15

Coral Reef Communities

Coral Reef

Animal, vegetable or mineral?

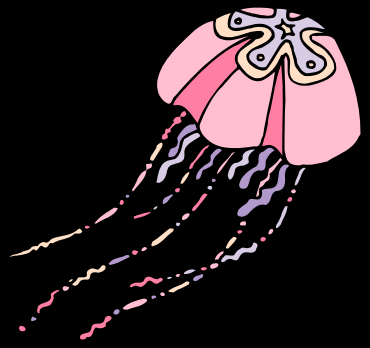
Illustration by Geoff Kelley in JEN Veron (2000) *Corals of the World*, AIMS, Townsville

It's an animal which may live with a plant and makes a mineral-based skeleton.

Coral Reef Video

Coral Structure

- Individual animals are called polyps
- Several polyps make up a colony
- Corals are closely related to jellyfish and sea anemones—they all contain stinging cells called nematocysts.



Coral Reef Communities

- High biodiversity, "Tropical rain forest in the sea"
- Up to 500 spp. at same sites.

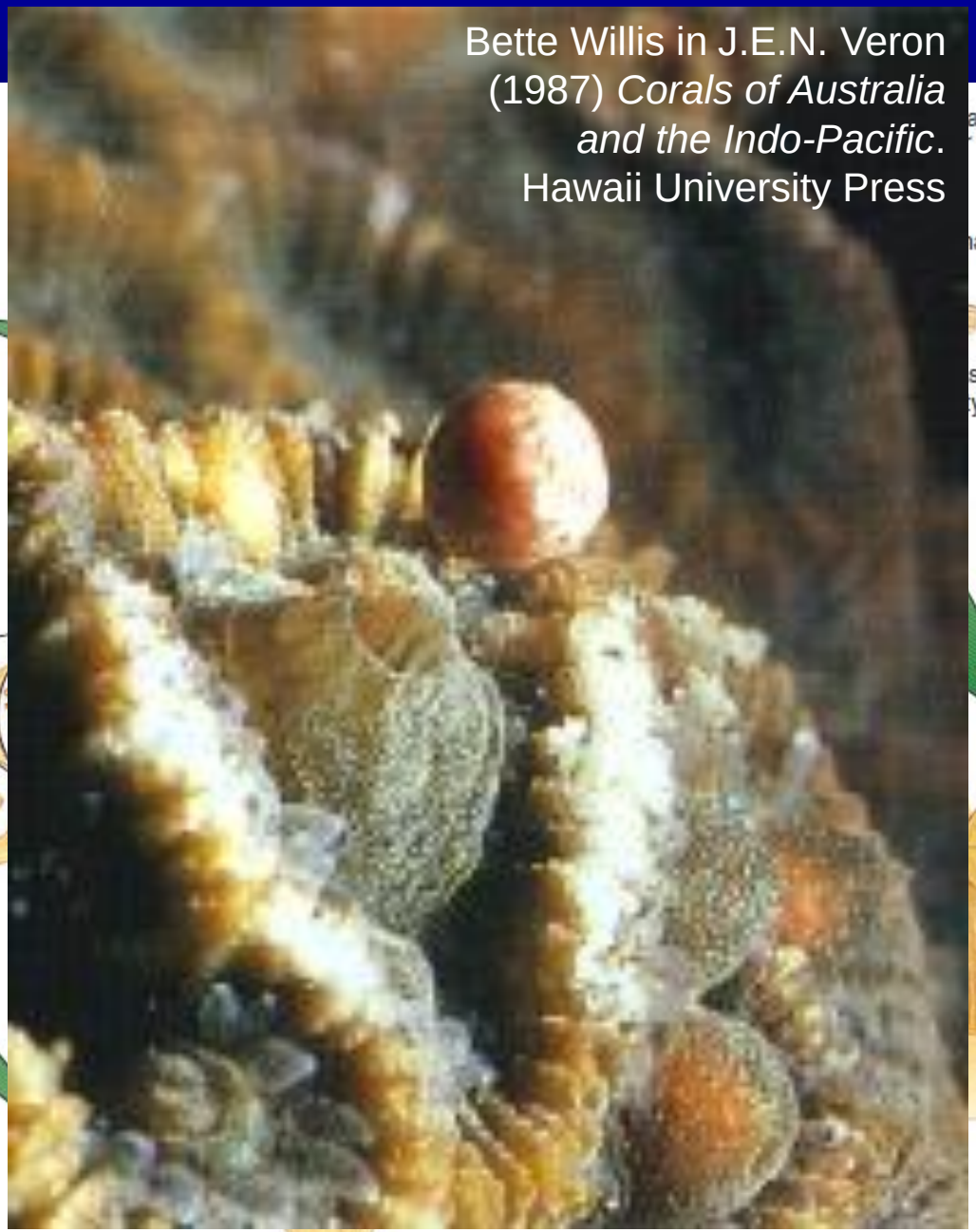
Coral Reef Distribution

Organisms That Build Coral Reefs

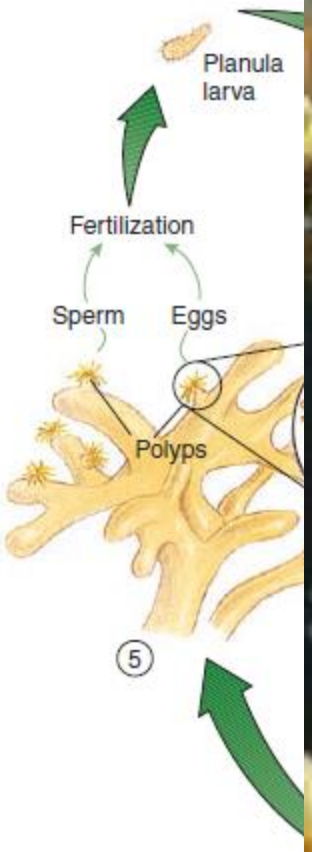
Zooxanthellae are dinoflagellate symbionts in the tissues of many marine organisms, including corals, jellyfish, and molluscs. In addition to shelter, the host provides carbon dioxide and other waste products that can be used in photosynthesis. The host gains significant amounts of energy from its symbiont..

Scleractinian corals are members of the phylum Cnidaria, class Anthozoa, order Scleractinia. They are exclusively polyps and lay down a hard skeleton.

GLOSSARY



Bette Willis in J.E.N. Veron (1987) *Corals of Australia and the Indo-Pacific*. Hawaii University Press



