DEPARTMENT OF OCEAN SCIENCE

Module overview - Humans and the Sea

Human Impacts on Marine Life?

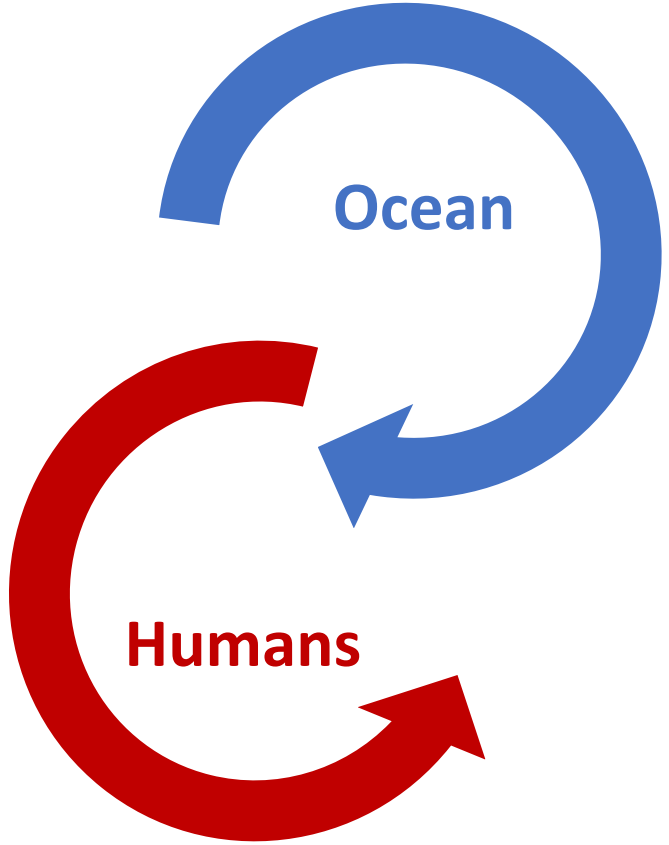
- In 2017, ~3 billion people (~50% of world's population) live within 100km of coast
- Anthropogenic (Human-made) pollution is the main source of toxic contaminants in coastal water
- Almost half of toxic pollutants come from runoff from rivers and streams
- Marine life can consume and accumulate toxins > affecting food chain and human health!

Image: University of Hawaii

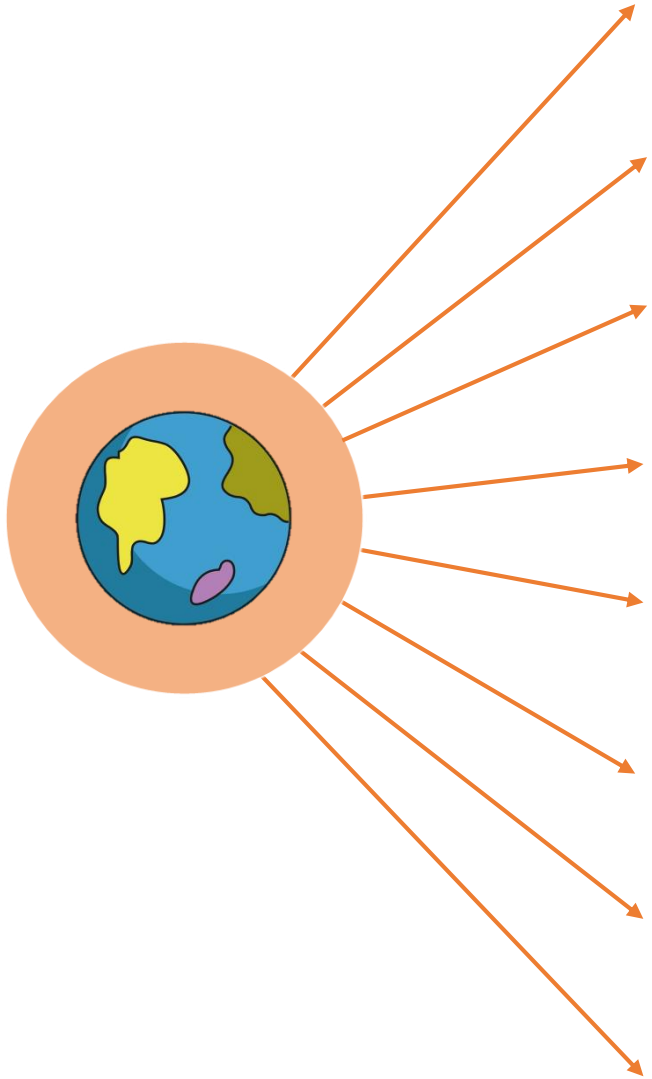
Humans and the Sea – Interconnected

Increasing demand for ocean resources → changing the ocean environment!

- **Ocean impacts on humans:**
  - Provides oxygen, food, minerals, energy resources, medicine
  - Supports living, jobs, economies, shipping, transport, national security, cultural heritage
  - Moderates the Earth's climate
- **Human impacts on the ocean:**
  - Pollution & wastes
  - Changing ocean chemistry and physics
  - Biological impacts
  - Fisheries
  - Poor ocean management



Humans and the Sea – Topics Covered



- Ocean and the climate
- Ocean and global warming
- Ocean acidification
- The Global Coral Reef Crisis
- Resources from the Ocean
- Coastal pollution and other anthropogenic impacts
- Oyster Farming and Seafood Safety
- Marine Protected Areas

Learning Outcomes

- Review prior knowledge of ocean
- Explain how humans benefit from the ocean
- Evaluate the physical, chemical and biological impacts of human activities on the ocean.
- Apply knowledge of human dependence on the ocean to decision making in ocean management.

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The Ocean and Climate

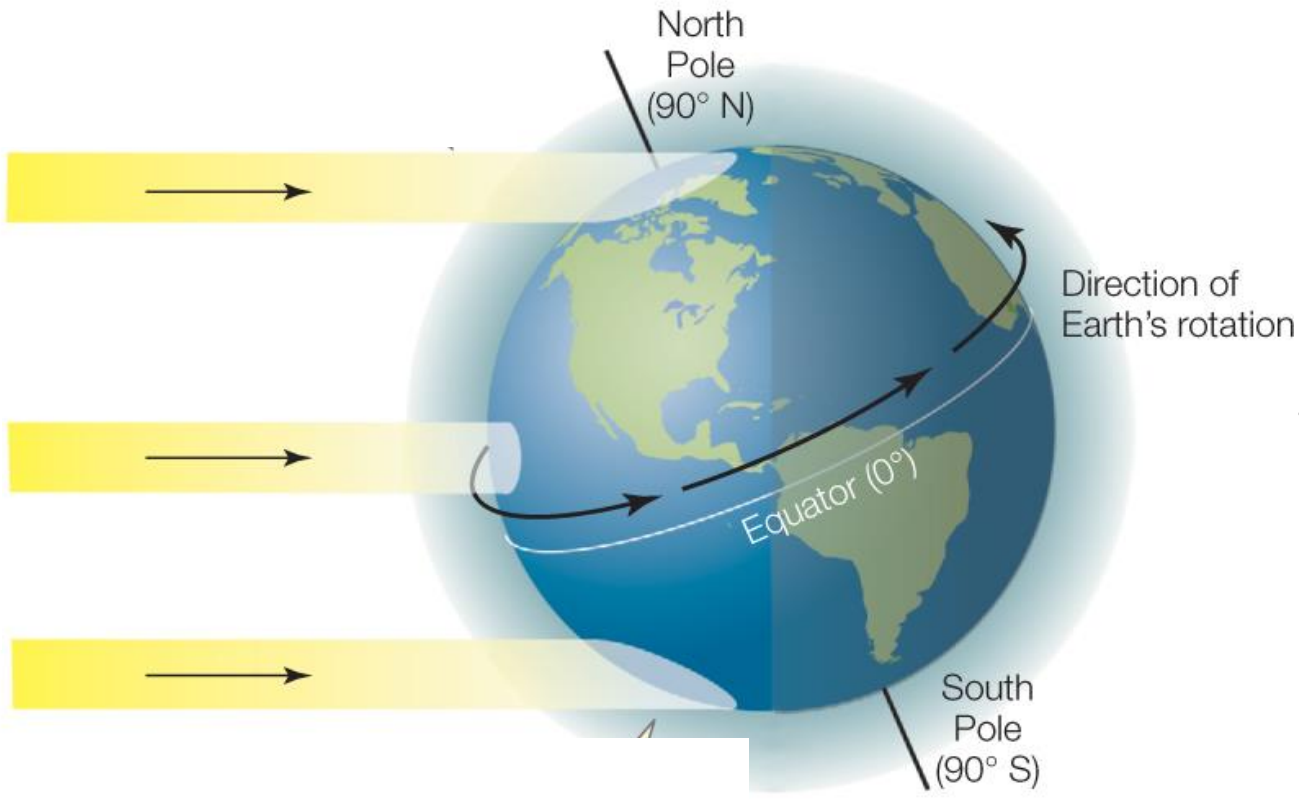
Overview of the Ocean and Climate

- What are the major components of Earth's climate system?
- How does the Sun affect our climate?
- How does the Ocean regulate the climate?

Earth's climate system – Primary components:

- **Atmosphere** – air part
- **Hydrosphere** – liquid part, mostly ocean
- **Biosphere** – living part
- **Cryosphere** – frozen part

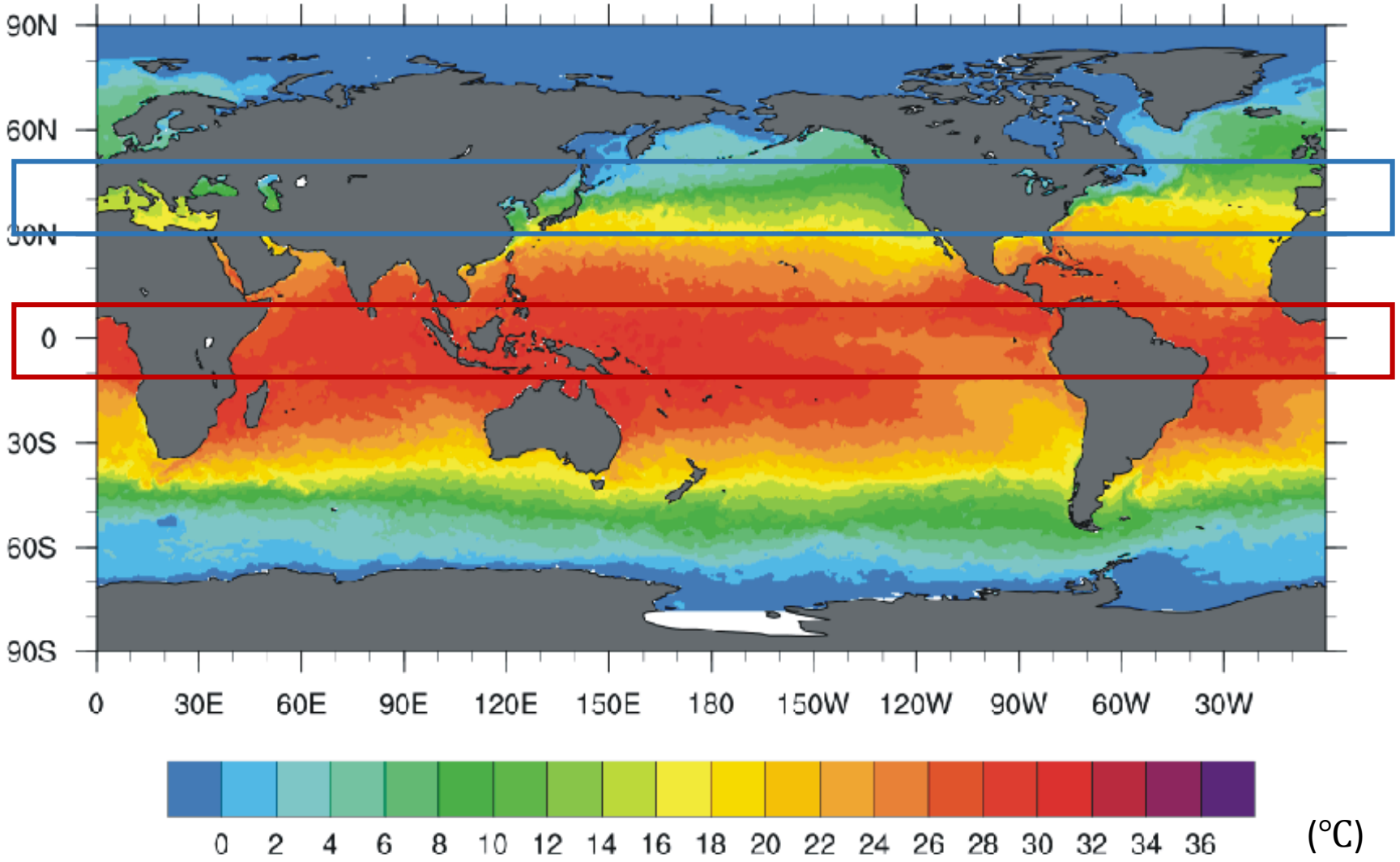
The Earth's climate system and the Sun:



The **angle of incoming sunlight** affects the amount of solar energy that reaches a given area of Earth's surface.

The Ocean moves the heat around

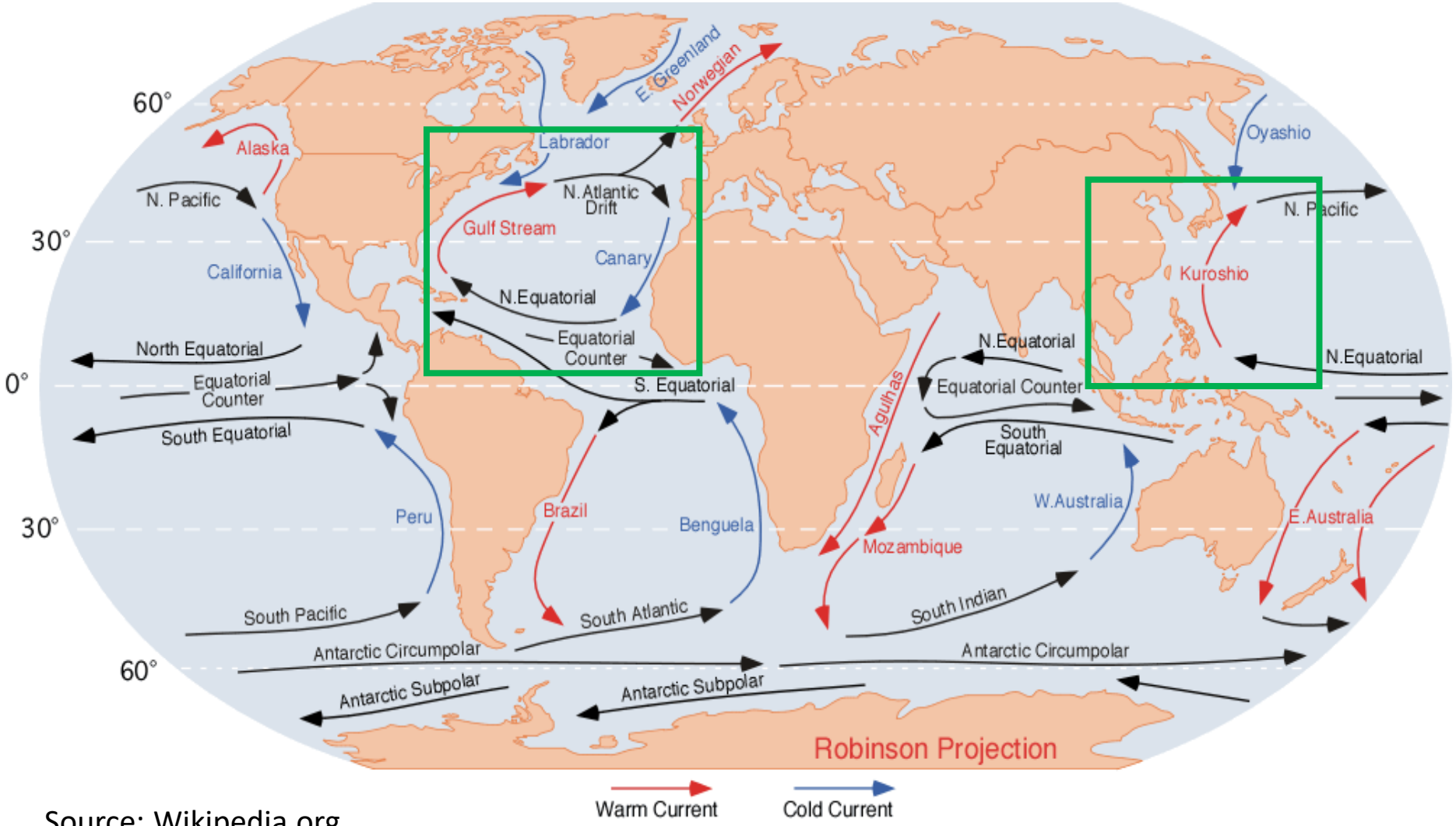
Global sea surface temperature (16 Feb 2020)



The Ocean plays an important role in **moving around the energy** on this planet.

Source: Plymouth State Weather Center

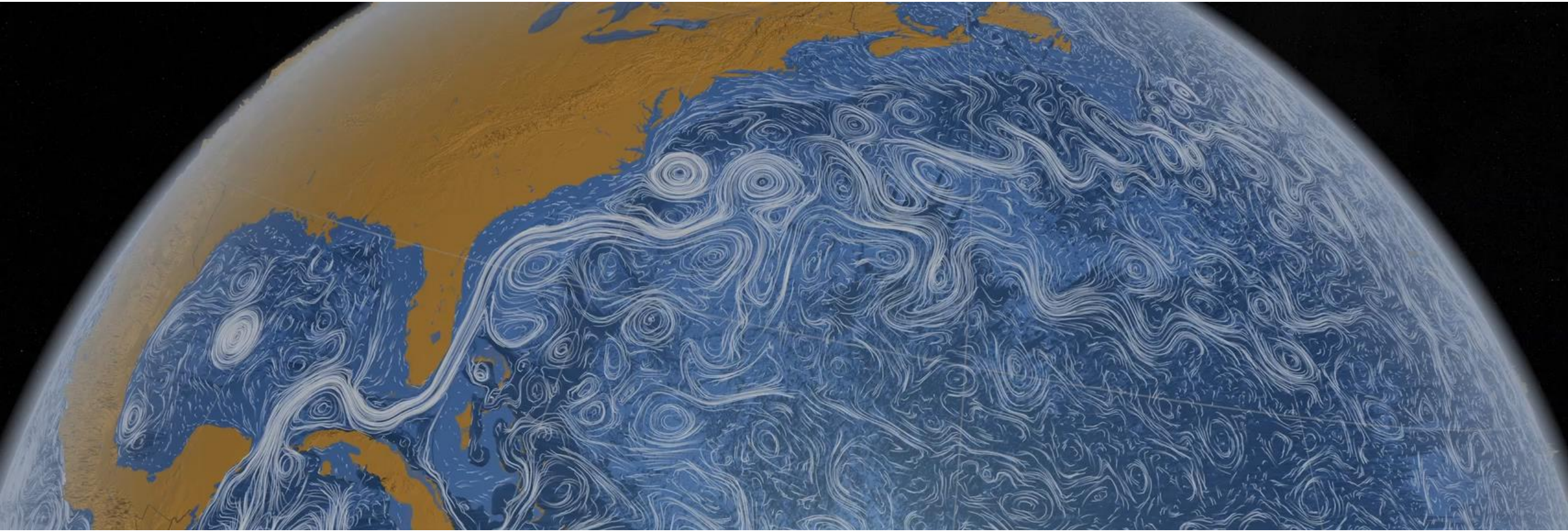
Ocean currents and temperature of regions



Source: Wikipedia.org

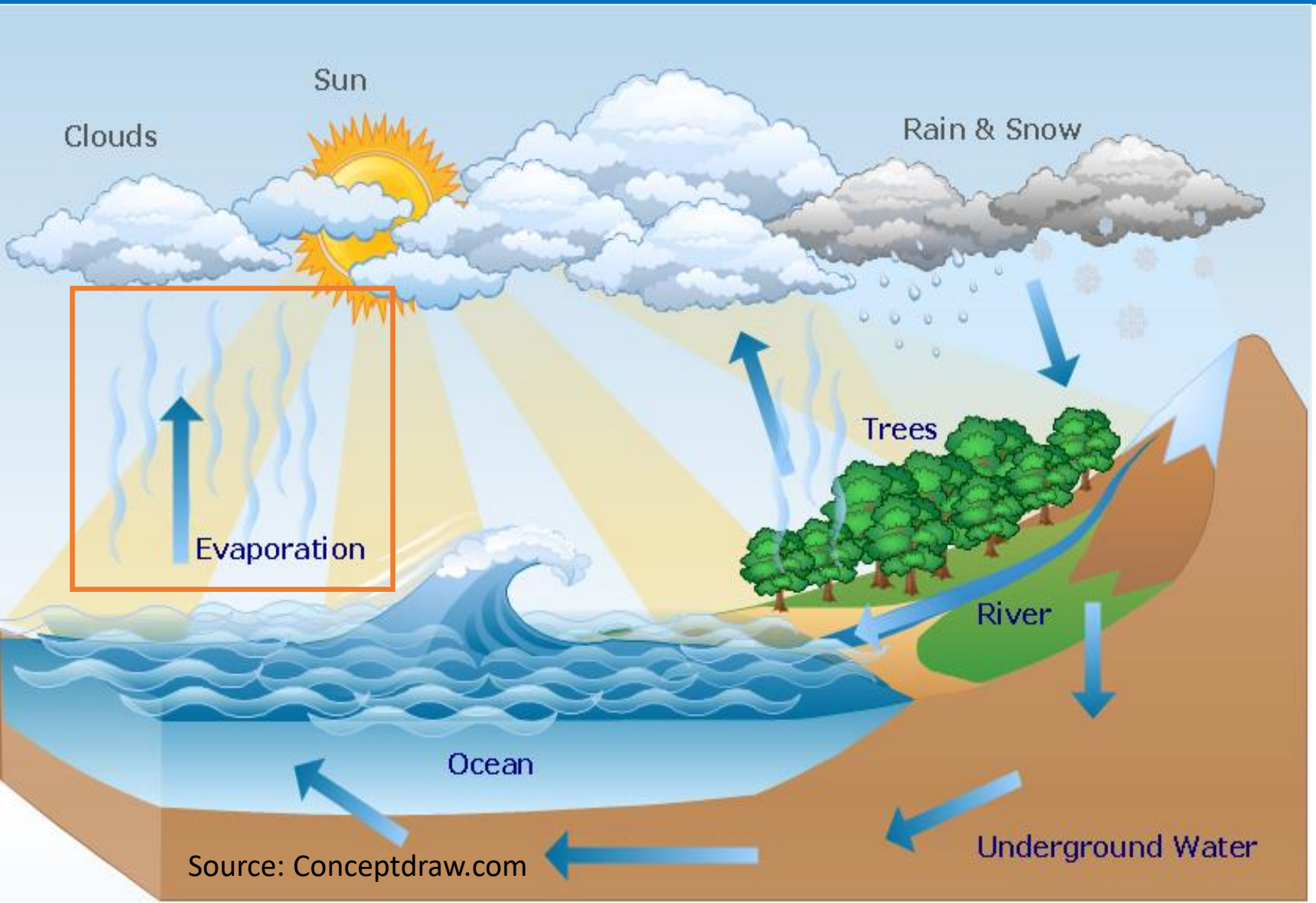
Ocean currents **influence the temperature of the regions** through which they travel

Gulf Stream Sea Surface Currents and Temperatures



Source: NASA

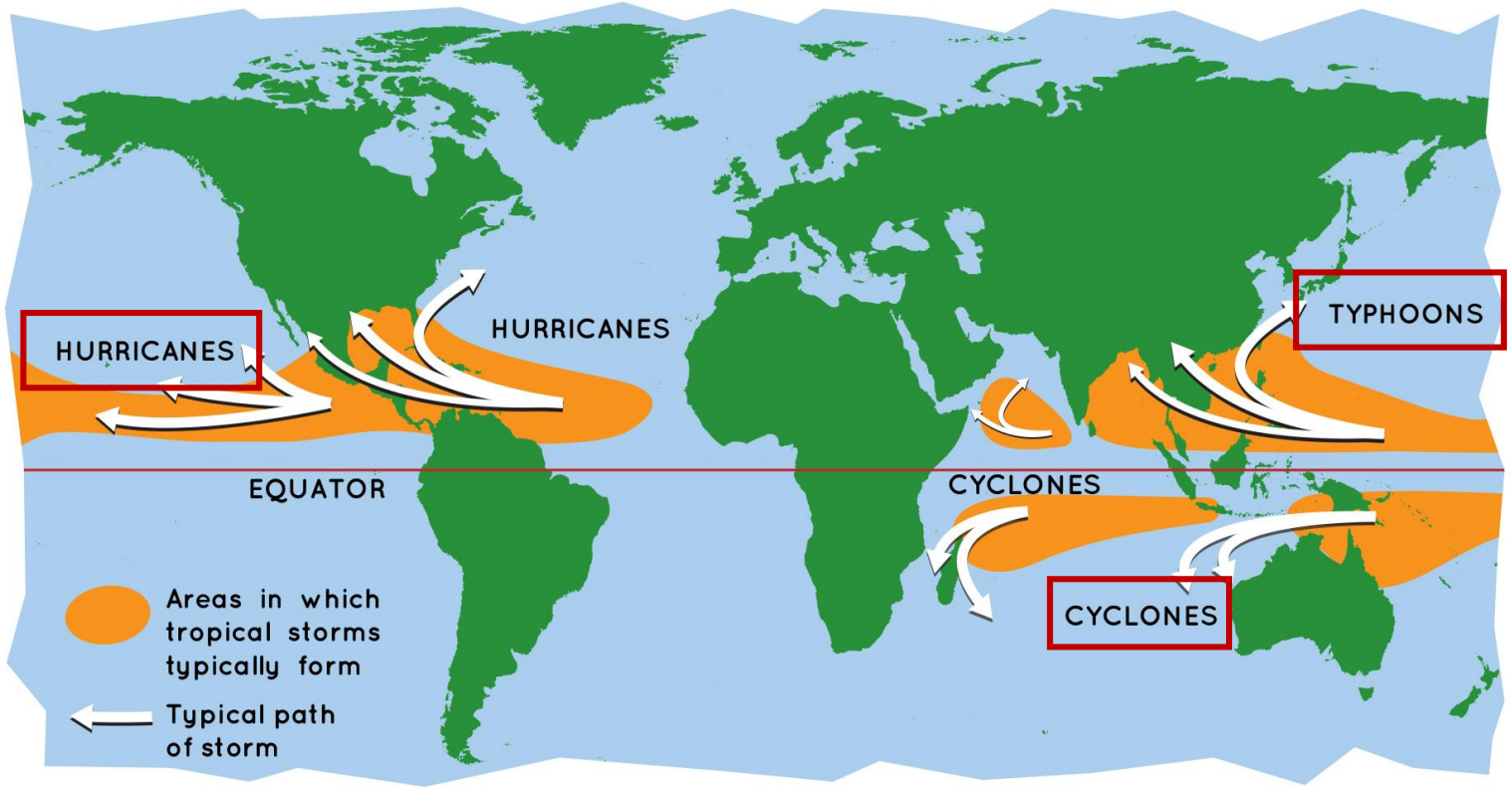
The Ocean is a vital part of Hydrological cycle

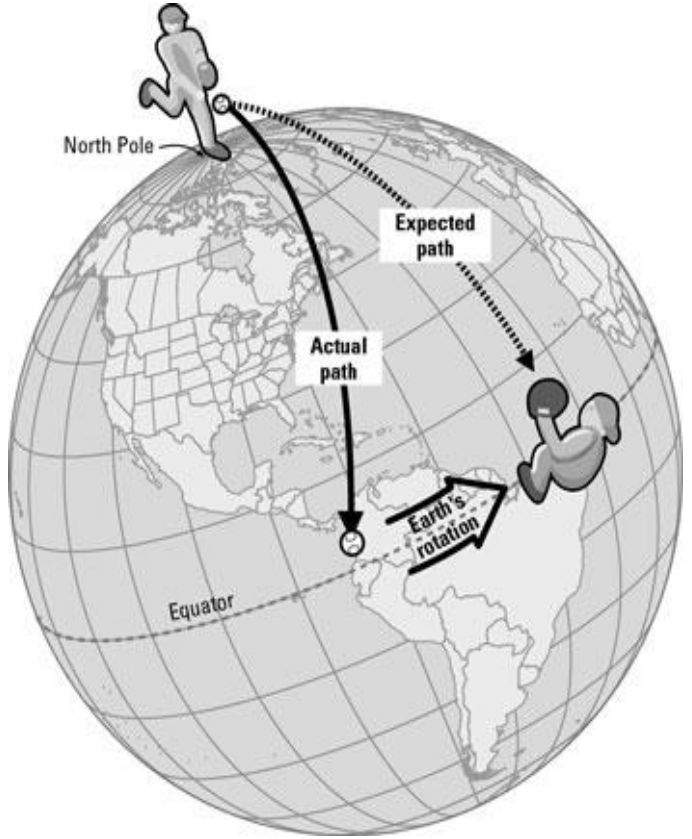


Source: Conceptdraw.com

More evaporation in warmer ocean

Tropical cyclones from *near* the equator





Tropical cyclones only form over **warm ocean waters** near the equator (but at least five degrees of latitude away from the equator)

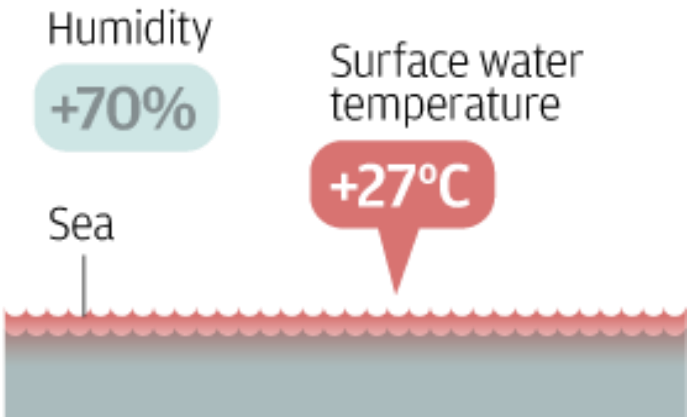
Coriolis Force

- things (like planes or air currents) traveling long distances around Earth appear to **move at a curve** instead of a straight line.

