Exploring Coral Reefs

By Aaron Khan

Image by Katrin Knogler from Pixabay

Biome Climate

- Water temperature ranges from 70°F to 86°F, required for stable coral growth.
- Water tends to be very salty, usually between 32 to 42 parts per thousand.
- Typically found in shallow, clear waters to allow photosynthesis.

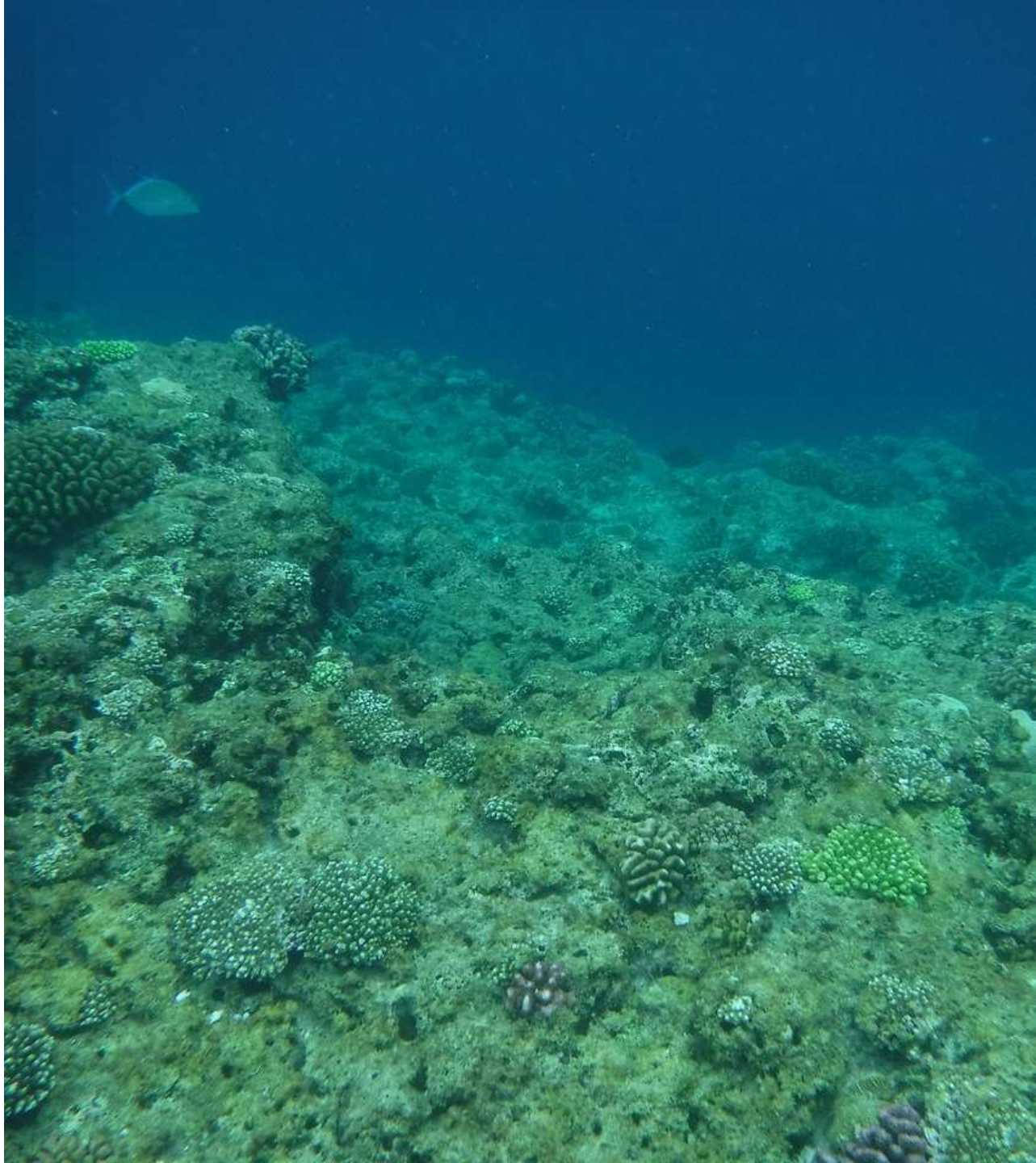
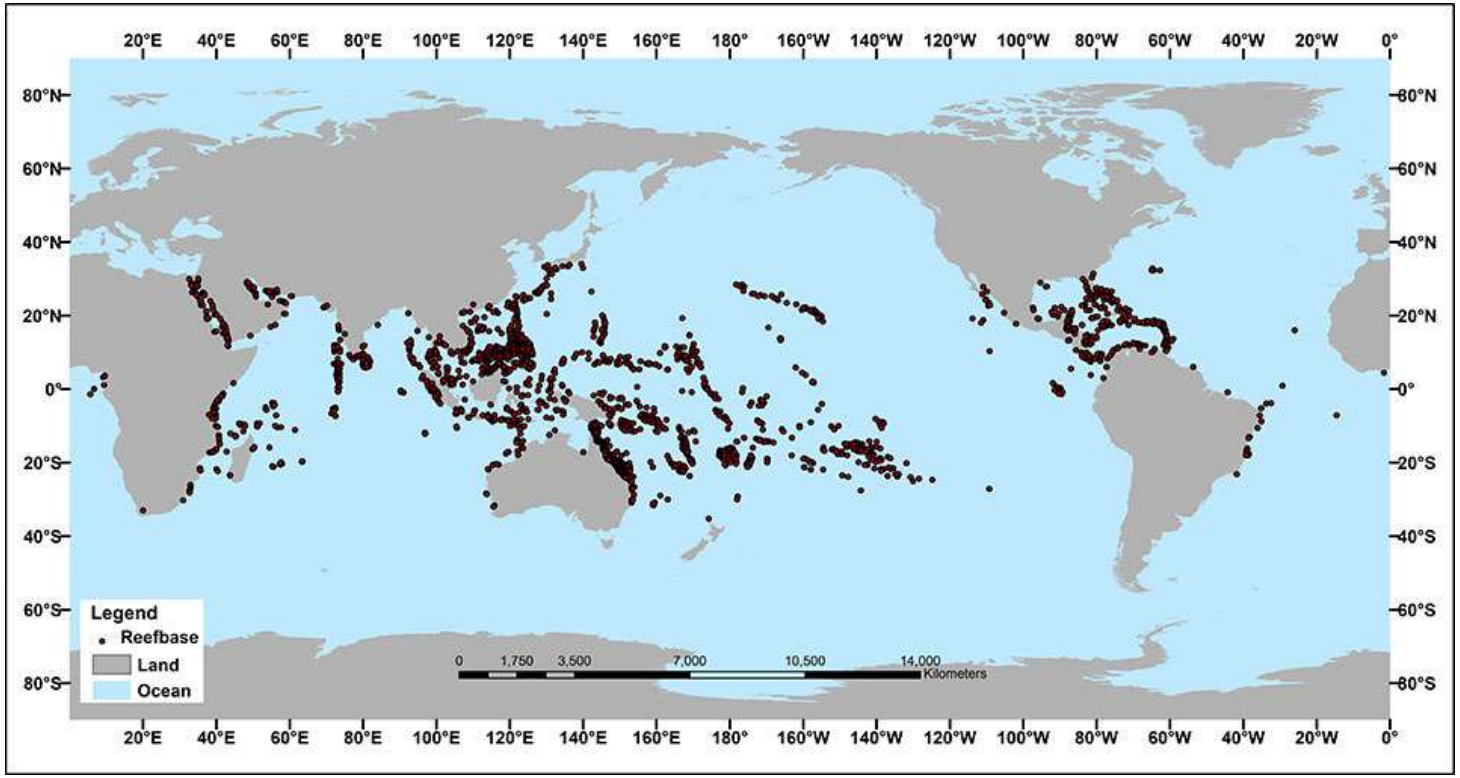


