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# Coastal & Marine Environment

# Coral Reef Environment

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# Contents

- What is coral reef?
- Its Importance
- Threats
- Artificial reef

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Invertebrate: اللافقاريات
Solitary: الانفرادي
Anemones: شقائق النعمان
Cnidarians: الكائنات المجوفة

# What is coral?


Sun Coral Polyps

- It's a living organism!
- It is an invertebrate,
- Coral reefs are the largest structures built by a living organism,
- The organisms that build coral reefs are adapted to intertidal conditions as well as life on the continental shelf,
- The reefs themselves are created by the calcium carbonate that is deposited by polyps living in large colonies,
- The main structure of the reef is actually fossils of polyps that lived in the past (hermatypic),
- There are polyps in the reef that do not contribute to the structure – these are called ahermatypic corals,
- Coral is cousins to jellyfish and anemones (Cnidarians).

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# Coral Builds Reefs?

- The animal portion of the reef is called a polyp
- The polyp absorbs calcium carbonate out of the water
- The calcium carbonate is used to build the reef

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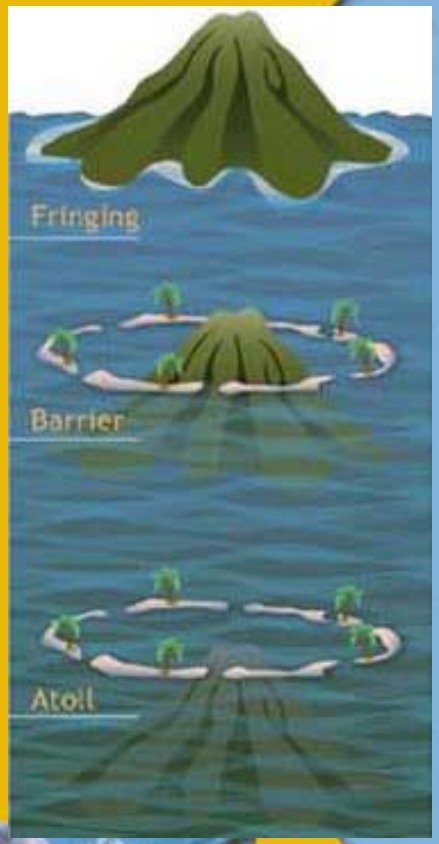


http://www.nos.noaa.gov/education/kits/corals/media/coral04a_240.jpg

# Reefs Corals Build

Corals can build three types of reefs:

- Fringing: grows close to shore
- Barrier: also grows close to shore but has a lagoon separating it from the shore
- Atoll: a ring of coral that surrounds a lagoon, often grows on a submerged mountain or volcano

# Ahermatypic Corals

Precious Coral

Soft Coral

Black Coral

Sea Whips

Sea Fans

Gorgonians

# Sea Fan

- This is a sea fan growing on a coral boulder.
- A sea fan is a type of soft coral.
- By watching the movement of the fan, you can tell the direction of the sea currents.

# Physical characteristics of coral

Fungia

Star Coral Colony

## Size

- One of the largest corals, *Fungia* (mushroom coral), is a solitary coral that can extend 25cm in diameter.
- Colonial coral polyps are much smaller and average 1-3mm in diameter.
- Coral colonies also vary in size. Some corals form only small colonies. Others may form colonies few meters high. Star coral (*Montastrea annularis*) colonies reach an average height of 3-4m.

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Pigments: أصباغ

# Physical characteristics of coral

## Color

- Natural pigments in coral tissue produce a range of colors including white, red, orange, yellow, green, blue, and purple.
- Algae that live within the tissues of some corals may make the coral appear brown, green, or orange.

