
- **A 1999 study found 6 TIMES MORE PLASTIC THAN PLANKTON, by weight.**
- **More recent samplings have found 40-to-1 or higher, plastic to plankton ratio by weight.**
- **Plastic garbage has increased 100-fold during the past 40 years.**

Plankton is the most abundant food source in this area.

Sample trawl from North Pacific Gyre; 90% of the debris in gyres is plastic

Small Velella living alongside plastic pieces

MIDWAY ATOLL, which is home to two-thirds (1.5 million) of the global population of Laysan Albatross, and the rest of the **HAWAIIAN ISLANDS** receive substantial amounts of debris from the North Pacific Gyre.



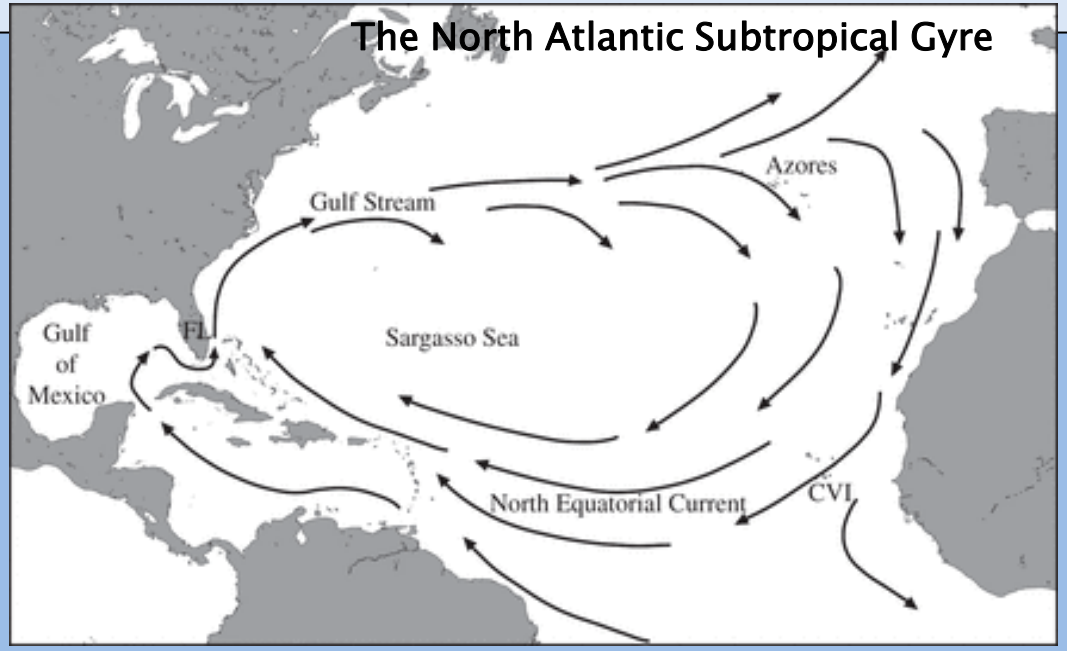
A large amount of the debris from the 2011 Japan tsunami has washed up on the shores of the Hawaiian Archipelago. It has also added to the debris in the North Pacific Gyre and has actually created its own 'mini islands' there.

Buoy Island, where an underwater ecosystem is developing around the tsunami waste.

Background photo: Rick Loomis, Los Angeles Times

THE NORTH ATLANTIC SUBTROPICAL GYRE is also called the North Atlantic Garbage Patch because it also has high average densities of plastic, similar to that found in the North Pacific Gyre. A 22-year study, published in 2010, found:

- Concentrations ranging from 1,400 pieces per sq. km in the Caribbean to more than 20,000 pieces per sq. km in the Sargasso Sea;
- The highest value recorded was 580,000 pieces per sq. km east of the Bahamas.
- The stomach of one triggerfish capture in a surface net tow contained 47 pieces of plastic debris.



North Atlantic Gyre sample collected with a surface plankton net – plastic pieces are typically millimeters in size.
Photo: Marilou Maglione, SEA

There are 4 major problems with plastics in the oceans:

1. Plastics leach toxins into the oceans as they decompose and also absorb other toxins that are in the surrounding waters.
2. Many marine animals become entangled in plastic debris.
3. Many marine animals mistake plastic for food and ingest it.
4. Plastics carry toxins and foreign organisms all over the oceans.

LEACHING AND ABSORPTION

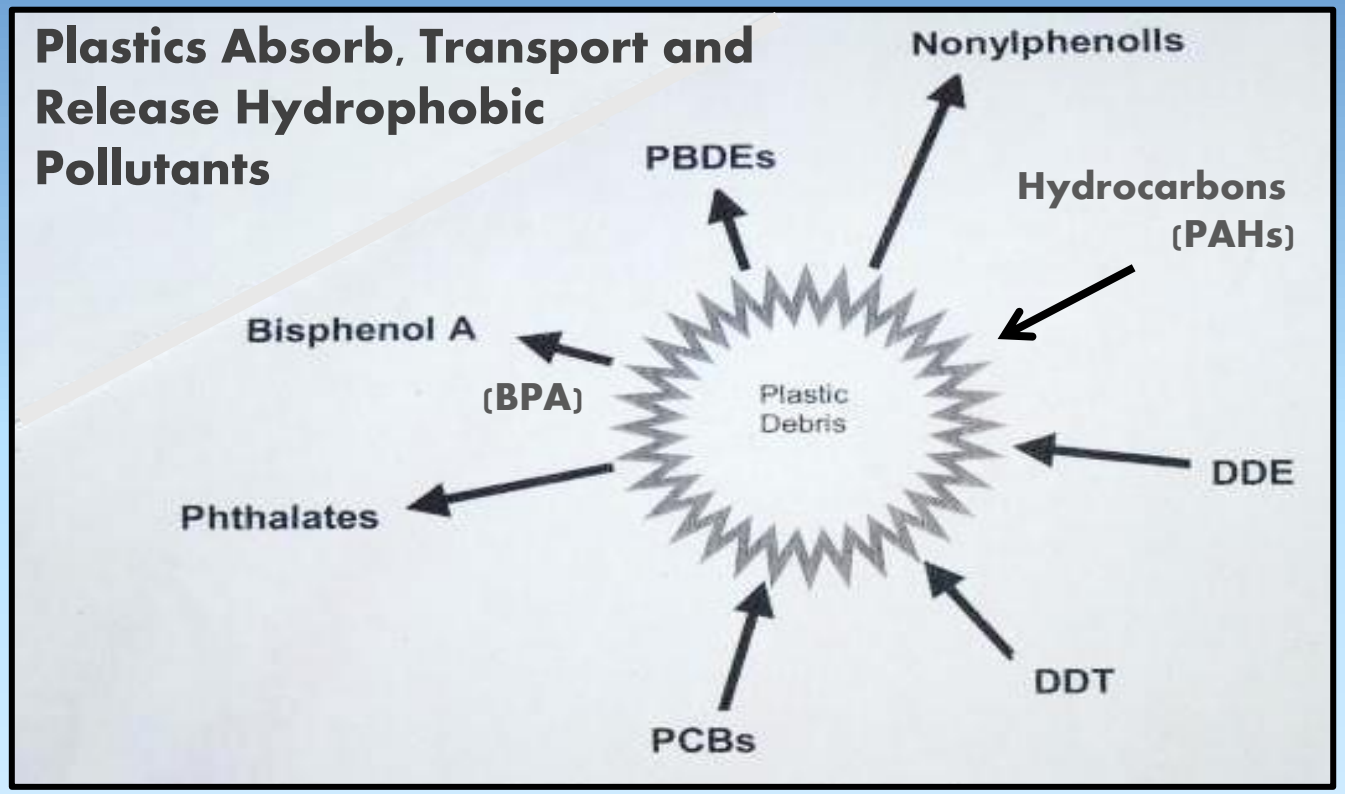
Chemical additives give plastics their desired properties, but they unbind from their host fairly easily. So, as plastics are exposed to water, and as they degrade, they leach these toxic additives out into their surroundings.

