The Oceans:

Natural systems, human use, and marine conservation

Case Study: Florida Keys

- https://www.youtube.com/watch?v=7_xrJ-QLCdU

- Our perception versus reality
- Water pollution, Urban development, Introduced species, Overfishing, Boating, Global climate change

Do we need to protect our oceans?

Case study: Everglades National Park

Third largest barrier coral reef, has vast amounts of biodiversity, attracts 3 million tourists a year (which comes with a price).

Creation of the Florida Keys National Marine Sanctuary – which came with lots of controversy. This marine protected area (any portion of the ocean protected from humans) was protested by the Conch Coalition

Oceanography

- **The study of the physics, chemistry, biology, and geology of the oceans.**

- 71% of the earths surface is ocean
- 97.2% of surface water are oceans
- Oceans are divided into 5 major basins
  - Pacific
  - Atlantic
  - Indian
  - Arctic
  - Antarctic
- Oceans touch and are touched by every environmental system and every human endeavor

Oceans contain more than water

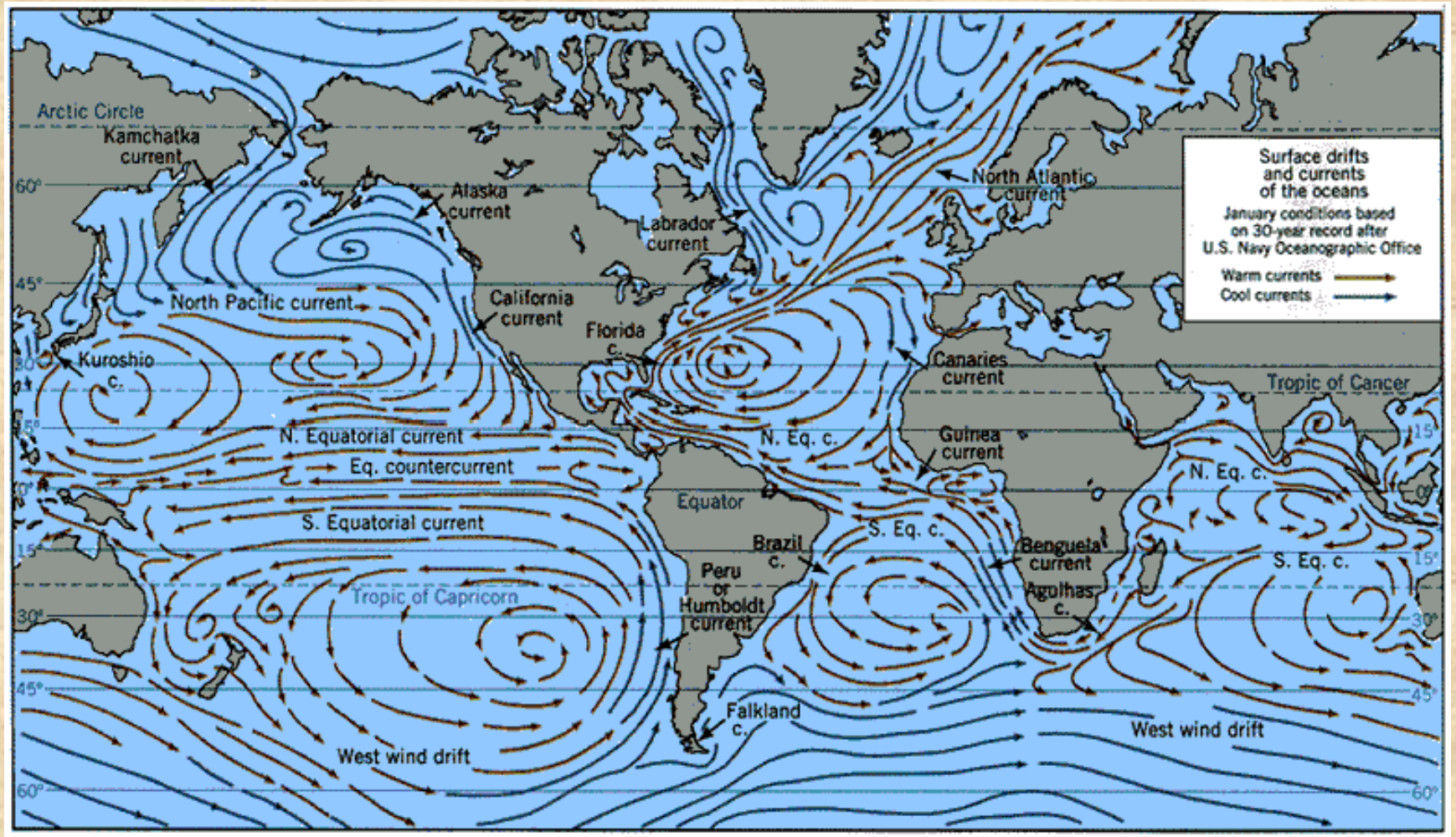
- 96.5% of the oceans mass is H_2O the rest is occupied by dissolved salts
- Ocean basins are the final repositories of water, so all the sediments from continents and rivers flow into the ocean, making them salkty.
- Salinity or salt content varies throughout the ocean, usually ranging from 3.3%-3.7%
- 36% of oceans are dissolved oxygen, produced by photosynthetic plants such as plankton or by batcteria and also by diffusion from the atmosphere

Ocean water is Vertically structured

- Surface waters in tropical regions receive more solar radiation and are warm. In polar regions surface water is coldest.
- Temperature declines with depth.
- Colder water sinks and warmer water rises
- Oceans experience yearly temperatures variations of only around 10 degrees Celsius.
- The ocean helps shape the earths climate.