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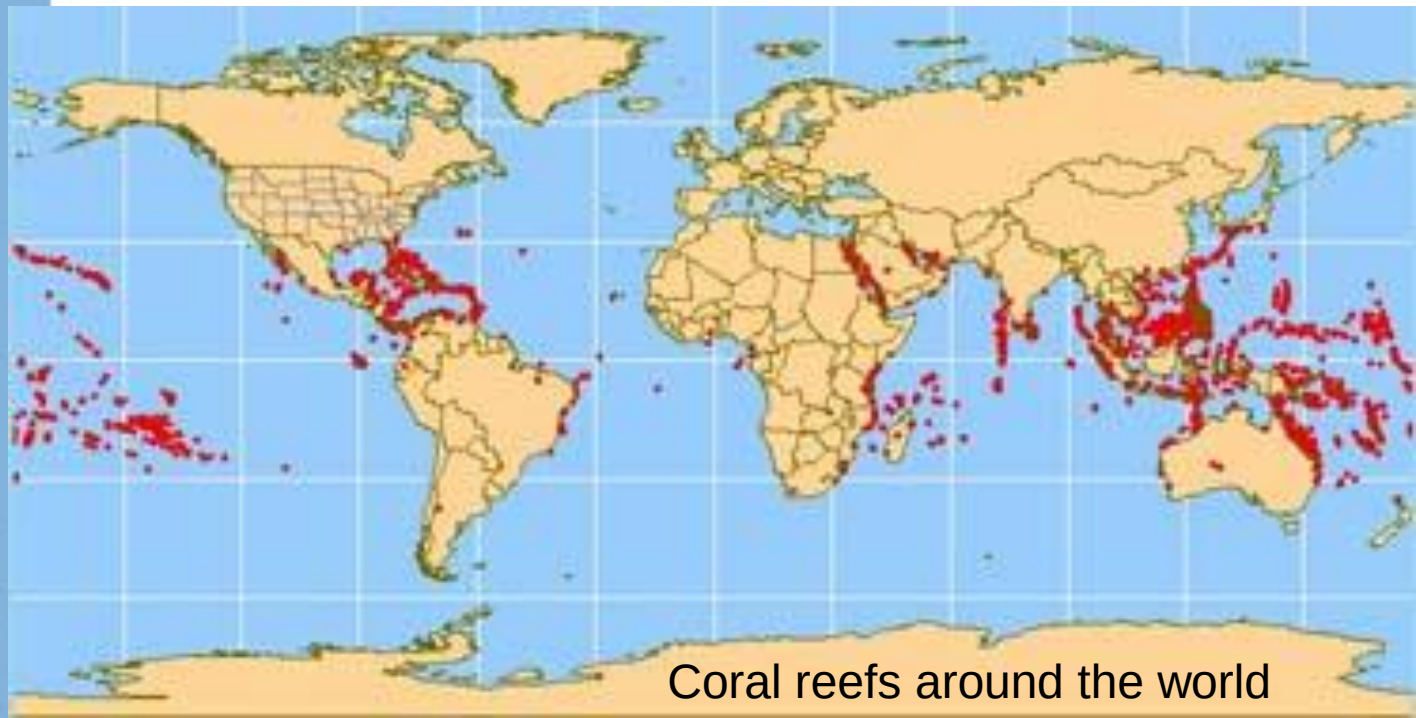
# Where can you find coral reefs?

- Coral is found all over the world:
  - Tropical
  - Temperate
  - Polar
- Only tropical corals build reefs



Coral reefs around the world

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# Importance of Coral Reefs

- 0.2% of world's oceans
- Habitat for 1/3 of marine fishes
- Habitat for tens of thousands of other animals
- The rainforests of the oceans
- Protection to coastlines
- Economic resources
- Biodiversity
- Natural beauty

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# Importance of Coral Reefs

- **Protection to coastlines:**
  - absorb energy of ocean waves
  - reduce erosion of shoreline
  - storm damage
  - flooding

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# Importance of Coral Reefs

- **Economic resources:**
  - Fisheries for food
  - Fisheries for jobs
  - Tourism
  - Building materials
  - Aquarium trade

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# Importance of Coral Reefs

- **Biodiversity:**
  - The rainforests of the sea
  - Genetic diversity
  - Pharmaceuticals