Source: NASA, dummies.com

Formation of tropical cyclones

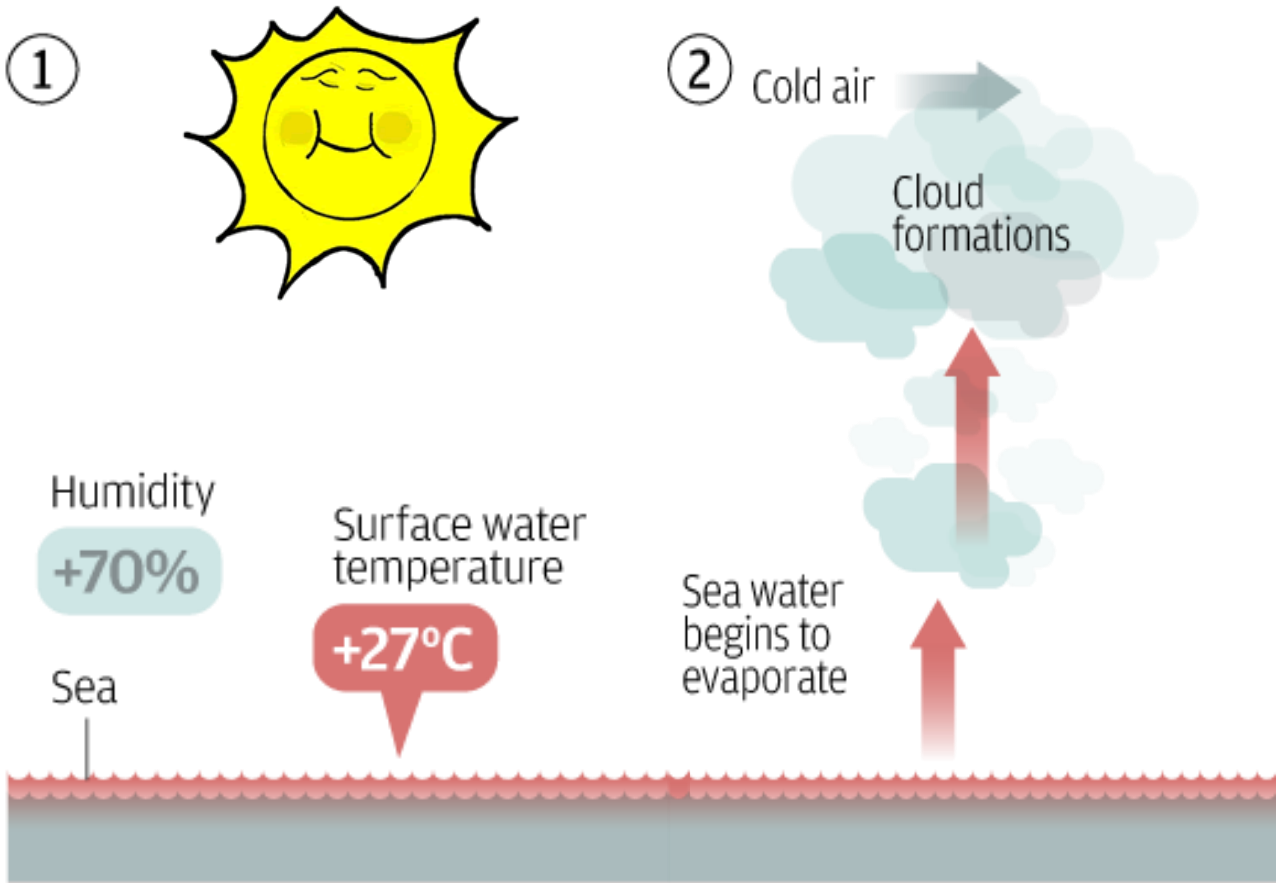
①



- Warm water (>27℃)
- Enough moisture
- Coriolis Force
- Low Wind Shear

Formation of tropical cyclones

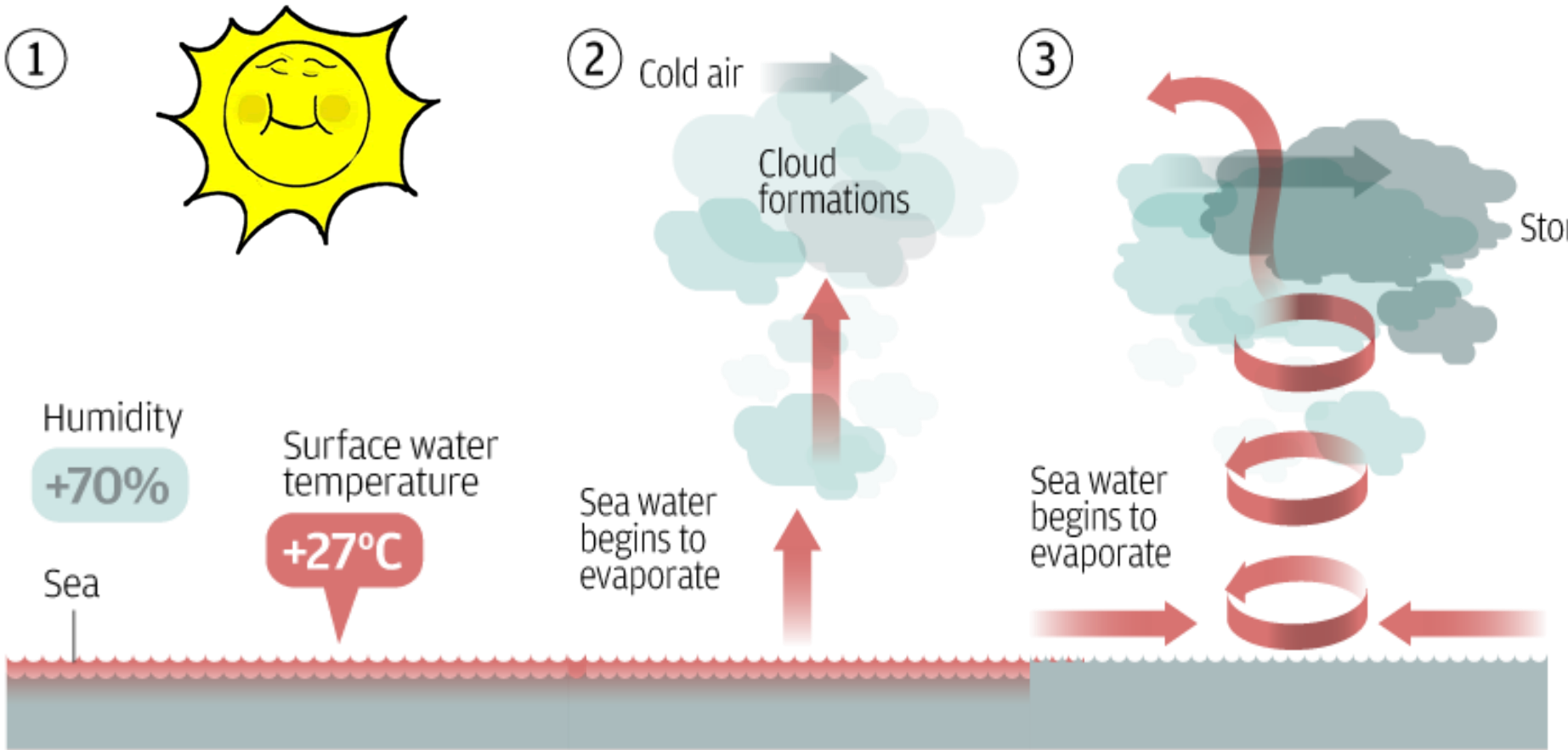
- Rising warm air **evaporates** and starts to **spin**



- **Warm water (>27℃)**
- **Enough moisture**
- **Coriolis Force**
- **Low Wind Shear**

Formation of tropical cyclones

- Rising warm air **evaporates** and starts to **spin**
- The air then **cools and condenses** to form cloud



- **Warm water (>27℃)**
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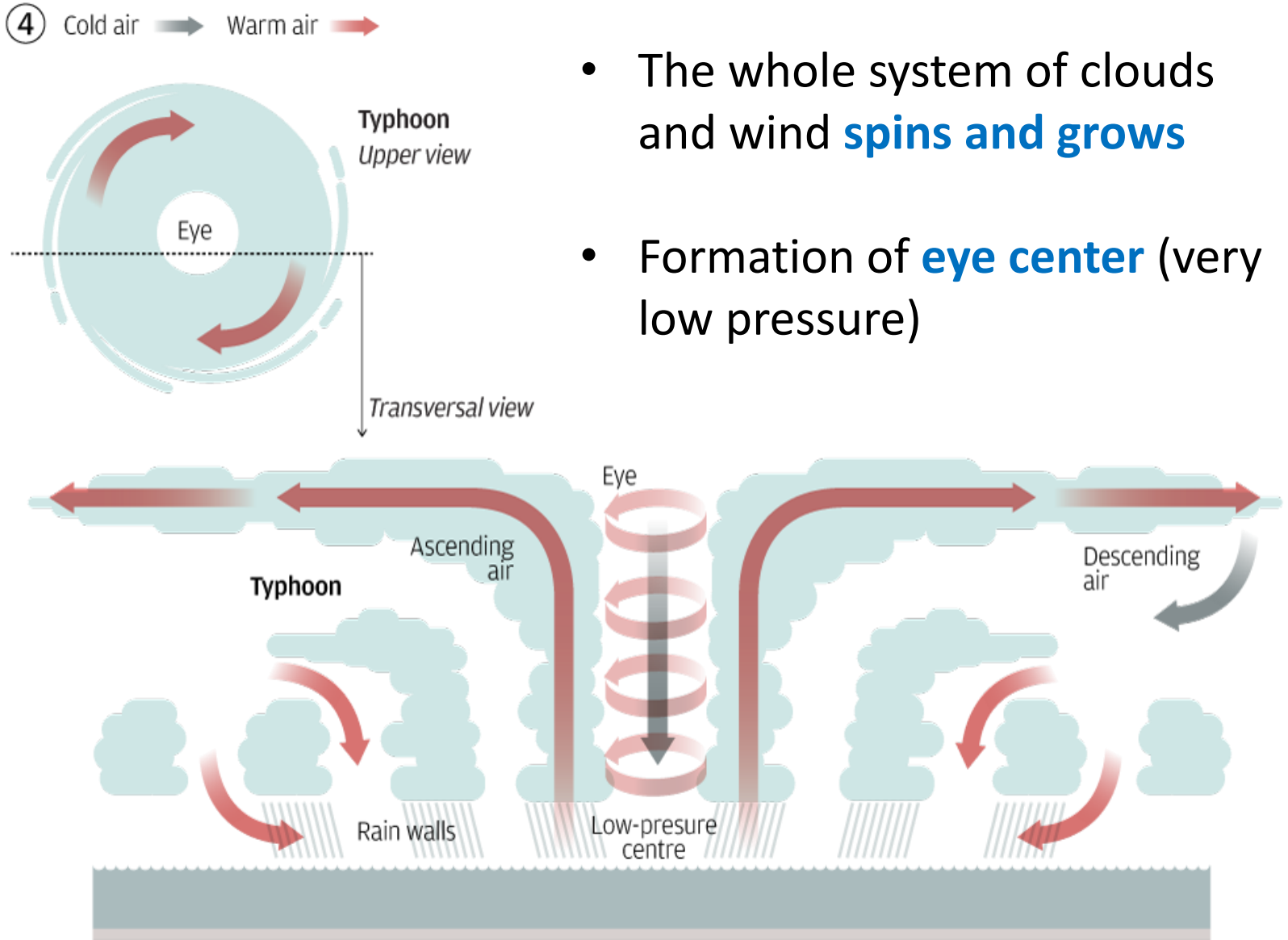
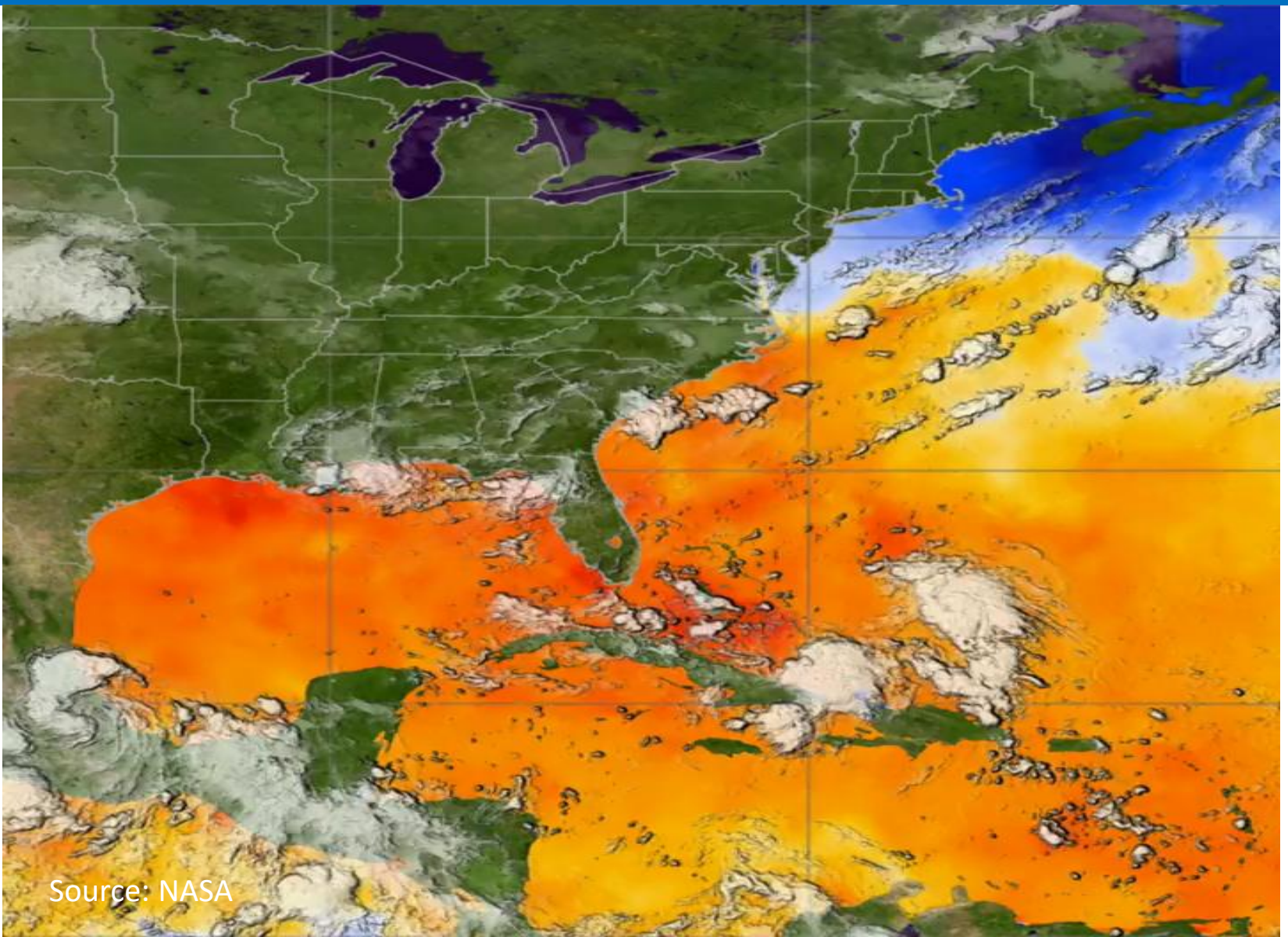
Formation of tropical cyclones



- The whole system of clouds and wind **spins and grows**
- Formation of **eye center** (very low pressure)

- **Warm water (>27℃)**
- **Enough moisture**
- **Coriolis Force**
- **Low Wind Shear**

Hurricane Katrina accelerated over warm ocean



Source: NASA

Warm oceans allow the formation of **super typhoons/ hurricanes**

Key concepts – The Ocean and Climate

- The Sun's angle to the Earth creates warmer and cooler parts of the earth

- The Ocean moves warm energy around the earth, influencing
  - **A region's geographical temperature:** Warmer parts of the ocean moves heat to cooler parts of the earth
  - **Weather:** more evaporation in warmer ocean results in rain or snow
  - **Tropical storms:** warm water and air near equator fuels and initiates the formation of tropical storms

Summary of the Ocean and Climate

- What are the major components of Earth's climate system?
  Atmosphere, Hydrosphere, Biosphere, Cryosphere

- How does the Sun affect our climate?
  Angle of incoming sunlight affects the amount of solar energy

- How does the Ocean modulate the climate?
  - **Ocean currents** and **regions' temperature**
  - **Hydrological cycle** and **weather**
  - Formation of **Tropical cyclones**

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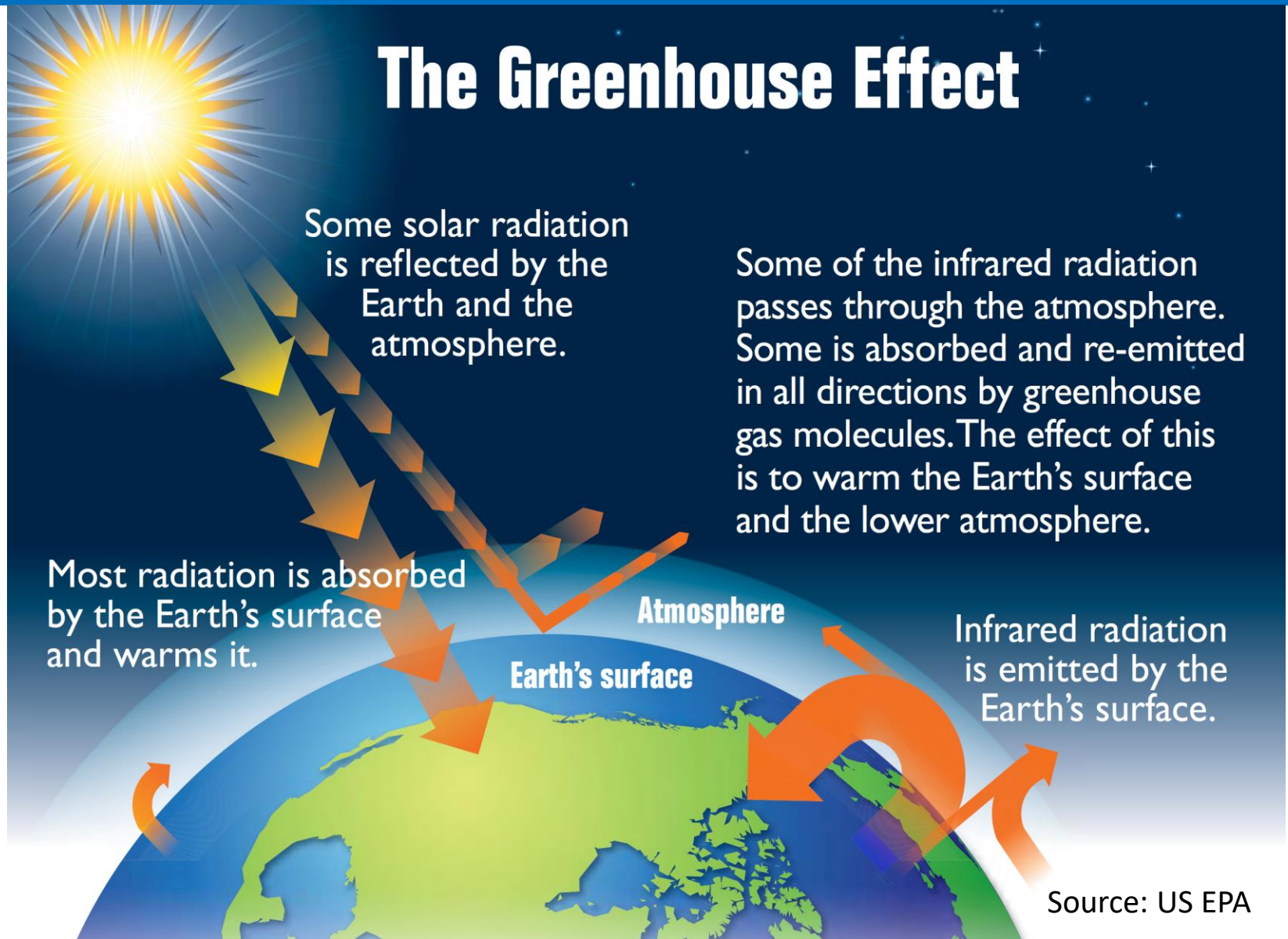
The Ocean and Global Warming

Overview of The Ocean and Global Warming

- What is the **Greenhouse effect**?
- What is **global warming**?
- What is **ocean warming**?
- What are the **impacts** of ocean warming?

Natural Greenhouse Effect Warms the Earth



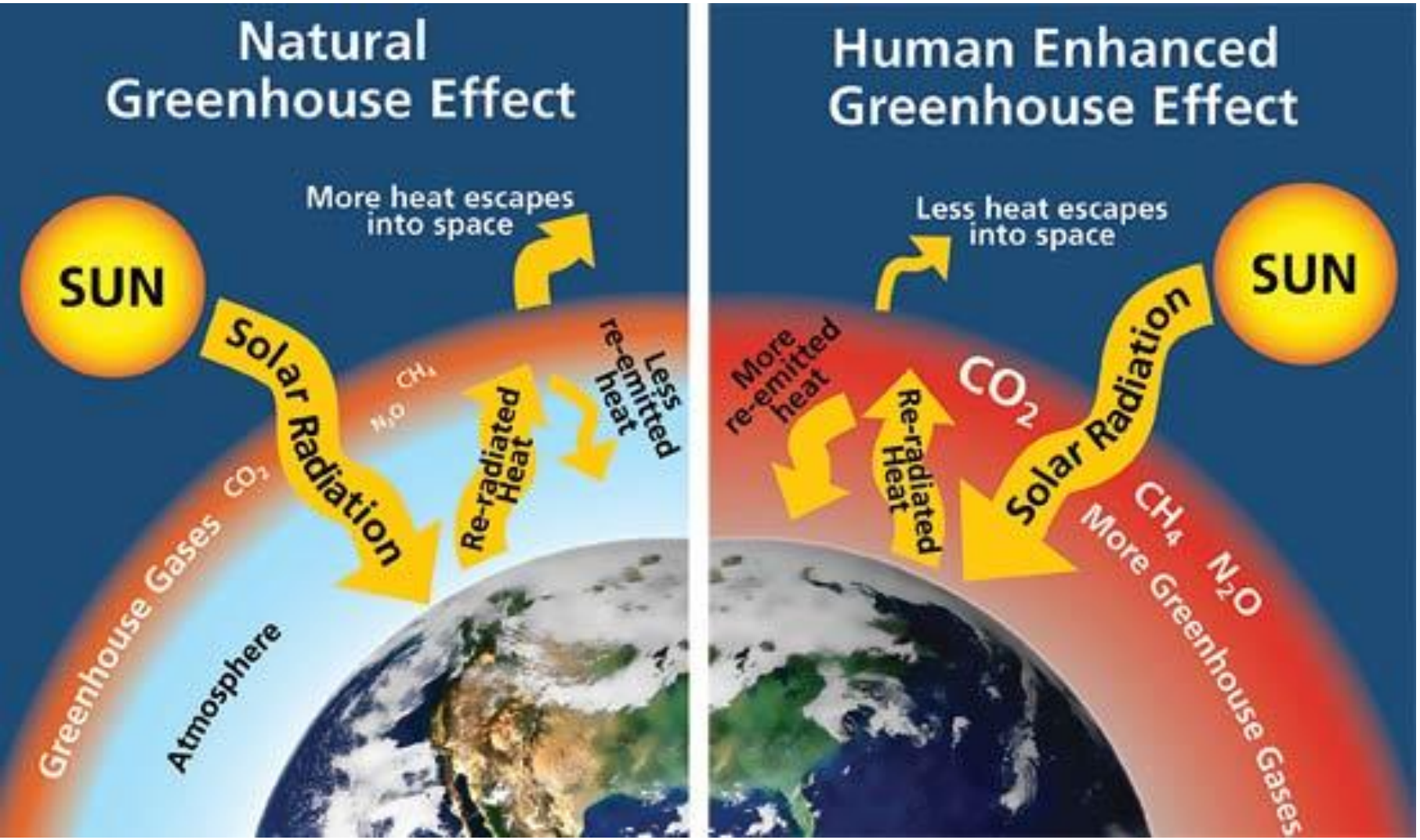
Source: US EPA

Average surface temperature

=

15°C

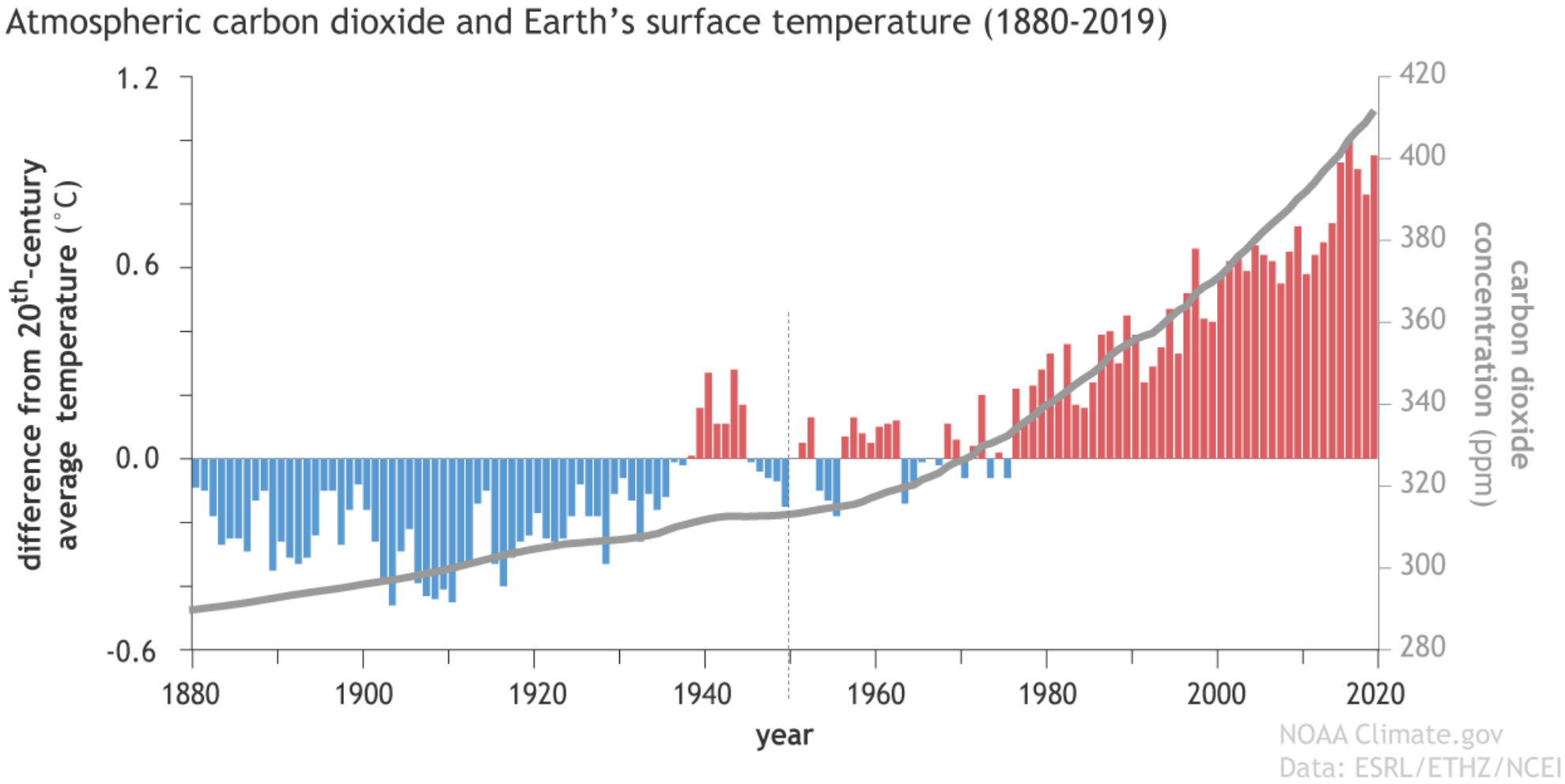
Human enhanced Greenhouse Effect



The presence of **more greenhouse gases** will absorb more of the **infra-red radiation**

GLOBAL WARMING

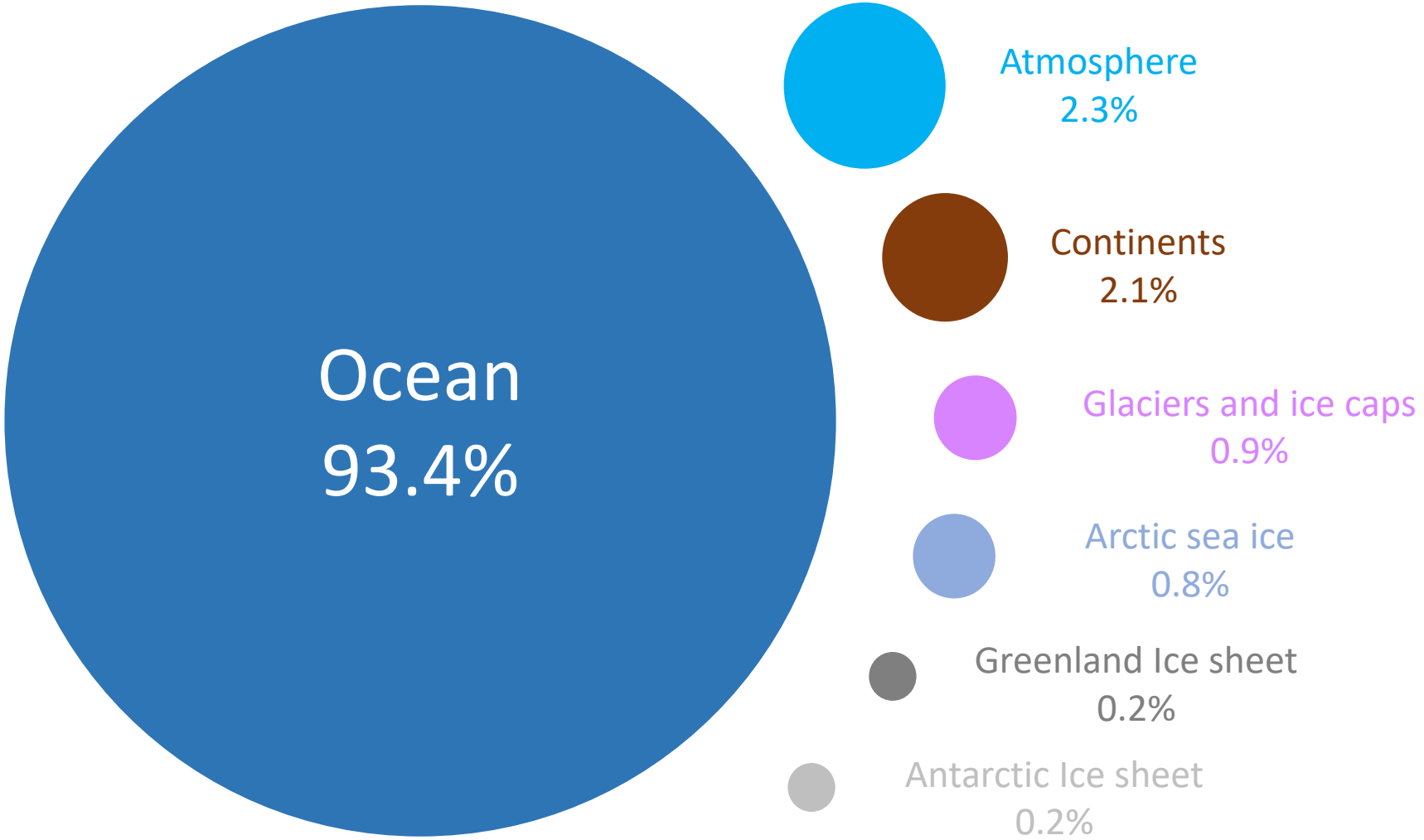
Global Temperature and Carbon Dioxide



Drastic rise of carbon dioxide levels since the 1950's should have taken 5,000 – 20,000 years!