And as plastics travel through oceans, they also act as sponges for waterborne contaminants.

Free-floating toxins from all kinds of sources – like automobile fluids, runoff of pesticides from agriculture, and discharges from industry – stick to the surfaces of floating plastics.

DDT and PCBs have been banned in most countries, but still persist in the oceans and can be absorbed by plastics.

THE TOXINS FROM LEACHING AND ABSORPTION OF PLASTIC ARE THREATENING THE HEALTH OF BOTH MARINE ANIMALS AND HUMANS

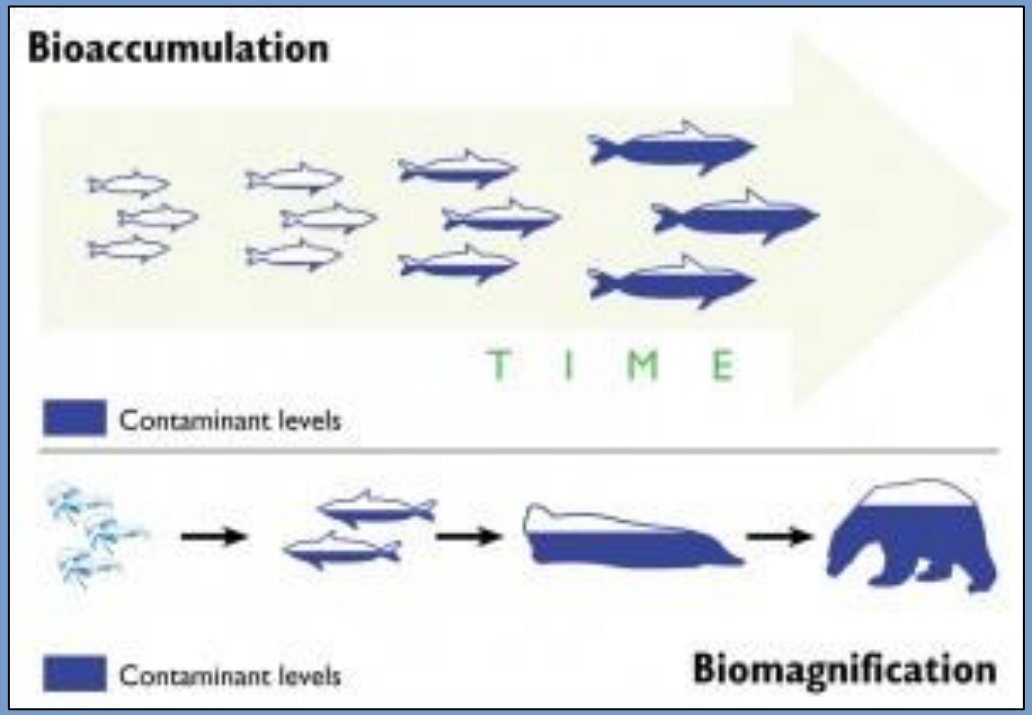


Recent studes have found that plastics can also leach and absorb heavy metals such as nickel, zinc, lead, and arsenic (listed as priority pollutants by the U.S. Environment Protection Agency).

Some are highly toxic and have a wide range of chronic effects, including endocrine disruption/hormonal imbalance, heart disease, and cell death.

BIOACCUMULACION AND BIOMAGNIFICACION

Contaminants know as persistent organic compounds (POPs) and heavy metals, both of which persist in the environment, are known to bioaccumulate in the tissues of marine organisms, then biomagnify up the food chain.



Since plastics can continue to break down once they are in the digestive tracts of marine animals, ingested plastics may release:

- the toxins from the plastic itself and
- other toxins that the plastic has accumulated from outside sources in the water.

Plastic materials accumulate and concentrate organic chemicals and environmental pollutants up to 1 million times their concentration in the surrounding sea water.

One plastic pellet can have up to 1 million times higher concentration of POPs than an equal volume of seawater. (Takada, 2001)

Therefore:

- Plastic debris is far more deadly in the ocean than it would be on land.
- High concentrations of toxins in plastics can enter the food web via ingestion of plastic by marine plants and animals.

MICROPLASTICS are of particular concern.