A few key terms

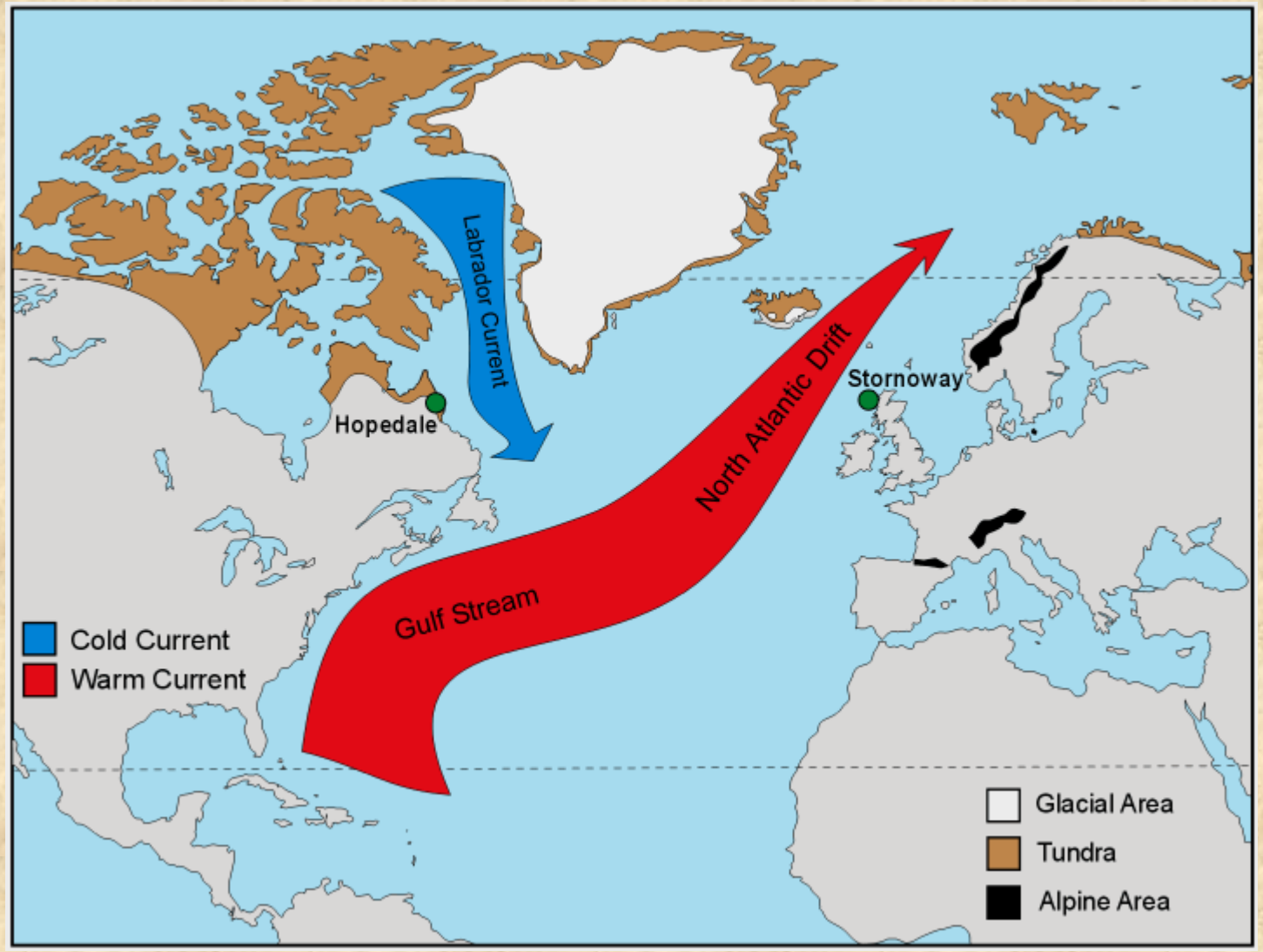
- **Currents**: The horizontal flow of a fluid in a certain direction (in the upper 400m of the ocean).
- **Upwelling**: The flow of cold, deep water toward the surface. It occurs in areas where currents diverge or flow away from each other. Why important?
- **Downwelling**: Areas where surface currents converge or come together and surface water is displaced downward. Why important?



The major surface currents of the world's oceans

Ocean Water Flows Horizontally in Currents

- The ocean consists of vast river-like flows which are driven by sunlight, wind, the Coriolis effect, and density differences.
- The currents influence global climate, are crucial in navigation, and can transport heat, nutrients, pollution, and larvae.
- An example of a powerful current is the Gulf Stream, which goes from the Gulf of Mexico all the way to Europe. This influences the region's climate.