Rising temperatures and higher carbon dioxide level

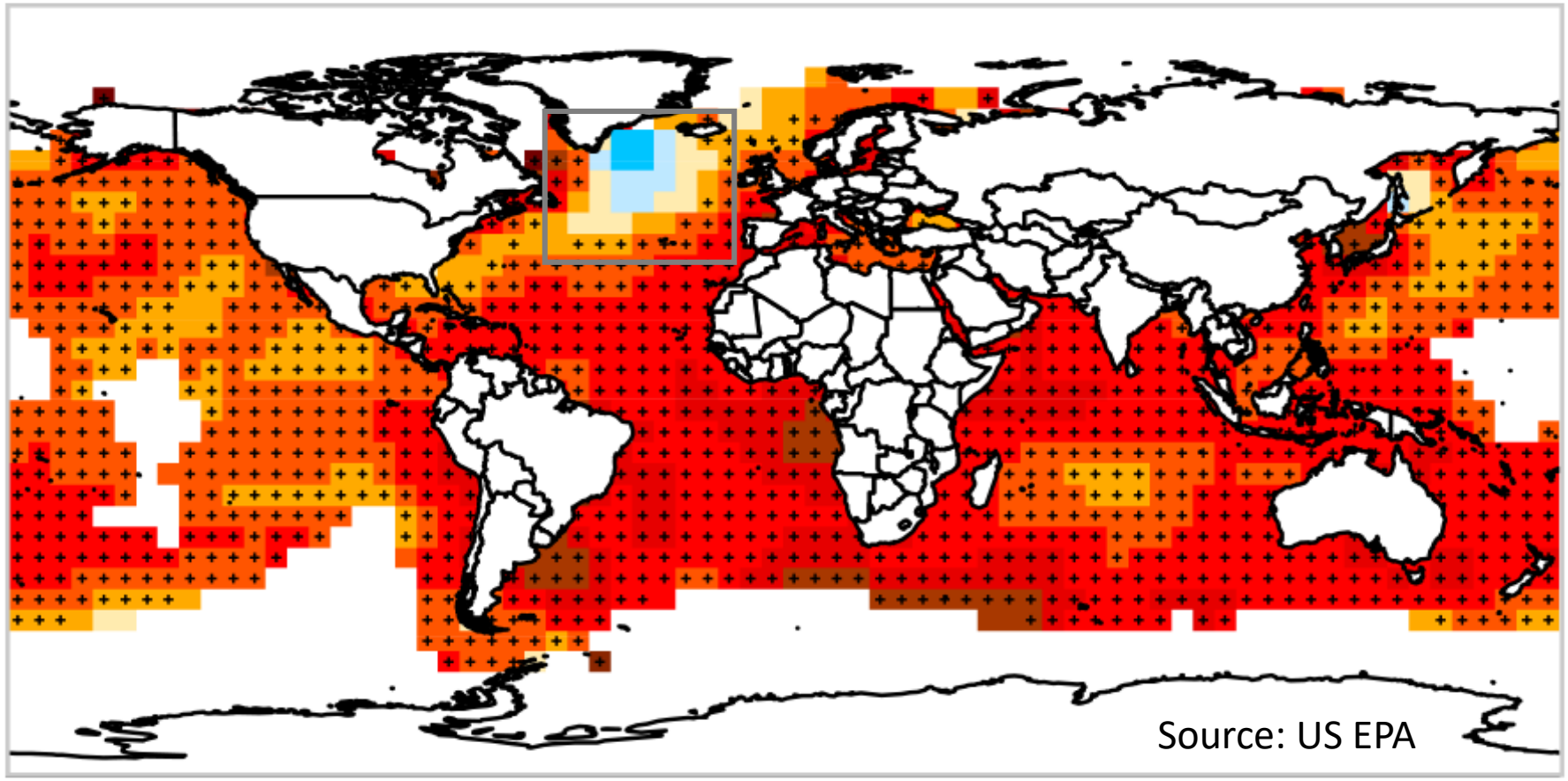
Where is global warming?



Global warming is ocean warming

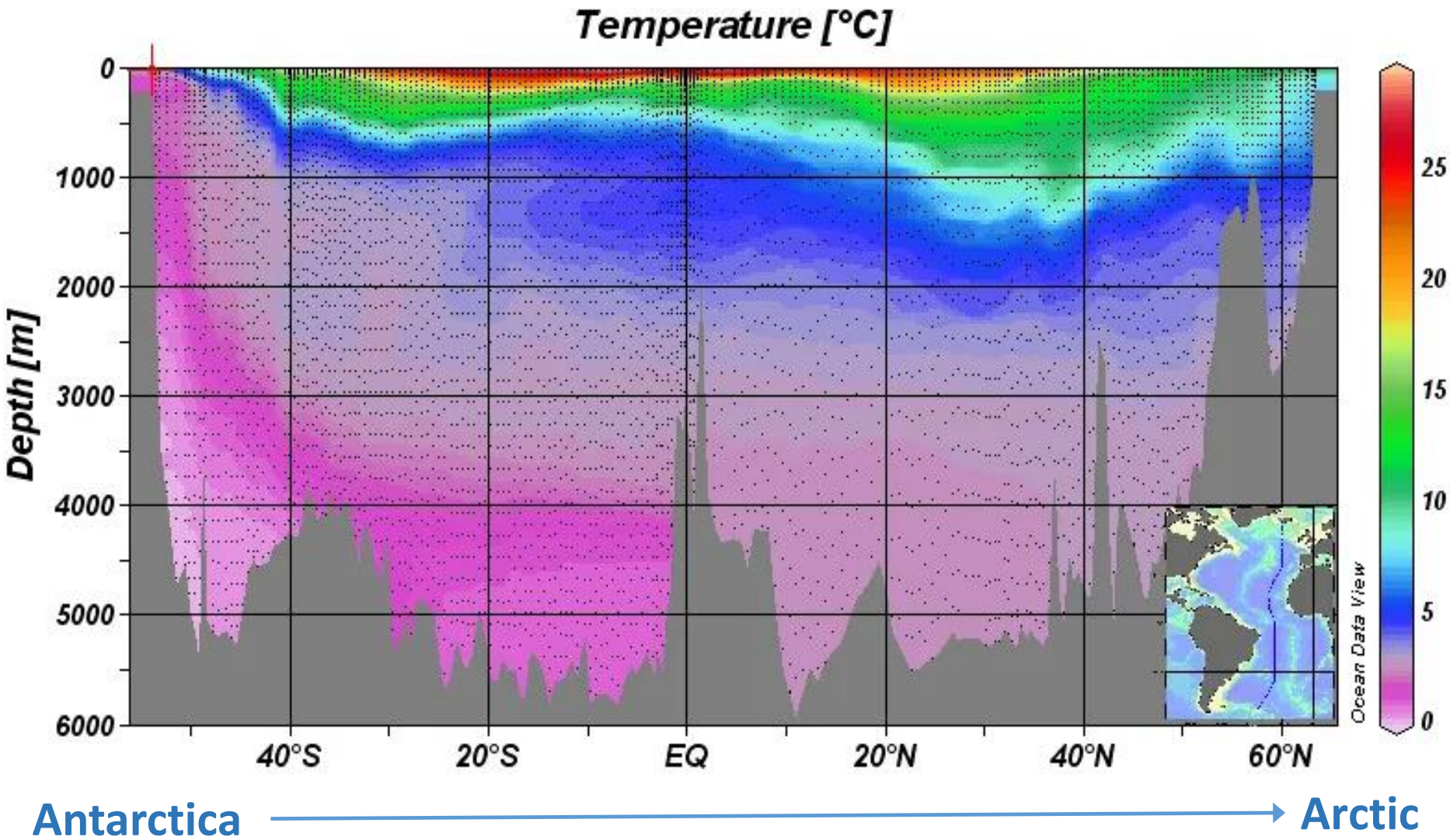
Components of global warming, 1993 to 2003 (IPCC AR4 5.2.2.3)

Change in Sea Surface Temperature, 1901–2015



- Changes in sea surface temperature vary regionally
- Most parts of the world's oceans experience temperature rise

Vertical currents - Bringing the warm water down to the deep ocean



Antarctica → Arctic

Cross section of the Atlantic Ocean from the southernmost high latitudes around Antarctica to the northernmost high latitudes in the Arctic

Source: NASA

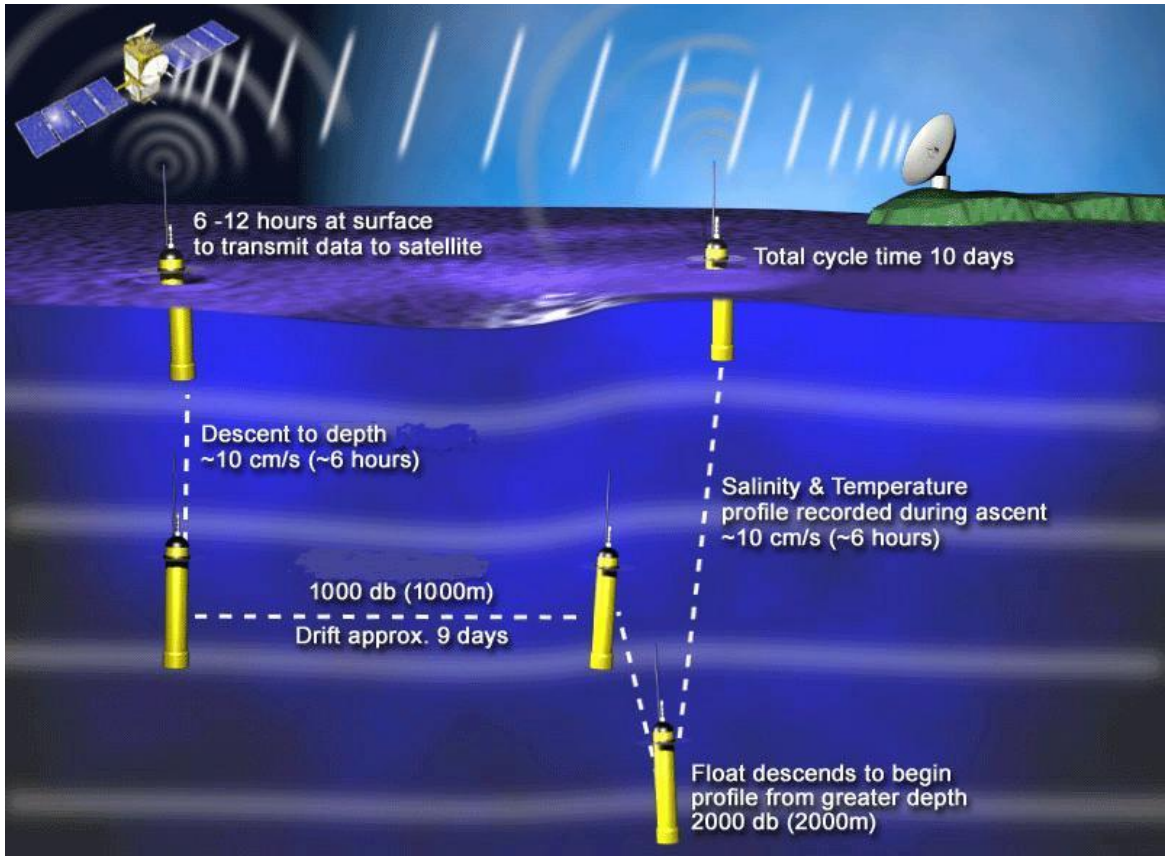
How do we measure ocean temperature?

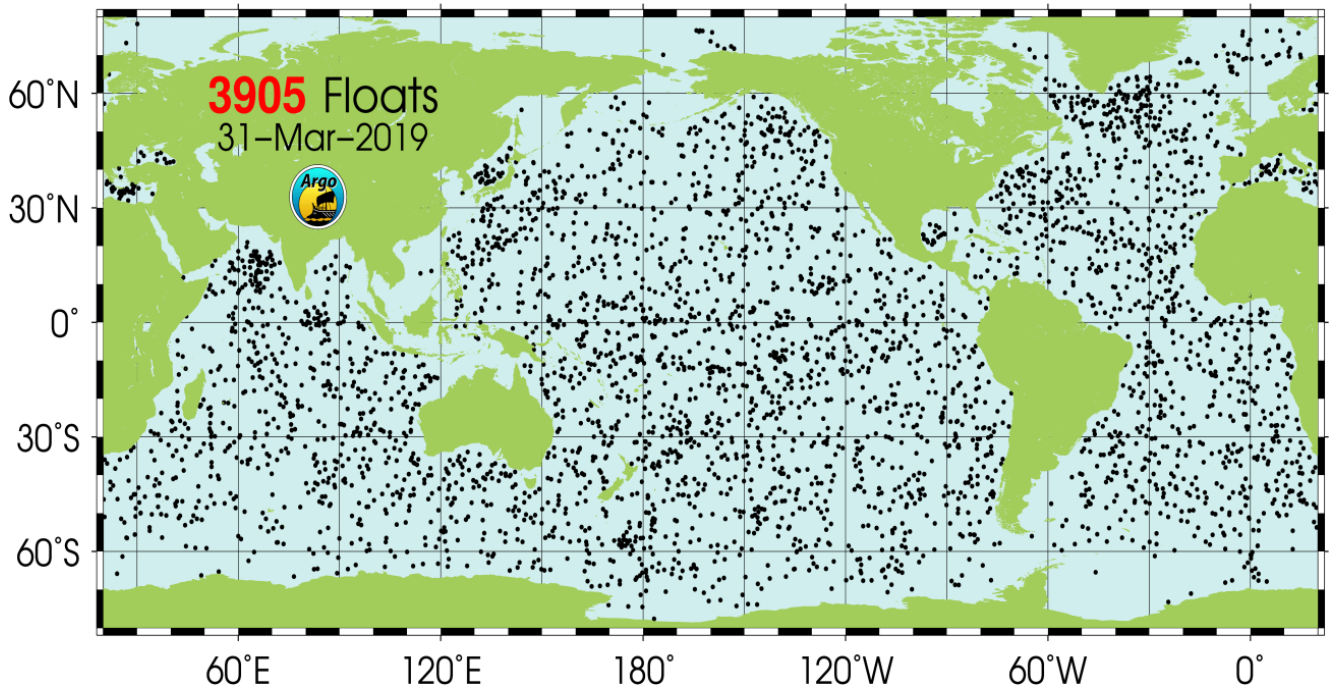
Research Vessel (RV Walton Smith from University of Miami) collects real-time data at sea.

Measurements of temperature, salinity, pressure etc are achieved via fine sensors such as CTD (Conductivity-Temperature-Depth) chains.

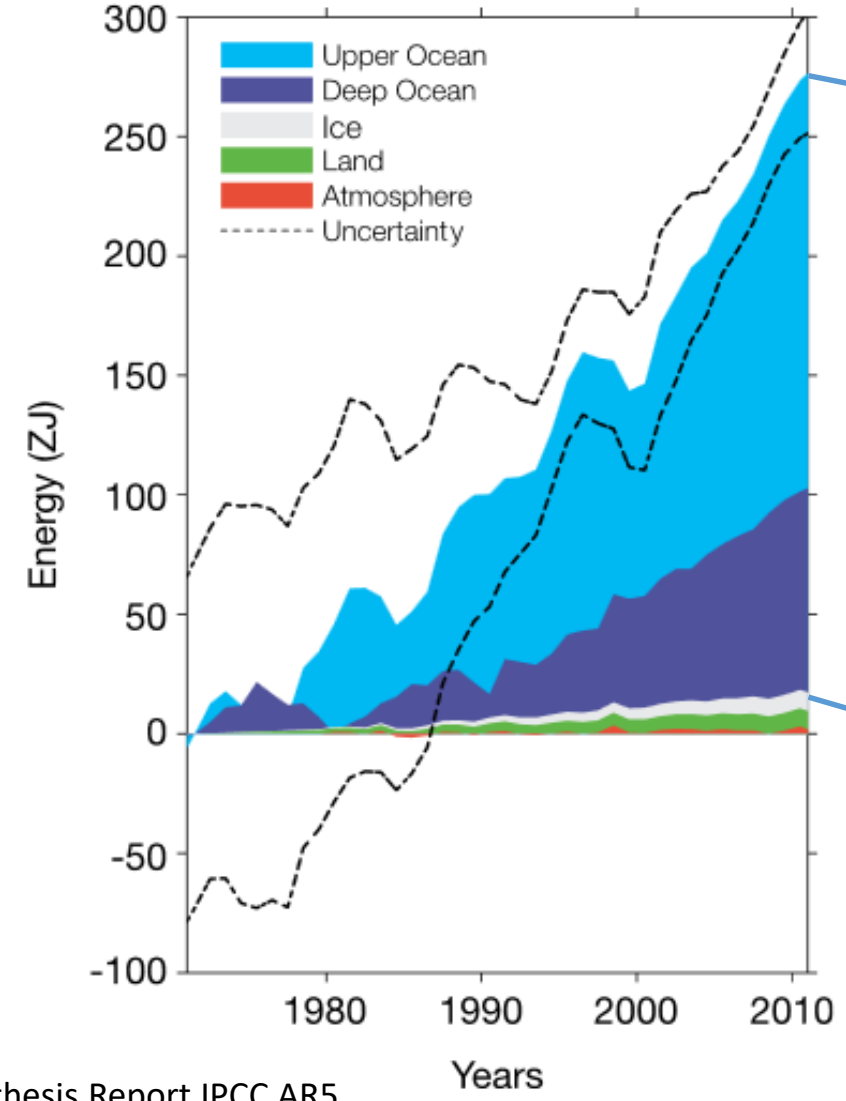
How do we measure ocean temperature?

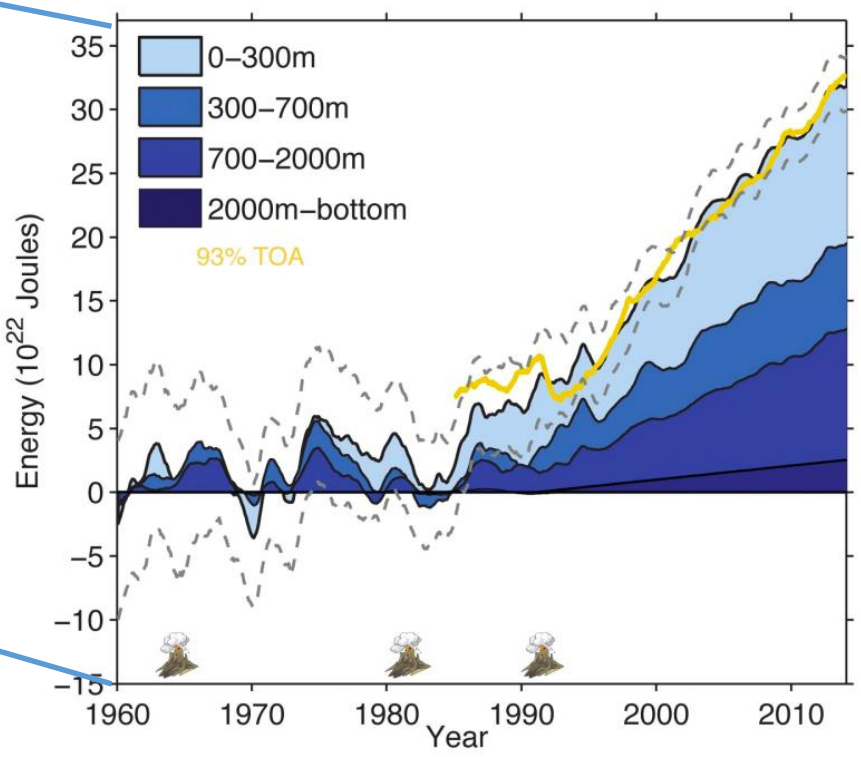
Argo Floats





Energy accumulation within the Earth's climate system





There is an acceleration of ocean warming for all depths.

Source: Synthesis Report IPCC AR5

Consequences of ocean warming

Sea level rise

Stronger storms

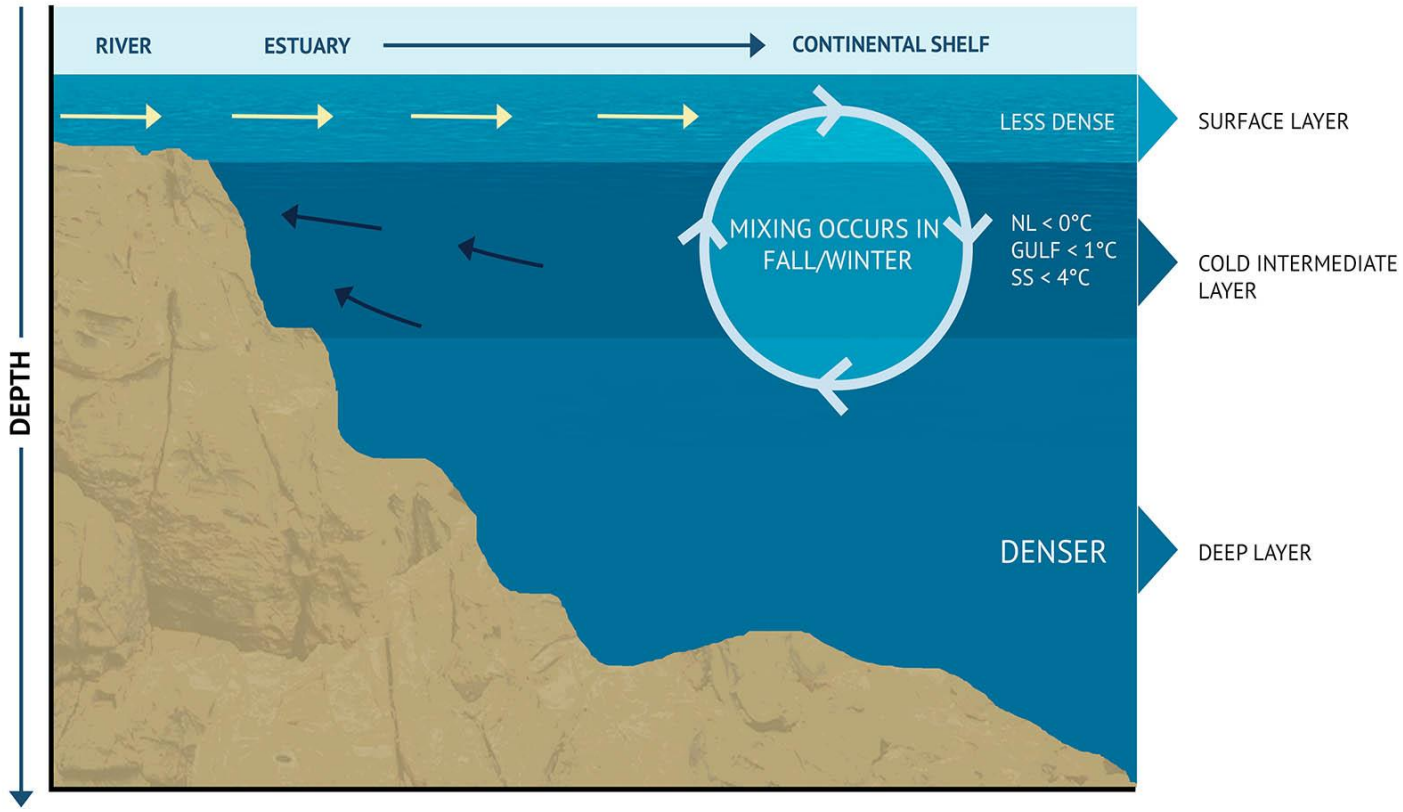
Consequences of ocean warming

More stratified ocean, less mixing

Lower biological productivity

Lower oxygen content in ocean water

STRATIFICATION AND THE COLD INTERMEDIATE LAYER



Key concepts – The Ocean and Global Warming

Global warming affects the ocean

- More greenhouse gases from human activity results in global warming
- Global warming = ocean warming
- Ocean warming is documented at all depths (from sea surface to deeper ocean)

Impacts of ocean warming

- melting ice → **sea level rise**
- warming ocean → **stronger storms**
- less ocean mixing

  → **less nutrients at surface** → **less biological productivity**

Summary – The Ocean and Global Warming

- What is the **Greenhouse effect**?

The **trapping of the sun's heat** in the lower atmosphere

- What is **global warming**?

Long-term rise in the **average temperature** of the Earth's climate system

- What is **ocean warming**?

Ocean **absorbs most of the excess heat** from greenhouse gas emissions, leading to **rising ocean temperatures**

- What are the **impacts** of ocean warming?

Sea level rise, **Stronger storms**, **Stratified ocean**, **Lower oxygen level**, **Lower biological productivity**

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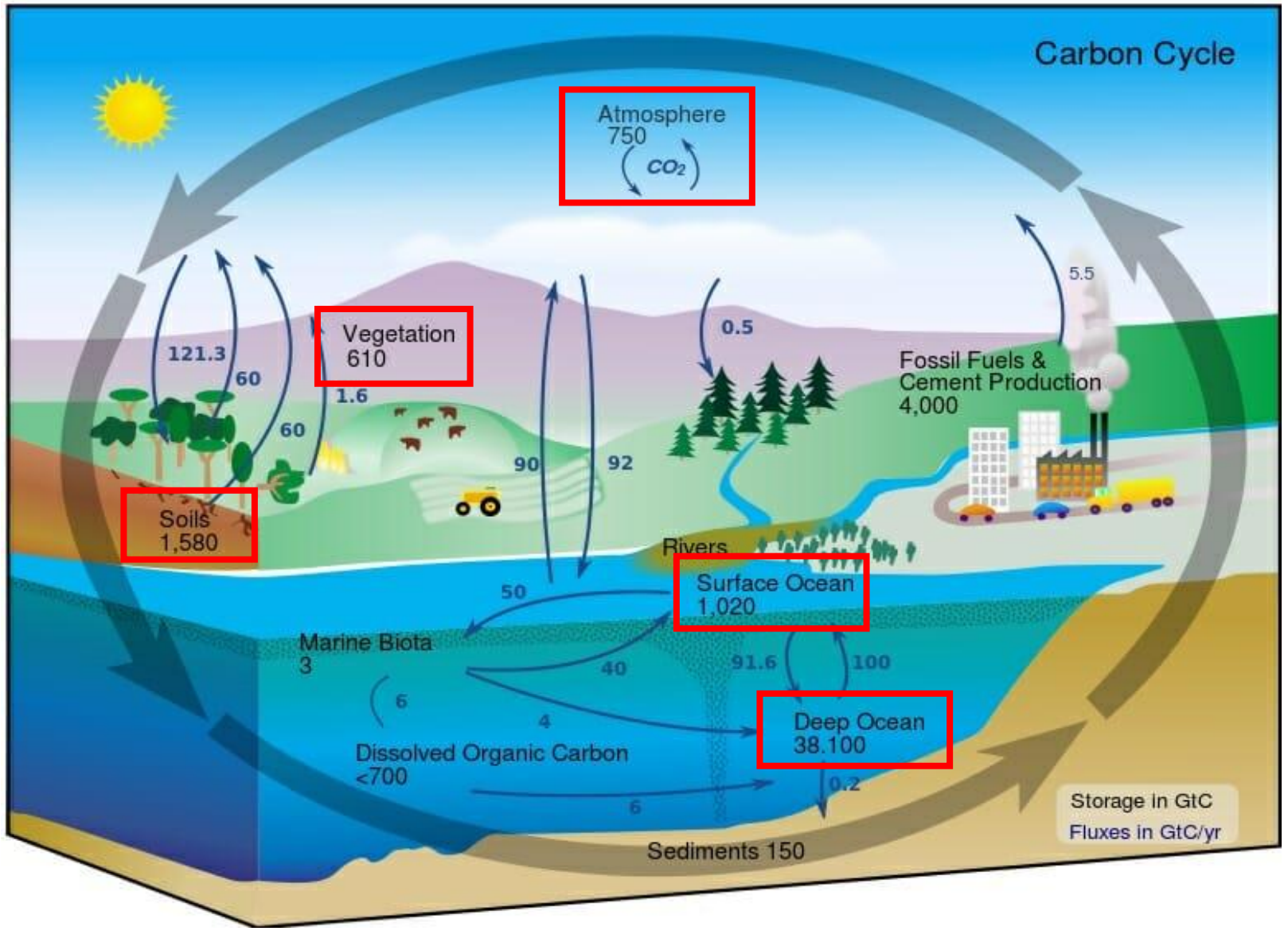
Ocean acidification (Causes)

Overview of Ocean Acidification

Ocean acidification is the ongoing decrease in the pH of the Oceans, caused by the uptake of carbon dioxide from the atmosphere.