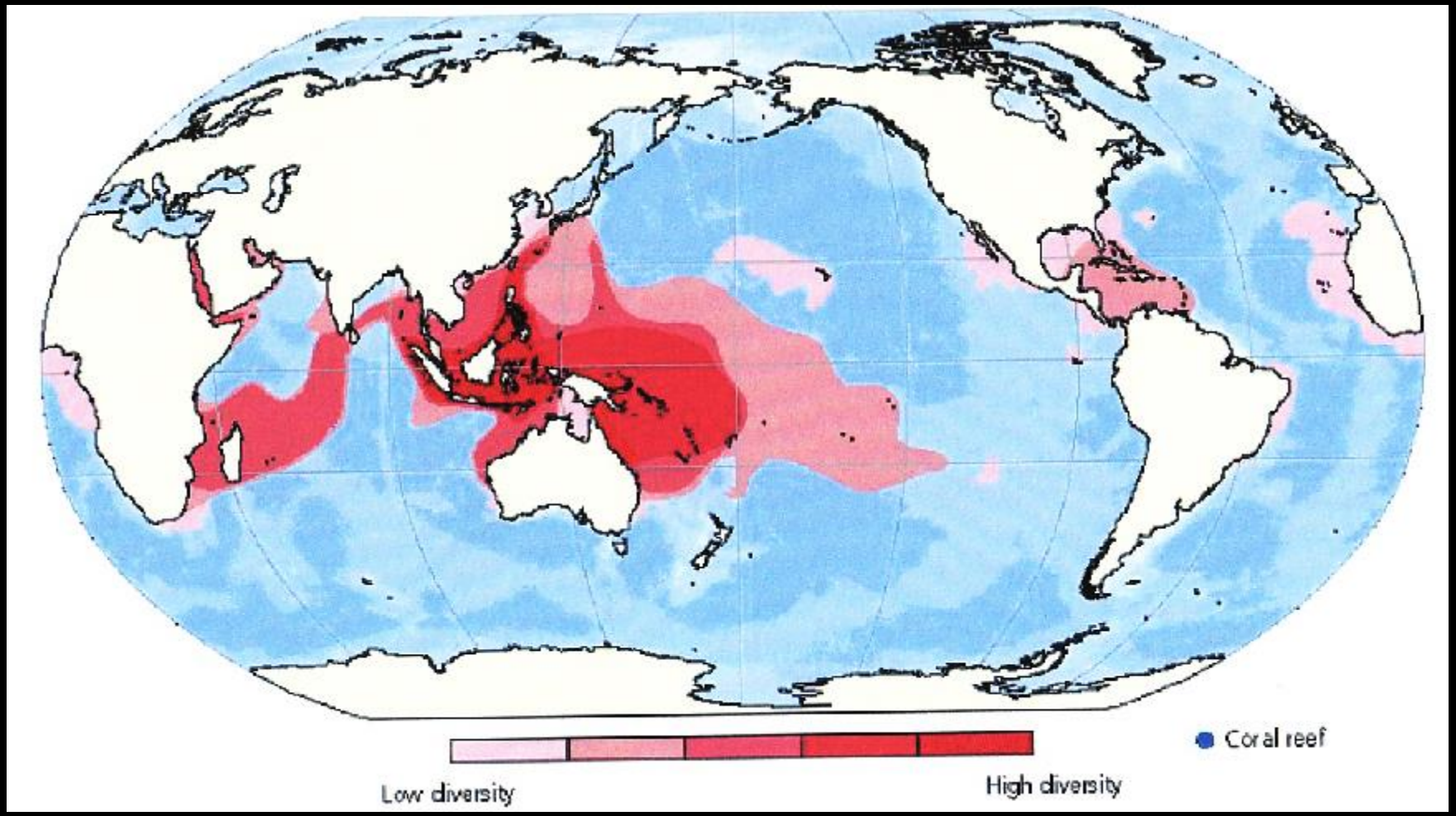
Coral Reef Spawning

Building the Reef

$CaCo_3$ addition - $CaCo_3$ loss = Accumulation

- Physical environment
  - Temperature of 25-31°C (limited Northwards by the 18°C minimum isotherm)
  - Salinity of 34-37 ppt
  - Light level
    - Predominantly in top 30 m of water
- Biological environment
  - Oligotrophic, highly stratified water column

Biodiversity Patterns



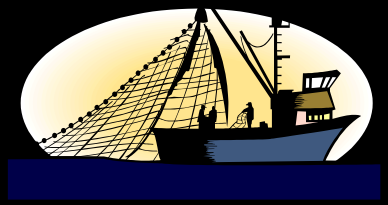
Coral Reef Ecology

- The net annual primary productivity on coral reefs is estimated to be 2,500 grams of carbon per square meter, a value comparable to tropical rainforests. The annual primary productivity of tropical oceans, in contrast, is estimated to be less than 50 grams of carbon per square meter.

- Reef photosynthetic organisms include the zooxanthellae of the corals and other organisms, benthic algae, turf algae, and algae, phytoplankton, and seagrasses.

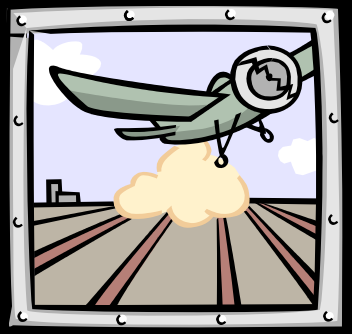
Status of Coral Reefs

- Globally, coral reefs are generally in decline
- Increasing human population (especially in coastal areas) increases the impacts on coral reefs



Threats to Coral Reef Systems

- Overpopulation
- Unsustainable fisheries
- Coastal development
- Sedimentation
- Nutrient enrichment
- Global climate change