The Gulf Stream current

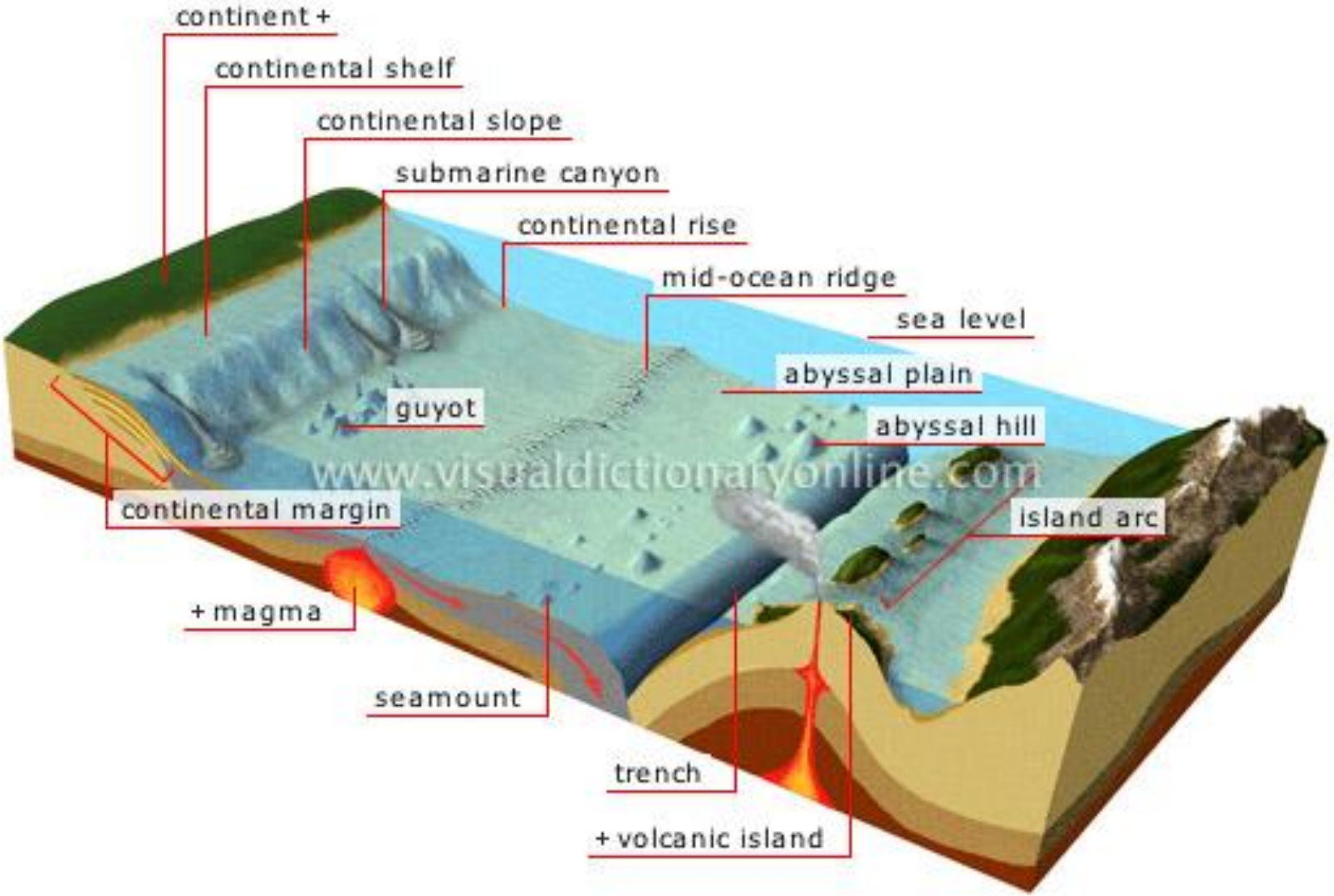
https://www.youtube.com/watch?v=UuGrBhK2c7U

Ocean Key Terms

- **Continental shelf**: the gently sloping, under-water edge of a continent, varying in width from 100 meters to 1,300 km, with an average slope of 1.9 meters/km.
- **Pelagic**: of, come, relating to, or living between the surface and floor of the ocean.
- **Benthic**: of, relating to, or living on the ocean floor.
- **Bathymetry**: study of ocean depths.
- **Topography**: physical geography, or the shape and arrangment of land forms.

Topography

- The ocean floor is rough, rocky and diverse.
- The deepest spots in the ocean are more than 11,000 m (36,000 feet).
- The planets longest mountain range is under-water
- Under-water volcanoes shoot forth enough magma to build islands above sea level.


continent +
continental shelf
continental slope
submarine canyon
continental rise
mid-ocean ridge
sea level
abyssal plain
guyot
abyssal hill
www.visualdictionaryonline.com
continental margin
island arc
+ magma
seamount
trench
+ volcanic island