- **How does CO_2 end up in the ocean?**
- **How does ocean acidification happen?**
- **What are the impacts of ocean acidification on marine life?**

Carbon cycle and the associated carbon sinks



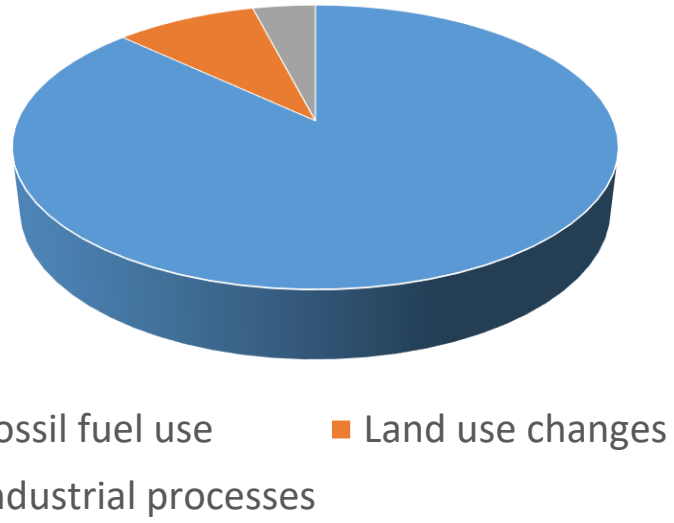
Carbon: the foundation of all life on Earth

Carbon cycle: the process where carbon travels from the atmosphere to organisms to oceans and back to the atmosphere

The Ocean is a major carbon sink

Carbon dioxide sources and sinks

Human sources of carbon dioxide



Where does it go? (carbon sink)

Atmosphere
(45%)

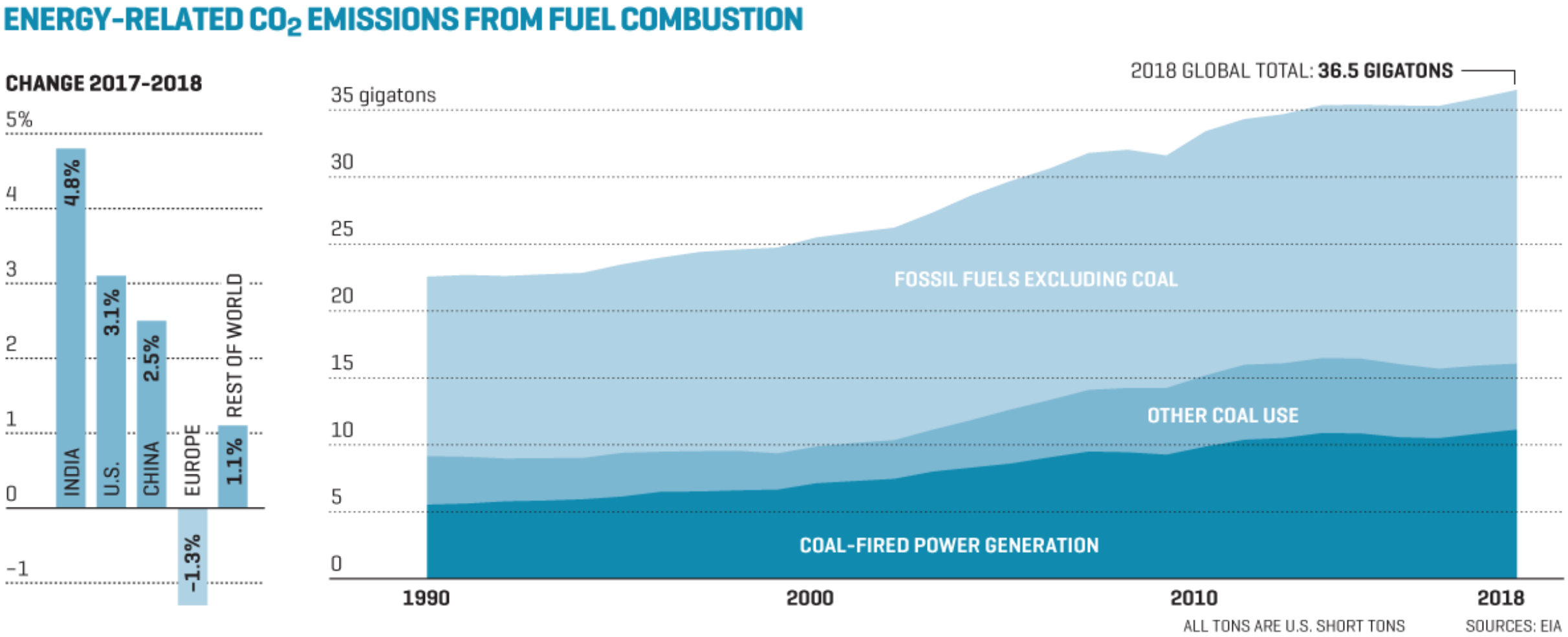
Plant and soil
(30%)

Ocean
(25%)

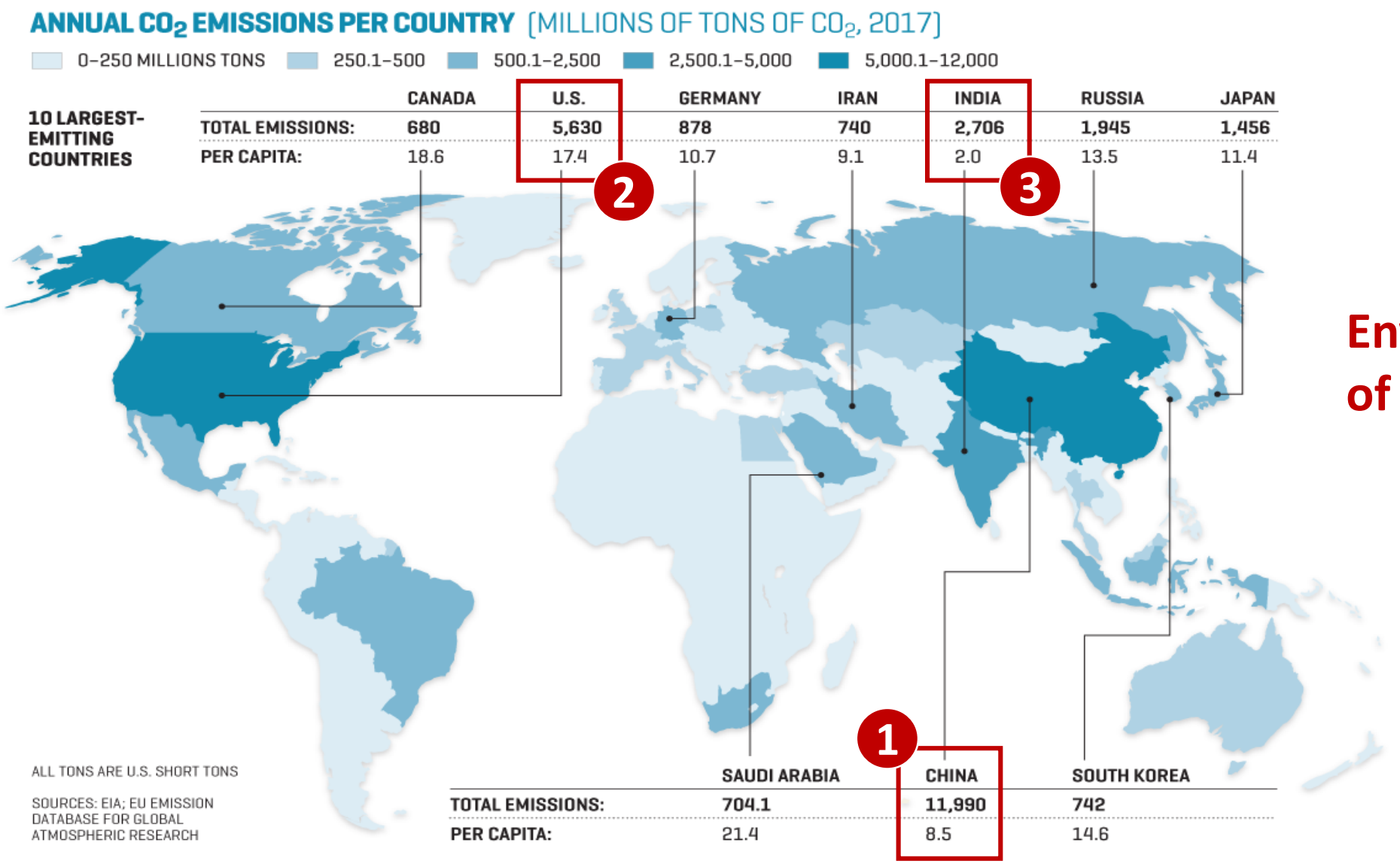
The ocean absorbs about ¼ of the carbon dioxide produced by human activity.

Global CO2 Emissions

Global energy-related carbon dioxide emissions is still increasing

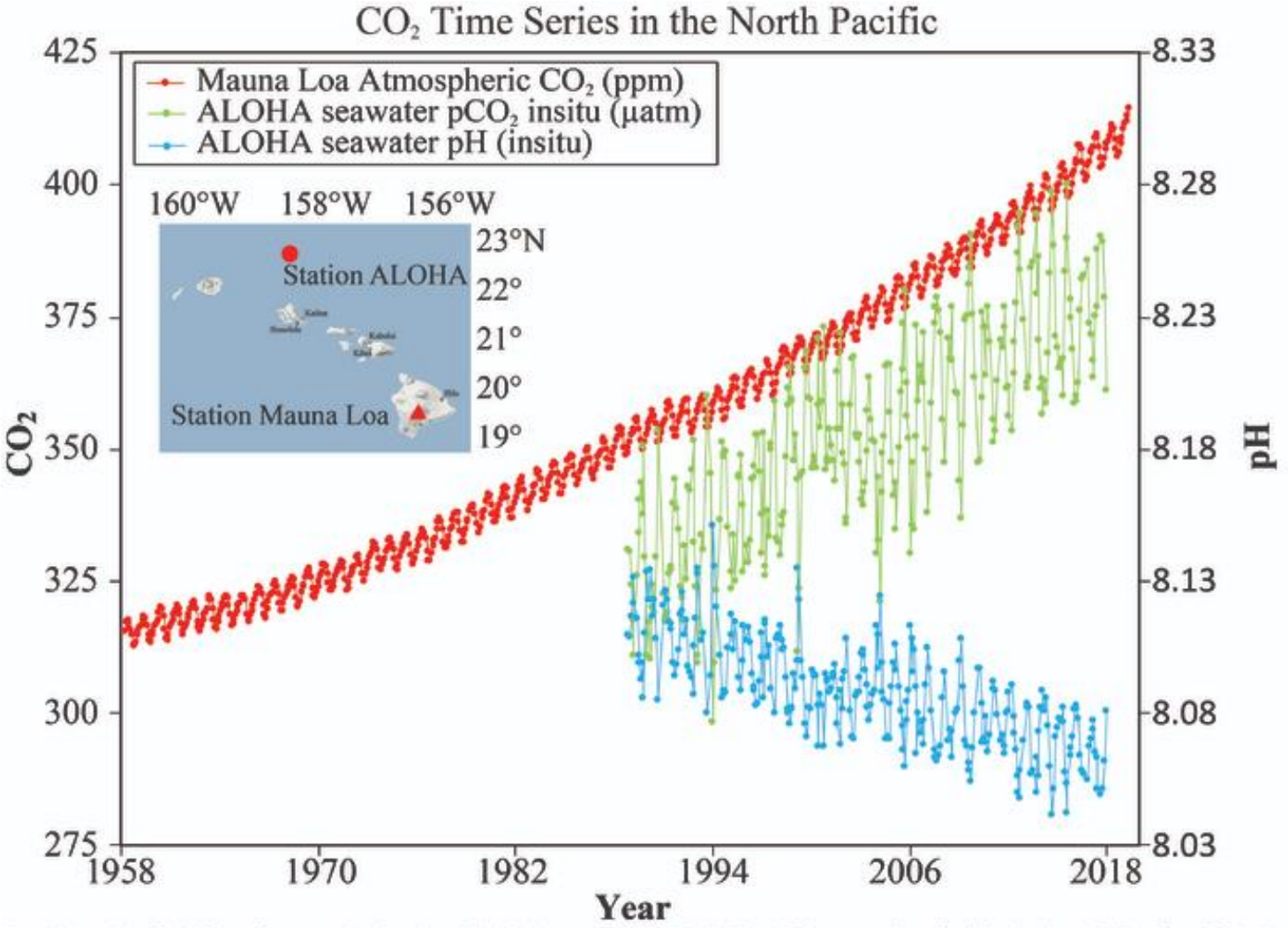


Global CO2 Emissions



Environmental impacts of a high living standard

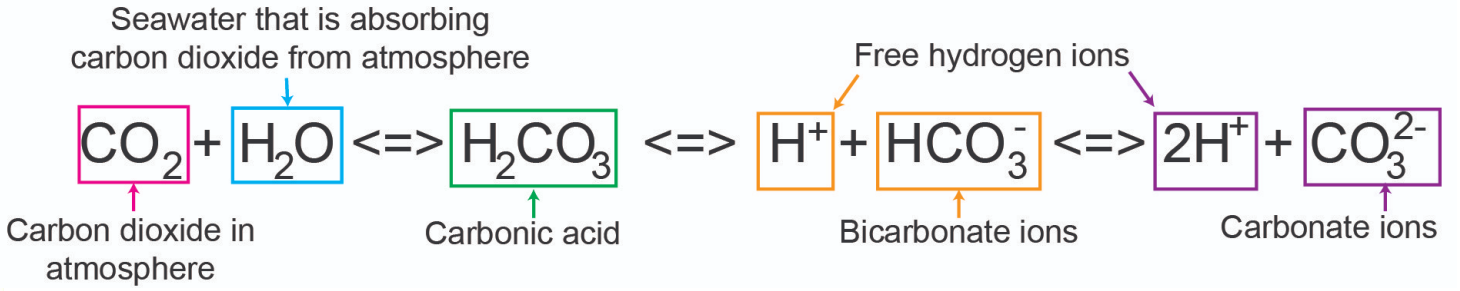
Trend of Atmospheric CO_2 and Ocean pH



Data: Mauna Loa (ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_mm_mlo.txt) ALOHA (http://hahana.soest.hawaii.edu/hot/products/HOT_surface_CO2.txt)
Ref: J.E. Dore et al, 2009. Physical and biogeochemical modulation of ocean acidification in the central North Pacific. *Proc Natl Acad Sci USA* **106**:12235-12240.

A clear connection between ***rising atmospheric CO_2 levels*** and ***declining ocean pH***

Ocean acidification: chemical changes in the ocean



- **Oceans have absorbed 25% of the anthropogenic CO_2** emitted into the atmosphere since pre-industrial time

- The extra CO_2 is affecting the **Ocean Chemistry:**
- **pH decreases** (more H^+ ion)
- **Carbonate ions decrease**

Stable pH (pre-1750) | Declining pH (post-1750)

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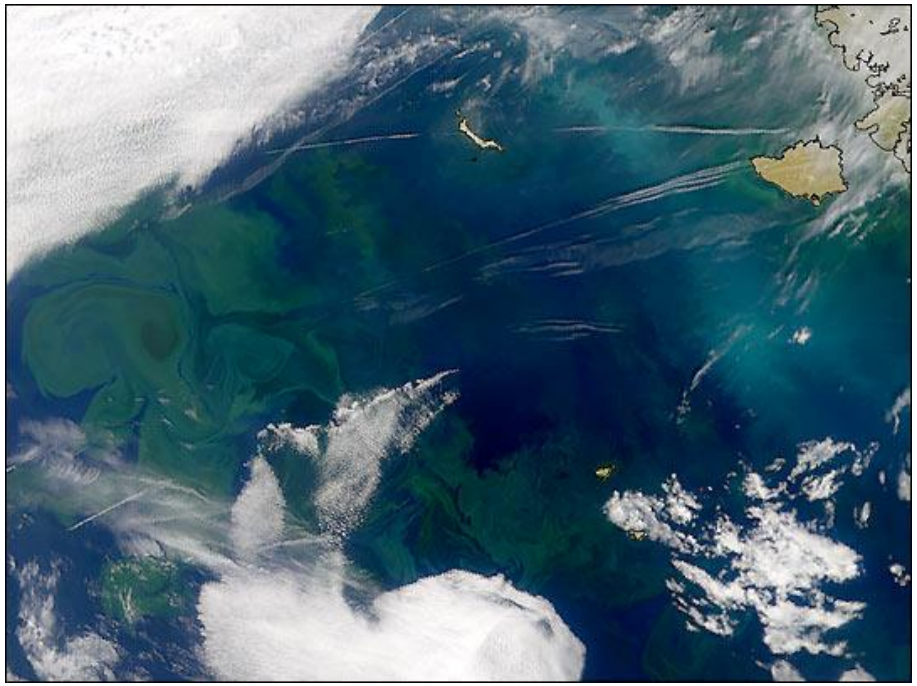
Ocean Acidification (Impacts)

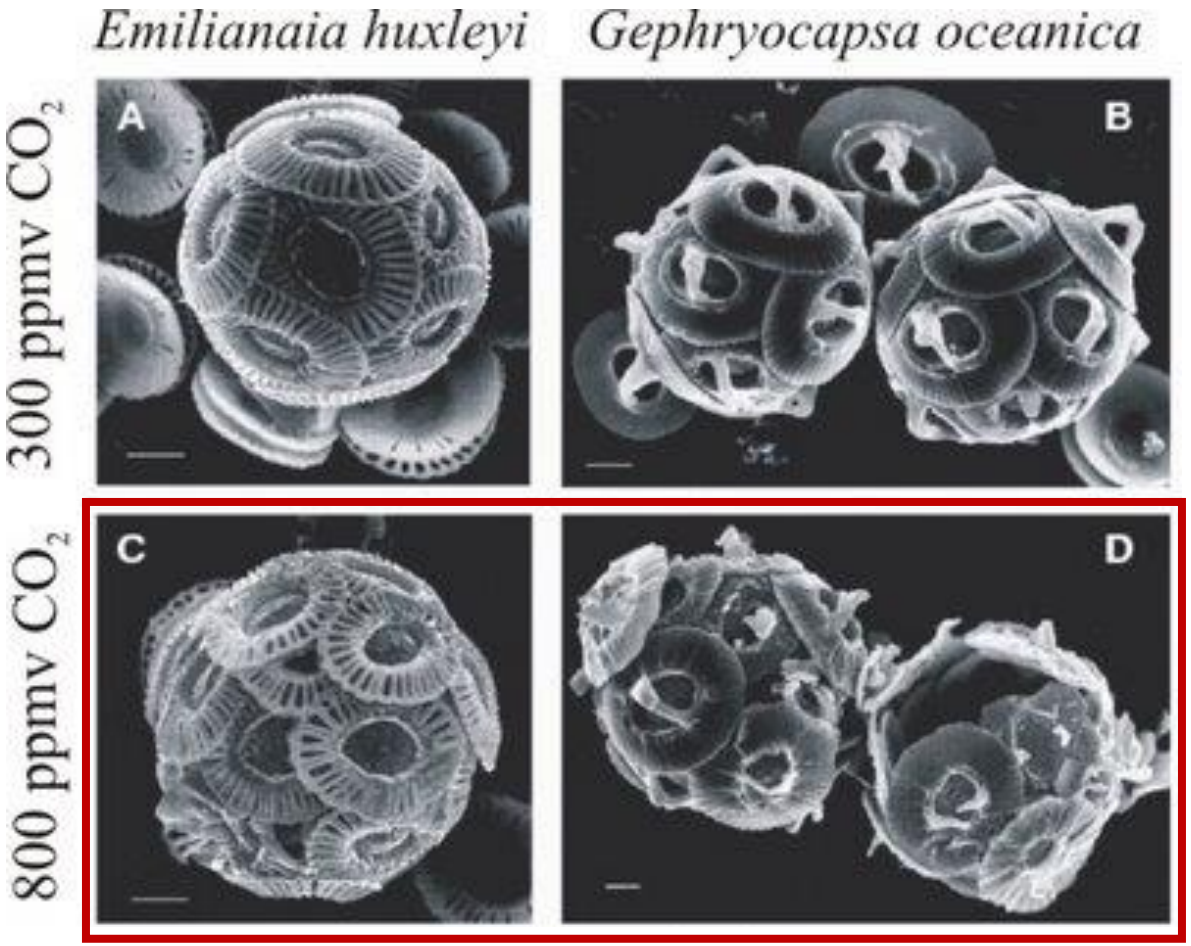
Impacts to marine life

- **Low pH and declining carbonate** will make it harder for shelled organisms to build and maintain their shells.

Impacts to Coccolithophores



Coccolithophore bloom in the Bering sea



High pH
High carbonate

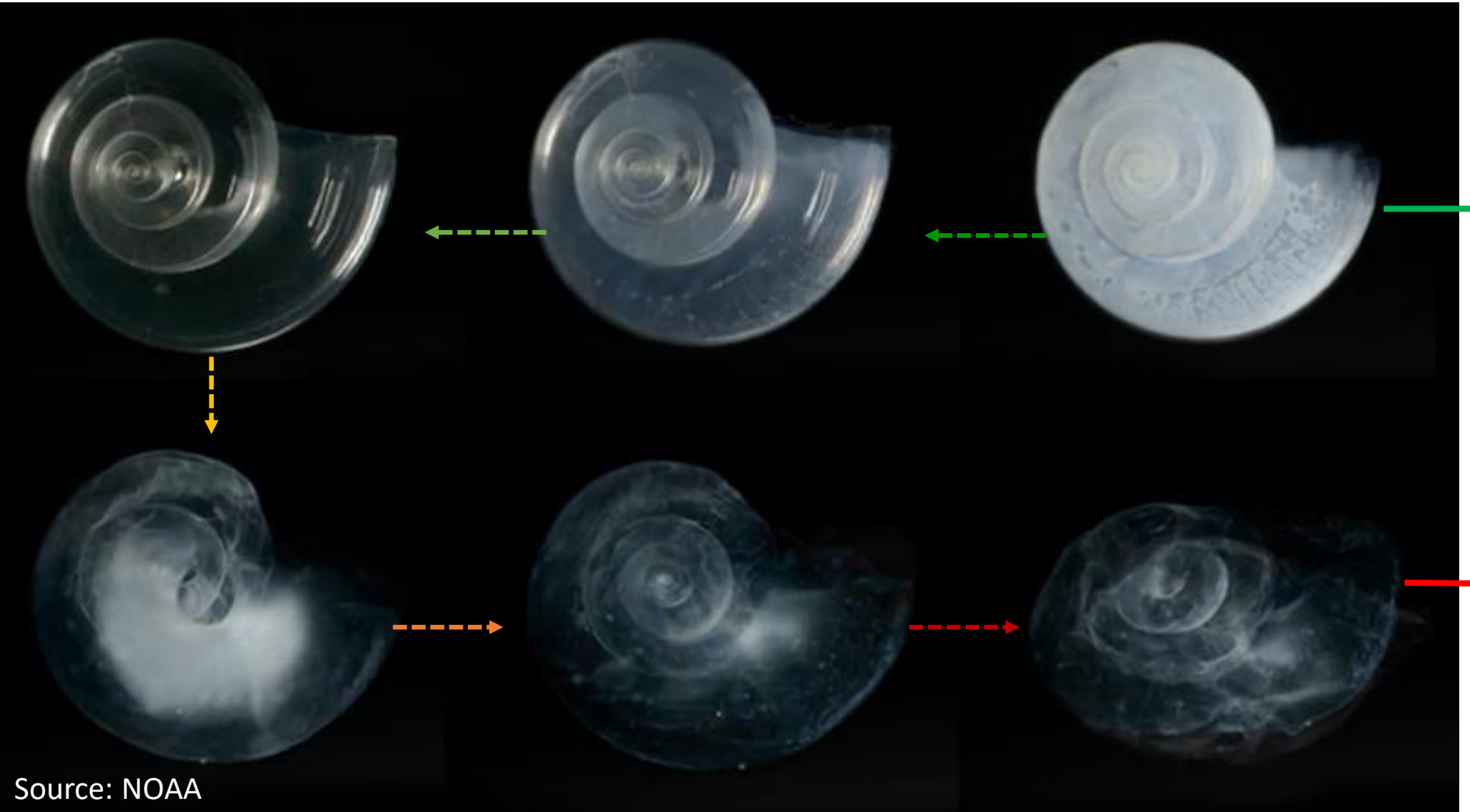
Low pH
Low carbonate

Shell damage at low pH

Source: NASA, Reibesell et al., 2000

Impact to pteropods

Low-pH water dissolves the shells of pteropods



Source: NOAA

Healthy

Degraded

pH affects pteropod's swimming behavior

Actively swimming pteropod in seawater with low surface CO_2 conditions that preserve the shell with no dissolution

Pteropod showing swimming difficulties and partially dissolved shell after exposure to elevated CO_2 conditions (1600 ppm) for 2 weeks

Impacts to Coral reefs

- Natural experiment studying the impact of pH on coral reef in Milne Bay
- Lower diversity and reduced coral

Volcano bubbles (with CO_2) @ Papua New Guinea

Normal pH (pH = 8.1) More biodiversity

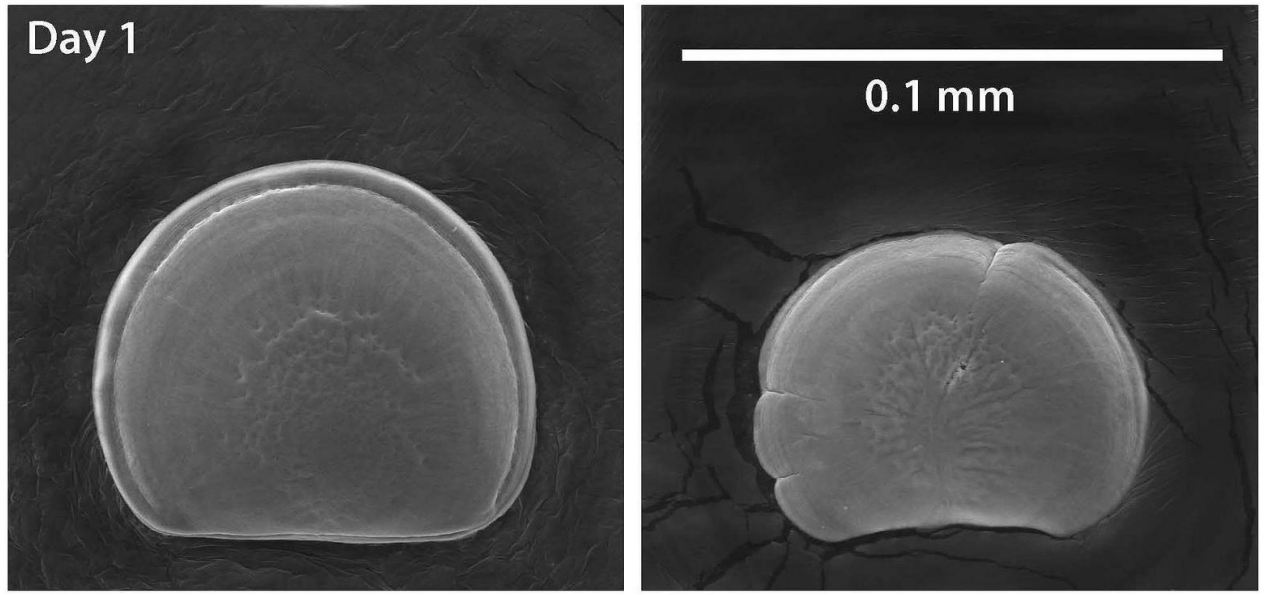
Reduced pH (pH = 7.9)

Very low pH (pH = 7.5) Less biodiversity

(Howes et al., 2015)

Impact to oyster larvae

Oyster Larvae



Normal condition **Acidified condition**

(Image: George Waldbusser and Elizabeth Brunner, Oregon State University)

Oyster fishery in the Pacific Northwest

(Image: Louisiana Sea Grant College Program)

Ocean acidification is a driver for changes in ocean ecosystems

Group			Main response
Algae		Fleshy algae	+22% growth
		Diatoms	+17% growth
		Calcifying algae	-80% abundance
Molluscs		Clams, scallops, mussels, oysters, pteropods, abalone, conchs and cephalopods (squid, cuttlefish and octopuses)	-34% survival -40% calcification
Echinoderms		Sea urchins, sea cucumbers, starfish	-10% growth -11% development
Corals		Warm and cold water coral	-32% calcification -47% abundance
Crustaceans		Shrimps, prawns, crabs, lobsters, copepods, and their relatives contributing to zooplankton	This group is relatively resistant to changes in ocean pH
Finfish		Small (herrings, sardines, anchovies), large (tuna, bonitos, billfishes), demersal (flounders, halibut, cod, haddock), etc.	Loss of habitat and food supply. Possibly some effects on behavior, fitness and larval survival

- **Different responses** within and between marine groups
- Ocean acidification has **huge impact** on marine ecosystems

What are the effects of ocean acidification on human societies?

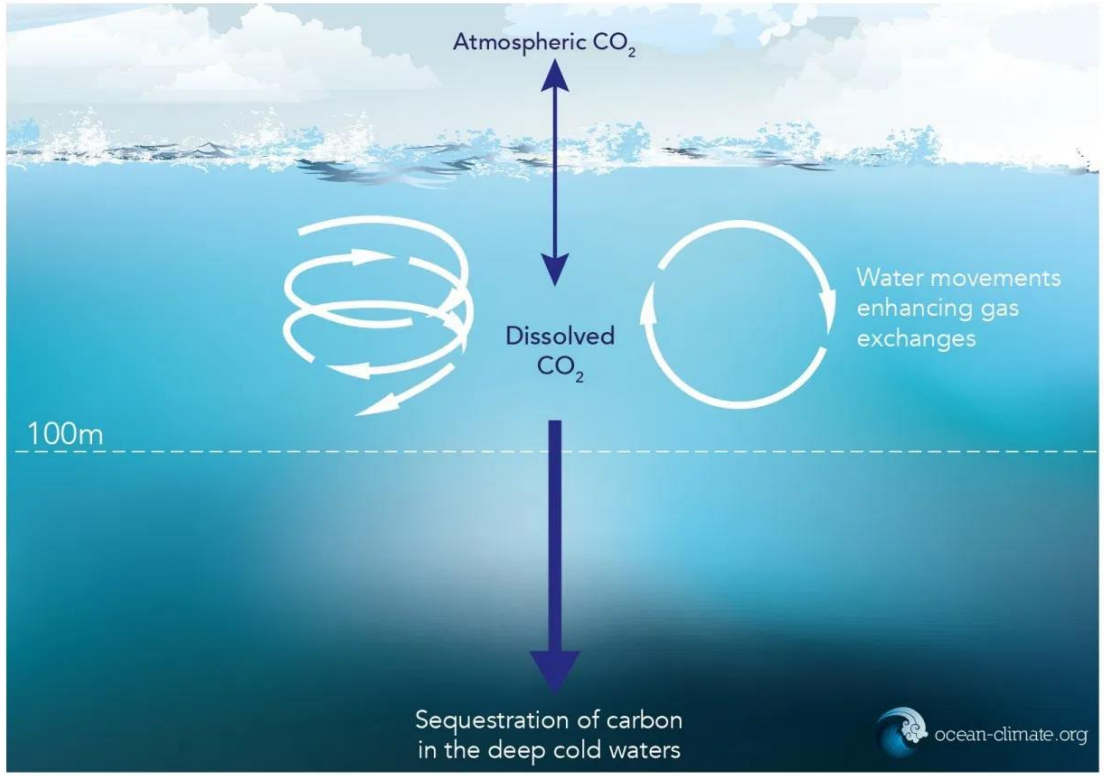
Food security

Coastal protection

What are the effects of ocean acidification on human societies?

Tourism

Carbon storage and climate regulation:



Physical carbon pump

What can we do to help?

- Lower **carbon footprint (greenhouse gas emissions)**
- Monitoring and regulating **localized sources of acidification** from runoff
- Development of **sustainable fisheries** management practices
- Implementation of **new technologies** – e.g. **Forecasting system**
- Establishment and maintenance of **Marine Protected Areas**

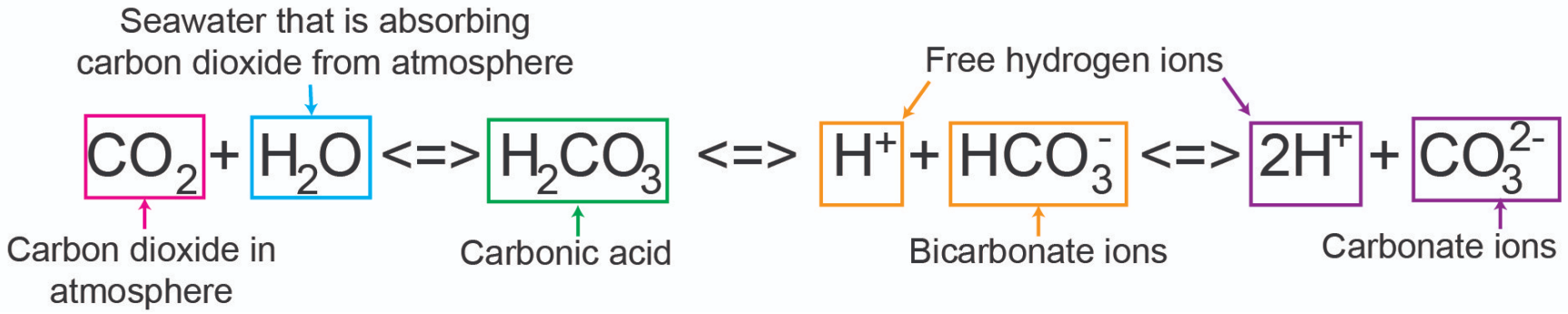
Summary – Ocean Acidification

Ocean acidification is the ongoing decrease in the pH of the Oceans, caused by the uptake of carbon dioxide from the atmosphere.

- How does CO_2 end up in the ocean?

Human activities have led to **more CO_2 released** into the atmosphere → About **25%** of human produced CO_2 dissolves in the seawater

- How does ocean acidification happen?



Summary – Ocean Acidification

- What are the impacts of ocean acidification on marine life?

Decreases in carbonate ions can make **building and maintaining shells** difficult for **calcifying organisms**

- What can we do to help?

Be mindful of your **carbon footprint**

Be a **scientist** or **policy maker**!