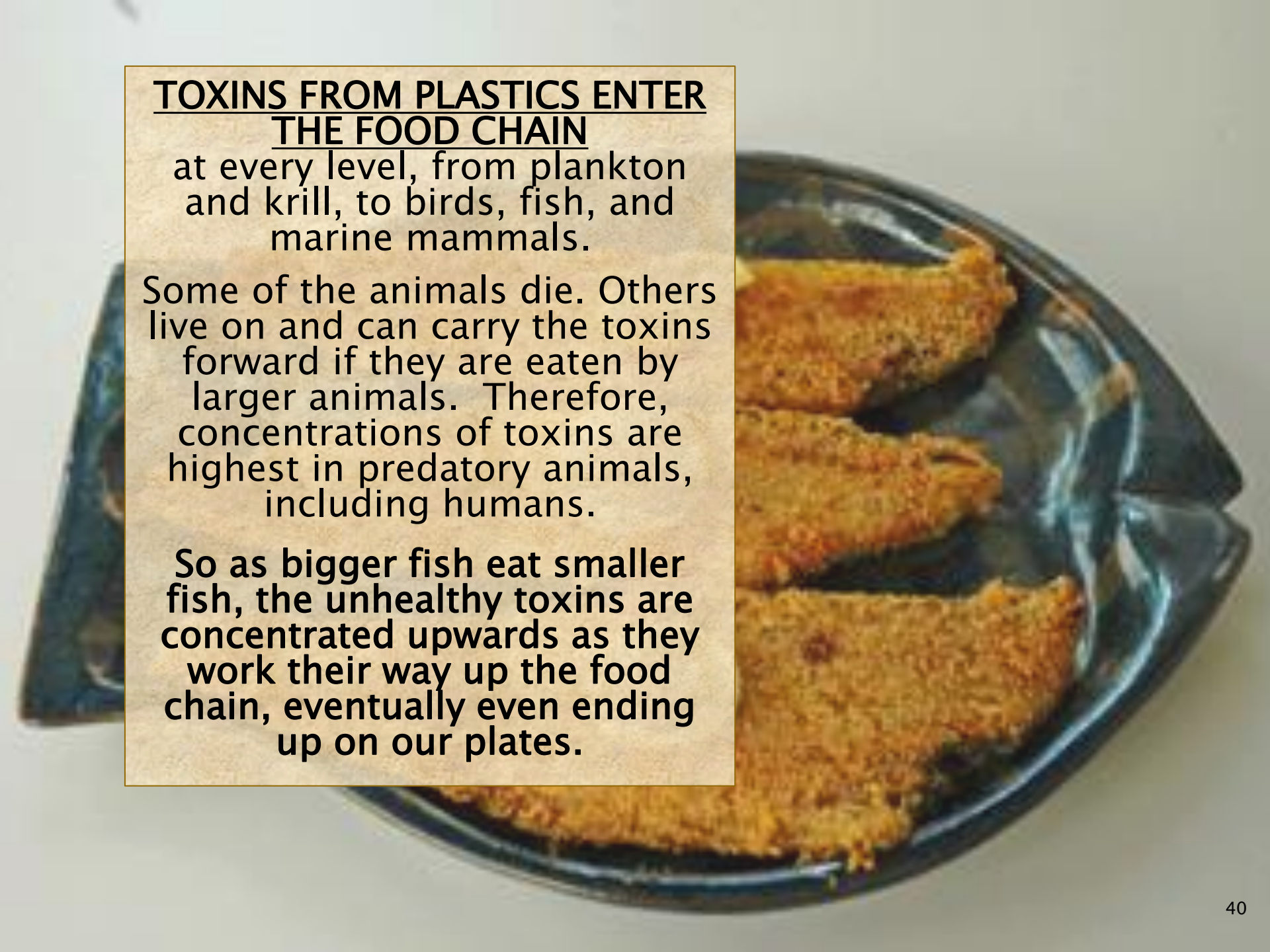
- They have a larger surface area to volume ratio than larger plastics, so they have a larger potential to collect toxic pollutants.
- They can transport pollutants over large oceanic areas.
- Because of their very small size, they are more accessible to a wide range of marine organisms, posing potential physical and toxicological risks to these organisms.
- They are virtually impossible to clean up in the ocean.

An example of microplastic debris pulled from the ocean.

Plastics made to fragment quickly speed up the creation of microplastics.
The more the plastic breaks down, the more contaminants released and the more surface area exposed to absorb toxins.

"You can think of these plastic bits as poison pills, moving all the toxins around the marine environment."

Charles Moore, Algalita Marine Research Foundation



TOXINS FROM PLASTICS ENTER THE FOOD CHAIN

at every level, from plankton and krill, to birds, fish, and marine mammals.

Some of the animals die. Others live on and can carry the toxins forward if they are eaten by larger animals. Therefore, concentrations of toxins are highest in predatory animals, including humans.

So as bigger fish eat smaller fish, the unhealthy toxins are concentrated upwards as they work their way up the food chain, eventually even ending up on our plates.

TOXINS FROM PLASTICS – HEALTH EFFECTS

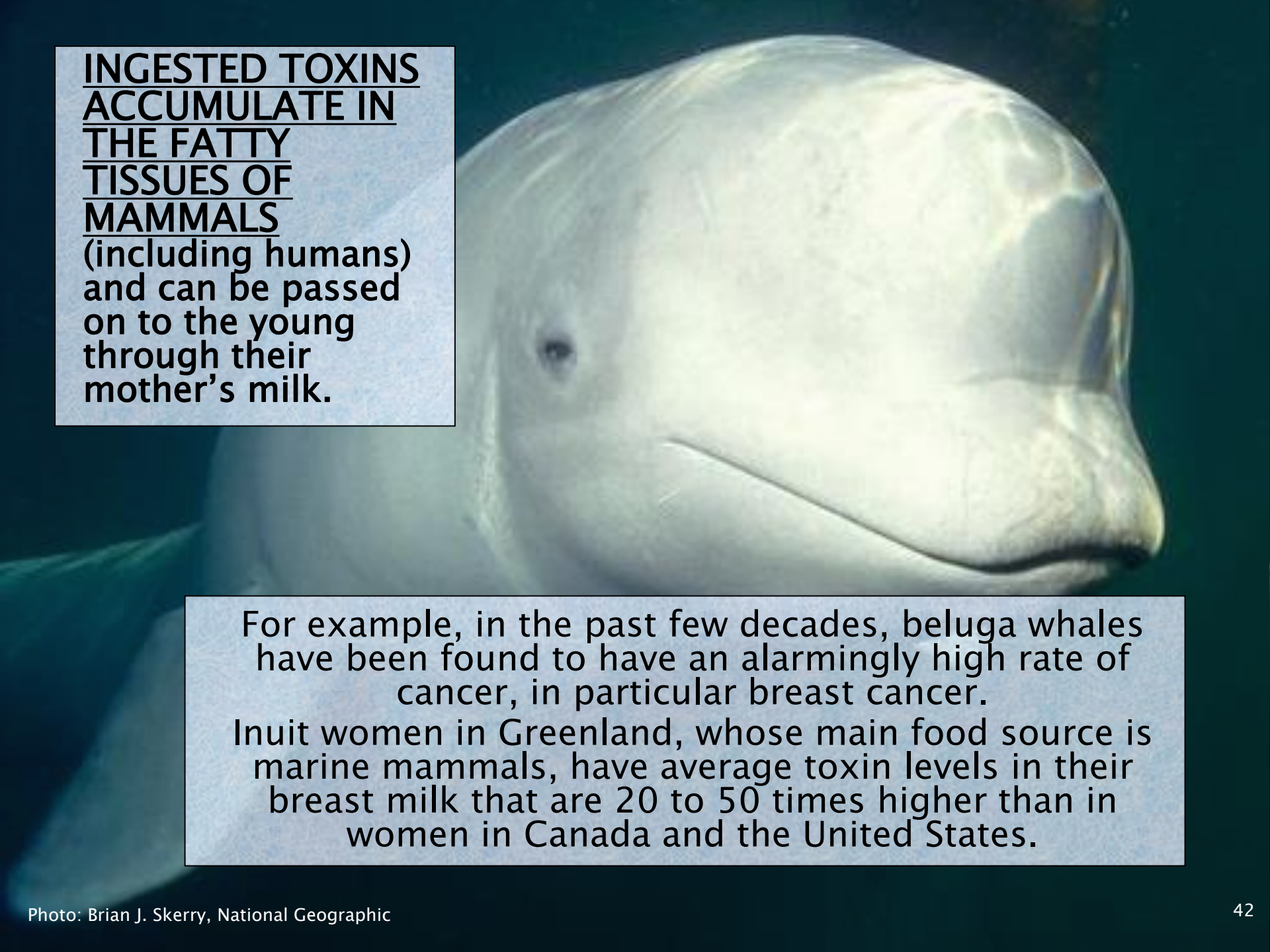
POPs: BPA, PCBs, PBDEs, DDT, DDE, PAHs, AND PHTHALATES have been linked to:

- Cancer (PCBs, PBDEs, BPA, DDT, DDE, PAHs)
- Immune system impairment (PBDEs, PAHs)
- Liver and thyroid toxicity (PBDEs)
- Kidney and liver damage (PHAs, PCBs)
- Nervous system damage (PCBs)
- Developmental problems (PCBs, DDT, DDE, PAHs, phthalates)
- Reproduction problems (all 7)
- Learning and memory impairment, brain development impacts (BPA, PBDEs)
- Diabetes (BPA, DDT, DDE)
- Breathing problems, lung-function abnormalities (PAHs)

Polystyrene, which includes "Styrofoam", contains **STYRENE AND BENZENE**, which are listed by the U.S. Environmental Protection Agency as suspected carcinogens and neurotoxins.