Image by konekone from Pixabay

Location

- Primarily located in tropical and subtropical waters
- Main regions are Indo-Pacific region, Coral Triangle, Indian Ocean, and the Caribbean.



NOAA. (2024). Coral reef locations around the world. In https://oceanservice.noaa.gov/facts/coralwaters.html.

Primary Producers

- Zooxanthellae, microscopic algae living within coral tissues and provides majority of the reef's energy.
- Seagrasses, flowering plants like Turtle Grass found in sandy areas between patches.
- Phytoplankton, microscopic organisms floating in the water column that form the base of the open-water food web.

Photo by Benjamin L. Jones on Unsplash.

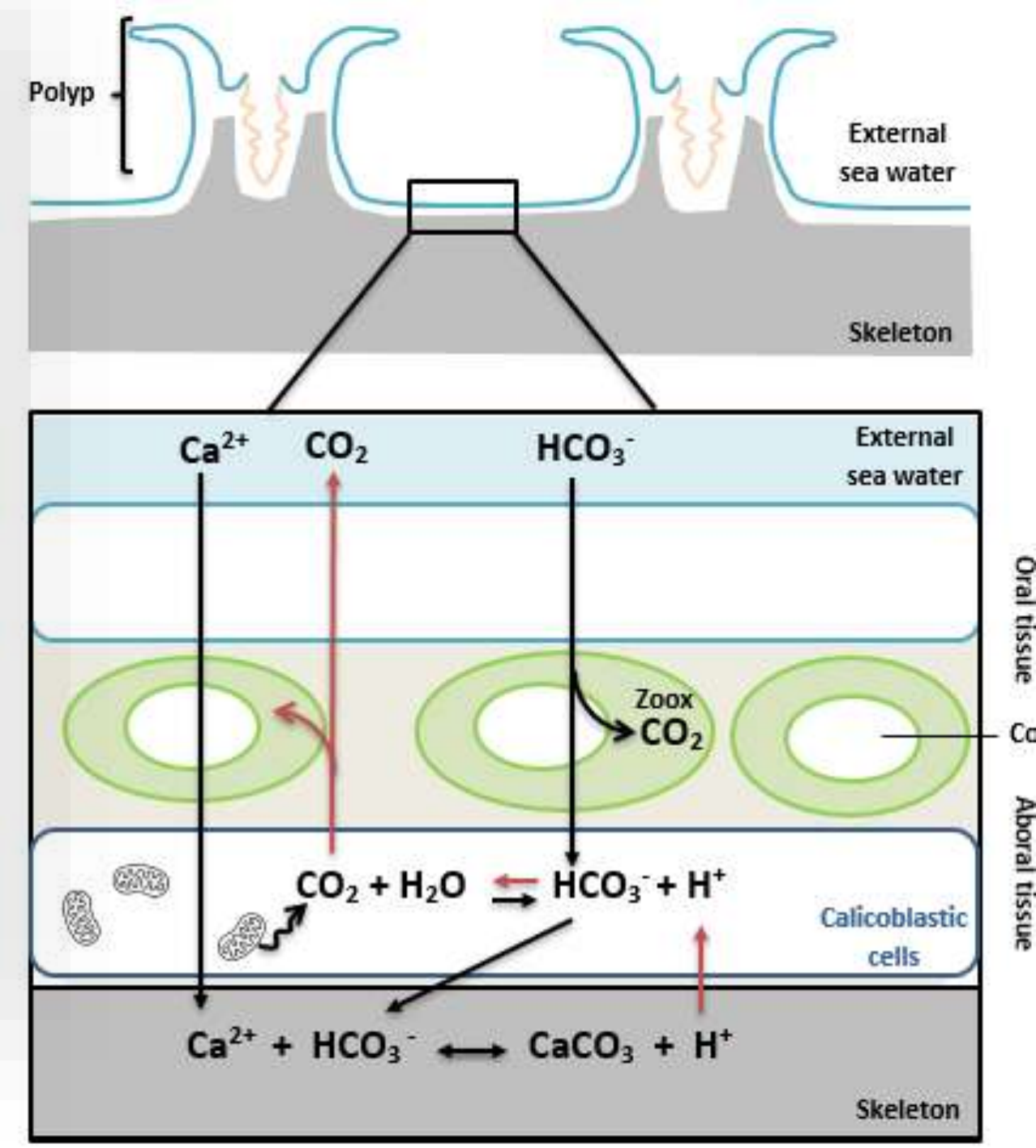
Biodiversity

- Home to over 4,000 species of fish.
- The 3D architecture of the reef creates niches for thousands of invertebrates, sponges, and marine mammals.
- Often called the "rainforest of the sea“ from the diversity of life found in a relatively nutrient-poor environment.

National Oceanic and Atmospheric Administration. (2026, February 11). Coral reef ecosystems. https://www.noaa.gov/education/resource-collections/marine-life/coral-reef-ecosystems

Nutrient Cycling

- Corals recycle waste products like CO2 and ammonia to their symbiotic zooxanthellae, which provide oxygen and glucose in return.
- Nitrogen and phosphorus tend to be limited as they get rapidly cycled through the biomass of fish and invertebrates rather than staying in the water column.