DEPARTMENT OF OCEAN SCIENCE

The Global Coral Reef Crisis

Overview of The Global Coral Reef Crisis

- How important are **coral reefs** to the ocean and humans?
- How serious is **Coral Bleaching**?
- What can we do to **help** the situation?

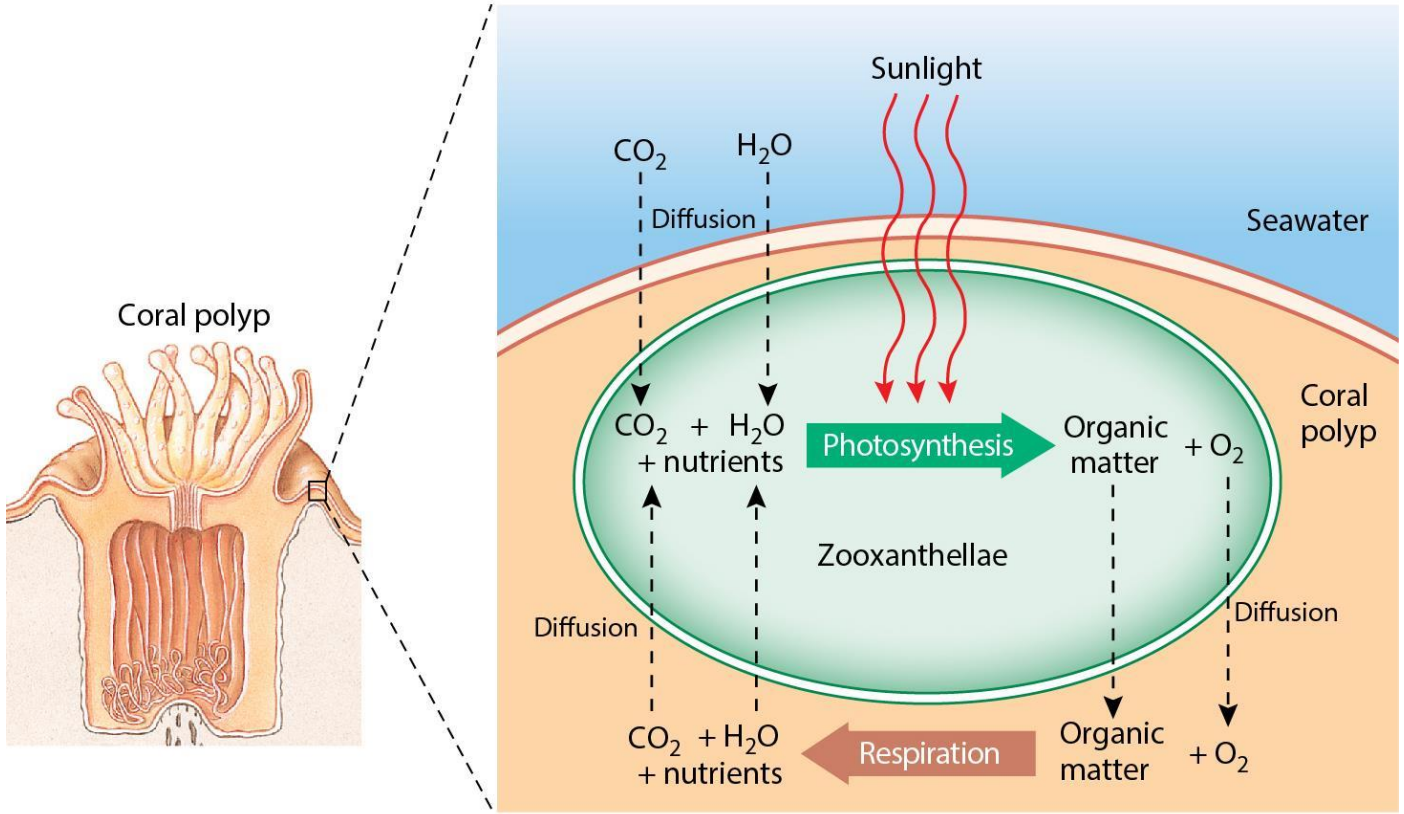
Coral reefs are an important part of the ocean ecosystem

- Coral reefs are found in **shallow** and **warm waters**
- Built by **corals**, **clams**, and other **calcifiers**
- Home for **fish**, **invertebrates** and **larvae**
- Support ~**¼ of all marine species**

Image: Irina Markova/ Shutterstock.com

Re-cap from Previous Modules

- Corals are made up of polyps that house **symbiotic photosynthetic algae, Zooxanthellae**



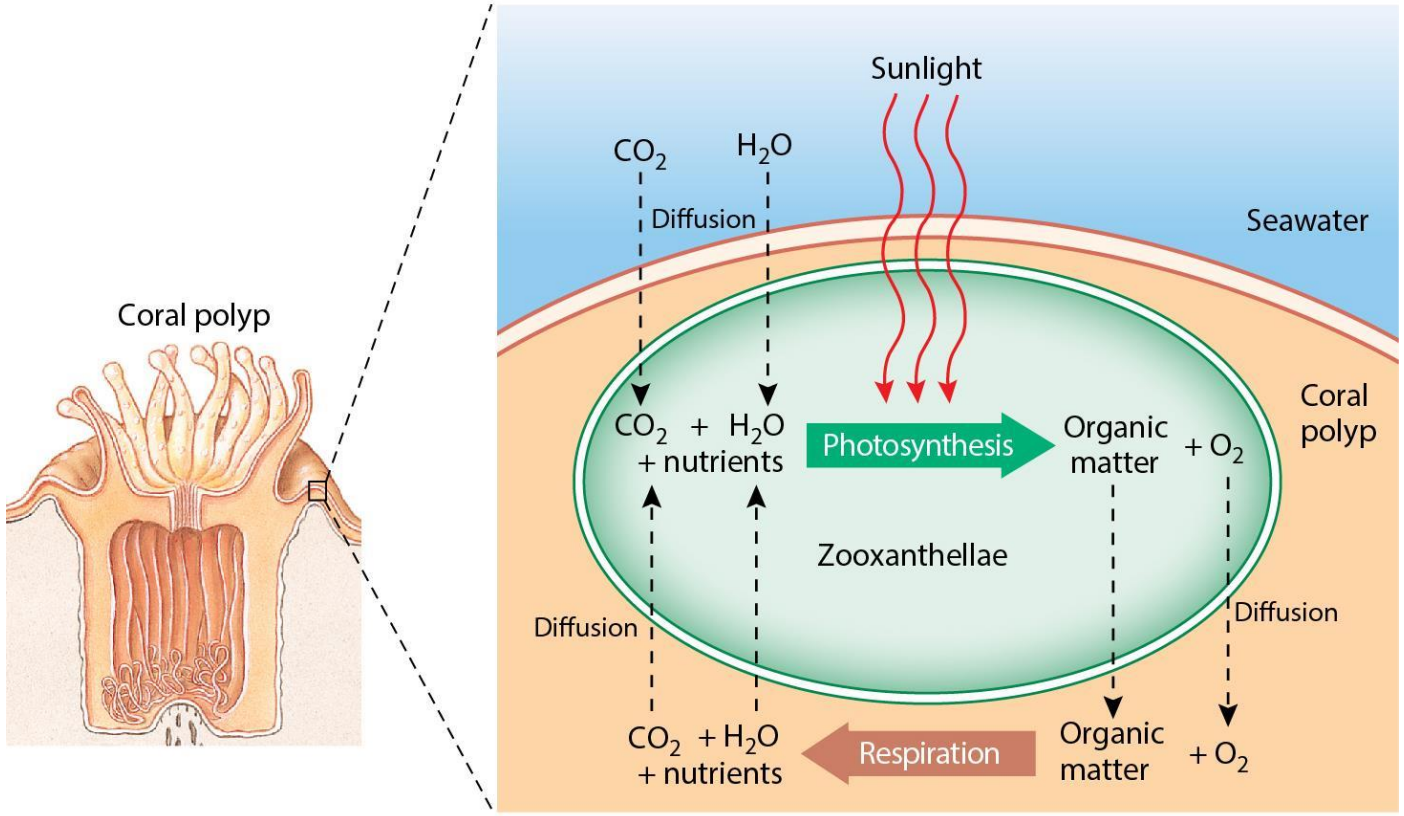
Source: Bill Ober

Coral feeding in close-up

https://www.youtube.com/watch?v=NuCt0-m3VI8

Re-cap from Previous Modules

- Corals are made up of polyps that house **symbiotic photosynthetic algae, Zooxanthellae**
- The coral provides algae with **protective environment** and compound for **photosynthesis**
- The algae produce **oxygen** and provide **nutrients** to the coral



Source: Bill Ober

Coral reef tourism

The global economic value of coral reefs for tourism is $36 billion/year

Image: The Nature Conservancy/Ami Vitale

Coral reef fishing

Fisher on the reef in front of the Yela forest on the island of Kosrae, Micronesia.

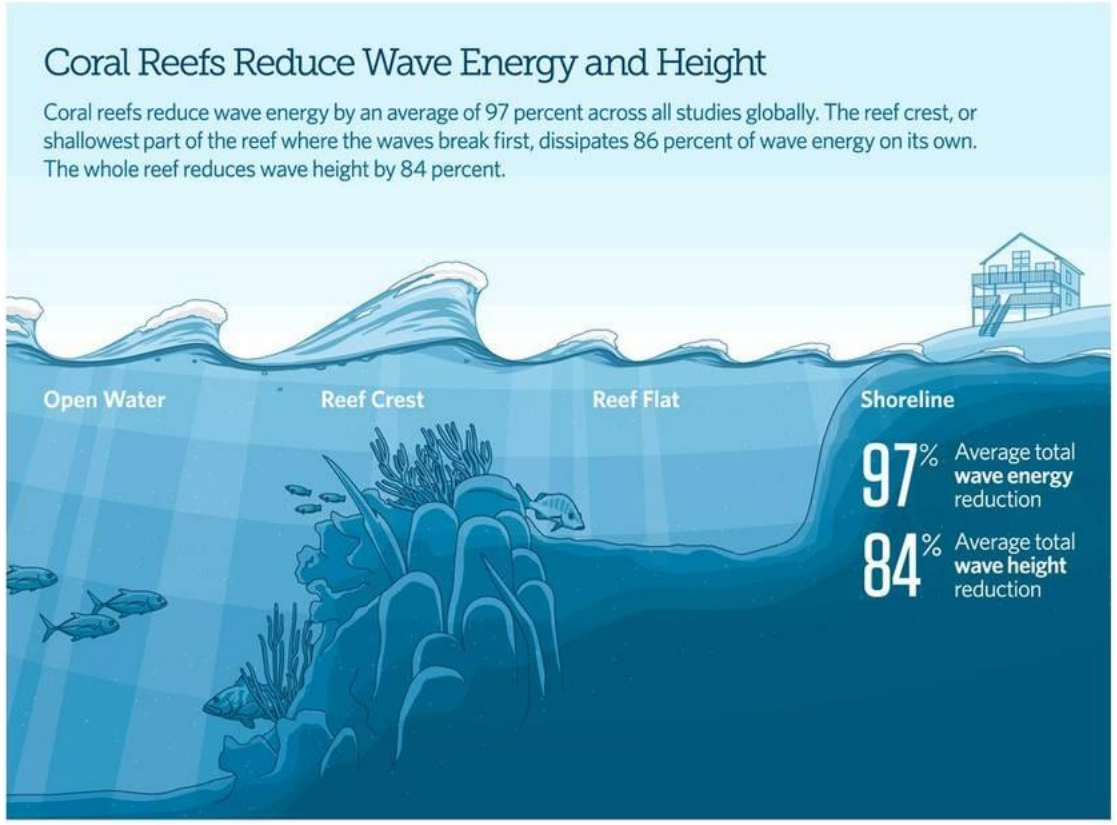
Photo: Nick Hall

Coral reef fisheries provide:

- **Income, food, and recreation**
- **Social safety net for people** when other sources of employment are unavailable.
- Significant **cultural and spiritual importance**

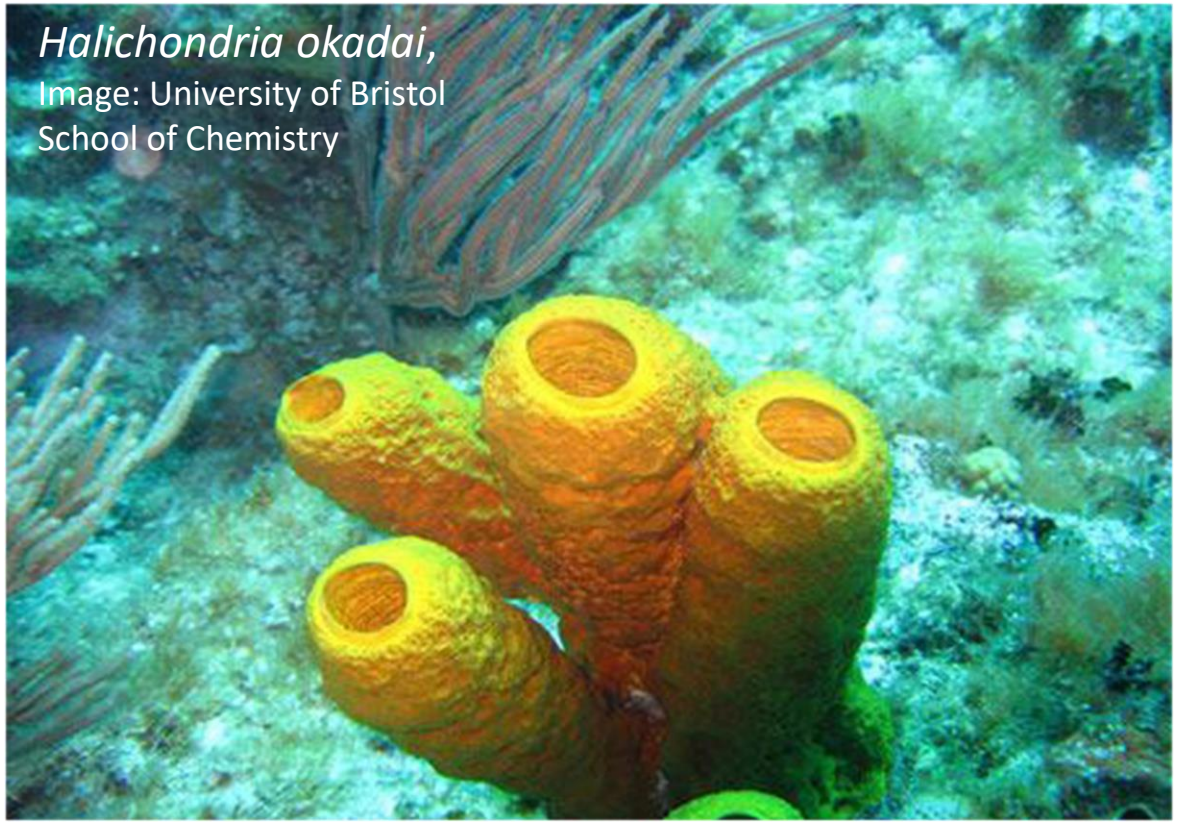
Other values of coral reef

Natural barrier



Study Citation: Ferrario, F., M.W. Beck, C.D. Storlazzi, F. Micheli, C.C. Shepard, L. Airoldi. 2014. The Effectiveness of Coral Reefs for Coastal Hazard Risk Reduction and Adaptation. *Nature Communications*. Doi:10.1038/ncomms4794

Source of the anticancer drug: Halichondrin B

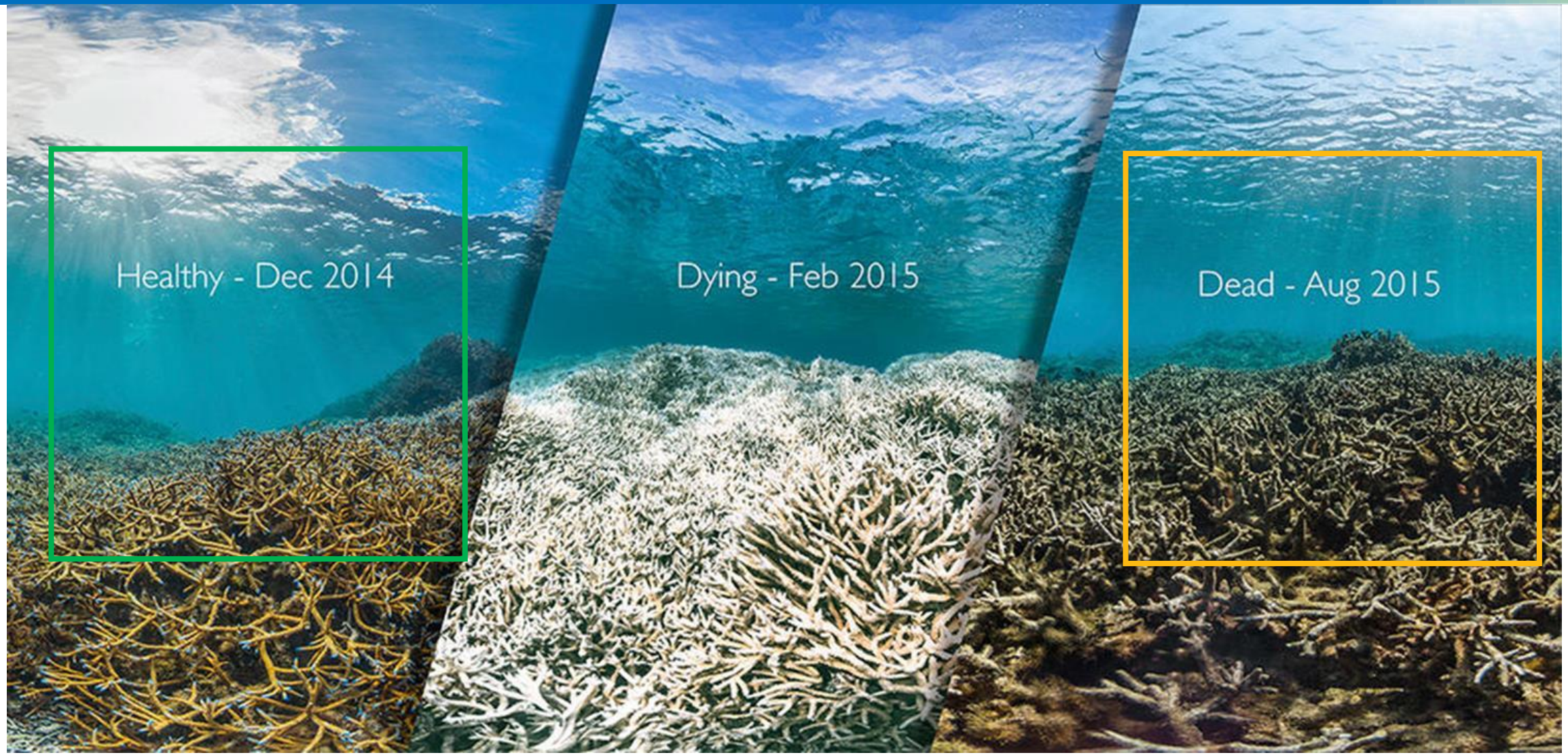


Coral bleaching

- **Bleaching**
  – a widespread **stress response** to warming temperature
- When water is too warm, **corals will expel the algae (zooxanthellae)**
  → **Corals turn completely white**
- **Corals basically *starve* without zooxanthellae**

Photo: The Ocean Agency/XL Catlin Seaview Survey/Richard Vevers.

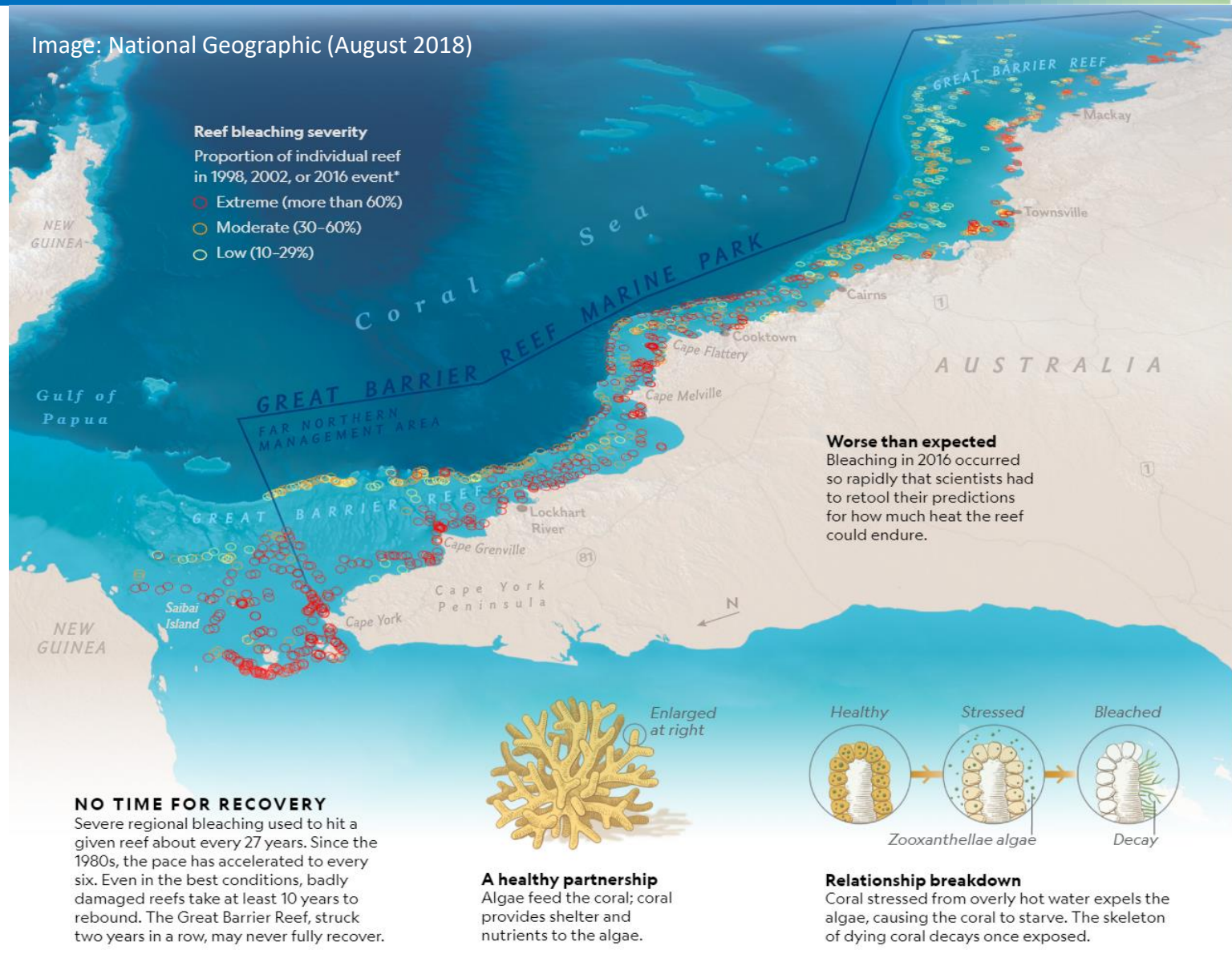
Coral bleaching leads to death



Half of The Great Barrier Reef is Dead

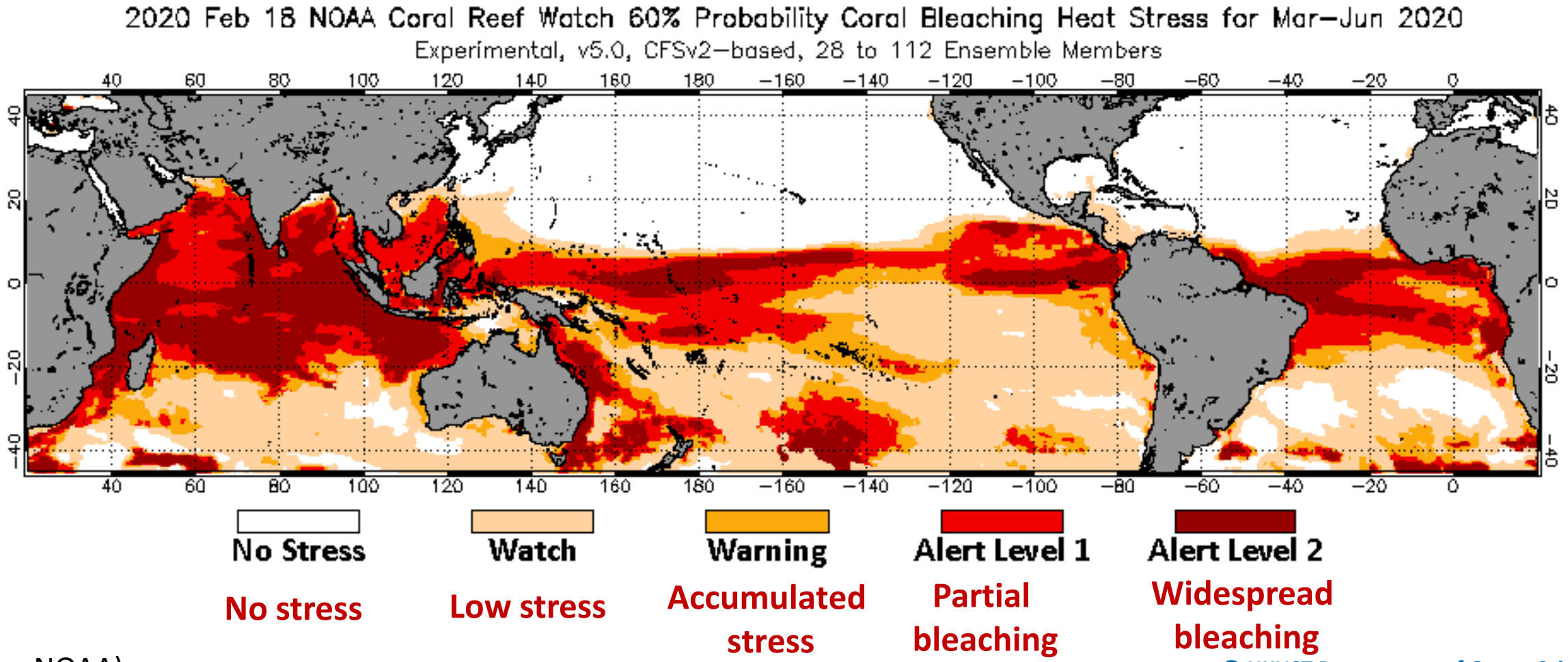
- Coral Reefs **can't withstand extended hot periods**
- The **effects of hot periods** for Coral Reefs are like **a forest after a fire**
- Coral Reefs become **barren** and **skeletal**

Image: National Geographic (August 2018)



Coral bleaching is now a global phenomenon

- **By 2030, if nothing is done to curb warming, we will see global coral bleaching in most years**



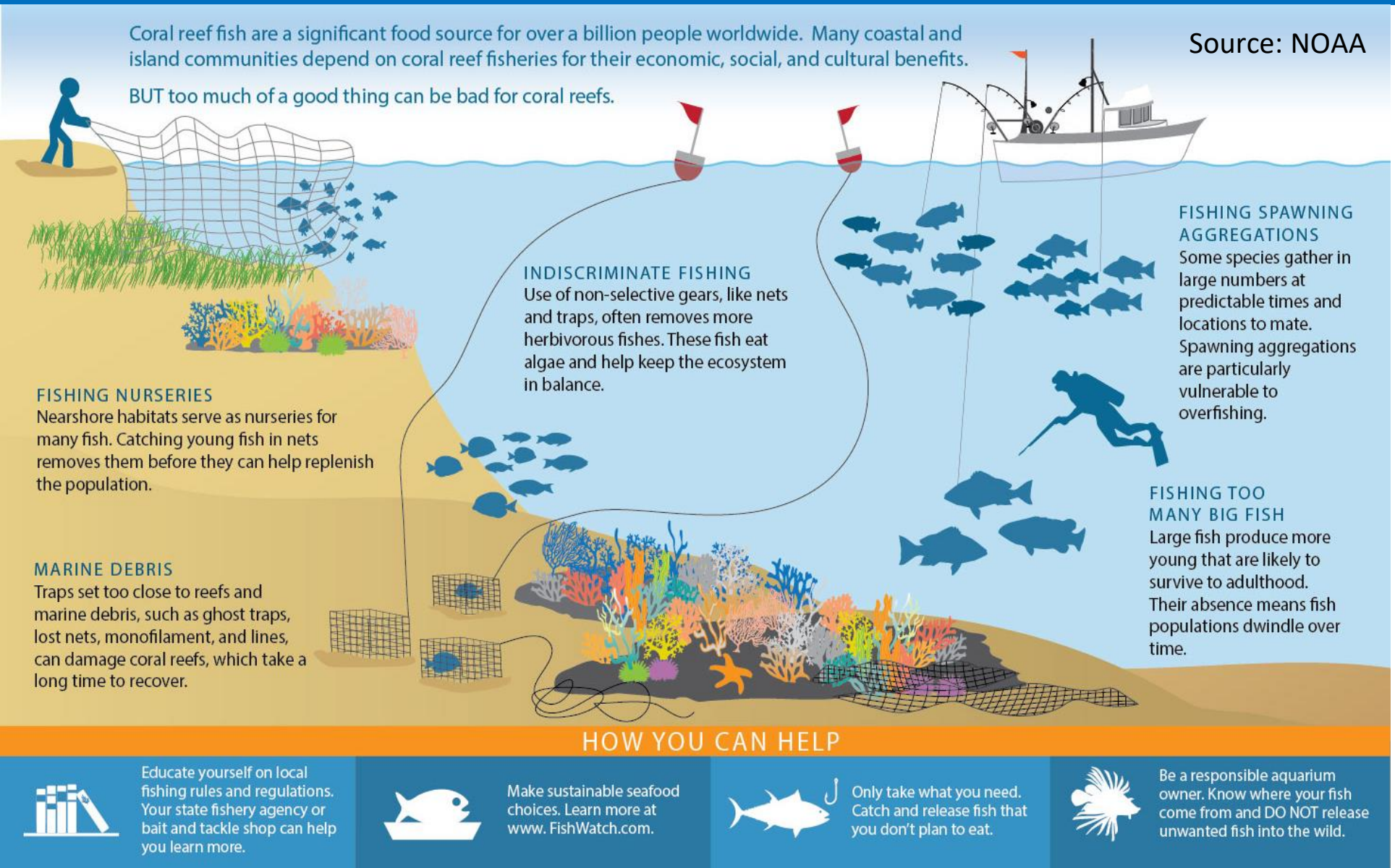
(image: NOAA)

Can scientists save the coral reefs?