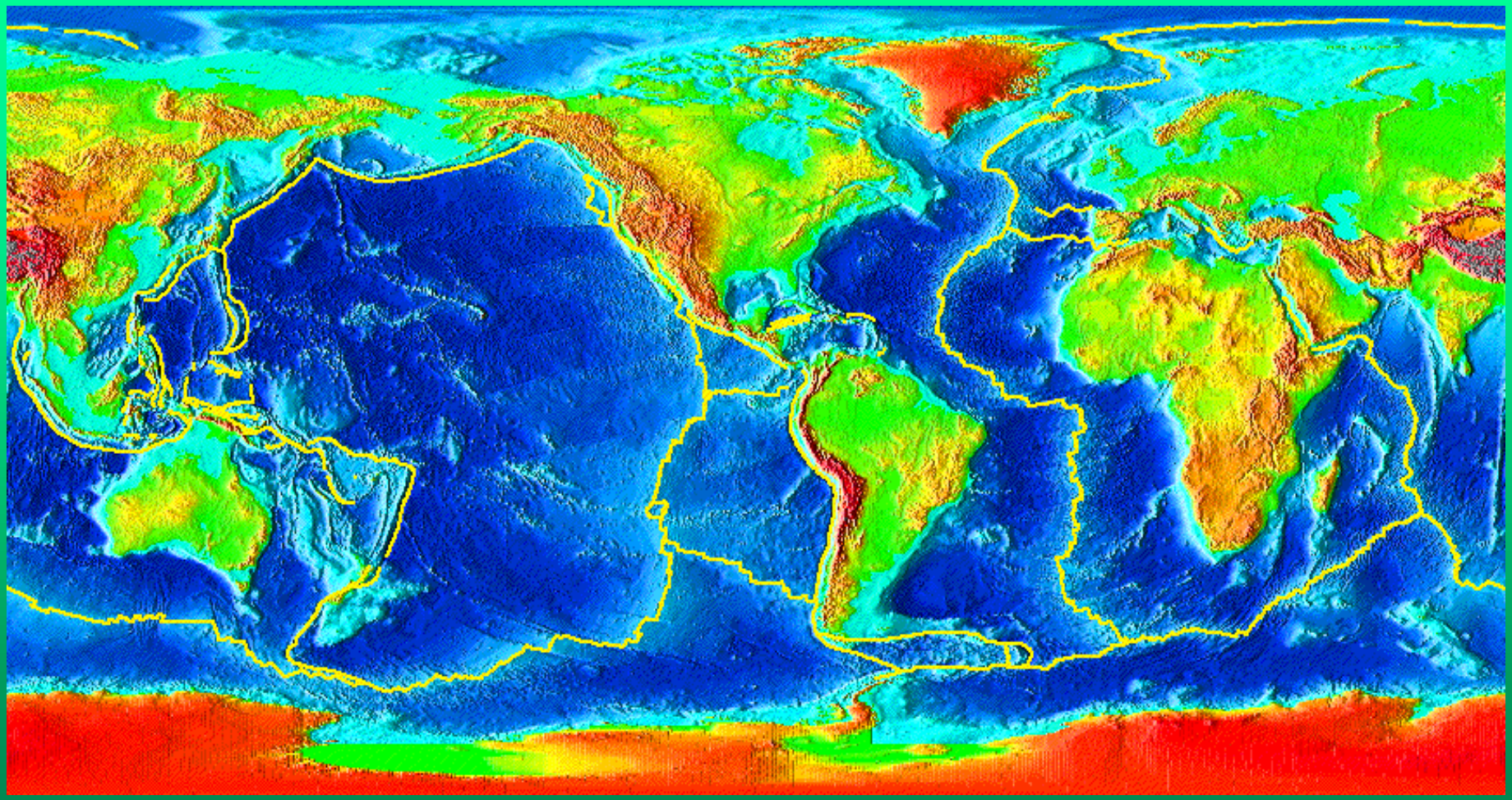
Topography Continued

- The deep ocean basins consist of abyssal planes, extremely flat expanses that make up much of the sea floor. Deepest trench is the Mariana's trench off the cost of Asia

- Different regions of the oceans have very different conditions, some of which support life more effectively than others.

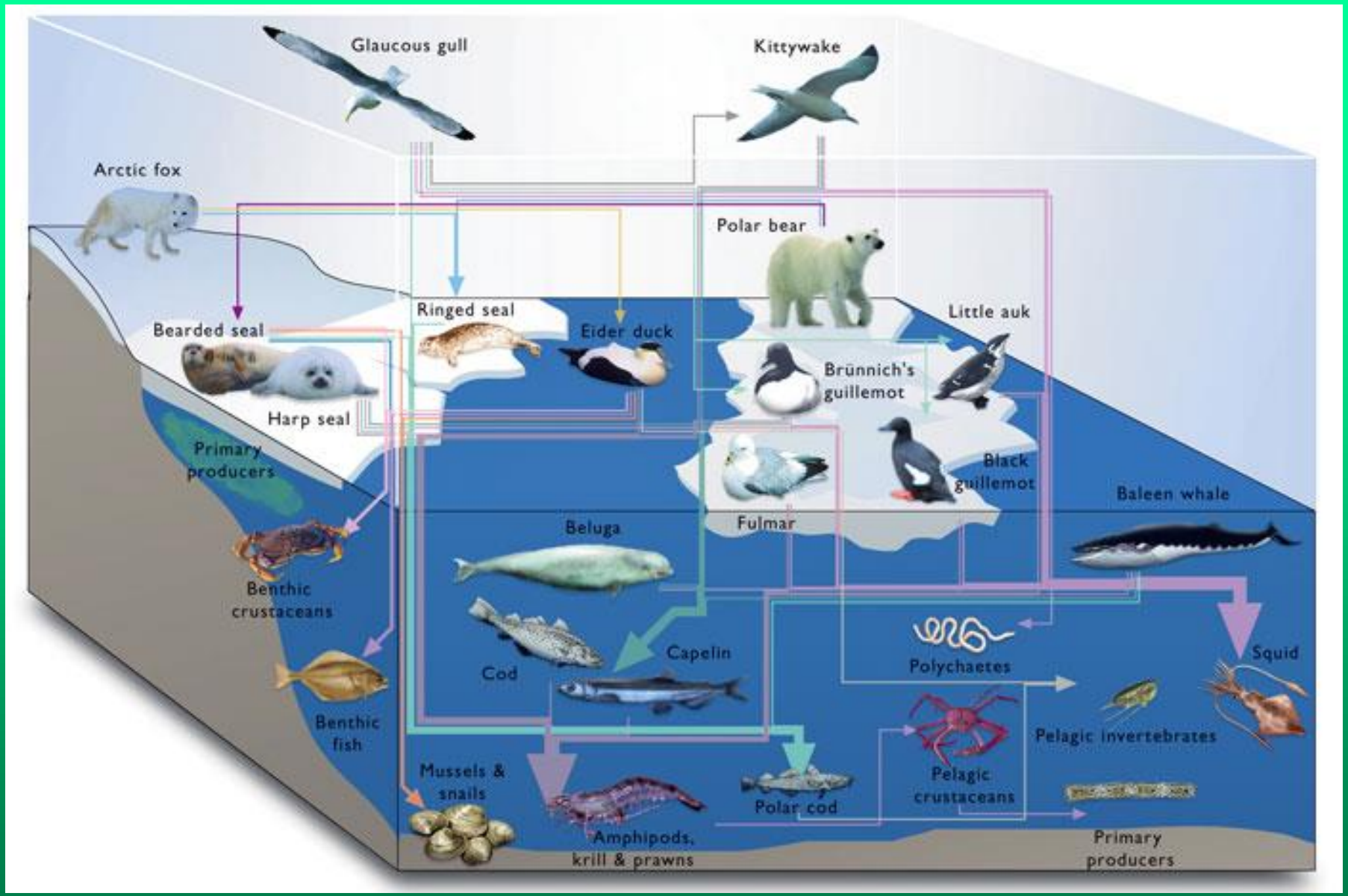
Topography Continued

- The uppermost 10 m of ocean water absorbs 80% of the solar energy that reaches is surface.
- For this reason, nearly all of the oceans' primary productivity occurs in the well-lit top layer of the oceans.
- The shallow waters of continental shelves are most biologically productive and support the greatest species diversity.



Marine Ecosystems

- Most marine ecosystems are powered by solar energy (exceptions?)
- Sunlight derives photosynthesis among the plankton in the euphotic zone
- Organisms in benthic habitats dwell in or on the sea floor, pelagic organisms live in open water away from continents and islands, and coastal organisms dwell in shallow waters near the shore.