Evidence already shows that styrene causes cancer in animals.

Exposure to **heavy metals** has been linked with developmental retardation, various cancers, kidney damage, birth defects and other adverse health effects. (WRI)



INGESTED TOXINS ACCUMULATE IN THE FATTY TISSUES OF MAMMALS (including humans) and can be passed on to the young through their mother's milk.

For example, in the past few decades, beluga whales have been found to have an alarmingly high rate of cancer, in particular breast cancer.

Inuit women in Greenland, whose main food source is marine mammals, have average toxin levels in their breast milk that are 20 to 50 times higher than in women in Canada and the United States.

Photo: Brian J. Skerry, National Geographic

In fish toxins can cause liver damage, stress, affects on brain activity and behaviour, and endocrine disruptors from toxic chemicals in plastic can cause males to become female or fail to produce sperm, all of which can result in population decline.

One study showed that young zebrafish exposed to PBDEs through their mothers swam up to 60% slower.

Impacts on fish are a good indicator of what is happening to larger marine animals.

Photo courtesy of Frank Hyde

PLASTICS ARE HURTING, POISONING, AND KILLING MARINE ANIMALS

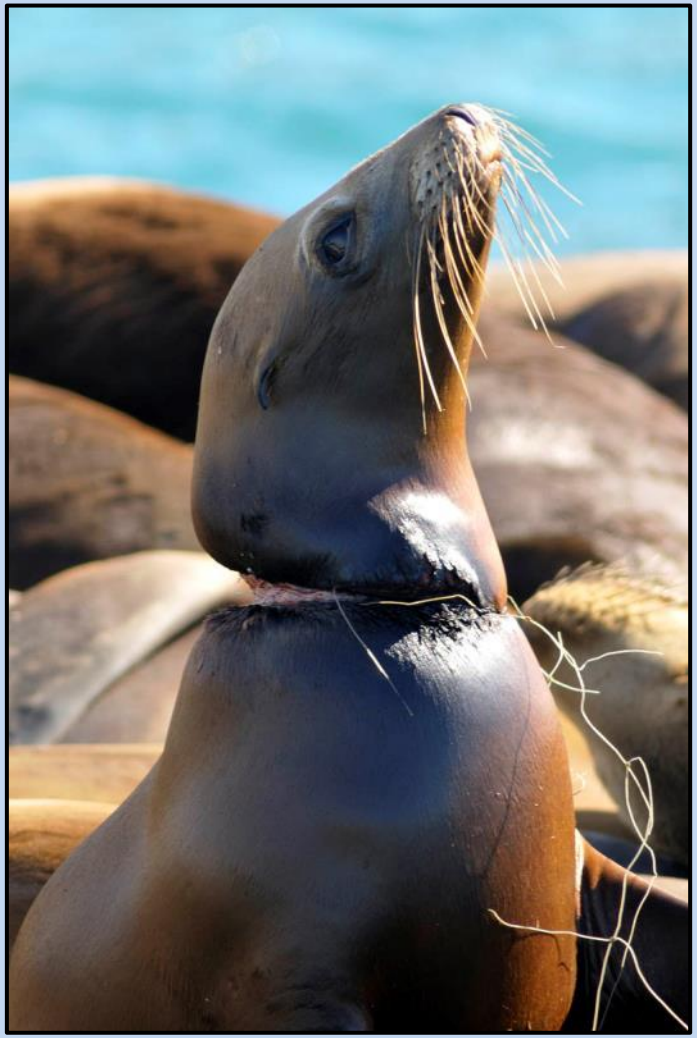
The vast amount of plastic debris collecting on beaches, in gyres, and other areas of the oceans, and on the ocean floor means that most species of marine animals cannot avoid encountering it.

More than 80% of entangled Antarctic fur seals die

It is estimated that hundreds of thousands of marine mammals and sea turtles, one million seabirds, and countless fish die each year from ingesting or becoming entangled in plastic.

This is what can happen to old fishing line and gear that is thrown onto a beach or into the ocean:

Seals and sea lions are particularly affected by entanglement, possibly due to their very inquisitive nature of investigating objects in their environment.



An estimated 40,000 Northern Fur Seals a year in the Bering Sea die from entanglement (2002).

This is where a discarded plastic bag can end up:

Garbage bags, plastic beer and soda rings, and styrofoam particles are regularly eaten by sea turtles, whose primary food is jellyfish.

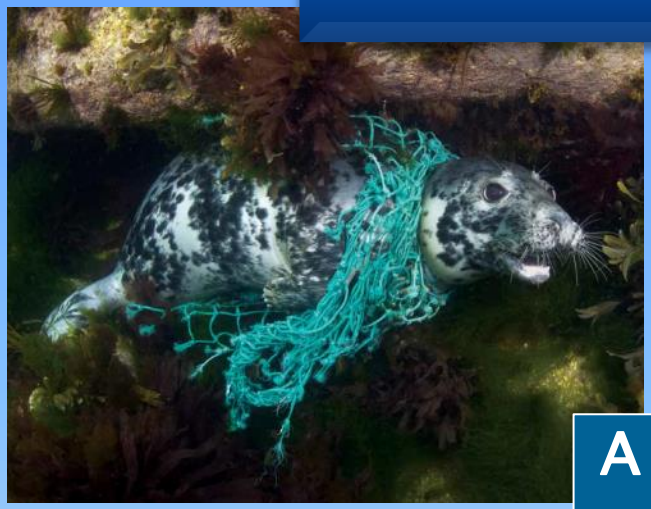
Leatherback turtle ingesting plastic

This is the kind of suffering and death that discarded bottle caps and other small plastic items can cause:

Laysan Albatross carcass, filled with plastic junk which was mistakenly ingested as food

Birds, in particular, are attracted to shiny colourful plastic, like bottle caps, fishing buoys, small plastic toys, candy wrappers, and lighters, and ingest them by mistake.

ENTANGLEMENT



A large percentage of marine animals that are entangled find it impossible to escape and do not survive.

Sea turtle entangled in ghost net

Whale dead from starvation as a result of line wrapped around its mouth

Only 10% or less of entanglements are witnessed and reported.

THE PLASTIC DEBRIS WHICH CAUSES THE MOST ENTANGLEMENT

INCLUDES:

- nets and pieces of nets,
- fishing line,
- rope and twine
- rubber bands used on crab pots,
- strapping bands for fishing bait boxes and packaging,
- hooks and other fishing gear,
- 6-pack rings,
- plastic bags.