Image: Martin Valigursky/Shutterstock

- Certain corals in Samoa have **evolved to tolerate higher water temperatures**.
- **Heat tolerance maintains** after transplantation
- **Climate breakdown will transform coral reefs** into entirely different environments
- **Coral reef restoration is difficult!!!**

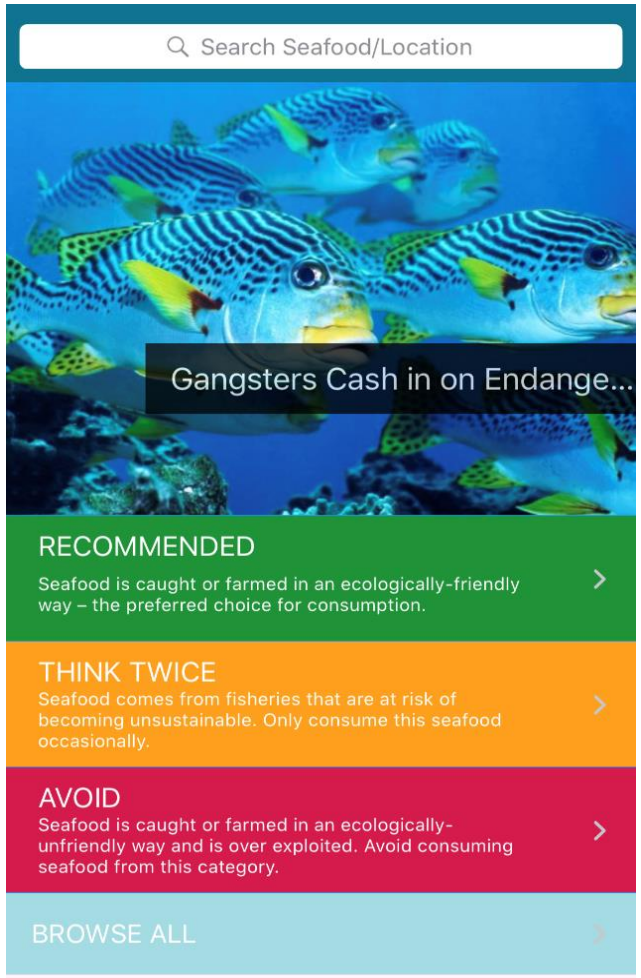
Threats to coral reefs: Overfishing



What can we do?

1 in 10 grouper species face extinction, with most eaten in Hong Kong

WWF App HK Seafood Guide



Use Oxybenzone-free sunscreen

Summary – The Global Coral Reef Crisis

- How important are coral reefs to the ocean and humans?

Coral reef provides an important **ecosystem, income, food, natural barriers and source of medical drugs**

- How serious is Coral Bleaching?

Coral bleaching is a **worldwide phenomenon**

- What can we do to help the situation?

Low carbon footprint, Sustainable seafood, reef-safe sunscreen

Be a marine scientist!

DEPARTMENT OF OCEAN SCIENCE

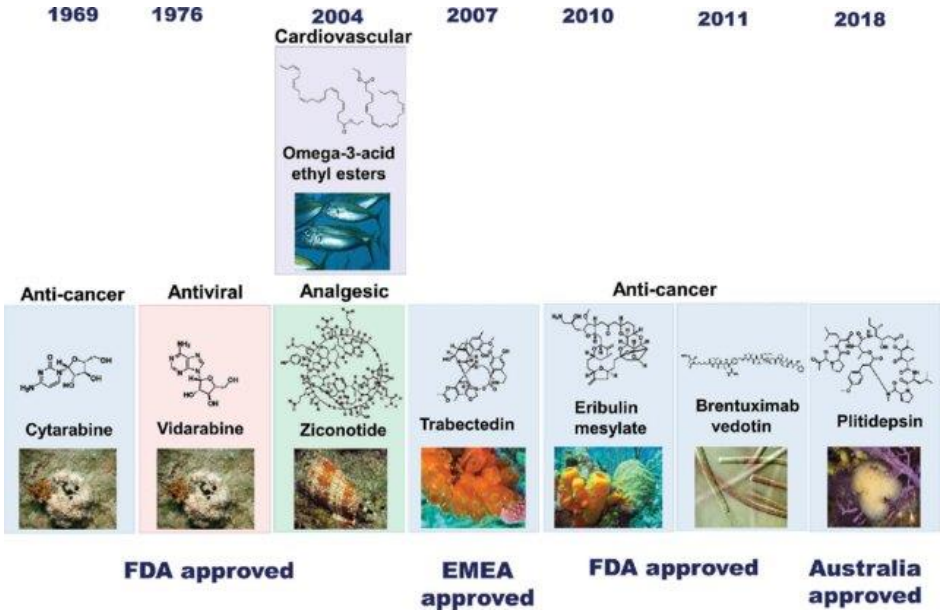
Resources from the Sea

Overview of Resources from the Sea

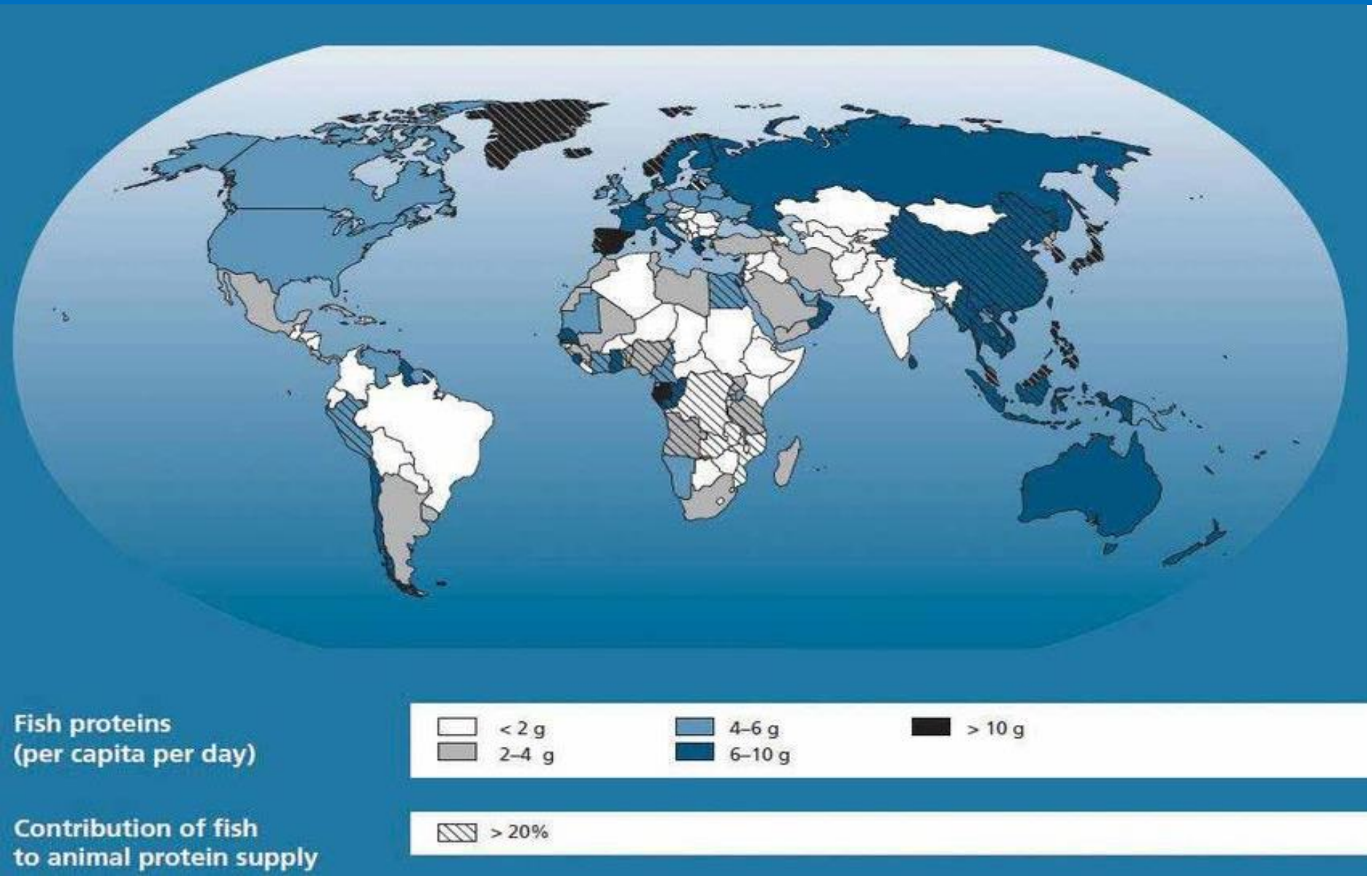
- **What resources** can we get from the sea?
- How can we meet the **increasing demand for seafood**?
- What are the **consequences of overexploitation** of marine resources?

Growing Demand for Marine Bio-Resources

- **Living Marine Resources used for:**
  - Food
  - Pharmaceutical Industry
  - Materials and products
- Focus from **Producer-focused** to **Consumer-focused (nutrient-rich)**
- Focus from **Mass Production** to **Food Safety**



Contribution of fish to animal protein supply



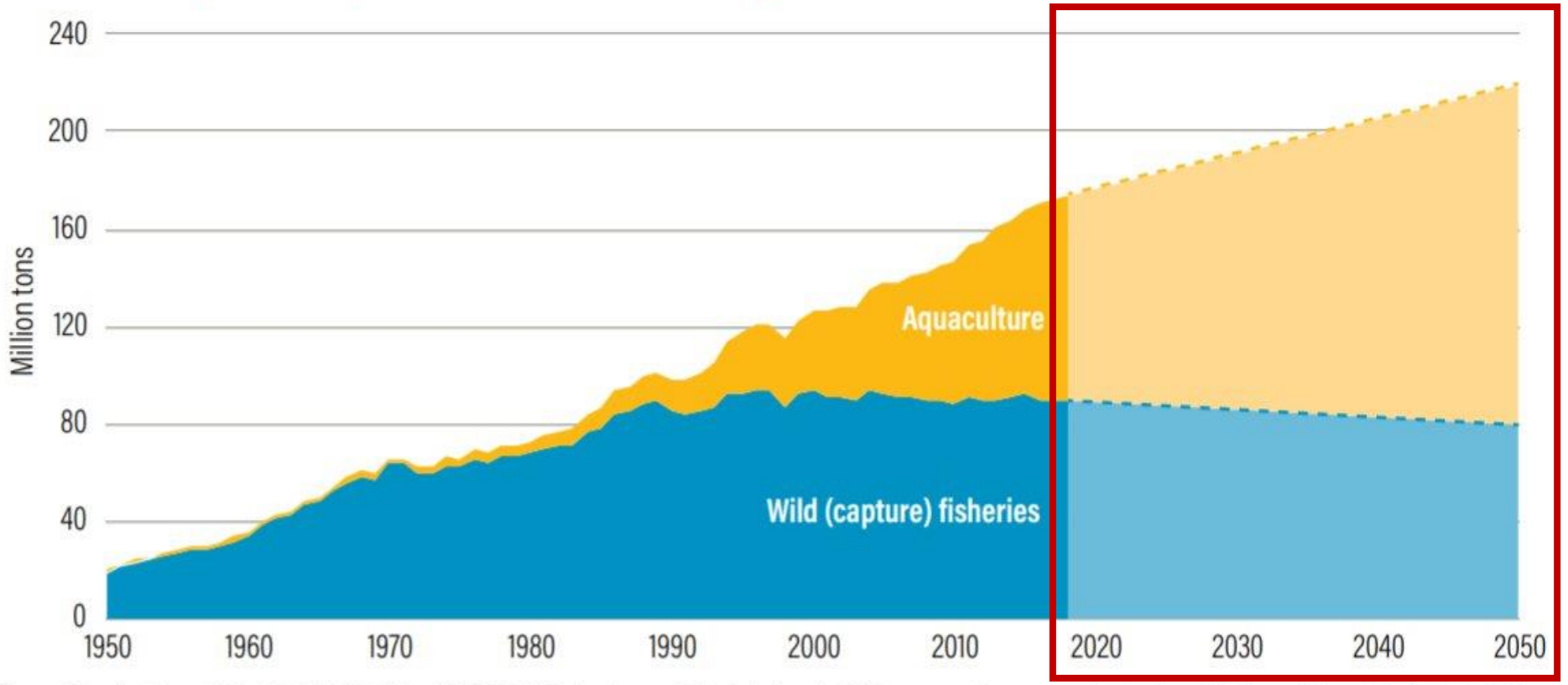
~17% of the world's **animal protein** is provided by ocean fish

Ocean Fish - Nutrient-Rich Source

- **Good calories and protein**
  - Low calorie
  - Good source of protein
- **Good fat and cholesterol**
  - Saturated fat
  - Omega-3 fatty acids (good for health)
- **Good vitamins and minerals**
  - Vitamins A and D, Vitamin B-complex
  - Zinc, iron, iodine

Greater Demand Requires MORE Global Seafood Production

Figure 16 | Aquaculture production must continue to grow to meet world fish demand

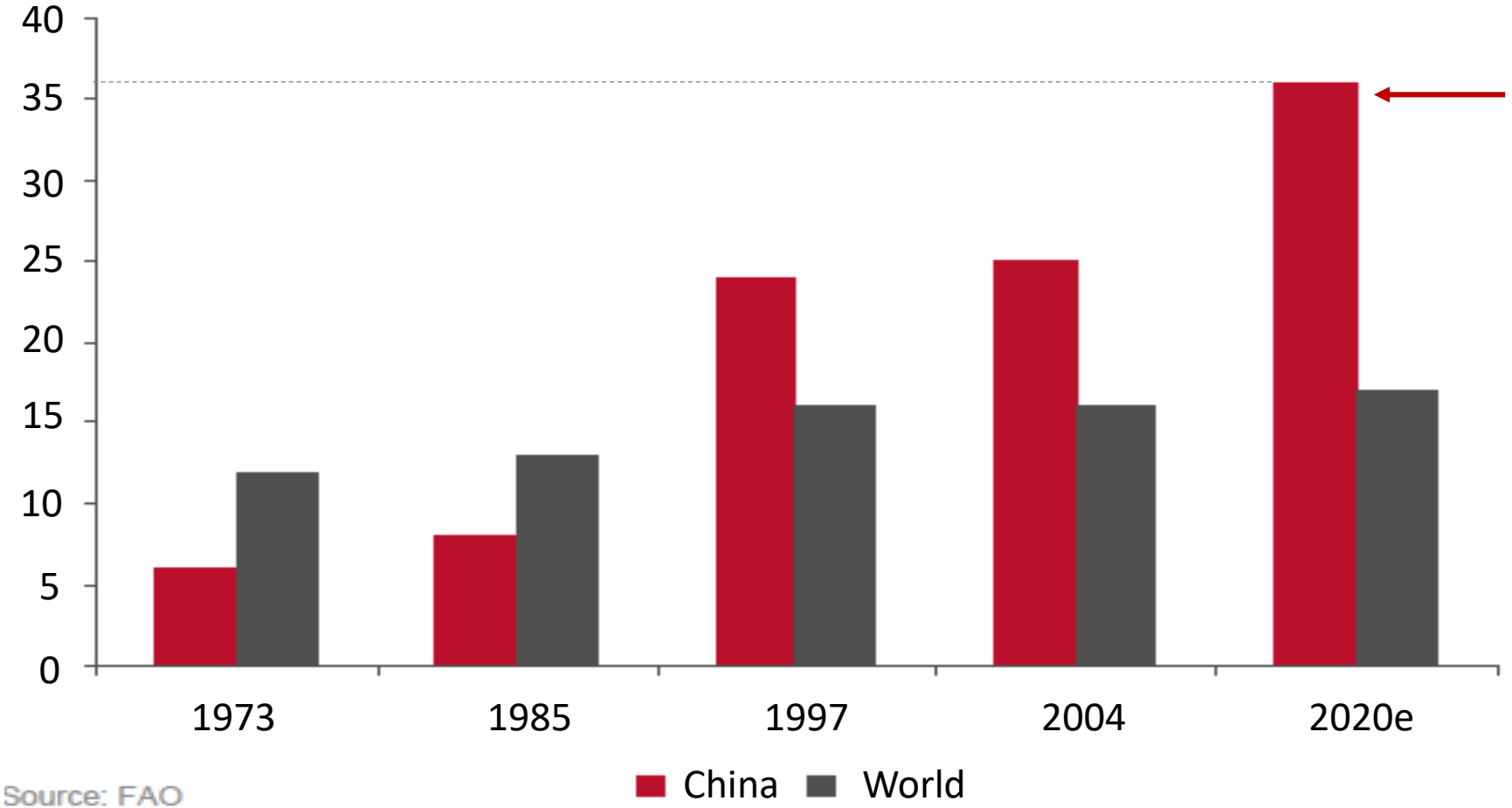


Source: Historical data, 1950–2016: FAO (2017b) and FAO (2018). Projections to 2050: Calculated at WRI; assumes 10 percent reduction in wild fish catch from 2010 levels by 2050, linear growth of aquaculture production of 2 Mt per year between 2010 and 2050.

- Aquaculture production is expanding
- Wild fisheries is reaching the maximum capacity

Growing Increase in Chinese Consumption

1973-2020 Consumption prediction for Chinese Seafood
(In kg per capita)



Source: FAO

Chinese seafood consumption is higher than worldwide average

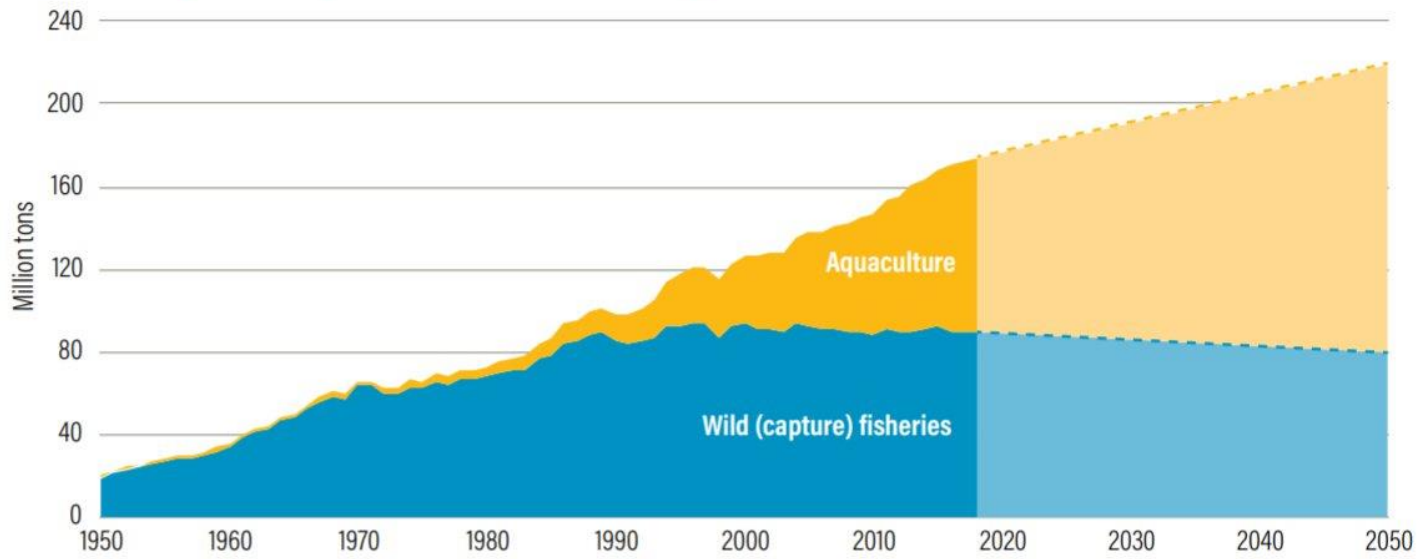
Commercial fishing

Industrial fishing operations (e.g. herring fishing) are often not **sustainable**

Overfishing

Overfishing - the removal of a species of fish from a body of water at a rate that the species **cannot replenish in time**

Figure 16 | Aquaculture production must continue to grow to meet world fish demand

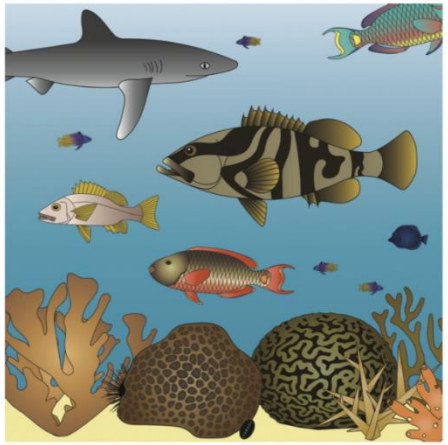


Source: Historical data, 1950–2016: FAO (2017b) and FAO (2018). Projections to 2050: Calculated at WRI; assumes 10 percent reduction in wild fish catch from 2010 levels by 2050, linear growth of aquaculture production of 2 Mt per year between 2010 and 2050.

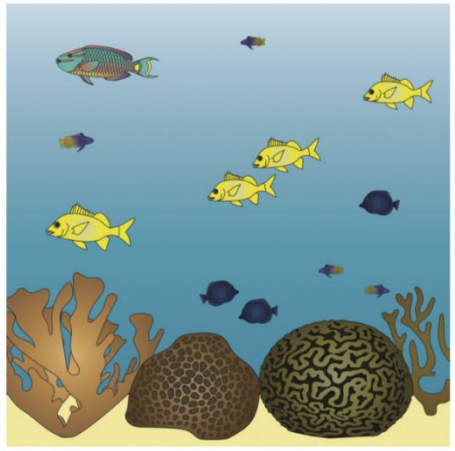
Fisheries can disrupt the food chain

- **Overfishing** can affect the marine biodiversity
- **Effect on food chain:** Fishes disappear, resulting in the disappearance of top predators.

Unfished



Fished



Overfished

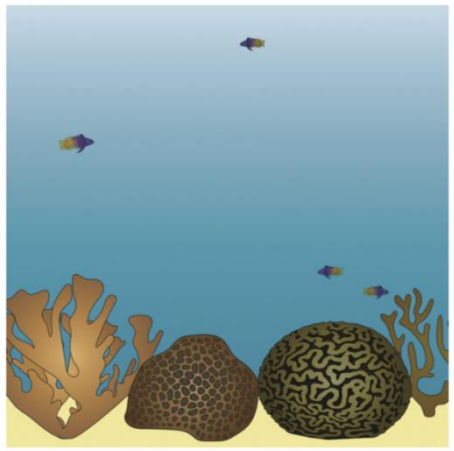


Image: Phys.org

Effect food chain

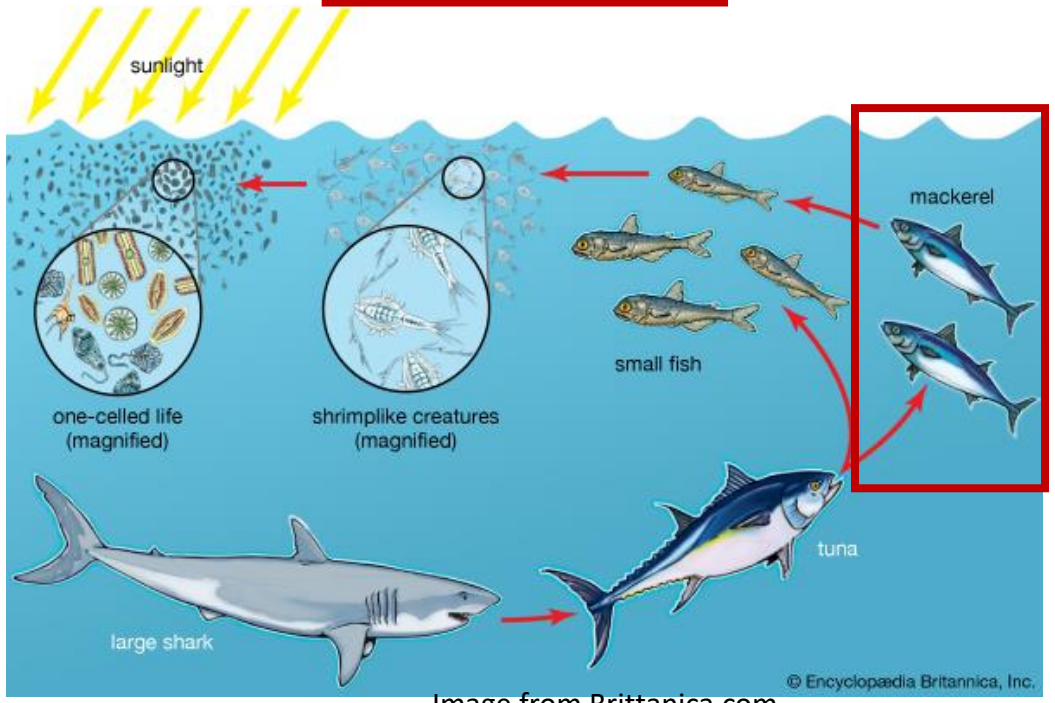


Image from Brittanica.com

Summary – Resources from the Sea

- What resources can we get from the sea?

Food, medicines, materials …

- How can we meet the increasing demand for seafood?

Aquaculture must continue to expand capacity

- What are the consequences of overexploitation of marine resources?

Overfishing, reduced biodiversity, disruption of the **marine food chain**

DEPARTMENT OF OCEAN SCIENCE

Coastal pollution and other anthropogenic impacts

Overview of Coastal pollution and other anthropogenic impacts

- What are the different kinds of **marine pollution**?
- What is the fate of **plastics** in the ocean and their **impact** on the ecosystem?
- What are the **human activities** that would impact the ocean?

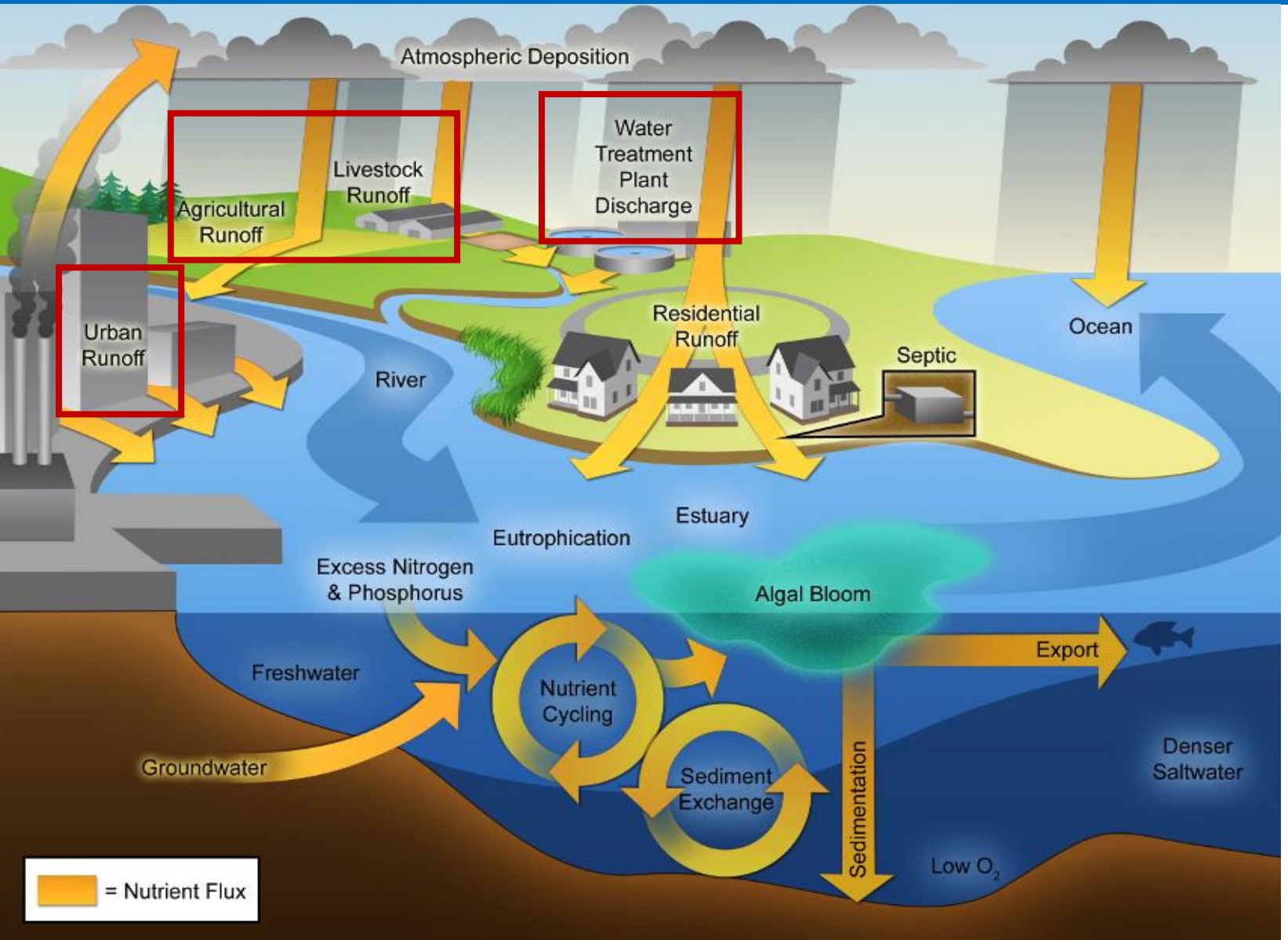
Living on the coast

- ~3 billion people (~ 50% of the world's population) live in coastal areas or live within 100km of the coast

(image: The Telegraph)

(image: SCMP)

Terrestrial runoff leads to eutrophication



- **Algal Bloom**
- **Hypoxia**

Marine Pollution

- Marine pollution – generally **coupled with economic activity**
- **Widespread:** Many pollutants are considered **global pollutants** – one can find pollution in pristine environments
  - Polar regions
  - Across the world and deep sea
- **Products:** Many of the man-made products end up in the marine environment (like a sink) and are **non-degradable**
- **Chemicals: Persistence, Bioaccumulation, Toxicity (PBT) Principle**
  - **Persistence:** will **not disappear** in 10, 20, 100+ years
  - **Bioaccumulation:** if in the environment, **can accumulate**
  - **Toxicity:** once accumulation is high, **can be toxic**

Marine Pollution – Main Types

- **Chemicals**: the most commonly perceived type of pollution
  - Toxic metals / Organics (PBT)
  - Antibiotics
  - Pesticides/insecticides
  - Radionuclides
- **Physical**: products, suspended particles, heat pollution
  - plastic, car tires
  - dredging
  - thermal pollution - heat from water release
- **Ocean alteration**
  - Shipping
  - Land reclamation

Chemical Pollution

Chemical waste can flow into streams, rivers and eventually end up in the ocean.