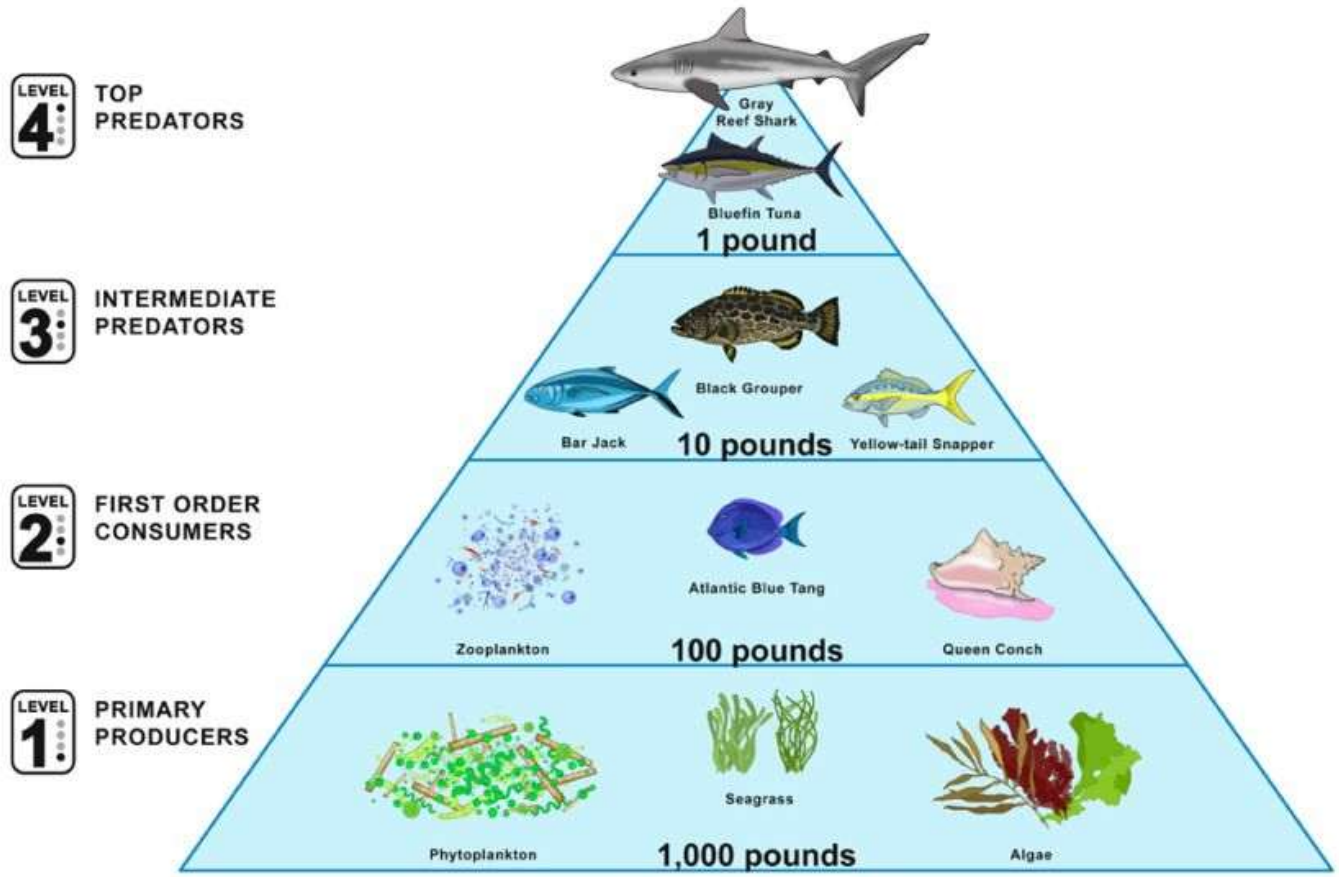


Ecosystem Services

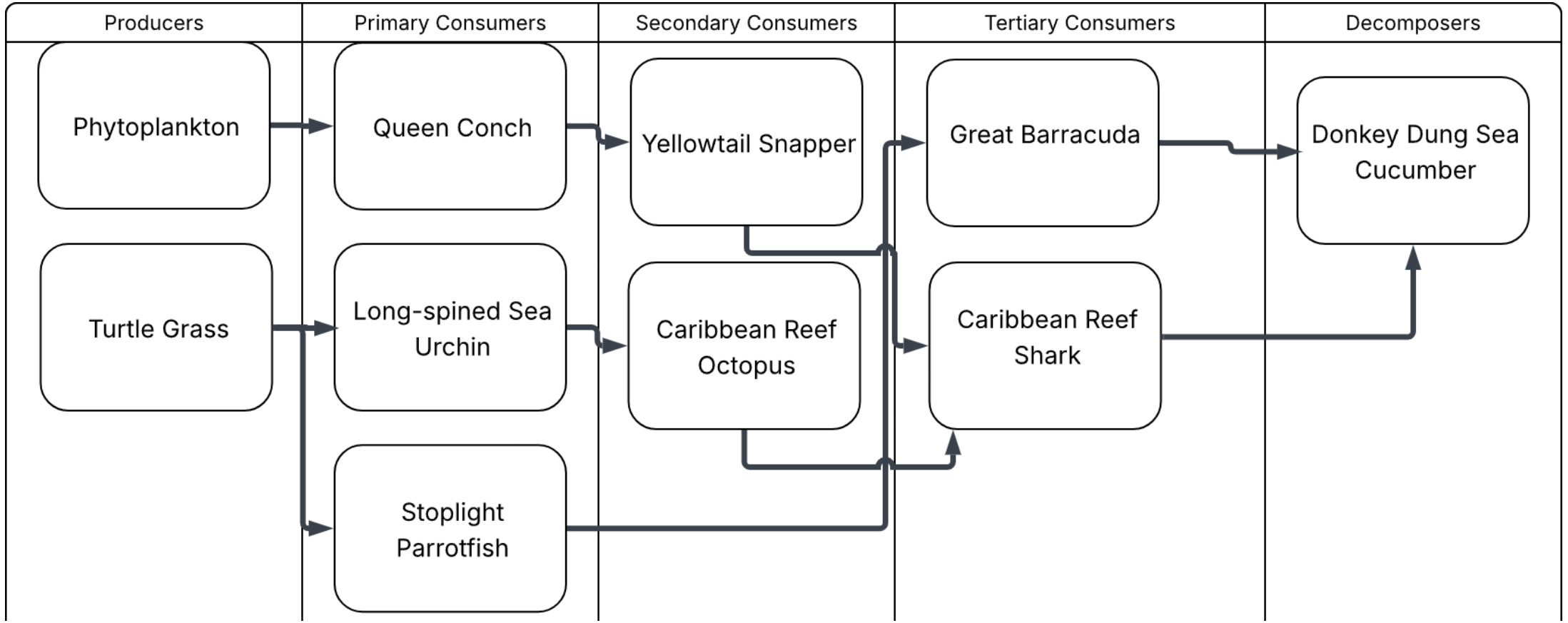
- Coral reefs act as a natural barrier that dissipates wave energy, reduces storm impacts, and protects against coastal erosion.
- Support fisheries that provide nutrients for millions of people.
- A major source of revenue for coastal cities is diving, snorkeling, and recreational fishing.

Energy Flow

- The flow starts with the sunlight captured by photosynthetic organisms such as zooxanthellae, calcareous algae, phytoplankton, and marine plants.
- The transfer of energy is very efficient with significant contributions from both reef based and open ocean sources.



Florida Keys Reef Tract Food Web



Keystone Species: Parrotfish

- They graze on macroalgae that would overgrow and cover coral colonies if left unchecked.
- They create new space for new corals by grinding the dead corals and turning it into sand.