Mesh bags from beach toys and produce can also cause entanglement

GHOST NETS

Nets that break free, are abandoned, or are simply cut loose, will drift with ocean currents and become "ghost nets".

As they drift, they continue to catch and kill fish and shellfish as well as other marine animals.

Abandoned or lost fishing pots, traps and cages can also 'ghost fish' for years.

For example, in inland waters in Washington, U.S., 31,278 invertebrates, 1,036 fish, 514 birds, and 23 marine mammals were recovered from 870 derelict gill nets.

56% of invertebrates, 93% of fish, and 100% of birds and mammals were dead.

Photo courtesy TEDxGP2

RESULTS OF ENTANGLEMENT

Entangled birds, marine mammals, and turtles that cannot surface drown.

Animals that survive continued entanglement may suffer from:

- Severe and chronic pain
- Restricted movement, impairing the animal's ability to swim or fly and therefore to find and catch food or escape from predators
- Amputation of flippers, tails or flukes
- Body cuts or wounds that can become infected skin lesions or open sores that won't heal
- Constricted circulation, which may lead to death
- Less ability to reproduce
- A reduced quality of life that often leads to a slow, painful death from starvation or sickness that can take minutes to years.

Photo courtesy: www.turtlehospital.org

Wounds left after seals freed from fishing line or net entanglement

Photo: Department of Primary Industry, Parks, Water and Environment *

ENTANGLEMENT MATERIAL can also tighten over time causing even deeper wounds.

Plastic loops that have slipped around an animal's neck or body can also cut into flesh as the animal grows, creating 'deadly necklaces' that may lead to maiming, disfigurement, constricted growth, strangulation, or can cut through vital organs.

Turtles deformed from 6-pack ring and plastic milk jug ring around their bodies.

Snapping turtle

ENTANGLEMENT HAS BEEN REPORTED IN 51 SPECIES OF SEABIRDS. Species commonly reported as entangled include pelicans, gannets, albatrosses, petrels, and shearwaters.

Bird tallons entangled in a plastic bag

Photo courtesy: depontilivejournal com

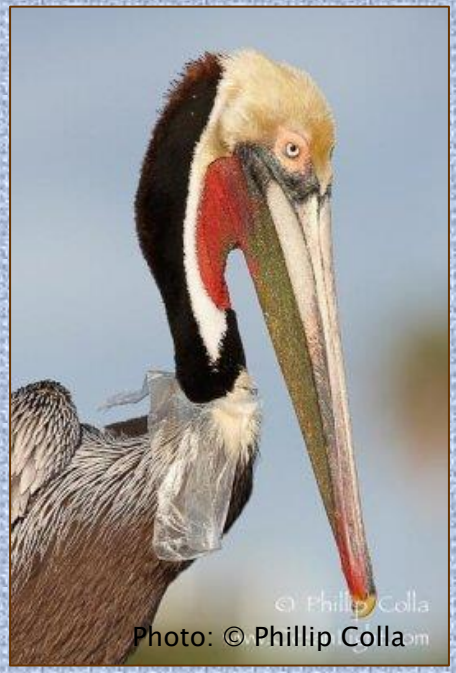


Photo: © Phillip Colla

Oystercatcher, doomed to die a slow death from starvation once it stabbed this lid with its beak

Gannets entangled in a piece of fishing net

Photo © Peter Reynolds/ Frank Lane Picture Agency/ Corbis Images

Some seabirds use fragments of fishing gear and other debris to build their nests, resulting in entanglement of nestlings and adults.

The greatest cause of entanglements in SEABIRDS is monofilament line and fishing net.

Canadian Goose entangled in fishing line and hook

Gannet ensnarled by balloon and string

Other commonly reported entanglements are due to fishing hooks, six-pack rings, wire and string.

ENTANGLEMENT IS OCCURRING IN ALL SEA TURTLE SPECIES.

Diver frees one of 17 sea turtles trapped and drowned by a discarded fishing net, Brazil

Photo courtesy: www.turtlehospital.org

Remains of fishing lines, nets and ropes can cut the skin of turtles, cause fatal infections, and even amputate a fin.

For example, an estimated 5,000 and 15,000 turtles are entangled each year by derelict fishing gear in northern Australia.

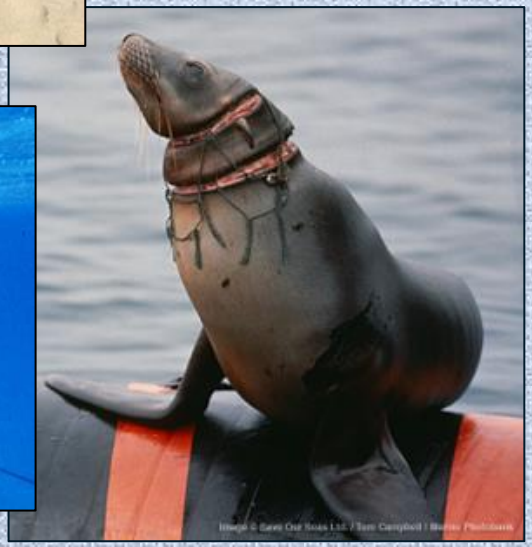
AN ESTIMATED 61% OF SEAL AND SEA LION SPECIES ARE KNOWN TO HAVE BEEN AFFECTED BY ENTANGLEMENT.

Entangled Ring Seal
Photo: ADF&G, fakr. noaa.gov

Elephant seal after rescue

Gillnet entanglement

Seal caught in a fishing net



Seal pups have higher entanglement rates and can get fishing net or plastic packaging bands stuck around their necks and as the pups grow this plastic collar tightens and strangles the animal or severs its arteries.

Predominant entangling materials are trawl nets, monofilament lines, and packing straps. Entanglement occurs in 4 to 8% of California sea lions in Mexico.

ENTANGLEMENT HAS BEEN REPORTED IN 41 CETACEAN SPECIES (WHALES, DOLPHINS, PORPOISES)

Of the large species of whales, the Northern Right Whale and the Humpback Whale have been the most affected by entanglement.

10% of some humpback whale populations are injured or killed by entanglement in ghost fishing gear and debris.

Entangled Humpback Whale
Photo: BARCROFT

Scarring indicates that 83% of North Atlantic right whales have been entangled at least once.

More than 200 feet of rope had been removed from this young Right whale. The numerous lesions are from its long entanglement and shark bites. The young female was significantly underweight.

When large WHALES become entangled in fishing gear, their larger size means they are often capable of dragging fishing gear away with them.

The attached gear hinders their ability to eat and migrate, can penetrate through multiple tissue layers often resulting in infection and sickness, depletes their energy as they drag gear for months or years, and can result in a slow and painful death.


Humpback Whale entangled in gill net


This Humpback is deformed by its entanglement


Rescue divers work diligently to free a whale from a drift net

Photo: Alberto Romeo, Marine Photobank

The most common entangling materials are fishing nets, traps (especially lobster), and gear – e.g. ropes and floats, monofilament and braided lines and hooks.

IMAGINE WHAT IT WOULD BE LIKE TO BE AN ENTANGLED WHALE!