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# Importance of Coral Reefs

- **Natural beauty:**

http://sustainableseas.noaa.gov/missions/florida2/background/coralspawning.html

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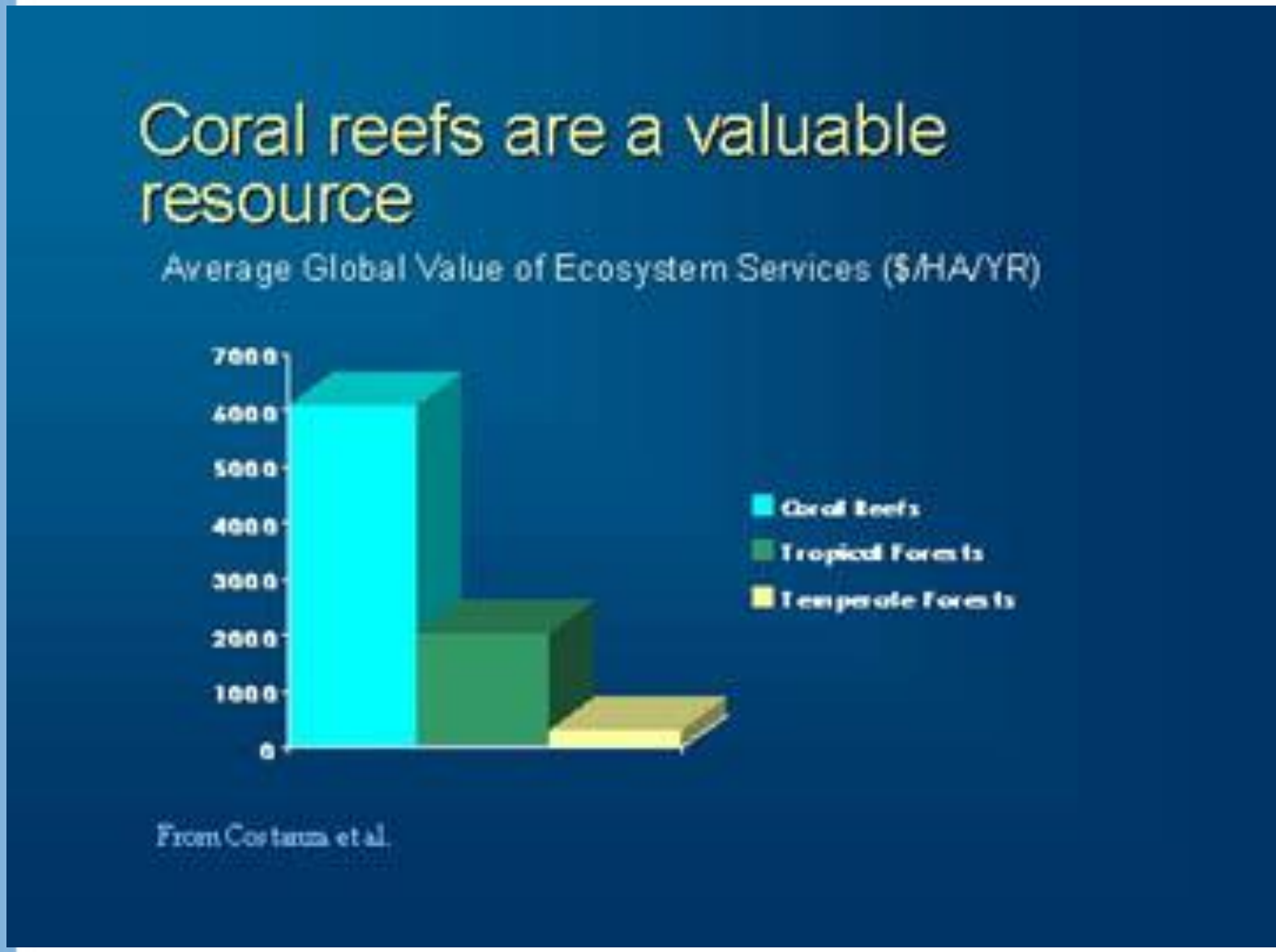
# Importance of Coral Reefs




$375 billion in environmental goods and services
Reefs at Risk 1998 (http://www.wri.org/powerpoints/reefswww/sld011.htm

# Coral Reefs –
## Support, Nurture, Protect, Provide

# Threats to coral and coral reefs


1) Natural

2) Anthropogenic of human origin

bleaching

invasive species and
starfish outbreaks

deforestation, soil erosion,
sediment & nutrient loading

overfishing

destructive fishing practices

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Smothering: الخانق


# 1. Natural disturbances that affect corals and coral reefs?

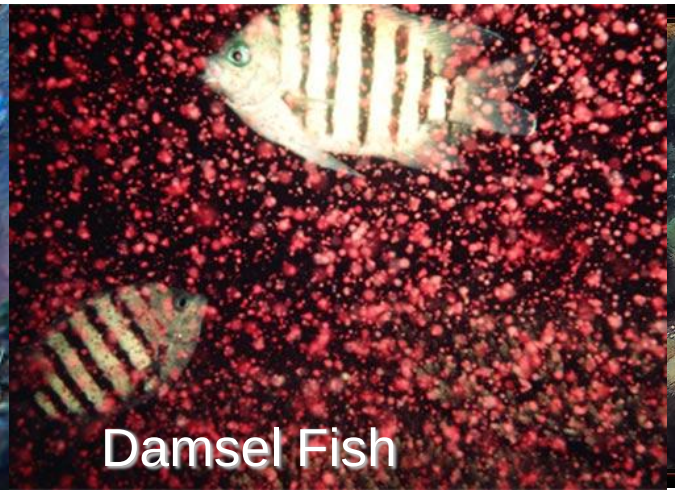
- Hurricanes: Physical damage, smothering, destruction of other ecosystems upon which coral reefs depend
- Tsunamis: Physical damage, erosion, possible disruption of reproduction and recruitment
- Volcanoes: Depends upon where volcano occurs, Heat, smothering and sedimentation
- Earthquakes: Little direct impact, Indirect impacts (triggers tsunamis, coastal landslides)
- Predators & competitors: see next slide
- Bleaching: see next slide
- Pathogens: see next slide