Photo by Anastasia on Unsplash

Type of Strategist

- The Caribbean Reef Shark is a K-strategist, characterized by a low offspring count, a long lifespan, and a significant investment of energy into survival.
- The Great Barracuda, like the Caribbean Reef Shark, is a K-strategist, a long-lived predator that matures more slowly compared to its prey.
- The Queen Conch is also a K-strategist because of its heavy shell, and it takes years to reach reproductive age.
- The Long-spined Sea Urchin is a R-strategist due to its high reproductive rate of releasing millions of eggs into the water.
- The Phytoplankton are also an R-strategist because of how quickly they reproduce fast and massive numbers in response to nutrient spikes.

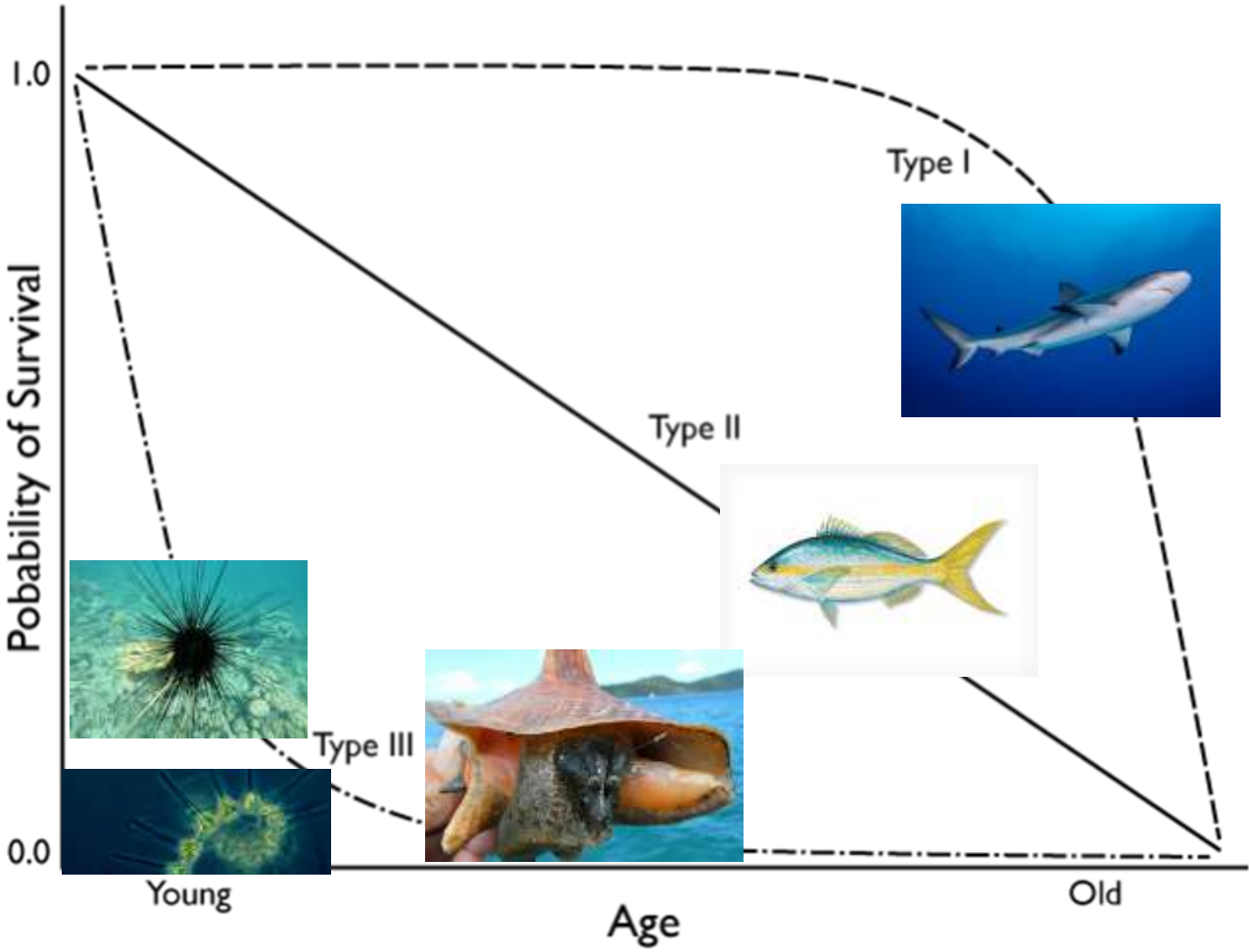
Survivorship Curve

Type I: Reef Shark is a Type I as most survive to old age like humans do.

Type II: Yellowtail Snapper has a constant death rate and can be eaten by a bigger fish at any stage.

Type III:

- Most Sea Urchins die as larvae with very few reaching adulthood. If they get a hard shell and find a crevice, survival rates skyrocket.
- The Phytoplankton have a massive mortality rate in the start of its life cycle.
- The Queen Conch have a high mortality rate while still being a larvae before being able to develop a hard shell.