- You have managed to break away from most of the fishing gear, but part of it remains attached to your flipper and your mouth and seems to be getting caught up on more of your body. This makes it hard to swim normally and it is therefore difficult to find food, so you are hungry.
- The attached fishing gear is also cutting into you, penetrating through multiple tissue layers and causing tissue damage and hurting you. You are also bleeding from these wounds and they are getting infected.
- You are afraid and stressed and so you behave differently and infection is spreading throughout your body.
- You are slowly starving and getting sicker, but very slowly, so you suffer for almost a year before you finally die.

Entanglement in fishing gear is jeopardizing the survival of many <u>DOLPHIN AND PORPOISE</u> POPULATIONS around the world.

Dolphin entangled in gill net
Photo credit: NMFS Beaufort Lab

Dolphin that tried to free itself from entanglement before it drowned

Wounds from entanglement on dolphin's tail

Dolphin killed from entanglement

Discarded fishing line is as much of a threat to dolphins and porpoises as "ghost" fishing nets.

INGESTION

Ingestion impacts marine animals directly through physical effects and indirectly via transportation of toxins into the digestive tract of marine species.

Plastic dinner

"Ocean plastic comes in every size-class and mimics the food for every single trophic level . . . Every size of organism, every creature in the food web in the ocean, from the tiniest plankton to the largest whales, is consuming plastic."

Captain Charles Moore

Suspended plastic bags look like jellyfish to sea turtles and whales

Photo source: SurfiderHumboldt

Plastic bottle caps look like food to many marine birds

WHY DO MARINE ANIMALS INGEST PLASTIC?

Many marine animals, particularly sea turtles and birds, cannot distinguish plastic from food and mistakenly ingest plastic that is in the ocean.

They often ingest specific shapes or colours because they look more like their prey.

As well, organisms that encrust the plastic may make it more attractive for ingestion.

Even the smallest ocean feeders can be misled by tiny plastic fragments which can look like plankton.

Because the oceans are so overfished and now contain so much plastic, predatory animals may eat plastic because they cannot find enough of the food they normally eat.

Predatory marine animals may also ingest plastic because it is already present in the gut of their prey.

Plastic can never be digested.

MANY OF THE PLASTICS THAT MARINE ANIMALS COMMONLY INGEST

Found on the beach in Melaque, Mexico
Photo: Michelle Mech

Snack and fast food bags, plastic bottle wrappings, plastic bags and food wrapping, pieces from plastic cup and spoon and Styrofoam tray, drinking straws, balloon, toothbrush, piece of fishing net, rope, bottle caps, candy wrappers, lighter

Entangled monofilament line, often with hook attached

Styrofoam fragments and pellets

Small beach toys

TINY TO LARGE PLASTIC FRAGMENTS FROM ITEMS SUCH AS TOYS, BOTTLES, AND OTHER CONTAINERS

RESULTS OF INGESTION OF PLASTIC BY MARINE ANIMALS

Eating plastic can give animals a false sense of fullness. Since plastic cannot be digested, as the animal eats more plastic, it accumulates in the animal's stomach to the point that its stomach is completely full of plastic, with no room for food. **This will cause the animal to stop eating and slowly starve to death.**

Ingestion of sharp objects can damage or perforate the digestive system and may result in inflammation, bleeding, infection, pain, and even death.

Plastic often break down into pieces with sharp corners

Heron eating fish wrapped in plastic
Photo: Andrea Westmoreland

INGESTED PLASTIC CAN ALSO CAUSE:

- Malnutrition, starvation, general exhaustion, or death by:
  - Blocking nutrients from being absorbed
  - Becoming lodged in the throat or digestive tracts and blocking passage of food

- Festering skin wounds
- Dehydration, suffocation, drowning
- Intestinal and thyroid gland injury
- Stomach ulcers and other ulcerating sores
- Suppressed immune system and thus an increased risk of disease and infection
- A change in hormone levels (Hormones control such body activities as growth, development, reproduction, hunger, and digestion.)
- Reduced fitness and ability to successfully reproduce, catch prey, migrate, and avoid predation.

AT LEAST 44% OF MARINE BIRD SPECIES ARE KNOWN TO INGEST PLASTIC AND AN AVERAGE OF 65% OF INDIVIDUALS WITHIN A SPECIES HAVE PLASTIC IN THEIR GUT.

Birds appear to suffer the broadest impacts of plastic ingestion.
Plastic ingestion in seabirds is predicted to reach 95% of all species by 2050.

Toxins from microplastics in the digestive tracts of seabirds can eventually enter the bloodstream, reach other organs, and be excreted into growing feathers.

Photo: Jennifer Lavers

Researchers studying the feathers and tissue of Flesh-footed Shearwaters on Lord Howe Island in Australia, found extremely high levels of mercury, chromium and silver – from ingestion of significant quantities of plastic (275 pieces in one bird's stomach). The more plastic ingested, the more concentrated the metals. As a result, these birds are one of the world's most heavily contaminated and many fledglings could become ill or die.

SEABIRDS that feed on the surface of the ocean, such as Albatross, Pelicans, Boobies, Cormorants and Shearwaters, are the most susceptible to plastic ingestion. Shorebirds, such as Gulls and Terns, also commonly ingest plastic.

Sea bird chicks are especially vulnerable as they receive plastic debris in regurgitated food from their parents.

Plastic pellets and fragmented plastic particles like Styrofoam balls can look like fish eggs to birds.

Photo: Ashok Khosla, www.seabirds.com

In the southern North Sea 98% of Fulmars have plastics in their stomachs.

Photo: Jan van Franeker, Wageningen IMARES

LAYSAN ALBATROSS AND PLASTIC

Adult Laysan albatross fly long distances to feed in the North Pacific Gyre for squid, fish eggs, and small fish to feed their young, unknowingly consuming plastic debris that looks like food, such as: **bottle caps, toys, balloons, pens, combs, toothbrushes, fishing lures, cigarette lighters, and fragments of plastic.**

Laysan Albatross have been classified as 'near threatened' with danger of extinction since 2010 on the IUCN red list.

Albatross body with stomach full of plastic.
Photo: Chris Jordan

On Midway Atoll, in the Hawaiian archipelago, 97.6% of Laysan Albatross chicks have plastic in their stomachs. 40% die from ingesting plastic.

Albatross parent feeding chick

These 272 pieces of rubbish were fed to this one fledgling albatross, along with fish, caught by its mother. The pieces accumulated in its stomach until it was literally 'too full to eat'.

Image: Greenpeace

A TRUE STORY FROM RESEARCHERS ON MIDWAY ISLAND

The adult Albatross returns from sea, lands, and waddles and weaves her way through other calling chicks to find her own. "The whining chick begins eagerly nibbling the adult's bill . . ." which stimulates the adult into regurgitation. "The adult hunches forward, neck stretching, retching. The chick, with sudden frenzied expectation, thrusts its bill up tight to the adult's gaping mouth . . . The adult abruptly pumps out several thick boluses of food: semi-liquified squid and purplish fish eggs, which the chick bolts down.