Glaucous gull
Kittywake
Arctic fox
Polar bear
Ringed seal
Eider duck
Little auk
Bearded seal
Brünnich's guillemot
Harp seal
Primary producers
Black guillemot
Baleen whale
Fulmar
Beluga
Benthic crustaceans
Capelin
Cod
Polychaetes
Squid
Benthic fish
Pelagic invertebrates
Mussels & snails
Pelagic crustaceans
Polar cod
Amphipods, krill & prawns
Primary producers

Kelp Forests

- **Kelp-** large brown algae or seaweed.
- Grows from the floor of continental shelves, reaching upward toward the sunlit surface.
- Some kelp reaches 200 feet in height and can grow 18 inches in a single day.
- Dense stands of kelp form underwater forests on the continental shelves in many temperate waters.
- Kelp forests with their complex structure supply shelter and food for invertebrates and fish, which in turn provide food for higher-trophic-level predators such as seals and great white sharks.

Coral Reefs

- **Coral Reef-** a mass of calcium carbonate composed of the skeletons of tiny colonial marine organisms called corals.
- Coral reefs may occur as an extension of a shoreline, as a barrier island paralleling a shoreline, or as a ring around a sunken island, a formation called an *atoll.*
- **Zooxanthellae-** derive nourishment from symbiotic algae that inhabit their bodies and produce food through photosynthesis.
- Though small in numbers, hold huge amounts of biodiversity

- Coral populations and coral reefs have been experiencing declines in recent years. This is mainly because of coral bleaching and divers who stun fish.
- Coral bleaching is a process that occurs when zooxanthellae leave the coral, thus depriving it of nutrition. Corals lacking zooxanthellae lose color and frequently die.
- Coral bleaching may be a result of increased surface temperatures.
- When divers dive into bodies of water to catch fish, coral reefs can also receive some damage. It is estimated that for each fish caught this way, one square meter of reef is destroyed by cyanide poisoning.

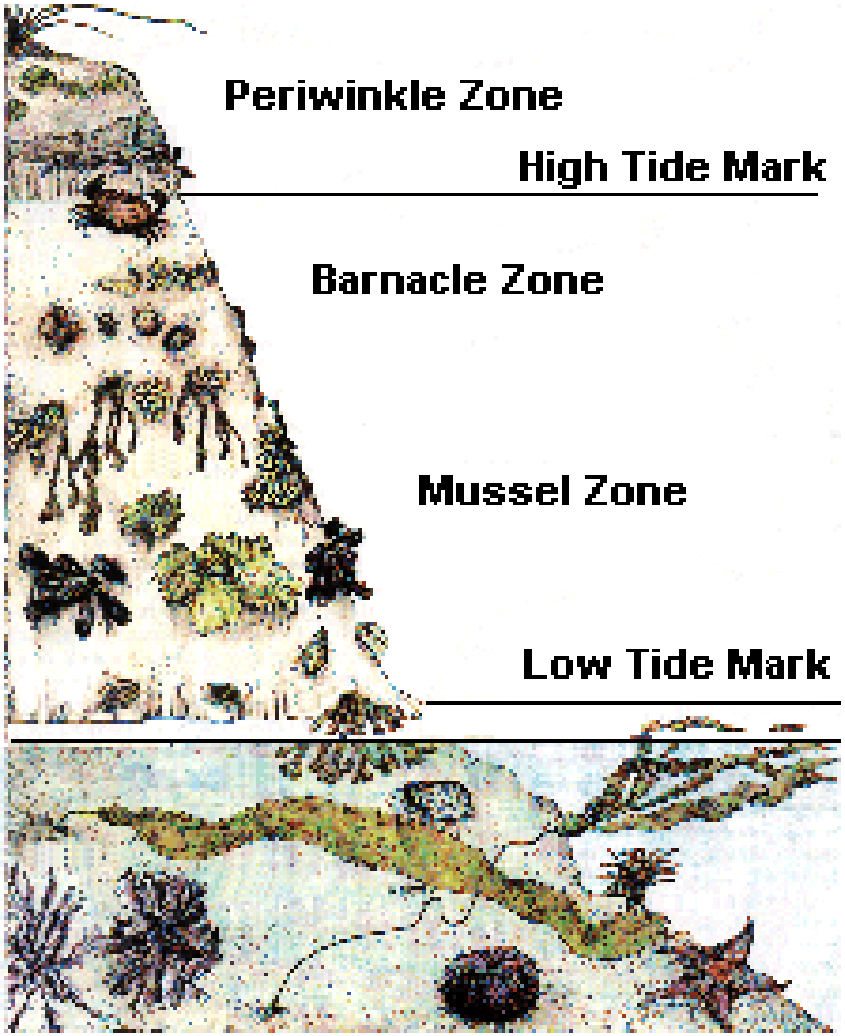
Coral bleaching

Intertidal Zones

- **Tides** are the periodic rising and falling height at a given location which is caused by the sun and moon's gravitational pull.
- **Intertidal** also known as the littoral, ecosystems lie along the shorelines between the farthest high tide and the lowest low tide.
- Intertidal organisms spend their days in **3 ways**
  - Submerged in water
  - Dry and exposed to air and sun
  - Lashed and beaten by waves
- These organisms must deal with extreme temperatures, moisture, sun exposure, salinity and marine predators at high tide.
- Anemones, chitons, muscles, and barnacles (Sessile animals) live attached to rocks in the ocean and filter feed food from the water washing over them.

Intertidal Zones Continued…

- Urchins and sea slugs eat algae that grows into the intertidal area.
- At high tide many predators prey on filter feeders and herbivores.
- Low tide birds go by and pick off animals.
- The intertidal that is rocky is very diverse. The environmental variation gives rise to the organisms that array themselves in the zones according to their own needs.
- The diversity in organisms closer to the sandy intertidal areas are lower although many burrow into the sand at low tide waiting for high tide, when they can emerge for food.



Salt Marshes

- Salt Mashes are created when the ocean tides reach inland and spread across large areas.
- Salt Marshes are located in high latitudes and temperate regions.
- Are common where gently sloping, sandy, or silty substrate meets the ocean.
- Rising and falling tides that flow in and out of channels called tidal creeks and at highest tide spill over onto elevated marsh flats.