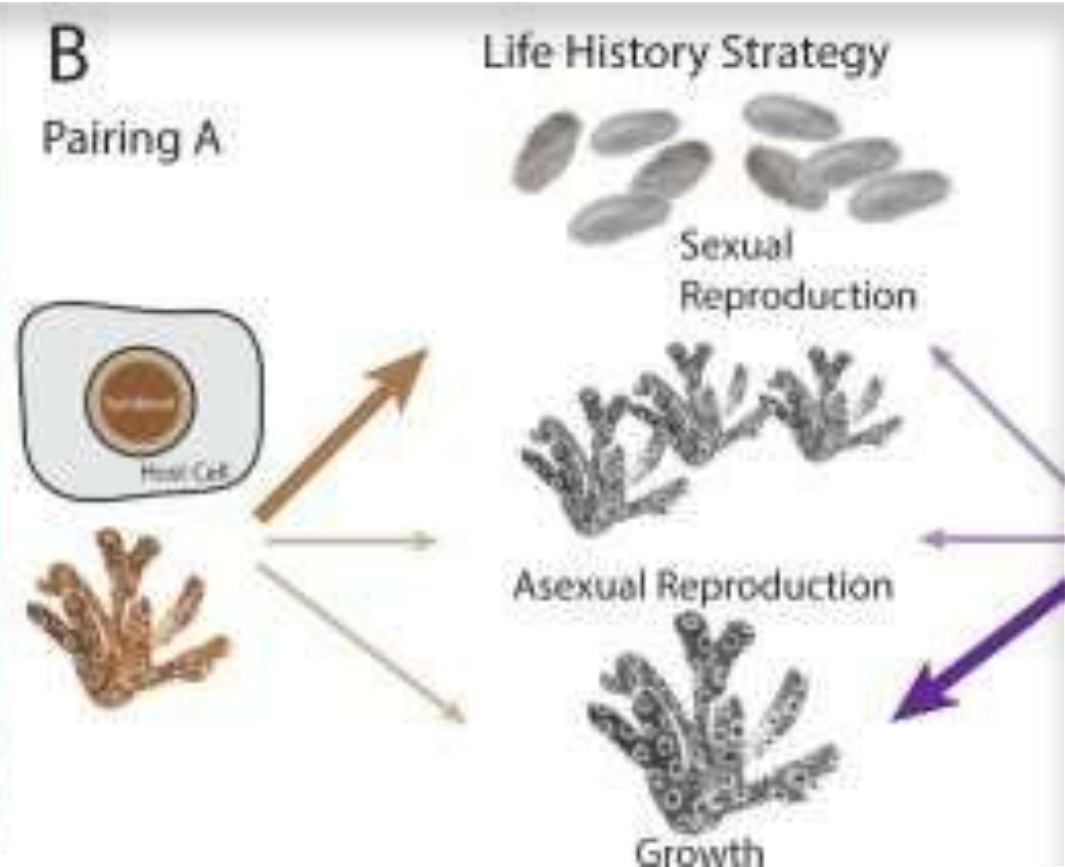


Adaptations

- Algae Adaptations
  - Halimeda algae incorporates calcium carbonate in its tissues, making them crunchy and unappetizing to most herbivores.
- Animal Adaptations
  - The Caribbean Reef Octopus have special skin cells called chromatophores, iridophores, and papillae to change their color, texture, and reflect light for camouflage or communication.
- Coral Adaptations
  - Many corals have stinging cells called nematocysts to capture plankton and defend against predators.

Symbiosis: Mutualism

- Coral and Zooxanthellae
  - The corals gives algae protection and necessities needed for photosynthesis.
- Algae's Aid
  - The zooxanthellae provide the coral with oxygen and organic products of photosynthesis.
- The benefit
  - This relationship allows coral reefs thrive in environments where nutrients are scarce.



Negative Impacts of Human Activities: Ocean Acidification

- Increased CO2 absorption from the atmosphere reduces the ability for the corals to build calcium carbonate skeletons.
- When water gets too hot, corals get stressed and kick out their zooxanthellae turning white and eventually starving.
- Example: Diver inspecting Elkhorn corals.