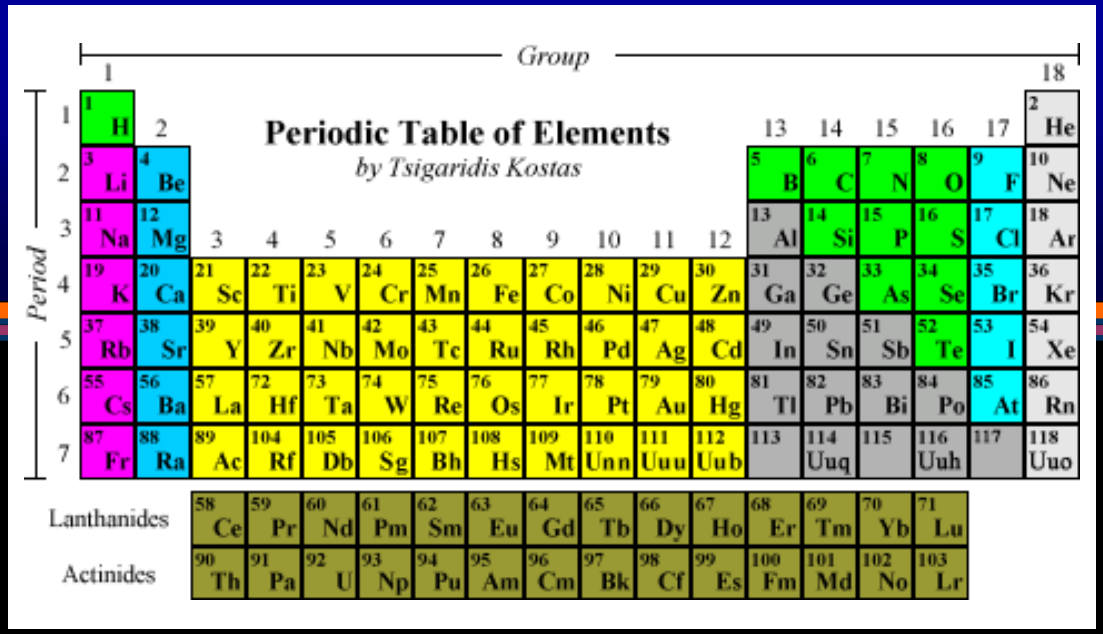


Overfishing

- Changes trophic structure
- Many large predators are no longer present
- Grazing fish species are being collected as food fish
- May allow algal overgrowth of corals

Nutrient Enrichment

- Nutrients are elements needed for growth
- If there are not enough of certain types of nutrients, they are said to be limiting nutrients
- Most common limiting nutrients in the marine environment are N and P



Nitrogen

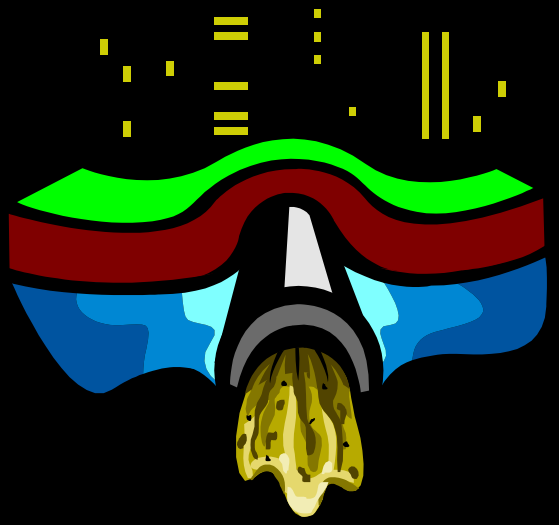
Available in water as nitrate, nitrite, ammonium or organic nitrogen (e.g. urea, plant or animal tissues)

Phosphorus

Available in water as dissolved inorganic phosphate or organic phosphorus (dissolved or particulate)

How does nutrient enrichment occur?

- Septic tanks/sewage
  - Leaks
  - Pumping into the ocean
- Fertilizer runoff
  - Agricultural
  - Homeowners
  - Golf courses



Coral Reef Ecology

- The ratio of gross primary production (P) to community respiration (R), called the P-R ratio, is sometimes used as a measure of the state of development of a biological community.
- P/R=1

Gross primary production (P) is the total production of organic compounds from carbon dioxide through the process of photosynthesis or chemosynthesis.

Community respiration (R) is the total energy acquired from organic compounds that is used by all members of the community for their metabolism.