# Predators

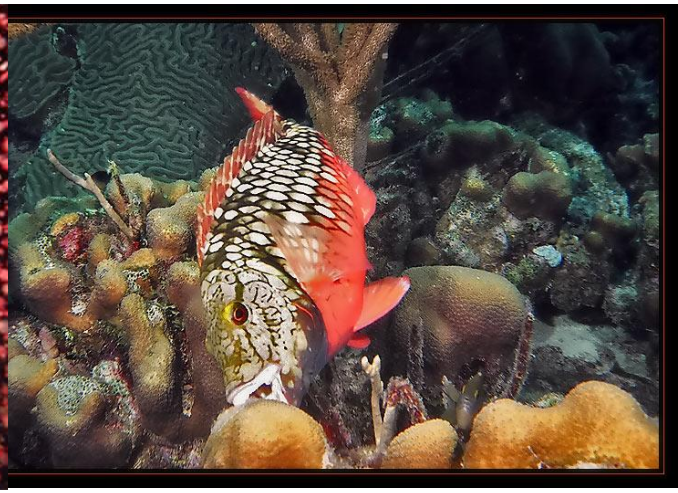
- crown of thorns starfish
- snails القواقع
- parrotfish الببغاء
- butterfly fish

Crown of Thorns Sea Star


Parrotfish



Damsel Fish



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# Cyanide fishing kills coral

Healthy

After cyanide exposure

# Competitors

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algae

Reefs are often covered with algae

Algae growth is often followed by Yellow-band disease

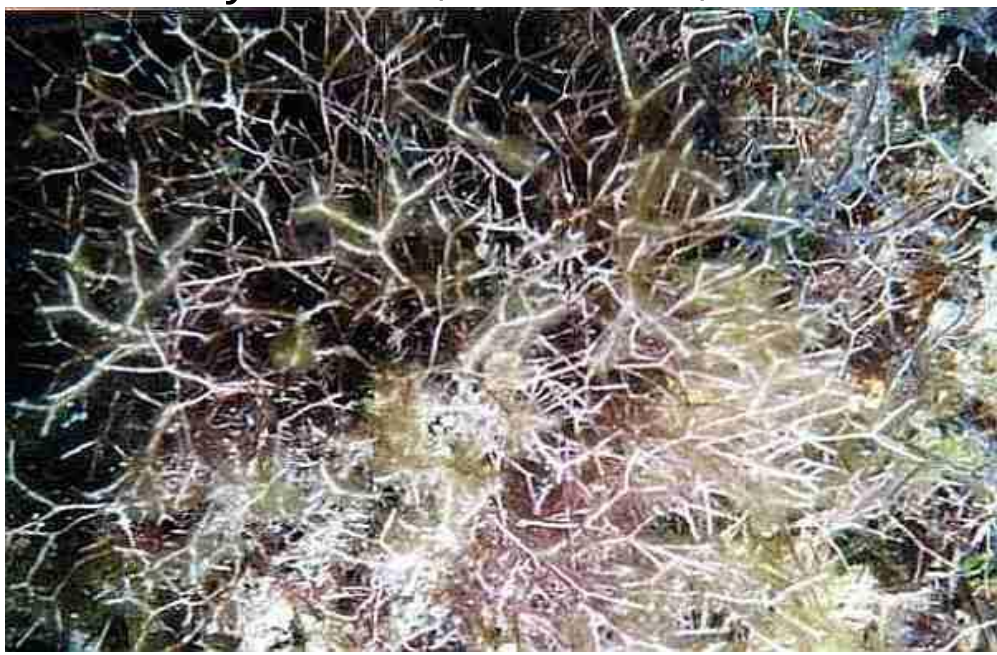
http://catbert.er.usgs.gov/african_dust/algae.html

# Competitors

It smothers and kills healthy coral

algae

Algae comes in green, brown and red
Bay Islands, Honduras, 2000



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Bleaching: تبيض

# Bleaching

- Color in coral comes from the photosynthetic symbiotic algae that live within the tissue of the coral
- Loss of zooxanthellae
- Causes:
  - higher than usual ocean temperature, algae die and are expelled and coral dies soon after. The optimal temperature for corals is a small range (24-29˚ C) and each coral species has a specific “bleaching threshold”
  - sharp changes in salinity
  - heavy UV light exposure


**Zooxanthellae** are golden-brown intracellular of various marine animals and protozoa, especially corals. Zooxanthellae provide the host with energy in the form of translocated reduced carbon compounds, such as glucose, glycerol, and amino acids, which are the products of photosynthesis. Zooxanthellae can provide up to 90% of a coral’s energy requirements.