Negative Impacts of Human Activities: Overfishing

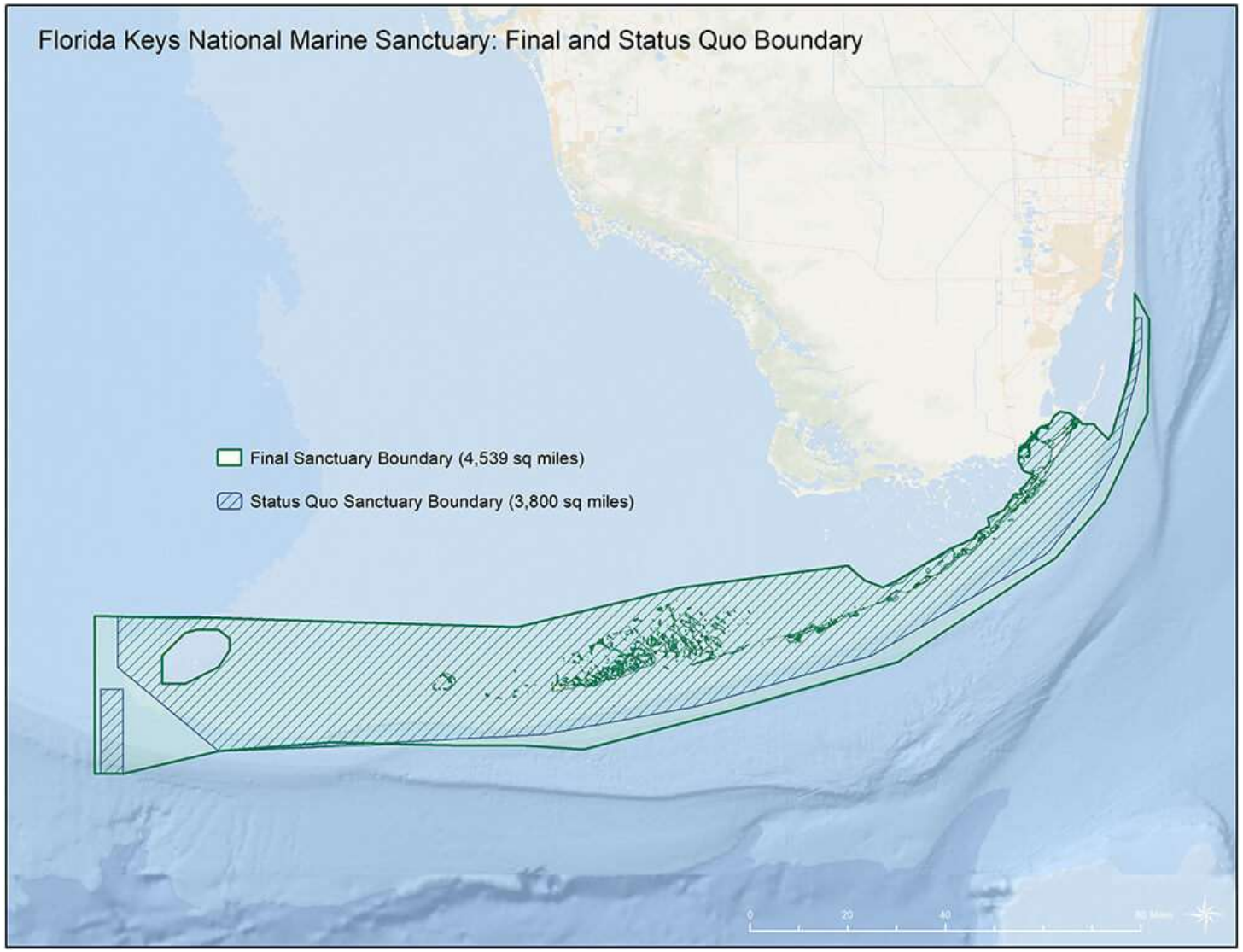
- Increased demand for seafood removes fish faster than they can reproduce. This allows macroalgae to grow without restriction, which covers living coral and prevents new larvae from settling.
- Example: In many parts of the world like the Florida Keys, the decline of grazing fish has led to "phase shifts" where reefs become dominated by algae instead of coral.

Negative Impacts of Human Activities: Land-based Pollution

- Runoffs from land like agriculture and failing septic systems carry fertilizers, pesticides, and untreated wastewater into the ocean. These excess nutrients trigger "eutrophication,“ a harmful algal bloom that blocks sunlight and promotes the spread of coral diseases.
- Example: Nutrient runoff from the Florida Everglades and agricultural areas has historically contributed to water quality degradation and disease outbreaks in the Florida Keys Reef Tract

Policies that Affect the Ecosystem: Florida Keys National Marine Sanctuary

- This policy protects about 4,500 miles of waters by regulating activities like anchoring, mining, or any activity that would alter the seafloor.
- It has reduced direct physical damage to corals using mooring buoys and restricted zones although accidents like boat grounds still occur frequently and difficult to enforce because of the large area.



Policies that Affect the Ecosystem: The Coral Reef Conservation Act

- A national U.S. policy established legal framework and funding for NOAA to map, monitor, and restore coral reef ecosystems. The act led to the creation of the U.S. Coral Reef Task Force, which coordinates federal and state conservation efforts.

Policies that Affect the Ecosystem: CITES (International Trade)

- Convention on International Trade in Endangered Species (CITES) is an international agreement on regulating the export of reef species like corals and queen conch.
- The agreement helps to prevent over-exploitation of reef organisms for the global aquarium and souvenir markets. Unfortunately illegal trade persists and difficult track in global supply chains.

Positive Impacts of Human Activities: Coral Nurseries and Transplanting

- Scientists grow endangered corals like Staghorn in underwater nurseries and then move them into degraded reefs. This helps increase diversity in the reef and recover faster than it would naturally.
- Example: Divers tending to small corals in a nursery and to be replanted or studied on resiliency.

Positive Impacts of Human Activities: Marine Protected Areas

- Designating no-take zones where fishing, shell collecting, and resource extraction is prohibited. These zones allow fish to reproduce to sufficient population, when there is a spillover, the fish are moved from protected areas to open waters
- Example: The Western Sambos Ecological Reserve has seen a marked increase in the size and abundance of spiny lobsters since its protection.