Both pause . . . Then the chick renews its drive for more. The adult arches her neck and is retching, retching. Nothing comes. More retching. . . Slowly, the tip-just the tip- of a green plastic toothbrush emerges in the bird's throat. *The sight is surreal – so out of place, so wrong – this bird in distress, this vital mother-child interaction interrupted* . . . With her neck arched, the mother cannot pass the straight toothbrush. She reswallows it and several times repeats the attempt to puke it up. Each time, she cannot pass it fully out. . . The parent albatross reswallows a final time, and with the toothbrush stuck inside her, wanders away from her chick."

– FROM "EYE OF THE ALBATROSS" by Carl Safina

"For me, kneeling over their carcasses is like looking into a macabre mirror. These birds reflect back an appallingly emblematic result of the collective trance of our consumerism and runaway industrial growth. . .

“Like the albatross, we first-world humans find ourselves lacking the ability to discern anymore what is nourishing from what is toxic to our lives and our spirits"
Artist/Photographer, Chris Jordan

Sadly, Laysan Albatross and other seabirds are giving their lives to show us what we are doing to the oceans.

The carcass of a baby albatross, filled with plastic that it was mistakenly fed as food. With very little room for food it slowly starved to death.
Photo: Chris Jordan

Photo courtesy: www.flpa-images.co.uk

Piles of bones, feathers, and plastic litter the beaches on Midway Atoll

SEA TURTLES:

Studies have shown that **from 50 to 80% of sea turtles found dead have ingested marine debris.**

You can see the difference, turtles do not.

Sea turtles often ingest plastic bags and sheets because they confuse them with jellyfish, their common prey.

Sea turtles also ingest a wide variety of other kinds of plastic, including plastic particles, balloons, string, rope, and monofilament fishing line.

One turtle was found with 180 meters of fishing line in its gut.

To help facilitate eating slippery prey, turtles have a system in their throat that stops their prey from sliding back out, so once they have started to ingest a plastic bag, it is impossible for them to reject it.

EXAMPLES OF INGESTED DEBRIS IN SEA TURTLES

From a Leatherback turtle
Credit: Peter Richardson

Plastic can block the intestines of sea turtles and make the animals float so that they cannot dive for food.

From a juvenile Green sea turtle Credit: Daiana Bezerra

3 fishhooks in Esophagus

Photo courtesy: www.turtlehospital.Org (48)

MARINE MAMMALS

including whales, dolphins, porpoises, seals, sea lions, and manatees, are ingesting a wide range of marine debris. Ingestion has been documented in 48 cetacean species. In examined carcasses, rates of ingestion were as high as 74% in some areas.

Credit: completly-coastal.com via Lynn on Pinterest

Sea otter pup ingesting plastic cookie wrapper

Plastic bags and sheeting can look like squid or jellyfish to marine mammals. They also ingest ropes, fishing line, plastic containers, many other types of debris, a prey that has ingested plastic.

Sperm and beaked whales appear to be especially vulnerable to ingestion of plastic debris, likely because they use suction to capture and ingest prey.

Since marine debris often concentrates in areas that whales migrate through and feed on abundant prey, filter-feeding or **baleen whales** such as Humpback and Gray whales, are also very vulnerable to ingesting plastic because they consume huge quantities of zooplankton and small, schooling fish, and often along with them, microplastics.

Gray Whale dead from ingestion of plastic

BALEEN WHALES have soft comb-like baleen plates that act as sieves as they fill their mouths with vast amounts of water and filter out their food with these plates.

Sadly they have no way of separating plastic particles from the proper food they need.

In the Mediterranean, plasticizer chemicals have been found in Fin whales and also in the plankton they eat.

Humpback whale feeding

Gray whale feeding in the Gulf of California
Photo: Christopher Swann

Baleen whales also ingest large sheets of plastic debris which can become entangled in their baleen plates.

EXAMPLES OF INGESTED DEBRIS IN WHALES

Plastic found inside the stomach of a dead Minke whale – 22 pieces of plastic, mainly plastic shopping and garbage bags – completely blocked its digestive tract

Photo: Jessie Huggins, Cascadia Research Collective

Duct tape, plastic bags, rope, fishing line, towels, sweatpants, plastic pieces, and even a golf ball made up the several kilograms of marine debris ingested by a Grey whale, stranded on a U.S. beach.

ANOTHER EXAMPLE:

This young whale was found stranded on Mykonos Island, Greece.

EXAMPLES OF INGESTION OF PLASTIC BY DOLPHINS

A study of 106 Fransiscana dolphins caught as bycatch in the SW Atlantic Ocean found 28% with plastic debris in their stomach contents. Of those:

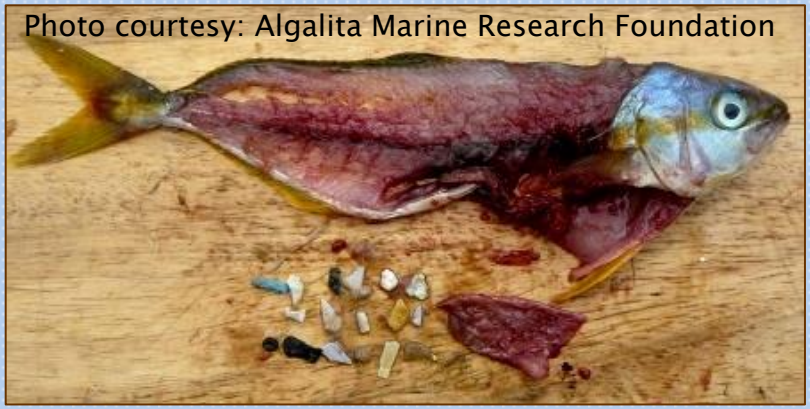
- 64% had packaging debris – cellophane, bands, bags.
- 38% had fishery-related fragments – ropes, nets, monofilament lines.

Another example:

- In California, U.S. a Dall's porpoise, was found 'Jammed with debris', including 13 pieces of clear plastic sheets, 3 heavy clear plastic bags, 2 plastic bread bags, and 2 plastic sandwich bags.

FISH: RECENT STUDIES AT MANY LOCATIONS AROUND THE WORLD HAVE SHOWN INGESTION OF PLASTIC DEBRIS RANGING FROM 5% TO 58% OF THE FISH SPECIES STUDIED.

Photo courtesy: Algalita Marine Research Foundation



Plastic fragments found in a 5-week old rainbow runner

Researchers estimate that fish in the northern Pacific ocean are ingesting 12,000 to 24,000 tonnes of plastic each year (2009).

The buoyancy of ingested plastic may make it difficult for deep dwelling fish, like Lanternfish, to return to deeper waters.

The increase in the density of plastic particles in the oceans may be affecting the ability of fish to distinguish between plastic and their natural food.

Plastic fragments (including nylon fragments from fishing lines and nets), plastic pellets (nurdles), particles, and fibres are being found in fish that feed in the water column and at the surface of the ocean.

These plastics leach toxins that may remain in the food chain.

In one study, fish showed a preference for cylindrical shapes of blue or yellow color; in another study, fish showed a preference for white, clear and blue, the colours similar to the area's plankton. This indicates fish are confusing plastic debris with possible prey.