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# Pathogens

Diseases on the rise:

- new pathogens
- land pathogens (*Aspergillus*)
- occurring at all depths
- More susceptible when stressed

http://ourworld.compuserve.com/homepages/mccarty_and_peters/coral/Bbd.htm

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Anthropogenic:الصنعية

# 2. **Anthropogenic** threats to coral reefs

- Overfishing
- Development
- Mining and dredging
- Recreation

# Overfishing

## Ecological imbalance

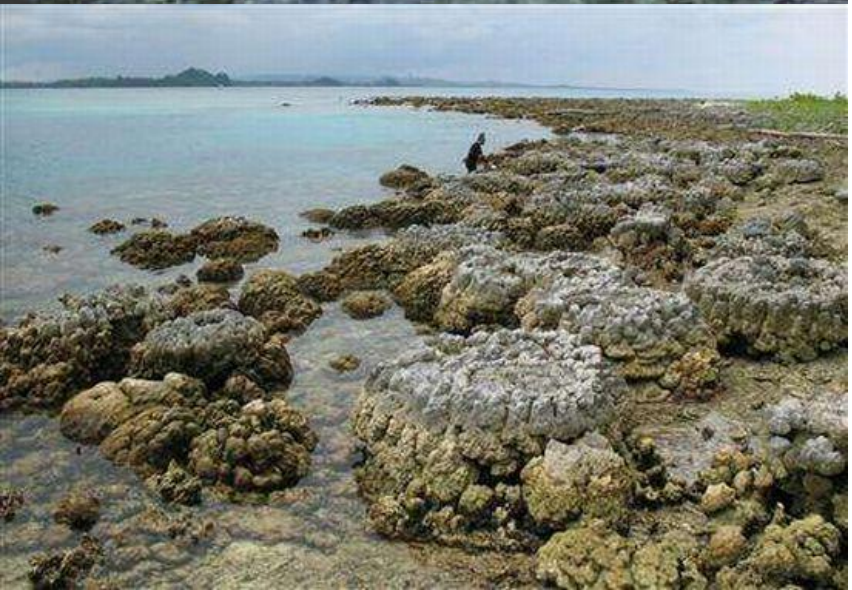
http://catbert.er.usgs.gov/african_dust/events.html

http://www.photolib.noaa.gov/reef/reef2570.htm

http://tools.coralreef.org/content/objects/view.acs?object_id=545

# Overfishing

## Destructive fishing practice



Source: Vaughan R. Pratt, International Marinelife Alliance

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# Development

- Sediment → smothering
- Freshwater input
- Pollutants & nutrients (sewage, pesticides, fertilizer, heavy metals, pathogens)

http://www.sanctuaries.nos.noaa.gov/scied/science/habitat/influences.html

http://www.wcmc.org.uk/marine/data/coral_mangrove/coral.danger.html

http://ourworld.compuserve.com/homepages/mccarty_and_peters/coral/c-intro.htm

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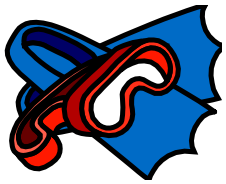
# Mining for construction materials and dredging

- Destruction of reef structure
- Stirs up sediment



## Recreation

Anchors, boats, flippers, hands, feet

- Kill animal tissue
- Skeleton breakage

http://www.sanctuaries.nos.noaa.gov/scied/science/habitat/influences.html

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Insult: أذى

# Synergistic effects

- Interaction of natural changes & human activity
- Multiple insults

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# Global climate change

- Reduced reef building
- Increase in frequency and intensity of hurricanes
- Increases in bleaching
- Increased in disease

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# Synergistic effects

**CORAL DOMINATED**

**ALGAL DOMINATED**

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Pristine: أصلي

# Reefs worldwide are Threatened

- 11% of reefs have been lost
- 16% of reefs severely damaged
- ~60% of studied reefs threatened by human activities
- No pristine reefs left

# Reefs are dying all over the world

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Today, 65% of the worlds reefs are dying (US Coral Reef Task Force, NOAA)