Salt Marshes

•Marsh flats grow thick with grasses, rushes, shrubs, and other herbaceous plants.

•Salt Marshes boast very high productivity and provide critical habitat foe shore birds, waterfowl, and the adults and commercially important fish and shellfish species.

• Around the world, people have altered salt marshes to make way for coastal shipping, industrial facilities, farming, and other development.

Mangrove Forests

- Mangrove forests replace salt marshes in tropical and subtropical latitudes
- Mangrove trees have unique roots that curve upward to attain the oxygen lacking in the mud
  - These roots also help to anchor the trees when water levels change.
- Trees are a source of habitat for snakes, fish, worms, shellfish, and other organisms
- Also a source of materials for people
  - Food, medicine, tools, and construction

Mangroves continued…

- Located in southern edge of United States, and in the Florida Keys Marine Sanctuary
  - Different species: red mangrove, black mangrove, and white mangrove. Adapted from a change in tidal zones
- However, many forests have been removed as people start to use these areas for commercial and residential use
- Coastal shrimp farming is one of the greatest threats, deforesting 65,000 ha in Thailand alone
- Unfortunately, it is estimated that half of Mangrove forest population have been destroyed, and only 1% receive protection

Fresh water meets Salt water in estuaries

Estuaries: areas where rivers flow into the ocean mixing fresh water with salt water.

•Experience significant fluctuations in salinity as tidal currents and fresh water runoff vary daily and seasonally.
• Provide a transitional zone where young fish make the passage from fresh water salt water.
•Affected by urban and costal development, water pollution, habitat alteration, and over fishing.

How Humans Use and Impact Oceans

- Transportation routes: ships carry everything from cod to cargo containers to crude oil.
- Ships transport ballast water which when discharged at ports may transplant species. Some of these species establish and become invasive in their new homes

Extracting Energy and Minerals From the Oceans

- We use the oceans as sources of commercially valuable energy
- By the 1980's around 25% of our production of crude oil and natural grass was coming from the exploitation of deposits beneath the seafloor
- Offshore areas may contain as much as 2 trillion barrels of oil
- The oceans hold potential for providing renewable energy sources
- Engineers have developed turbines that can generate electricity by utilizing the ebb and flow of the tides
- Ocean thermal energy conservation is another possible energy source
- In a day, the oceans capture as much energy from the sun as is contained in 250 billion barrels of oil. If we were to harness just 0.1% of this solar energy, it could be used to generate 20 times the electricity used in the United States each day

Extracting Energy and Minerals From the Oceans (cont.)

- We can also extract minerals from the ocean floor. This is done by using large vacuum cleaner-like hydraulic dredges, in which the miners collect the sand and gravel from beneath the sea
- Ex. Sulfur, phosphorite

Marine Pollution Threatens Resources

- Even in the mid-20th century, it was common for coastal cities in the United States to dump trash and pump untreated sewage onto mudflats and into embayments
- In Fort Bragg, people collect colorful beach glass. It is the site of the former town dump, and many visitors may find all different types of trash
- All of the coastal dumping has left a toxic legacy

Oil pollution

- Cause serious local & regional environmental problems
- Majority of oil pollution comes from the accumulation of innumerable widely spread small sources
  - Leakage from small boats& runoff from human activity on land
- The amount spilled into the ocean each year = the amount that naturally seeps into the water from seafloor deposits

Oil affects marine life

- Physically coats and kills intertidal and free-swimming marine life
- When ingested, it poisons marine life

Prevention plans:

- Gov. impliments more stringent safety standards fro tankers
  - Pay for tugboat escorts thru rocky coastal water (collects money for the future)
- US oil pollution act of 1990- $1 billion funding for prevention and cleanup

Other marine endangerments

- 89% of trash in the North Pacific is plastic
- https://www.youtube.com/watch?v=1qT-rOXB6NI
- Trash and plastic are often mistaken for food and the animals die after eating them
- Debris not only hurts the animals, but humans too
- Fishermen have problems for debris for it kills off their game and it makes it so that they catch debris
- Debris also costs a lot of money in insurance

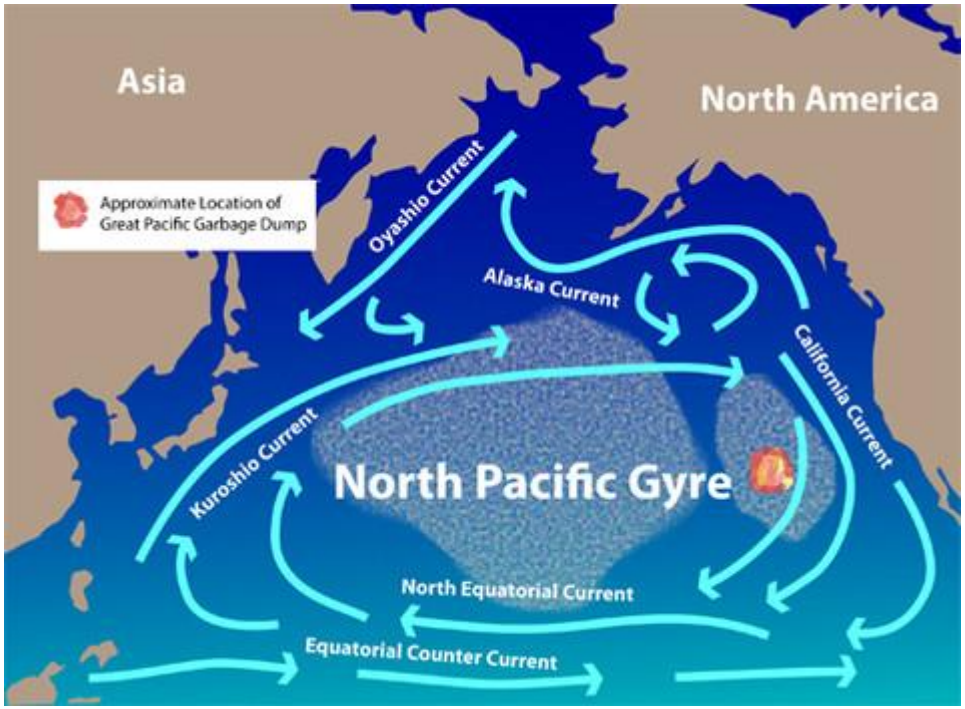

Asia
North America
Approximate Location of Great Pacific Garbage Dump
Oyashio Current
Alaska Current
California Current
Kuroshio Current
North Pacific Gyre
North Equatorial Current
Equatorial Counter Current