GLOSSARY

Effects of increasing nutrients

- Cause increase in plant (algae) growth
  - Macroalgae
  - Microalgae (phytoplankton)

HAB's/Red tides

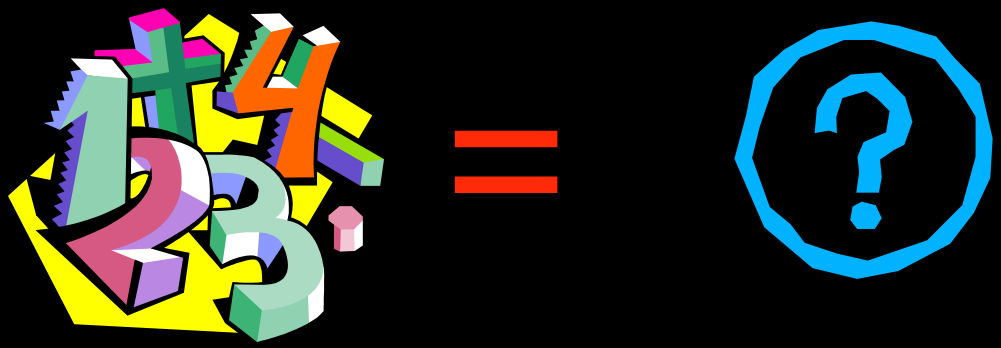
- Blooms of "harmful algae"
  - Pfisteria
  - Cause human health problems
  - Cause fish kills
  - May be killing dolphins, manatees

Effects of increased nutrients on corals

- Cause decrease in coral growth
  - Direct chemical interference with skeleton formation
  - Result of overshading by algae
- If zooxanthellae help corals calcify, then
  corals, which contain more zooxanthella
  - Zooxanthellae are N-limited
  - "Excess" photosynthate is given to co