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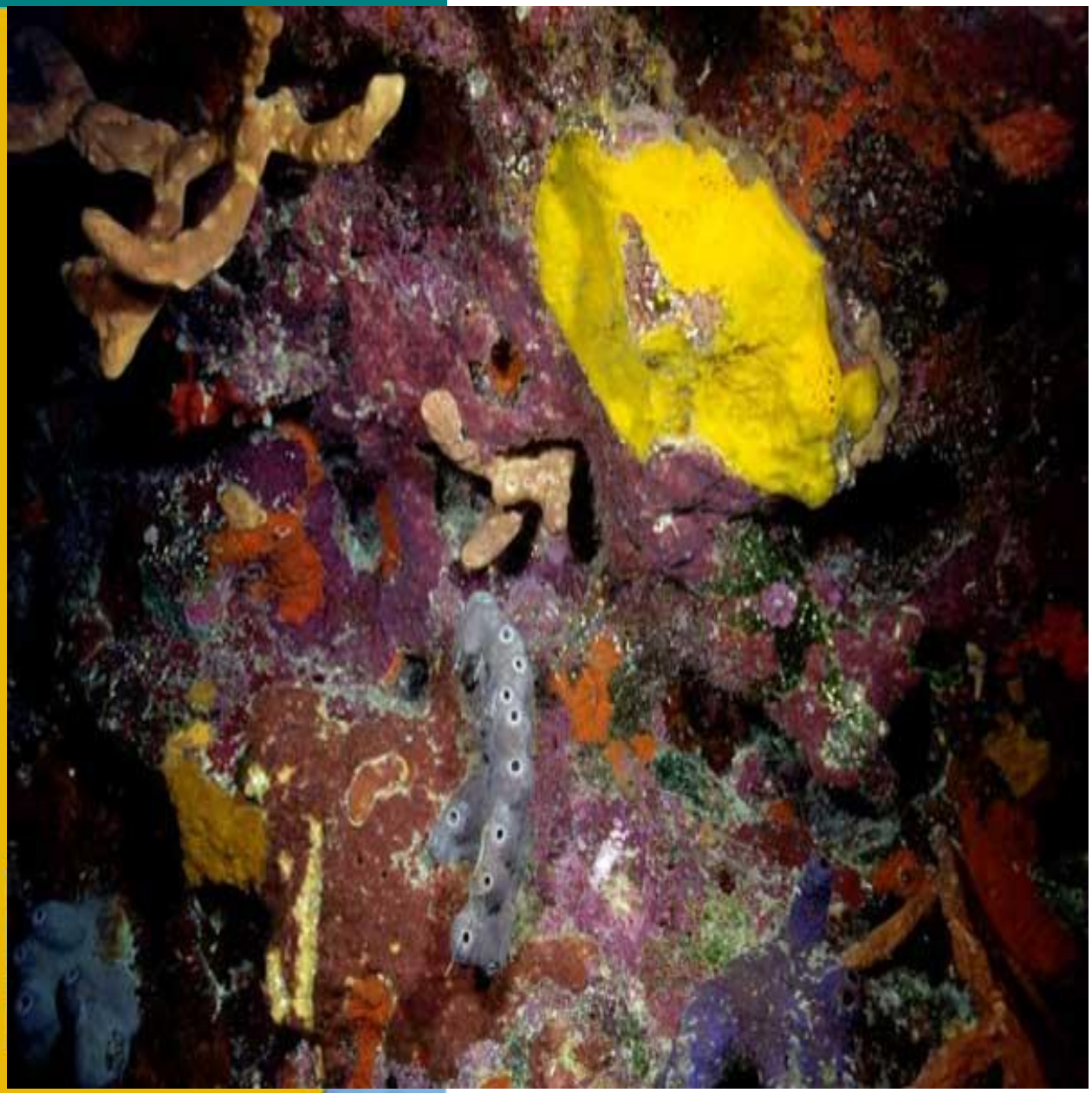
# Consider Cancun

- Only 12 families lived on this forested island until the 1970s
- Then the tourist industry arrived
- Today, 2.6 million people visit Cancun each year
- The island is bare, its forests long gone
- Sewage facilities process only one-quarter of the daily flow
- The rest goes straight into the sea



# Sick Coral

- This is a lot of coral that died from disease.
- It is being overgrown by colorful sponges and algae.

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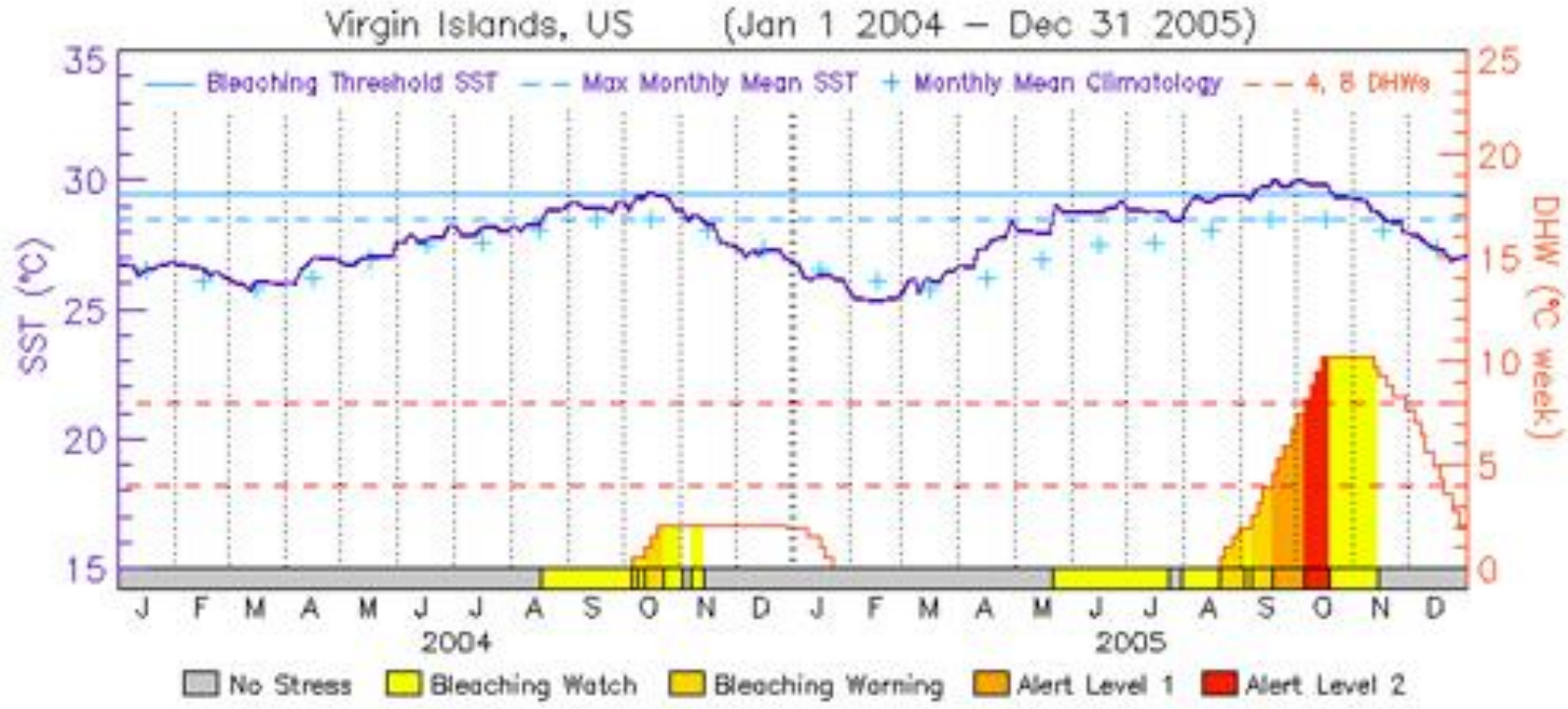
# Sponges increase while Corals decrease