In the North Pacific Gyre:

A 2008 study found that 35% of fish had ingested plastic. One of the fish sampled had a bellyful of 83 plastic bits – in an animal barely 5 cm long!

The 83 plastic bits and the comparatively small amount of plankton found in just ONE fish

Fhoto courtesy: Algalita Marine Research Foundation

Opah

Debris found in the stomachs of two opahs

In a 2013 study on both small fish and large pelagic fish that humans consume most often, two *Lampris* species (Opah) had the highest percent of ingestion with the large-eye at 43% and the small-eye at 58%.

SMALL FILTER FEEDERS AND PLANKTON are also ingesting plastic.

Microplastics (< 5mm) that are found in surface waters and in sediments are ingested by small filter feeding animals, such as barnacles and other crustaceans, clams, mussels, and sponges.

Salp with plastic filtered from seawater while feeding.
Salps and jellyfish are the ocean's most prolific and widely distributed filter feeders. They mistake brightly colored pellets for fish eggs, and tan ones for krill.

Filter feeders feed by straining suspended particles and small organisms from the water by passing or pumping the water through their specialized filtering structure.

33.5% of the barnacles studied in the North Pacific Gyre had plastic particles present in their gastrointestinal tract.

Even zooplankton can ingest smaller microplastic particles. This is of increasing concern because of the growing number of microplastics in the ocean, which fall within the size range of the staple phytoplankton diet of zooplanktons.

Zooplankton are the animal form of plankton and the only creature lower than them on the ocean food chain is phytoplankton, the plant version of plankton.

Zooplankton in lab experiments, with fluorescent microplastics ingested

Though zooplankton can usually pass microplastics beads, microplastics in the ocean include fibers (the most common form of microplastics) and irregularly shaped fragments, which can become entangled within the zooplankton's intestinal tract. As with other marine organisms, this can limit the ability of zooplankton to ingest and digest food.

As plankton species have a very small body mass, the quantity of contaminants in ingested microparticles could pose a significant toxic risk with health, reproduction, and mortality impacts.

Amphipods (small shrimp-like animals) are an example of zooplankton.
Photo: BAS photographer Peter Bucktrout

ZOOPLANKTON are at the base of the food chain and are eaten by a wide variety of ocean species such as krill, fish, shellfish, and sea turtles. Even baleen whales primarily eat zooplankton, and also krill and small fish. All life in the ocean depends on plankton.

Therefore, not only would any threat to plankton populations have serious and far-reaching effects in the oceans, ingestion of microplastics by zooplankton may result in the transfer and bioaccumulation of contaminants further up the food chain.

INVASIVE ALIEN SPECIES?

Alien Species are animals and plants that are introduced accidently or deliberately into a natural environment where they are not normally found.

Invasive species living in an area where they don't belong can harm the native species and/or out-survive them and cause severe ecosystem changes.

Zebra mussels from Russia are now an invasive species in Canada, the U.S., Mexico, and many countries in Europe. They can dominate native species, damage harbours and waterways and ships and boats, and cling on to pipes under the water and clog them.

PLASTIC DEBRIS CAN CONTRIBUTE TO THE SPREAD OF ALIEN SPECIES

Plastic debris which floats on the oceans can act as rafts for small sea creatures to grow and travel on.

Organisms can easily hitch a ride on a drifting net or cigarette lighter.

Since plastic can travel for long distances and can even reach places seldom or never visited by boats, it can readily transport marine animals and plants to many areas where they are non-native.

Organisms living on bottles can float around on the oceans to foreign waters.

"Every water point on the compass is now conscripted into our all-consuming culture, whether intended or not . . . no place, no creature remains apart from you and me. . .

Nothing could prepare the albatrosses [and other marine animals] for changes that have come in the flash of one long lifetime. In all the far reaches of the wide, wide seas, every single bird, fish, mammal, and turtle carries the trademark of human chemical manufacturing within its cellular tapestry.

"That creates a certain moral obligation. . . . empathy, foresight, compassion, generosity of spirit. . .the opportunity to create a better world. . . .The oceans make our planet habitable . . . We need the birds and the seas more than they need us. We need the life and stability and context they provide us. Will we understand this well enough to reap all the riches that a little restraint would engender?"

Carl Safina, Eye of the Albatross

"We've created a throw away society in which a product that lasts, for all practical purposes, forever… is used for only seconds and then discarded." Charles Moore

"Cleaning up the plastic trash in the ocean is virtually impossible, given the vast scale. . . Prevention is the critical step."
Miriam Goldstein, Scripps Institution of Oceanography

"It is imperative that we eliminate the flood of post-consumer plastic waste into the environment . . . and give the oceans a chance to spit it out [onto beaches where it can be cleaned up].
Charles Moore / Algalita Marine Research Foundation

THE CURRENT STATUS OF PLASTIC DISPOSAL

Currently, plastic that does not end up as environmental debris goes into:

- Landfills: Though better than discarding into the environment, plastics in landfills take up a lot of space and global landfill capacity is decreasing. Plastics in landfills are a waste of energy and can leach harmful chemicals into soils and groundwater.
- Recycling: Not all plastics are recyclable, but recycling technologies are improving. However, many countries have little or no recycling in place. Recycling needs to be vastly increased worldwide to have a substantial impact on plastic debris.
- Energy recovery: For plastic that cannot be recycled, many countries are using 'energy recovery' facilities to safely incinerate plastic (and other) waste to generate energy or fuel. *

Both landfills and energy recovery produce emissions and do not contribute to a reduction in production of virgin plastics.
The best environmental options are recyling and reducing the use of plastic, especially single use plastic items, by choosing other materials and techniques when we can.

* 9 countries in the European Union are sending less than 10% of their plastic waste to landfills. The rest is utilized in recycling and energy recovery.

SOME OF THINGS THAT WE CAN DO

- Lower your plastic consumption. For example: always recycle plastic; don't drink bottled water; don't using plastic carryout bags. (The four worst-offending plastics are Styrofoam, carryout bags, bottles and bottle-tops.)
- Start or get involved in campaigns to eliminate problem products and demand that companies take responsibility for their products. For example, lobby:
  - companies that use microplastics in their cleansers to replace them with environmental friendly alternatives;
  - fast food restaurants to stop using plastic cups, plates, cutlery;
  - stores to stop using plastic carryout bags;
  - the government to have plastics producers implement technological solutions to ensure that all plastics produced are recyclable and less harmful to the environment.
- Get involved in cleanups and/or developing plastic waste reduction programs in your school and/or in your community.
- Increase the understanding and awareness of the impacts of plastic debris by telling others, posting information online, writing articles, or by creating a video. Team up with other people or schools in a campaign.

"There is a lot to be hopeful about, with engagement, en masse." Stiv Wilson, The 5 Gyres Institute

OUR OCEANS AND THE IMPACTS OF PLASTIC DEBRIS

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ACKNOWLEGEMENTS

Editing assistance:	Capt. Charles Moore, Founder, Algalita Marine Research Foundation; Diana Gutierrez Carrillo, teacher, and Volunteer students at Preparatoria tecnológica Cecytej, Melaque;
Coordination and support:	Ramón Velasco Medina, Superintendent, Preparatoria de San Patricio de Melaque