Toxic Metals / Organics:

- **Industries:** Toxic metals, organic waste flow into streams → rivers → oceans
- **Home:** Chemicals from cleaning products/consumer products released into drains → ocean

Pesticides / Herbicides

- Pesticides and herbicides sprayed on crops to control insects/weeds leak from soil → ocean

Antibiotics:

- **Humans:** metabolised and released into drains → ocean
- **Aquaculture:** metabolised and released into the ocean

Radionuclides:

- Increase of radiation in the air and the ocean (Fukushima, Japan)

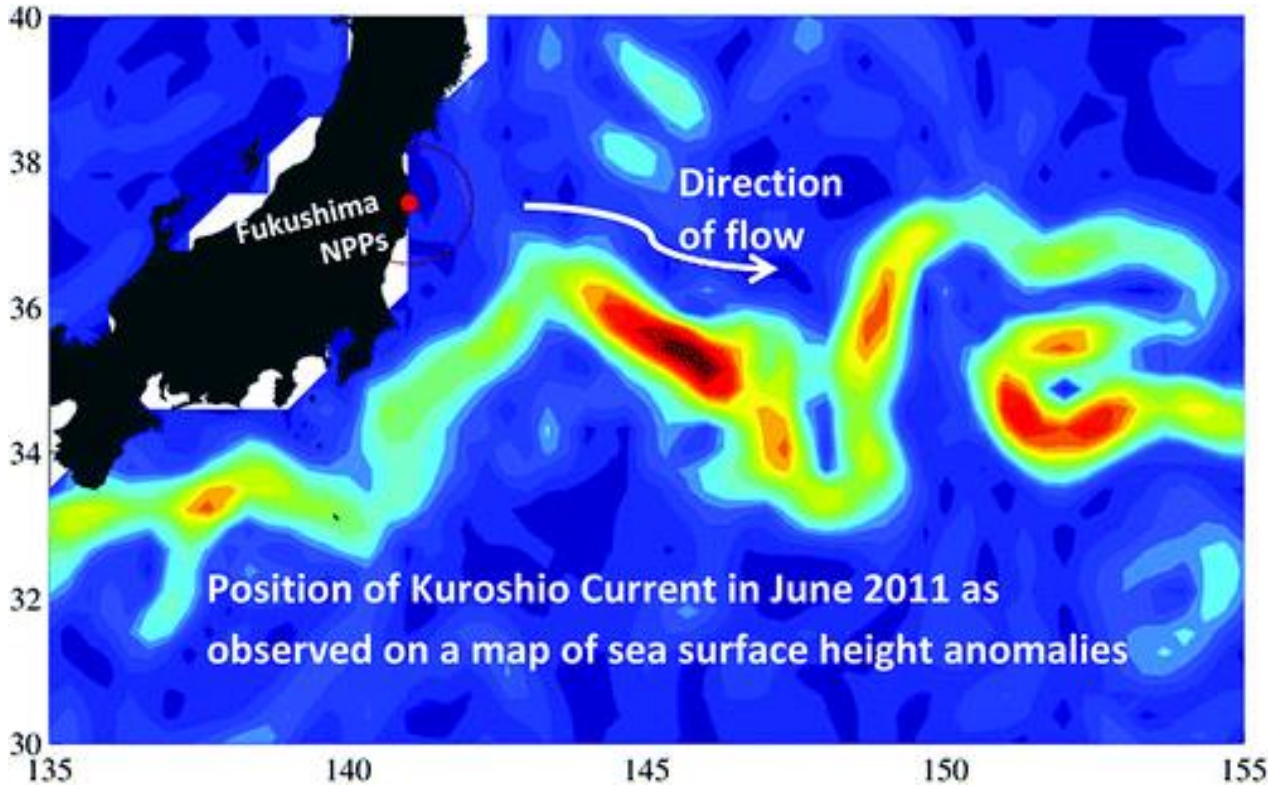
Chemical Pollution – Radiation Leak

- Fukushima, Japan in 2011

Image by Wikipedia, National Nuclear Security Administration / Nevada Site Office

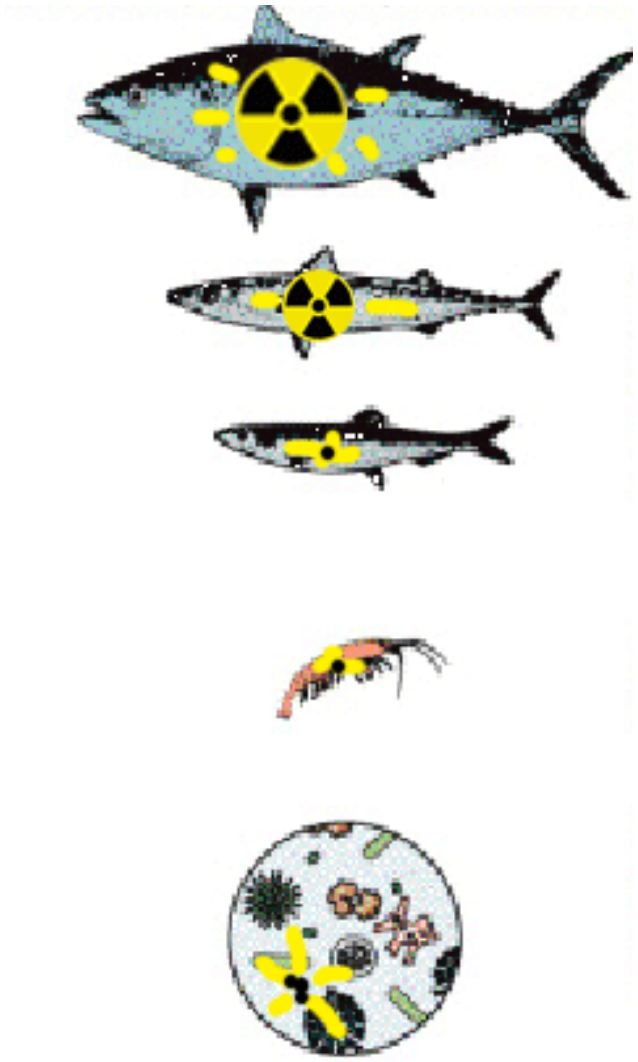
Chemical Pollution – Radiation Leak

- Fukushima, Japan in 2011
- **Radiation particles** flow with the **ocean current**
- Increased **radionuclides in marine life**



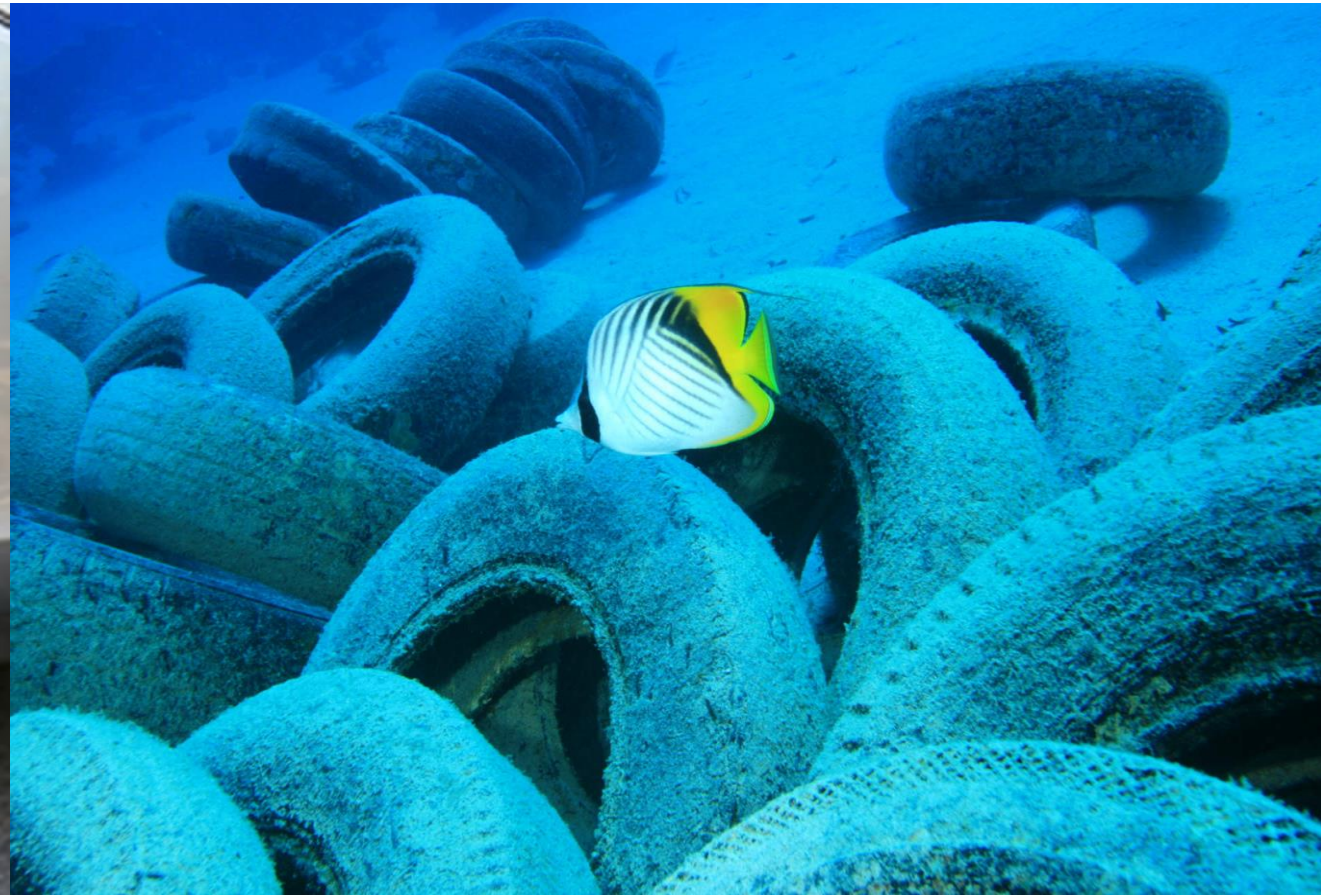
Chemical Pollution – Radiation Leak

- Fukushima, Japan in 2011
- **Radiation particles** flow with the **ocean current**
- Increased **radionuclides in marine life**
- **Greater radionuclides** effect the **higher up the food chain**



Physical Pollution – Car Tires

- Illegal **dumping of car tires**
- Rain can wash **car tire particles/ tire dust** into streams and oceans

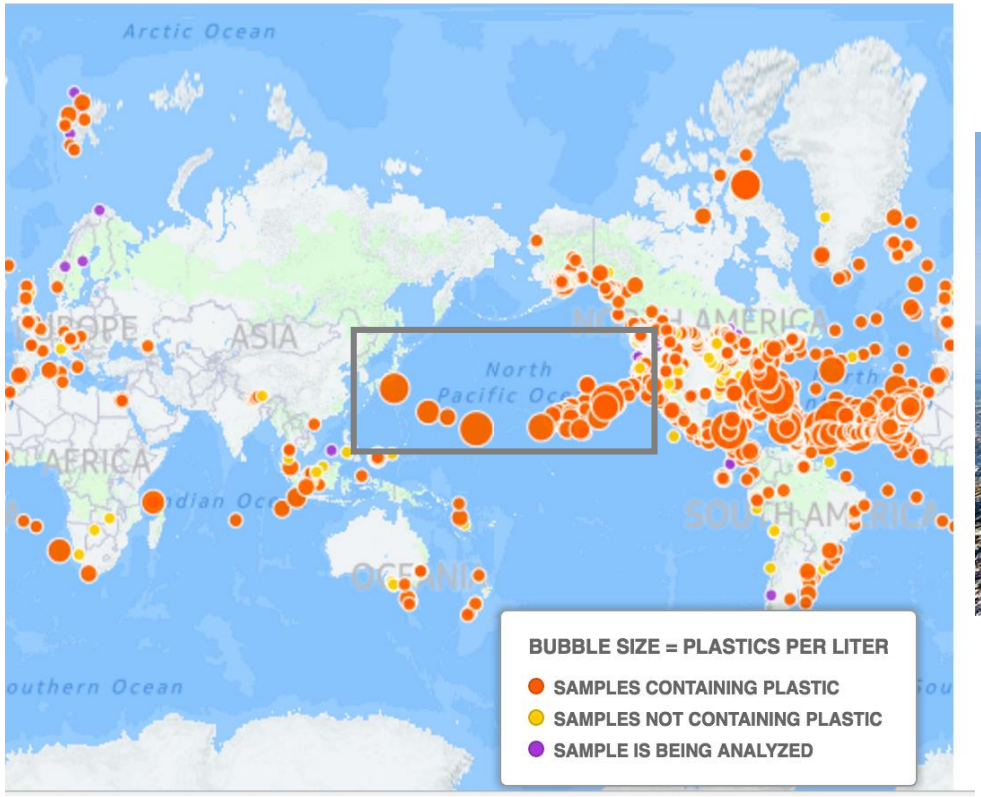


Physical Pollution – Plastic to Microplastic

- **Plastic** takes a long time to break down and will turn **into microplastic**

- **Wind and currents** cause **greater concentrations to build up**, (e.g. the Great Pacific Garbage Patch)

Global distribution of microplastics



Great Pacific Garbage Patch

Marine Microplastics – An Emerging Marine Pollution

Microplastics are a global concern, also found in humans

- **Microplastics**: <5mm, size of a sesame seed
  - **Microbeads,** are even tinier pieces of plastic added to **health and beauty products** like toothpaste and toothbrushes

- Flow from **water drains**

Image by National Geographic

Marine Microplastics – An Emerging Marine Pollution


Image by National Geographic

Microplastics are a global concern, also found in humans

- **Microplastics** : <5mm, size of a sesame seed
  - **Microbeads,** are even tinier pieces of plastic added to **health and beauty products** like toothpaste and toothbrushes

- Flow from **water drains**
- Microplastics are absorbing **hormone disruptive chemicals**
- Marine **organisms ingest microplastics/microbeads** and they **move up the food chain**

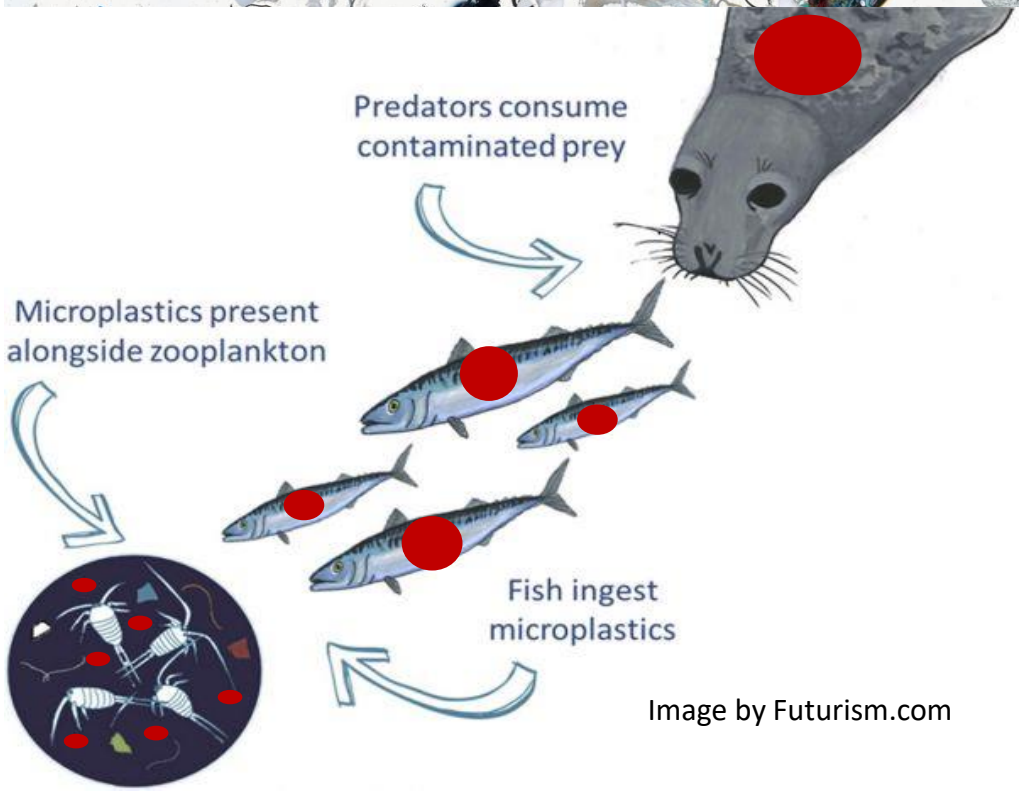


Image by Futurism.com

Physical Pollution – Dredging

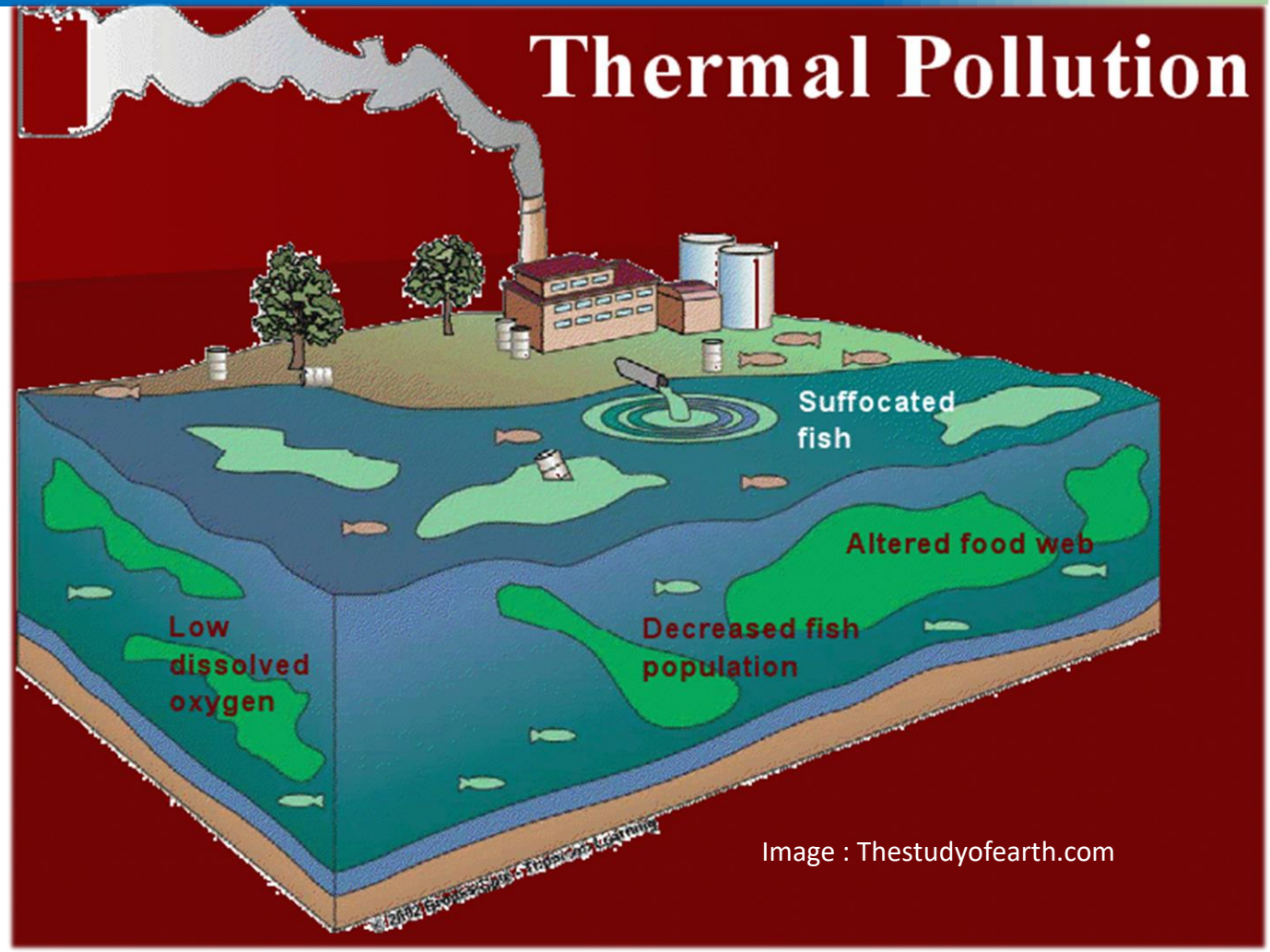
- **Dredging** is the act of **removing unwanted silt/mud from water** to clear water pathways or for land reclamation

- Uplift contaminants
  - **Harm habitats**

- Create turbid (muddy) sea water
  - **Turbid water can clog fish gills**

Physical Pollution – Thermal Pollution

- **Thermal pollution** is the effect of water quality by the **rise or fall in the water temperature**

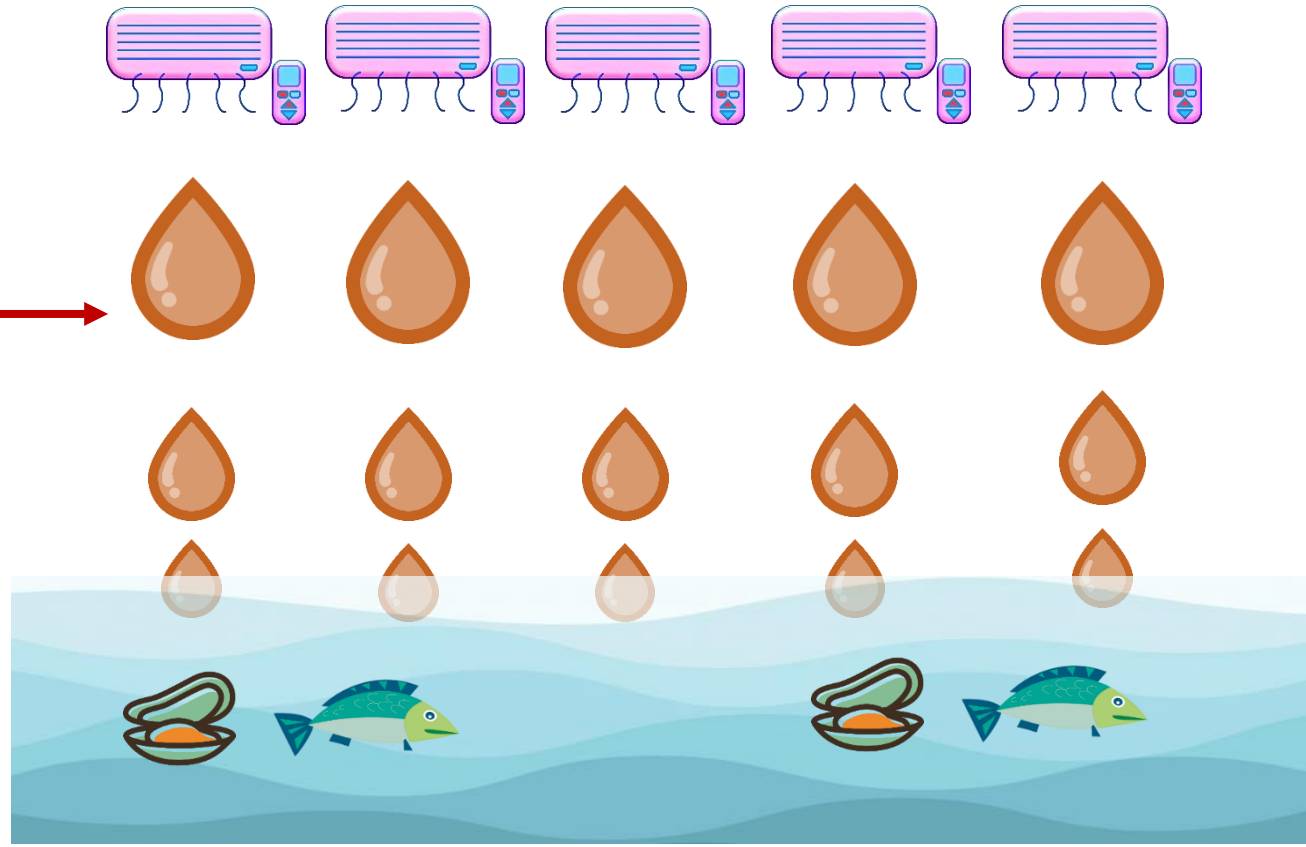


Physical Pollution – Thermal Pollution

- **Thermal pollution** is the effect of water quality by the **rise or fall in the water temperature**

- **Heated water waste** from industries and air conditioners flow into ocean

- **Effects on Marine Life**
  - Unable to adapt and die
  - Increase bacteria levels
  - Reduce biodiversity
  - Disturb the food chain

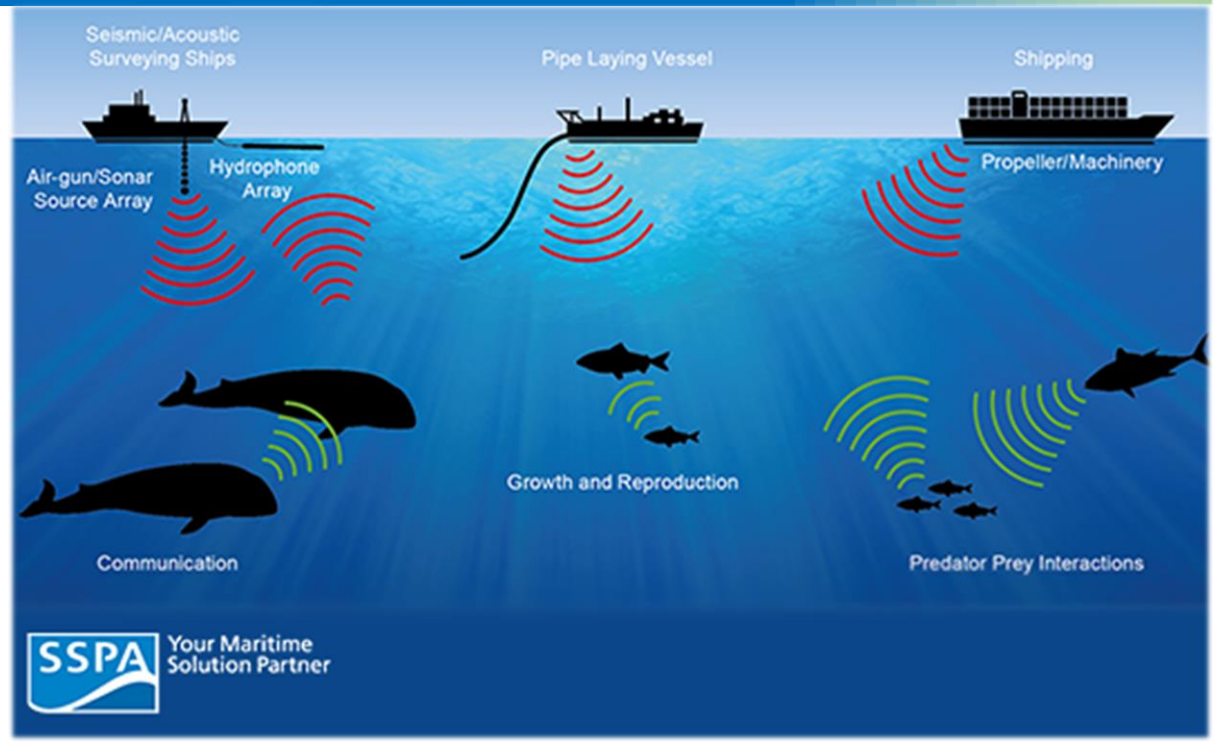


Ocean Alteration – shipping

- Release of oil, chemicals & dirty water
- Transfer of non-native species
- Noise pollution

Impact on Marine Life:

- Causes stress → weakens immune system
- Impairs hearing & communication
- Migration



Ocean Alteration - Land Reclamation

- Water & Waste pollution
- Noise pollution
- Flooding, Storm surges
- Disappearance of marine habitats and species
- Impact the food chain

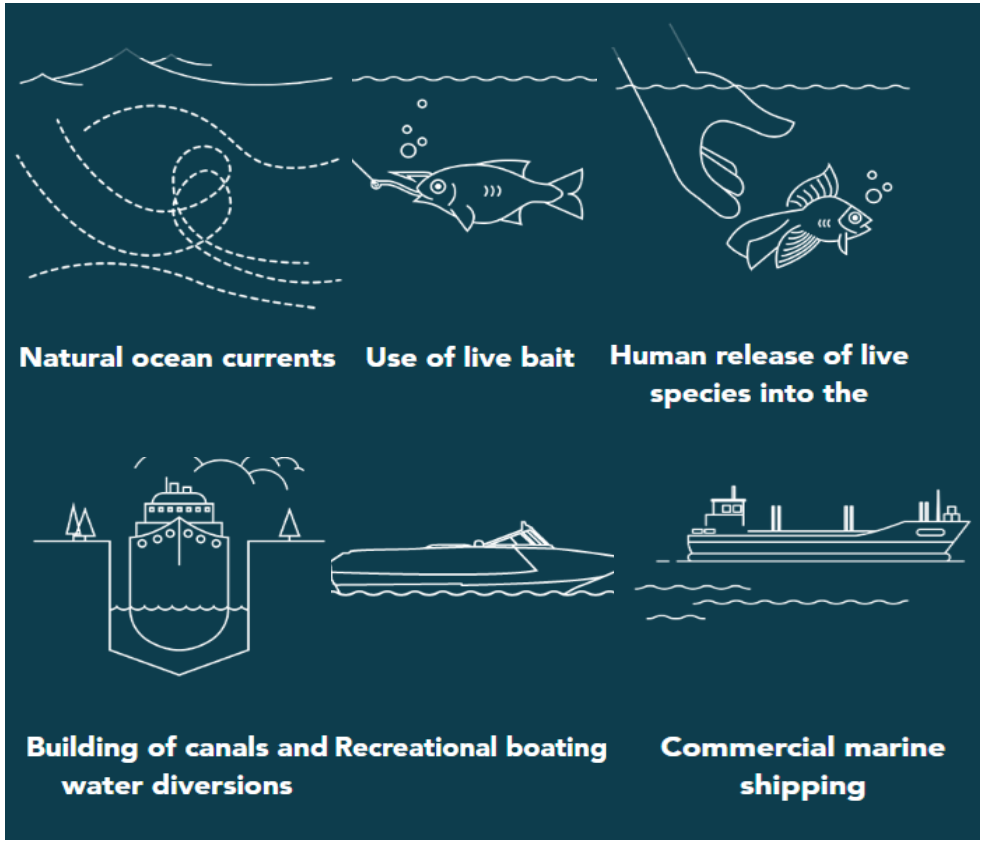
HK-Zhuhai-Macau Bridge Land Reclamation

Non-Native Species – Invasive Effect

Non-native species

=

Non-local species



- Can **compete for food with local species** and have **invasive effects on the ecosystem and function**

Invasion of lion fishes in Atlantic Ocean

Summary – Marine Pollution

What are the different kind of pollutions?

- **Chemical pollution**
  - Toxic Metals (PBT), Antibiotics, Pesticides, Radionuclides
- **Physical pollution**
  - Car tires, microplastic, dredging, thermal pollution

What is the fate of plastics in the ocean and their impact on the ecosystem?

Turn **into microplastics → being eaten by the marine organisms**

What are the human activities that would impact the ocean?