  - If zooxanthellae grow, there is less ph e
    to the corals

But….

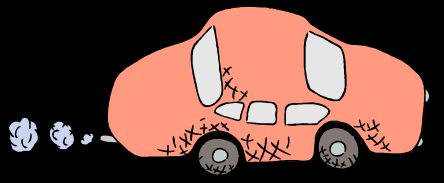
- There are more zooxanthellae per cm² of coral, so the animal receives the same amount of carbon…



- Is the type of carbon compound different in enriched and control corals?

Chemicals/oil

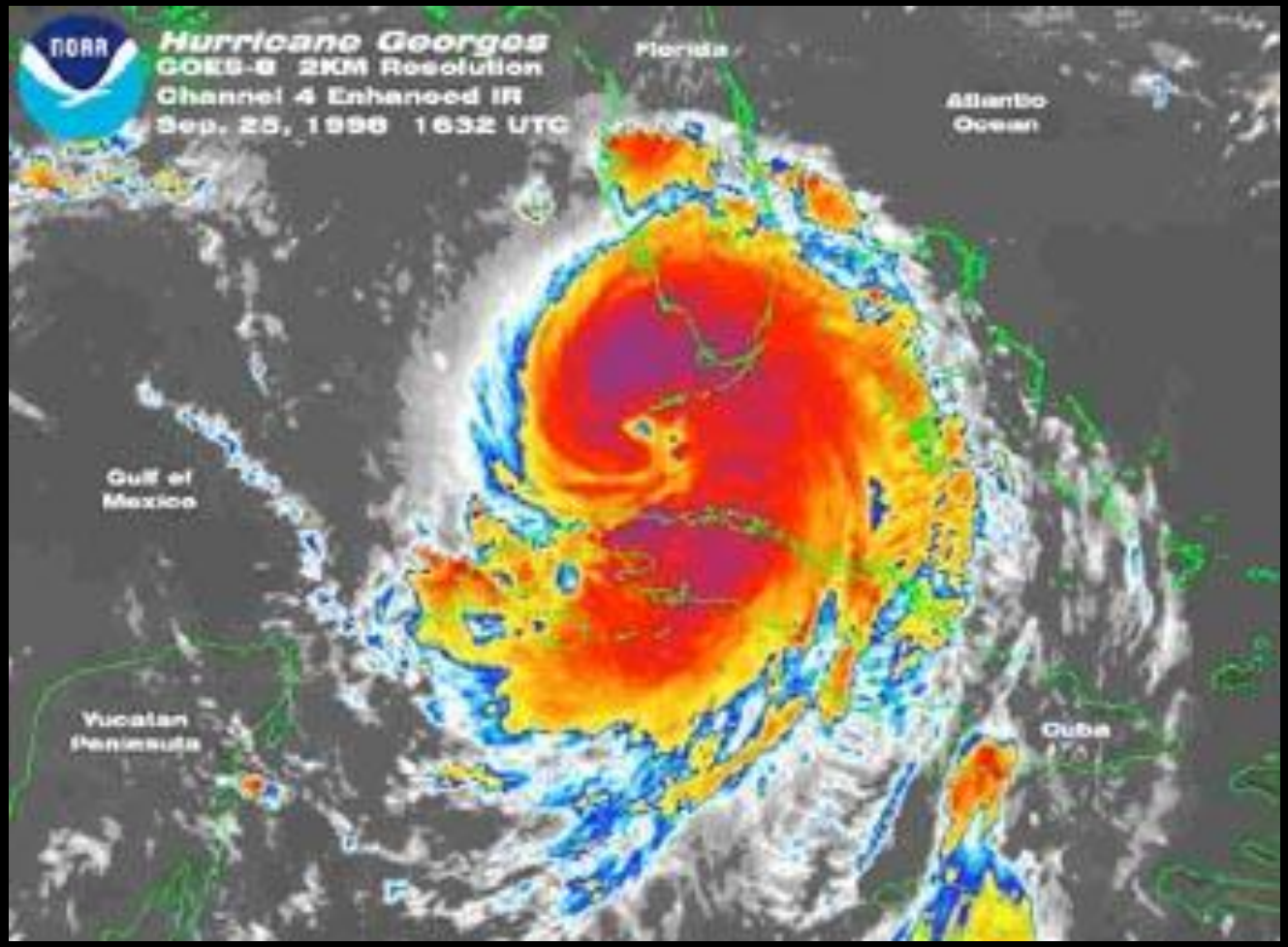
- Non point-source pollution
  - **51% of the oil entering the oceans is from runoff**
  - 5% is from big spills
  - 19% is from routine maintenance
  - 2% is from offshore drilling
  - 13% is from burning fuels (e.g. car exhaust)
  - 10% is from natural seeps