- Sponges have increased in numbers recently because of pollution and nutrient runoff coming from the surrounding islands.
- Corals are very sensitive to environmental changes and will die from pollution, too many nutrients and sea surface temperature changes.

This little fish is hiding amongst the finger and soft coral

## Cha


Virgin Islands, US (Jan 1 2004 – Dec 31 2005)
Bleaching Threshold SST
Max Monthly Mean SST
Monthly Mean Climatology
4, 8 DHWs
SST (°C)
DHW (°C week)
35
30
25
20
15
25
20
15
10
5
0
J F M A M J J A S O N D J F M A M J J A S O N D
2004
2005
No Stress
Bleaching Watch
Bleaching Warning
Alert Level 1
Alert Level 2

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# When reefs die…

- Fish populations disappear
- Fishermen lose their livelihood
- Beaches and shorelines wash away
- Land areas erode from waves
- Tourists find somewhere else to dive
- Local economies can be devastated

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# Definition Artificial Reefs

An artificial reef is one or more objects of natural or human origin deployed purposefully on the seafloor to influence physical, biological, or socioeconomic processes related to living marine resources. Artificial reefs are defined physically by the design and arrangement of materials used in construction and functionally according to their purpose. Items used in reef construction add vertical profile to the benthic environment. They may be either assembled expressly as a reef or acquired after being used for another, usually unrelated, purpose.

The definition of artificial reef has been changing in the modern era of reef-building, which is only 50 years old. Accidental shipwrecks have been classified at times as artificial reefs. Recent proposals have suggested the incorporation, secondarily, of various objectives sought with artificial reefs to structures already deployed for other purposes. A notable example is the recognition that harbor breakwaters can be designed to achieve "ecofriendliness".

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Mimic: يحاكي

# Why constructing artificial reefs and possible impacts

The construction of artificial reefs is carried out due to various factors. These, in order of significance, are:

1- Provide environmental enhancement (for example: to get rid of solid waste, non-hazardous waste, in order to increase the operation period of landfill sites).

2- Mitigate for damages to reefs due to unsustainable man-made activities (ship groundings, dredging, burial, pollution).

3- Restore damaged reefs (natural events: storms, tsunamis, etc.)

3- To mimic a reef habitat for tourism purposes to attract tourists.

4- To mimic reef habitats to aggregate fish communities and increase fish stocks.

5- Assist with shoreline stabilization.