- **Ocean alteration**
  - Shipping, land reclamation and Non-native species

Industrial / Anthropogenic Activities

Heavy Metals

Uptake

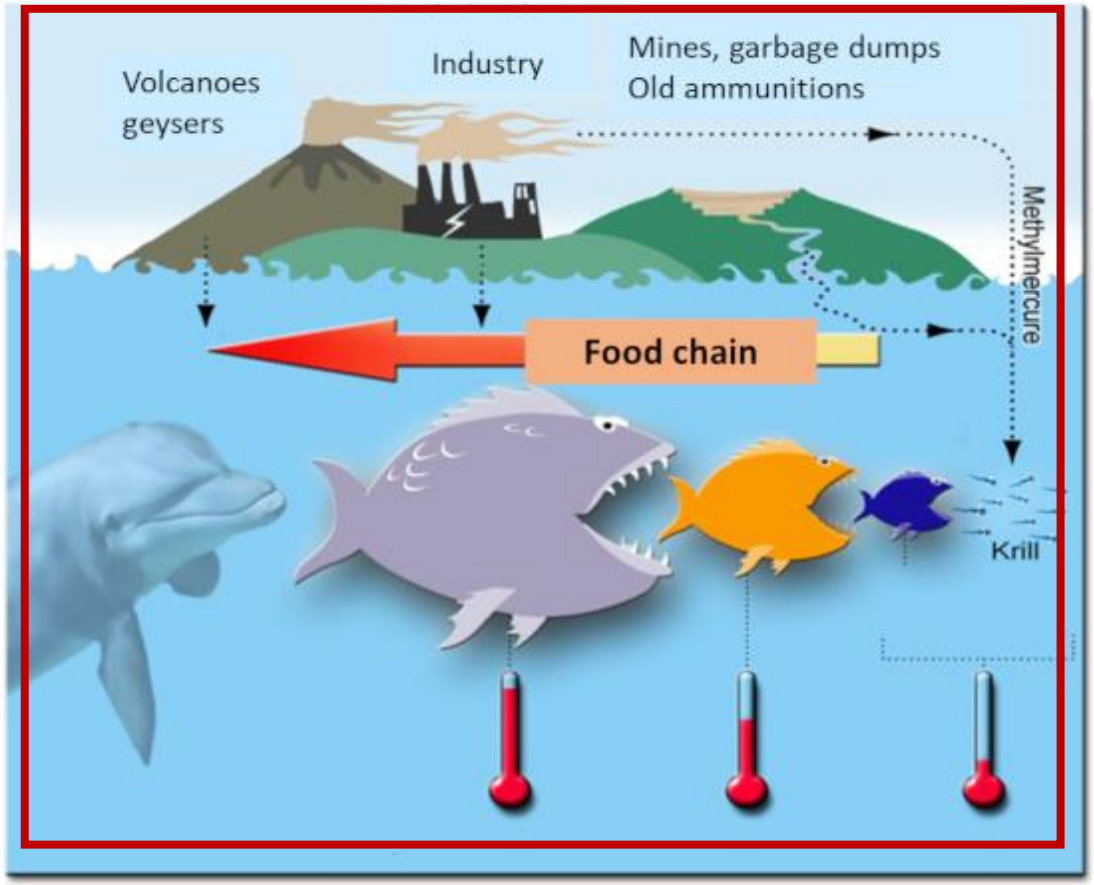
Consume

Potential Health Risks

DEPARTMENT OF OCEAN SCIENCE

Oyster Farming and Seafood Safety

Chemical Contaminants – Food Safety



Examples of **toxins absorbed through the gills** and **bioaccumulated** through food chain

- **Fish: Mercury (Hg)**

- **Oysters/scallop: Cadmium (Cd)**

What can happen when we consume contaminated fish or shellfish?

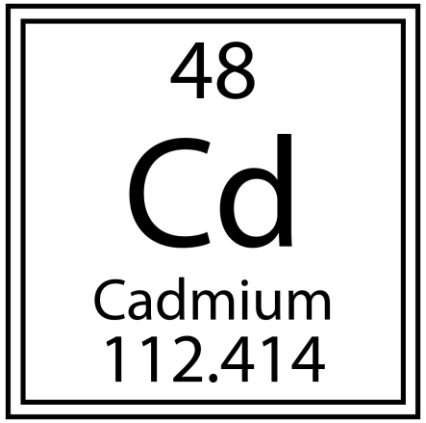
Toxic effects of mercury and cadmium

Health effects of mercury exposure:

- lack of coordination
- muscle weakness
- nerve loss in hands and face
- vision changes

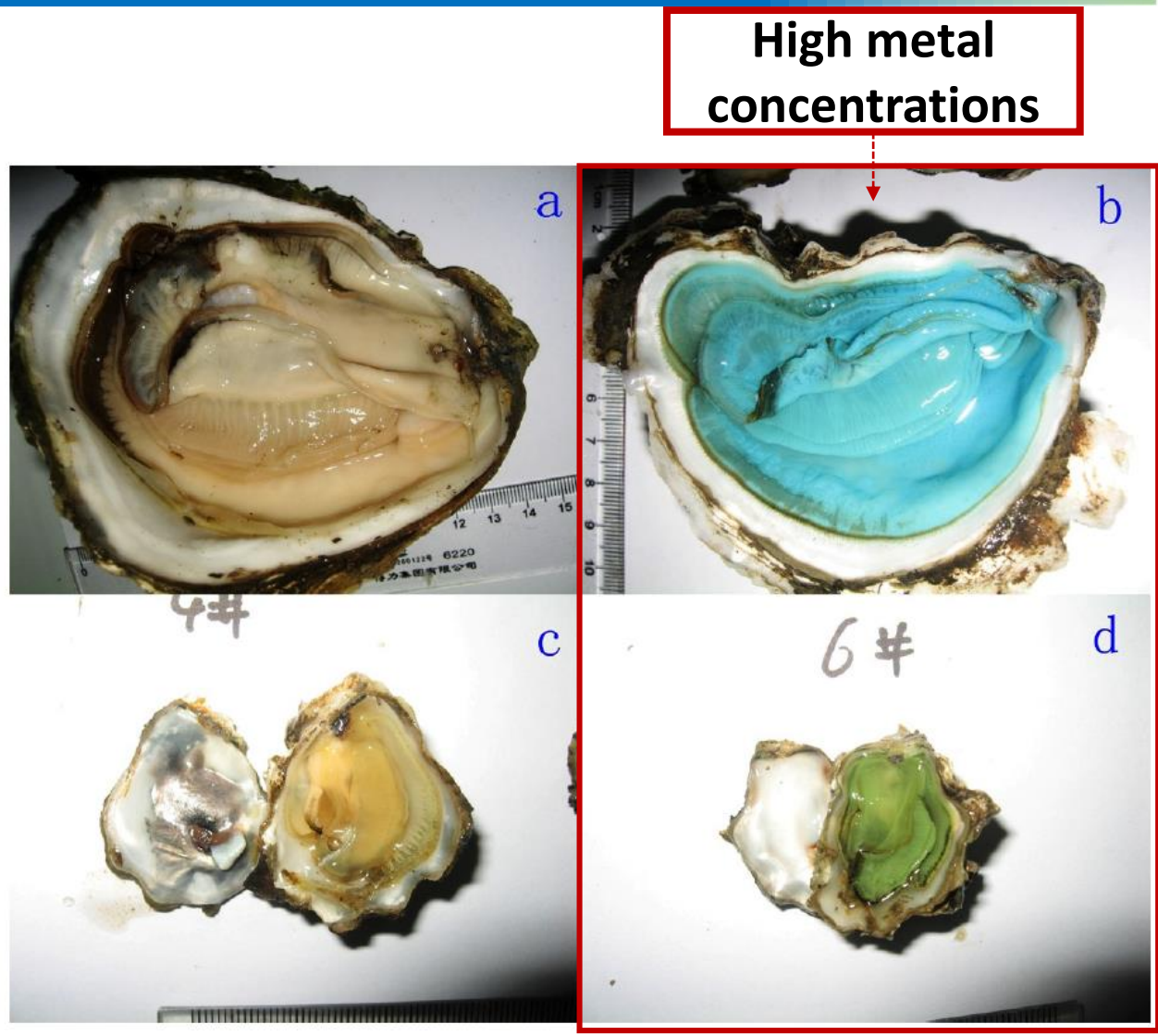
Health effects of cadmium exposure:

- Kidney or lung failure
- Bone disease



Oyster Farming and Food Safety

- Oysters are hyper-accumulators of many metals
- Some oysters are **estuarine** species (e.g. Hong Kong oysters) and can contain **high metal concentrations** as a result of **estuarine pollution**
- Currently, the **biggest threat** for oyster safety is **Cadmium (Cd)**
  - **Many cannot meet food safety standards**



A Recent Case…

Green oysters found with high concentration of Cadmium!

Fig. 1. This green oyster (*Crassostrea gigas*) was collected from the Mailliao Industrial Harbor locating in the western central Taiwan.

Advice from the Centre for Food Safety

- To reduce risk, raw oysters should only be consumed in or obtained from **reliable licensed premises**.
- **Susceptible populations** should avoid taking raw oysters.
- Maintain a **balanced diet** and avoid over-indulgence in oysters.
- **Thorough cooking** of oysters can significantly reduce the food poisoning risk.

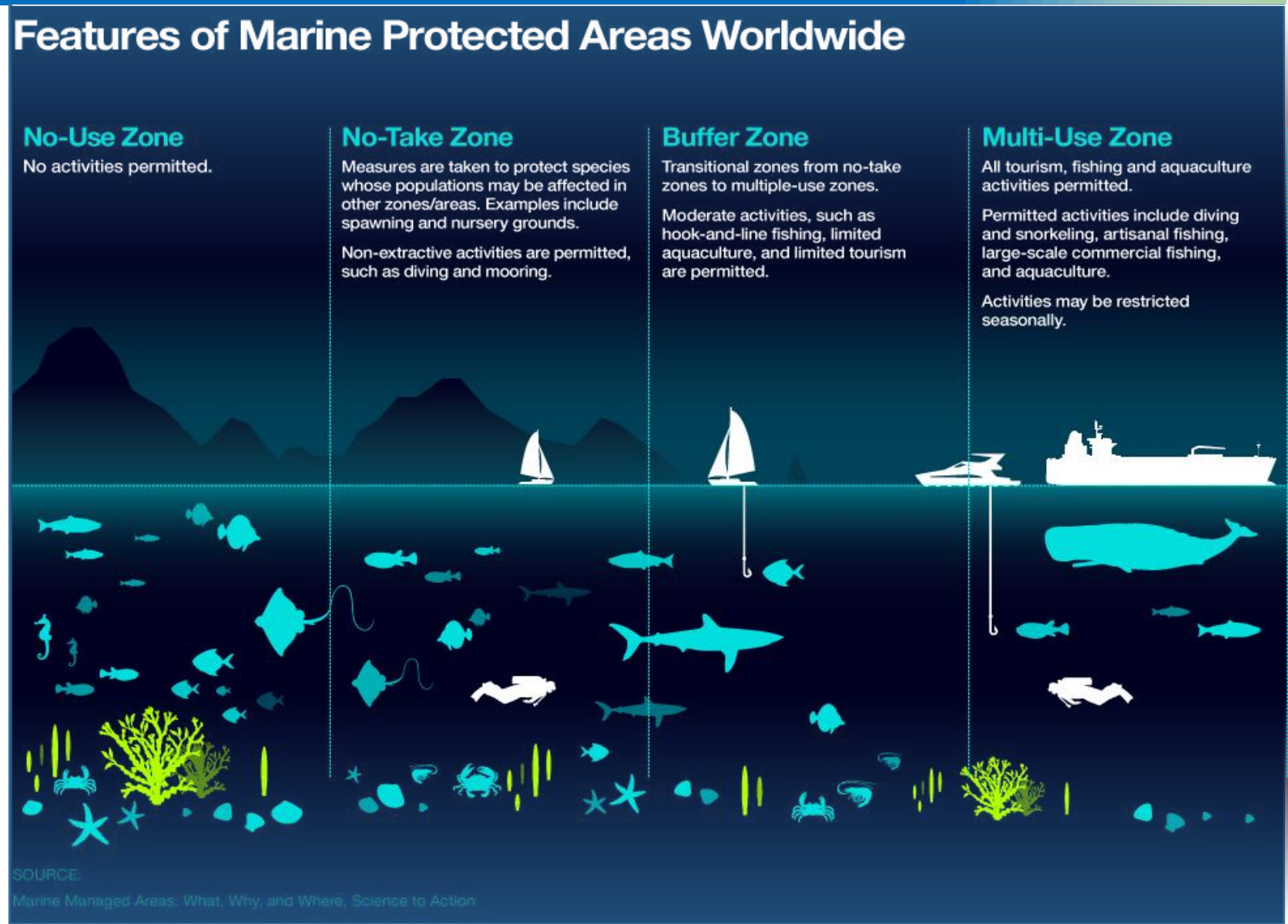
Oyster farming in Hong Kong

DEPARTMENT OF OCEAN SCIENCE

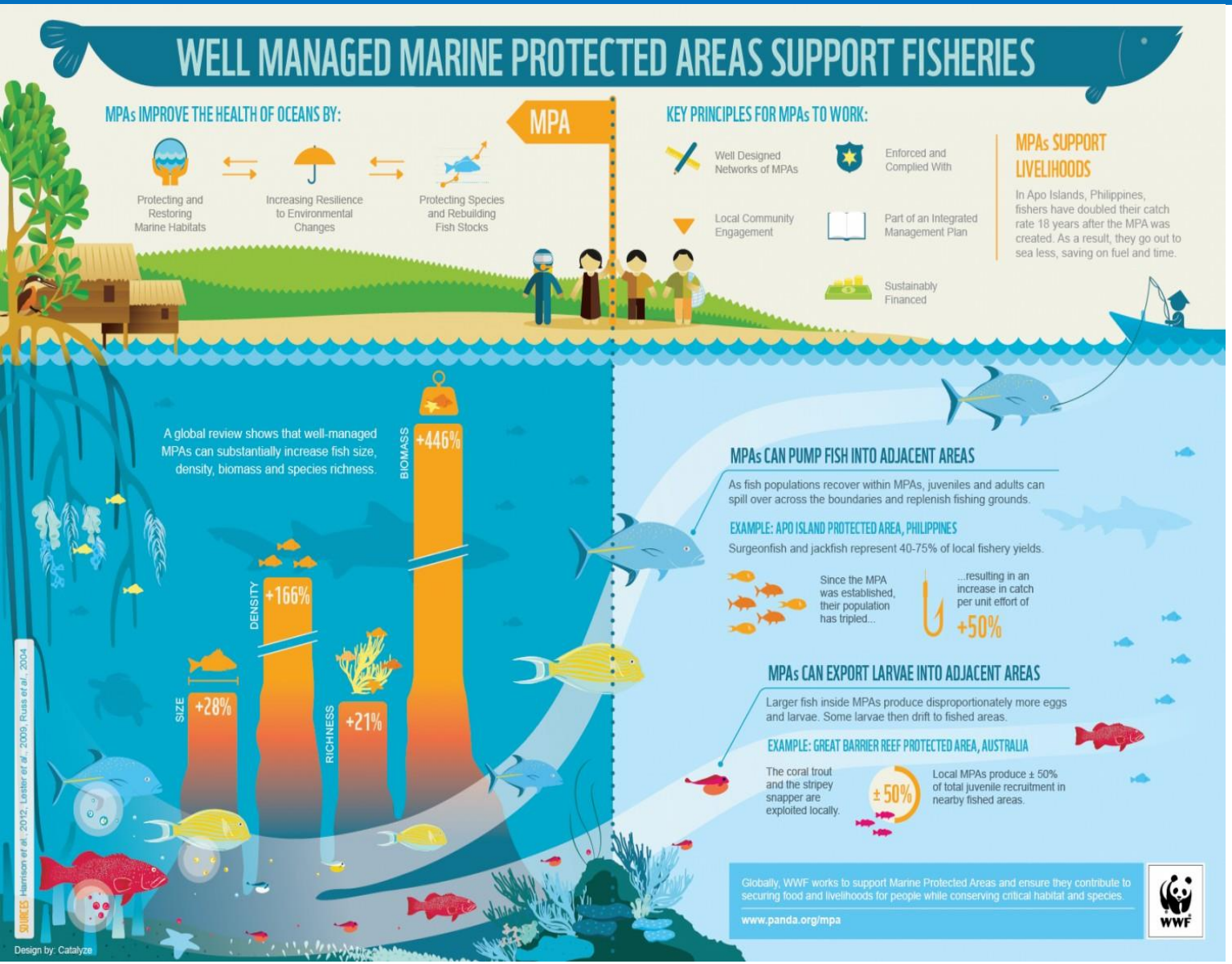
Marine Protected Areas

What is a Marine Protect Area (MPA)?

- **Geographically defined areas** that are designated for conservation to **protect marine resources**.
- Include **intertidal, sub-tidal, and pelagic** environments
- Protect the relevant body of water, bottom, **marine flora and fauna** and notable **historical and cultural features**

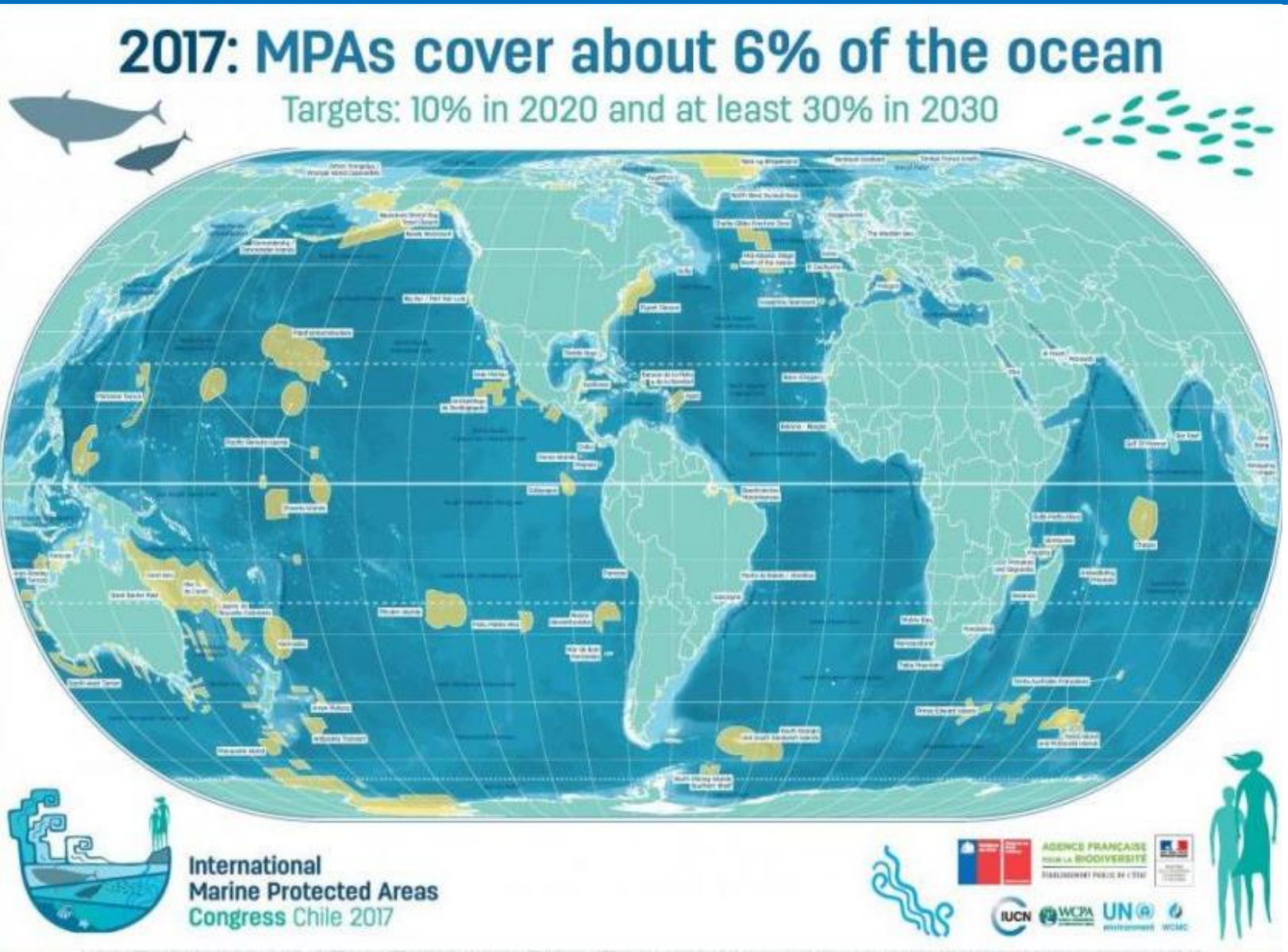


Why do we set up MPA?



- Maintain **biodiversity**
- Protect **critical habitats** from damage and allow them to **recover**
- Provide areas where fish can **reproduce, spawn and grow** to their adult size
- Building **resilience** to protect against damaging external impacts
- Maintain **local cultures, economies, and livelihoods,** which are intricately linked to the marine environment

What are the benefits of MPAs?



- The fish **biomass increased** by 4 to 5 times
- **Length increased** by 25%
- **Density of fish increased**
- **Number of species increased**
- **Coral cover increased**

No-take zone planning

Goal:

Create an area where fish are free to grow and breed, and they will spillover into the fishable areas

Factors to be considered:

- Location where overfishing occurs
- Size of the zone is depending on the behavior of the species, including dispersal capability, different life stages
- The area should be self-sustaining for the species
- Costs of fishermen
- Monitoring costs, biological assessment costs and enforcement costs

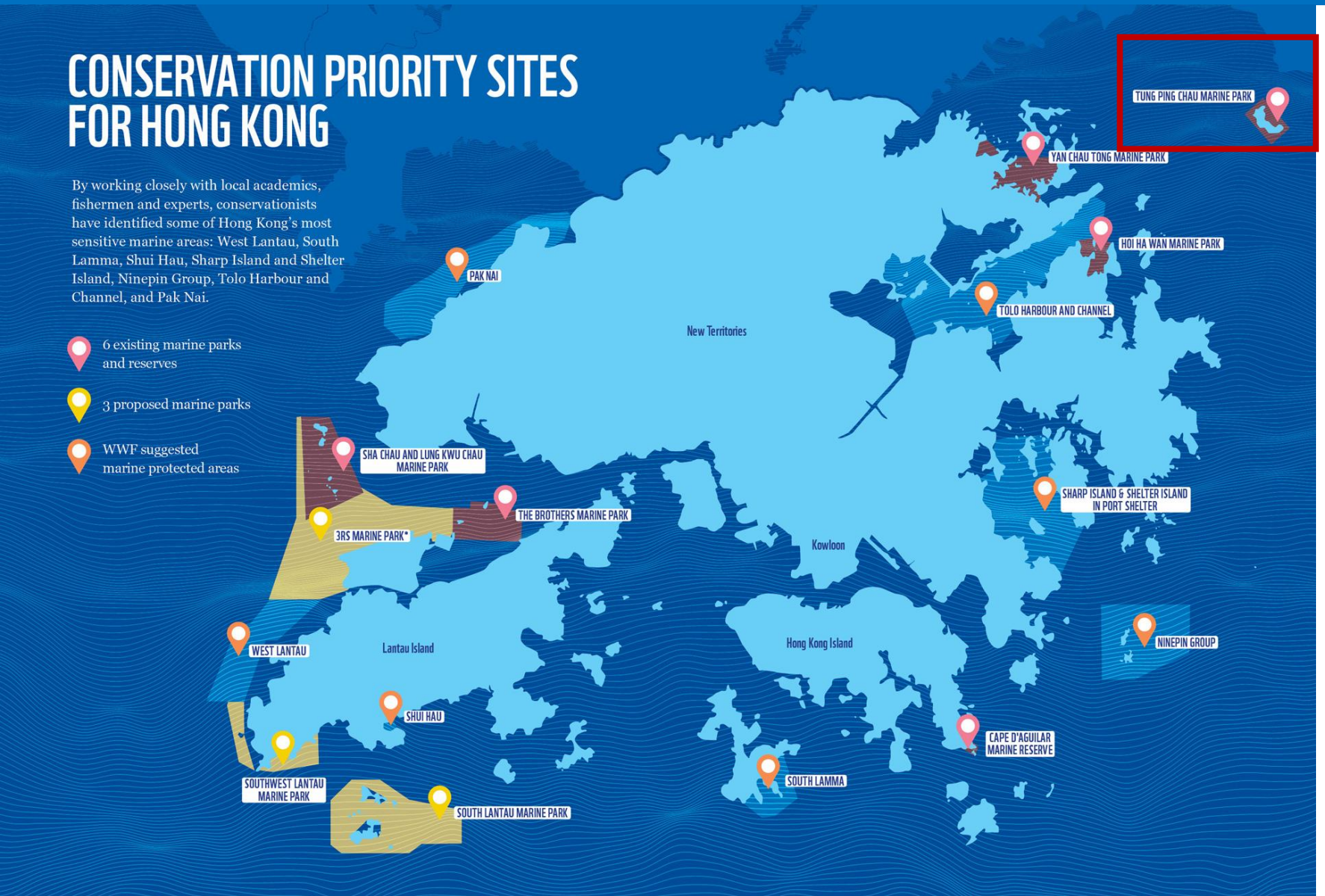
Marine Biodiversity in Hong Kong

HK has rich biodiversity

Challenges ahead

- Unregulated fishing
- Marine traffic
- Marine pollution
- Reclamation

MPAs in Hong Kong



Experts needed!

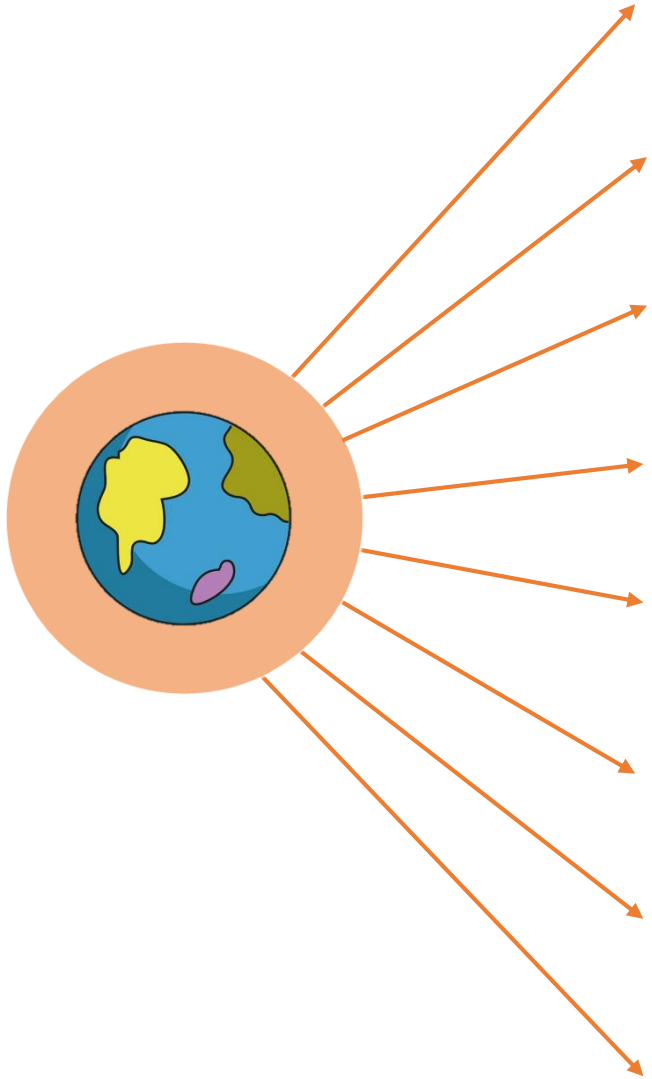
- Scientists
- Conservationists
- Fishermen
- NGOs

DEPARTMENT OF OCEAN SCIENCE

Overall Summary

Humans and the Sea

Humans and the Sea – Topics Covered



- Ocean and the climate
- Ocean and global warming
- Ocean acidification
- The Global Coral Reef Crisis
- Resources from the Ocean
- Coastal pollution and other anthropogenic impacts
- Oyster Farming and Seafood Safety
- Marine Protected Areas

MAPPING OCEAN WEALTH

TOURISM

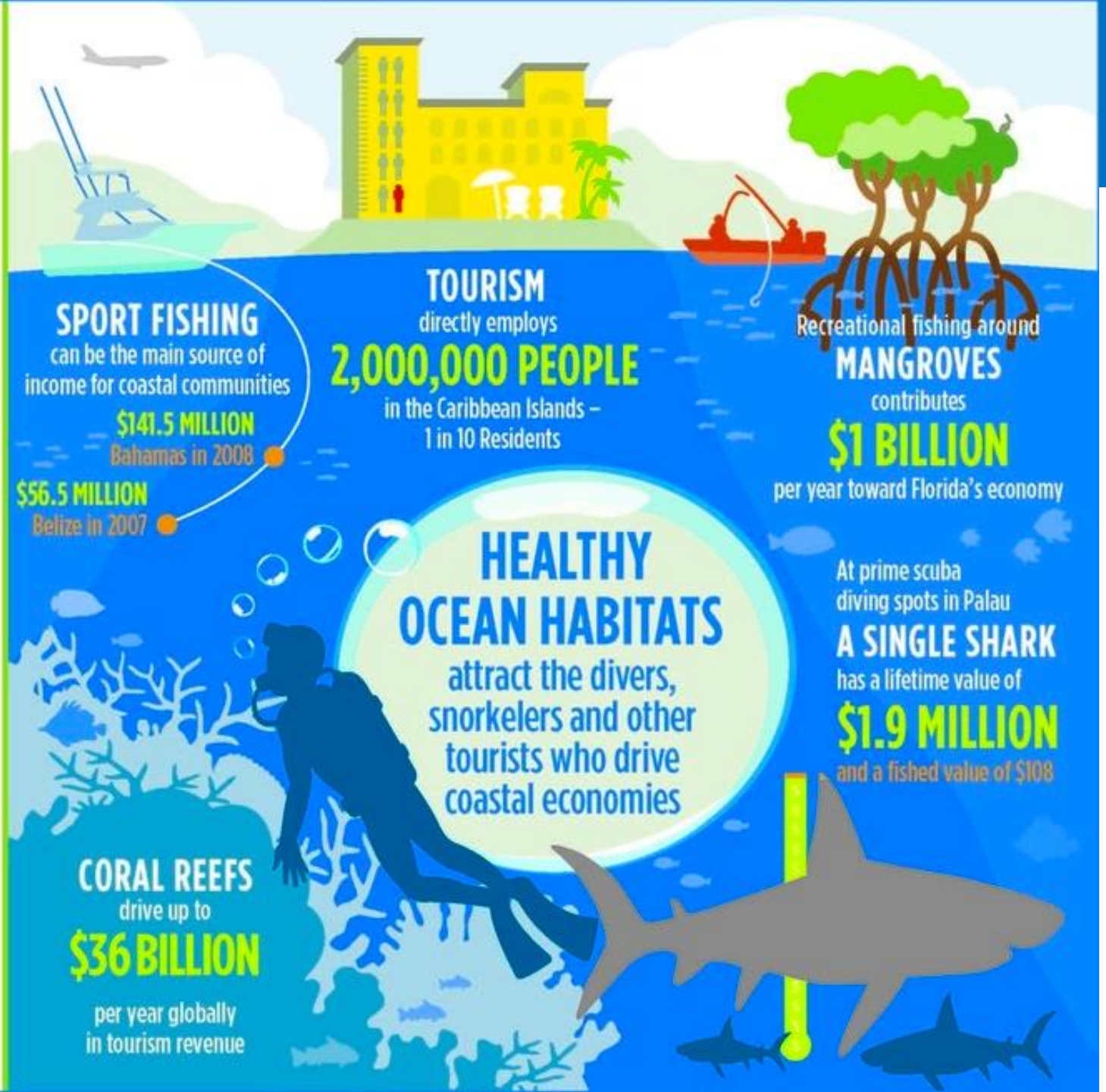
Ocean habitats provide scuba diving, fishing and other recreational opportunities that attract tourists from around the world.

Coastal communities, planners and the tourism industry should protect and restore the habitats that drive local economies.

Mapping Ocean Wealth demonstrates what the ocean does for us today so that we maximize what the ocean can do for us tomorrow.

oceanwealth.org @ocean_wealth

The Nature Conservancy
Protecting nature. Preserving life.



Ocean Wealth

Towards a Sustainable Future

The Ocean can clean itself but we need to do more to help the ocean continue supporting the life of billions of people on this planet.

- **Sustainable consumption and production**
- **Sustainable management of natural resources**
- **More research, mapping and surveillance needed**

Environmental Sustainability and Safety

- **Climate Change:** Can we increase sustainable consumption of goods, change to green energy and renewable energy?
- **Reduce CO_2:**
  - Can we inject CO_2 into the ocean floor and bury it there?
  - Can we increase primary productivity to absorb CO_2 out of the air?
- **Toxic Chemicals:** Can we employ chemical-eating bacteria to help remove toxins from the ocean?
- **Land Reclamation:** Can we create ecological recovery programs and artificial habitats?