Physical damage

- Fishing techniques in the South Pacific include dynamiting or poisoning reefs to collect aquarium fish for export
- Boat anchors and boat/ship groundings cause damage that can take thousands of years to re-grow

Natural impacts



Marine debris

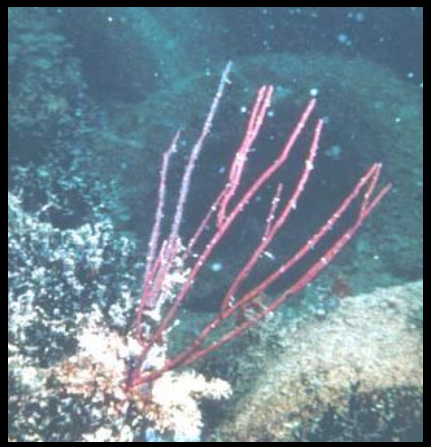
- Suffocation risk
  - Balloons/bags
- Entanglement/entrapment
  - Fishing line/ropes
  - Old nets
  - Abandoned traps/pots

What can you do?

- Reduce, reuse, recycle
  - Motor oil
  - Fishing line
- Read and follow instructions on chemicals including fertilizers
- Fix automotive leaks

What does the future hold?

The answer is up to you…



Key Concepts

- Coral reefs are primarily found in tropical clear water, usually at depths of 60 meters or less.
- Corals obtain up to 90% of their energy from zooxanthellae, symbiotic dinoflagellates that use coral wastes, produce carbohydrates, and aid in calcium carbonate deposition.
- The most important primary producers on coral reefs are symbiotic zooxanthellae and turf algae.
- Coral reefs are oases of high productivity in nutrient-poor tropical seas. Nutrients are stored in reef biomass and efficiently recycled.

Further Reading

- Yates, K. K., and R. B. Halley. 2006. CO_3^{2-} Concentration and pCO2 Thresholds for Calcification and Dissolution on the Molokai Reef Flat, Hawaii. *Biogeosciences* 3:357–369.
- Guest, J. 2008. Ecology. How Reefs Respond to Mass Coral Spawning, Science 320(5876):621–623.
- Hoegh-Guldberg, O., P. J. Mumby, A. J. Hooten, R. S. Steneck,P. Greenfi eld, E. Gomez, et al. 2007. Coral Reefs under Rapid Climate Change and Ocean Acidification [Review].Science 318(5857):1737–1742.