Positive Impacts of Human Activities: Everglades Restoration

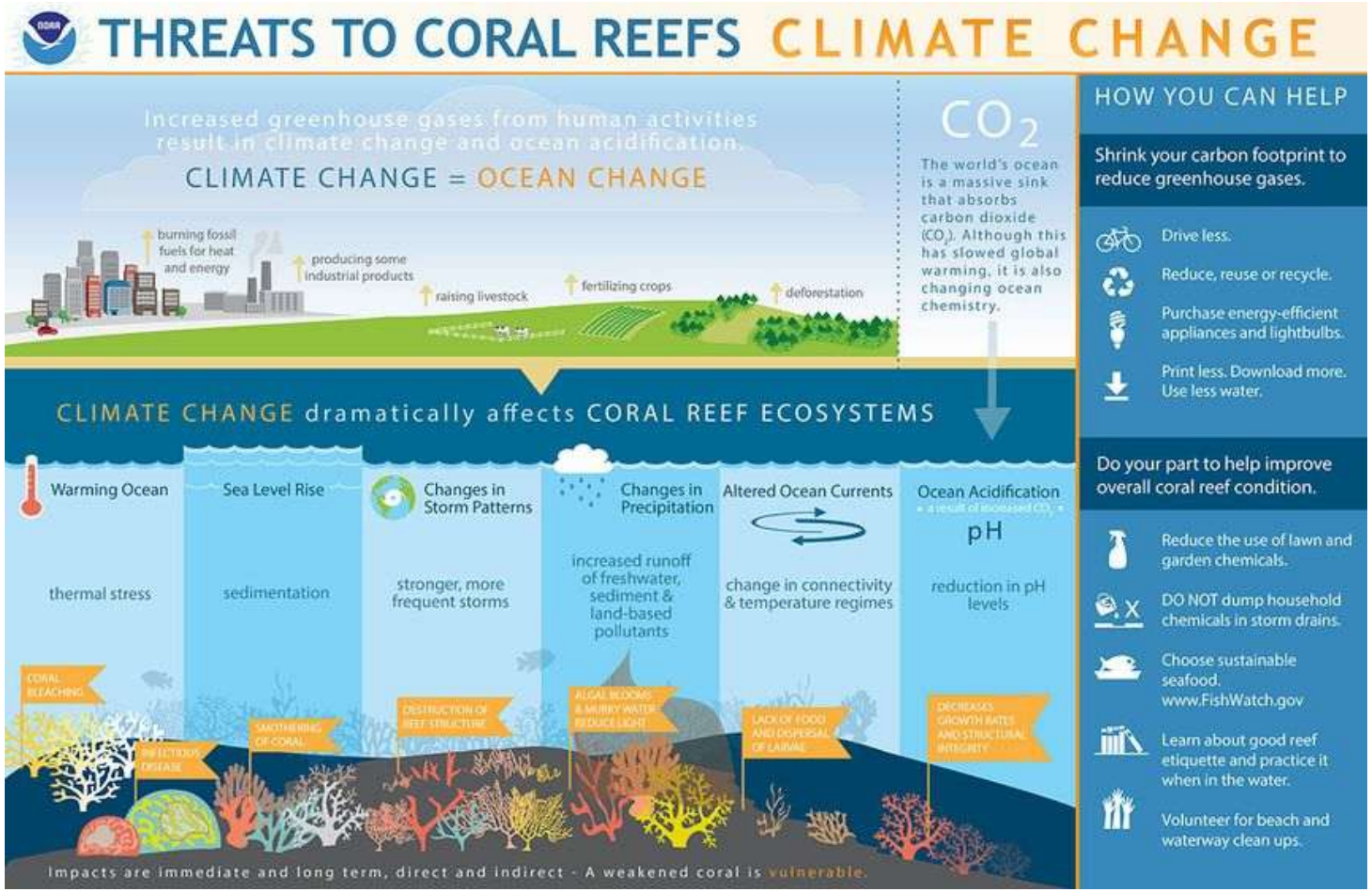
- Comprehensive Everglades Restoration Plan (CERP) aims to restore natural freshwater flow from the Everglades into Florida Bay.
- Improving the waterflow stabilizes salinity levels in the Florida reef tract, critical for coral health and seagrass survival.
- Example: Rebuilding bridges on the Tamiami Trail allowed more natural water flow to move south toward the Florida Keys.

How to Help the Ecosystem: Choose Reef-Safe Products

- Purchasing reef-safe products will prevent toxic chemicals from entering the water that could bleach corals and damage DNA.
- Use mineral-based sunscreens that use Zinc Oxide or Titanium Dioxide.

How to Help the Ecosystem: Reduce Carbon Footprint

- Reducing carbon emissions can reduce bleaching and slow acidification to allow corals to build their skeletons.
- Using energy-efficient appliances, support renewable energy, keep the single use of plastics to a minimum are ways to reefs healthy.



How to Help the Ecosystem: Citizen Science and Advocacy

- Researchers can put pressure on governments with the amounts of data they collect to prioritize environmental legislation,
- Be part of the community, join local reef cleanups, report coral sightings, and vote for policies that protect water quality.

Conclusion

- Coral Reefs is a high-biodiversity ecosystem that is essential for places like Florida’s economy, protecting the coast, and the marine life.
- Although human activities like overfishing and pollution do pose a threat, active restoration and strong polices offers a way for survival.
- Reefs like the Florida Reef Tract depends on large-scale policy changes and daily actions from everyone to reduce environmental stress.