Image by Chris Jordan
ChrisJordan.com

Excess nutrients

- Pollution from fertilizer runoff and other nutrient input release excess nutrients into surface waters
  - Cause unusually high growth rates and population densities of phytoplankton
    - Causing eutrophication in both freshwater and saltwater

Harmful Algae:

- Some species of algae produce powerful toxins that attack nervous systems of vertebrates
- Harmful alagal blooms-population explosion of toxic algae caused by excessive nutrient concentrations
- Red tides- harmful algal bloom consisting of algae that produce reddish pigments that discolor the surface waters

•We can reduce the risk of of these outbreaks by reducing nutrient runoff into coastal waters, we can minimize the health effect by monitoring to prevent human contact with or consumption of affected organisms.

•Half of the world's marine fish are fully exploited, meaning we can not harvest them more intensively without driving them toward extinction.

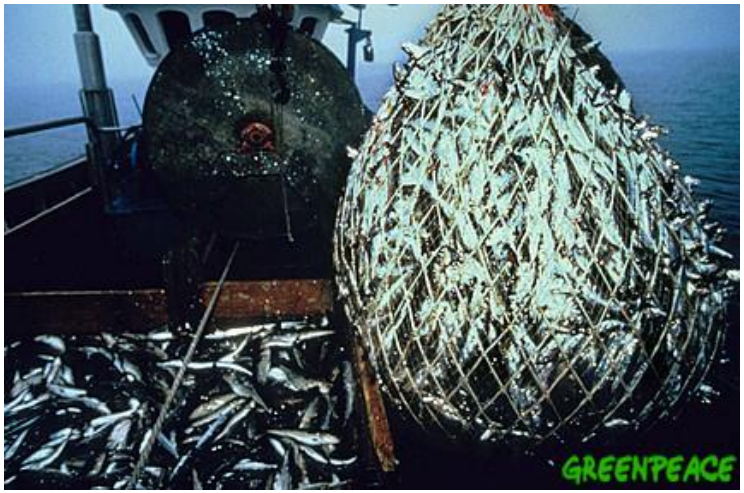
Overfishing Through the Ages

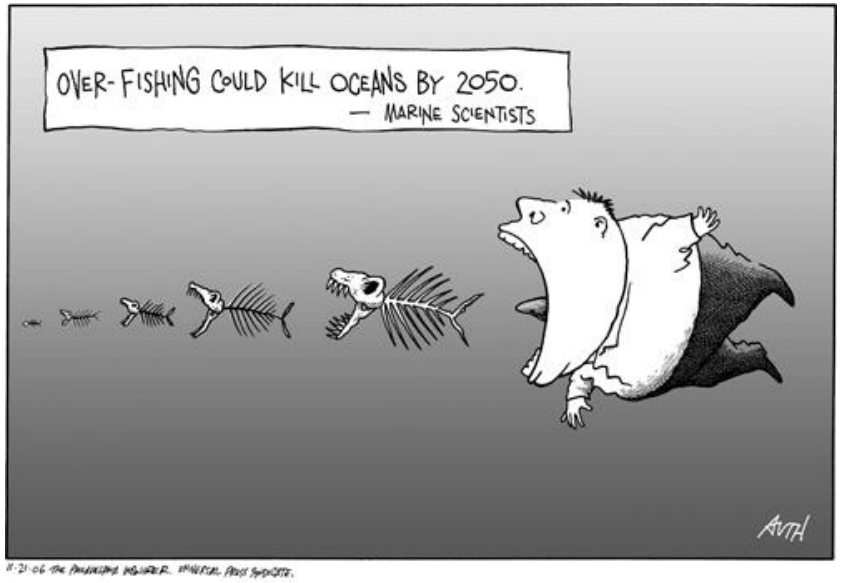
- Fish have always been an important part of the human diet, and there is even evidence that overfishing began centuries ago, and accelerated with the Colonial Age and the Industrial Revolution.

- One example of early overfishing in the 18th Century would be the ravaging of the oyster beds along the Chesapeake Bay.
- More recently in the 1980s, the overfishing of whales for commercial uses which led to many whales' extinction.

Modern Fishing and its Impact on the Marine Life

- Modern Industrial Fishing depletes marine life much more rapidly than traditional fishing
- Industrial Fishing catch rates generally follow the same pattern of being very high in the first decade than rapidly dropping and stabilizing at about 10% of their initial rates.
- Scientists estimate that today's oceans contain only 1/10th of marine life that existed years ago due to Industrial Fishing





Many Fisheries are Collapsing

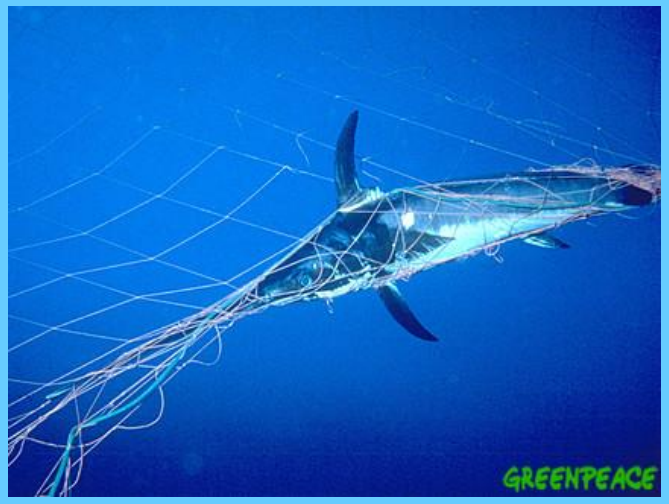
- These collapses take a severe economic toll on communities and regions that depend on fishing.
- A prime example of fishery collapse took place in the 1990's effecting ground fish fisheries in the Atlantic off the Canadian and U.S. coasts. The term ground fish refers to various species that live in benthic habitats, such as Atlantic cod, haddock, halibut, and flounder.
- In 2003 the Canadian government ordered a complete ban on cod fishing in the grand banks region off Newfoundland and Labrador.
- Fisherman began having better luck, especially in areas just outside the post regions, where satellite observations showed that fish were clustering.

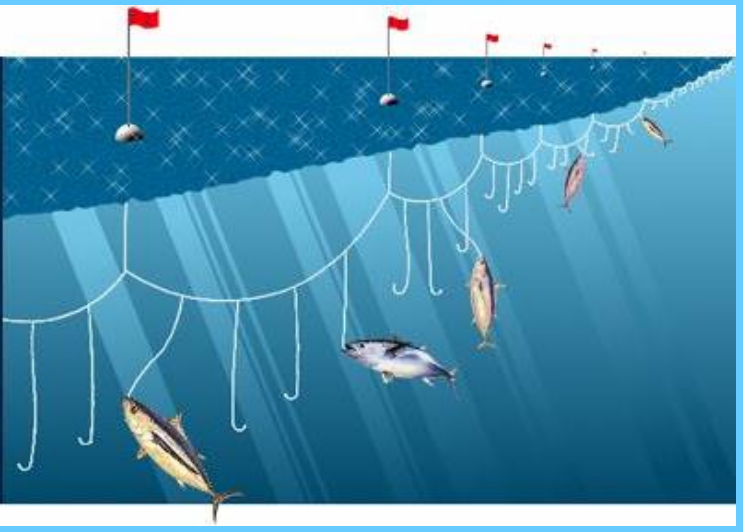
Fisheries declines are masked by several factors

- Despite the depletion of fish stocks in region after region as industrialized fishing has intensified, the amount of overall fish production has remained stable for 15 years.
- Fishing fleets now venture farther from their home ports in order to find fish.
- Improved technology also helps explain high catches in spite of declining stocks. They have access to an array of technologies that military's have developed for spying and for tracing enemy submarines, including advanced sonar mapping equipment, satellite navigation, and thermal sensing systems.

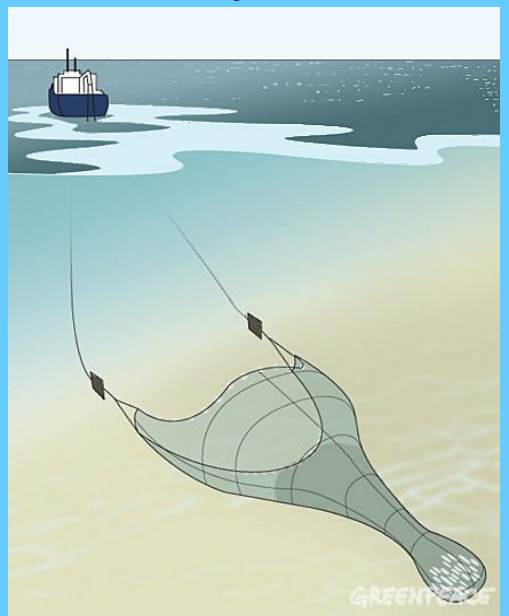
- As more desirable fish become less available, fisherman begin to target the less-desirable species of fish because they are more readily available. Because of this, they must catch fish at lower trophic levels, this process is called "*fishing down the food chain*".
- **By Catch:** The removal of species at high trophic levels from marine environments can have serious effects on the animals not meant to be caught. It accounts for the deaths of many thousands of fish, sharks, marine mammals and birds each year.

Driftnetting: The process in which boats drag large nets that end up capturing untargeted species of sea life such as dolphins, seals, sea turtles, and thousands of fish.





Longlining: The process in which boats drag extremely long lines with baited hooks spaced along their lengths. This kills many species of seabirds, along with many sea animals as well.



Bottom trawling: The process of dragging weighted nets over the floor of the continental shelf in order to catch such organisms as scallops and groundfish. This can directly damage entire ecosystems as the large net is dragged.

Maximum Sustainable Yield

- **Maximum sustainable yield-** allowing for maximal harvests of particular populations while keeping fish available for the future.
- Fisheries study fish population biology to regulate the timing of harvests, techniques used to catch fish, and the scale of the harvest.
- If yields look unsustainable, managers limit how many of that fish species can be harvested or restrict the type of gear fishermen can use.

Marine Protected Areas and Marine Reserves

- **Marine protected areas** do not necessarily protect their natural inhabitants. Nearly all MPAs allow fishing or other extractive activities.
- **Marine reserves-** areas where no fishing is allowed.
  - Designed to be refuges to preserve ecosystems intact without human interference.
  - Fish larvae produced inside reserves should disperse outside and stock other parts of the ocean, which should improve fisheries.

Opposition to Marine Reserves

- Fishermen oppose marine reserves because they are concerned they will put more areas off-limits to fishing and not increase fish stocks.
- There have been protests against the establishment of marine reserves, and some have turned violent.
- Many former opponents of marine reserves have become supporters when they see improvements in the marine life and ecosystems around them.

Effects of Marine Reserves

- Inside reserve boundaries:
  - Rapid and long-term increases in abundance, diversity, and productivity of marine organisms
  - Decreased mortality and habitat destruction
  - Lessened likelihood of extirpation of species
  - Increased densities, biomass, and average size of organisms
  - Increased species diversity
- Outside reserve boundaries:
  - “Spillover effect” when protected species spread outside reserves
  - Allow larvae of species protected in reserves to spread outside reserves
  - Increased total catch and record-sized fish

We Are Still Learning

- How big do reserves need to be?
- How many reserves do there need to be?
- Where do reserves need to be placed?

- Scientists are still answering these questions.