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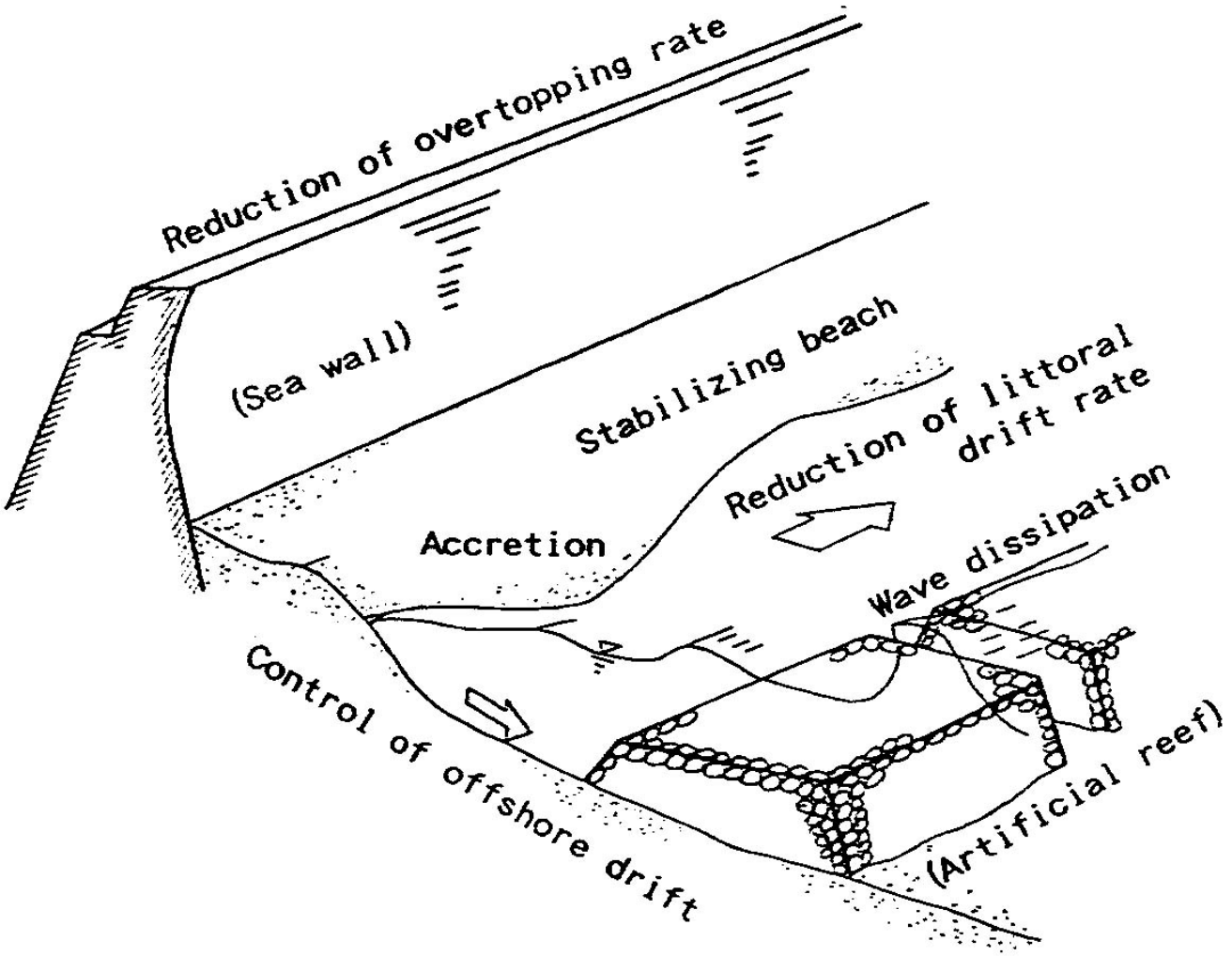
# Shoreline stabilization



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A

B

C

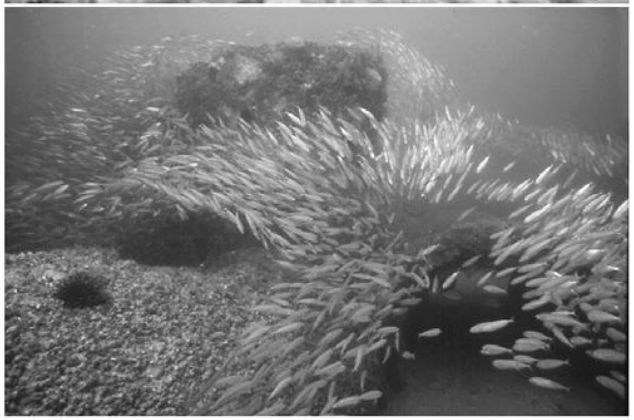

**Table 1.1 Uses of Artificial Reefs in Marine Environments**

| |
|---|
| Enhance Artisanal Fishery Production/Harvest |
| Increase Commercial Fishing Production/Harvest |
| Aquaculture Production Sites |
| Enhance Recreational Fishing by Hook-and-Line and Spear |
| Recreational Skin Diving Sites |
| Submarine Tourism Sites |
| Control Fishing Mortality |
| Manipulate Organism Life History |
| Habitat Protection |
| Conservation of Biodiversity |
| Mitigation (off-site) of Habitat Damage and Loss |
| Restore or Enhance Water and Habitat Quality (on-site) |
| Research |

Aquaculture: تربية الأحياء المائية

One of the newest purposes for artificial reefs is to provide sites for submarine viewing and nature based tourism, especially in clear tropical waters. (Photograph courtesy of R. Brock.)

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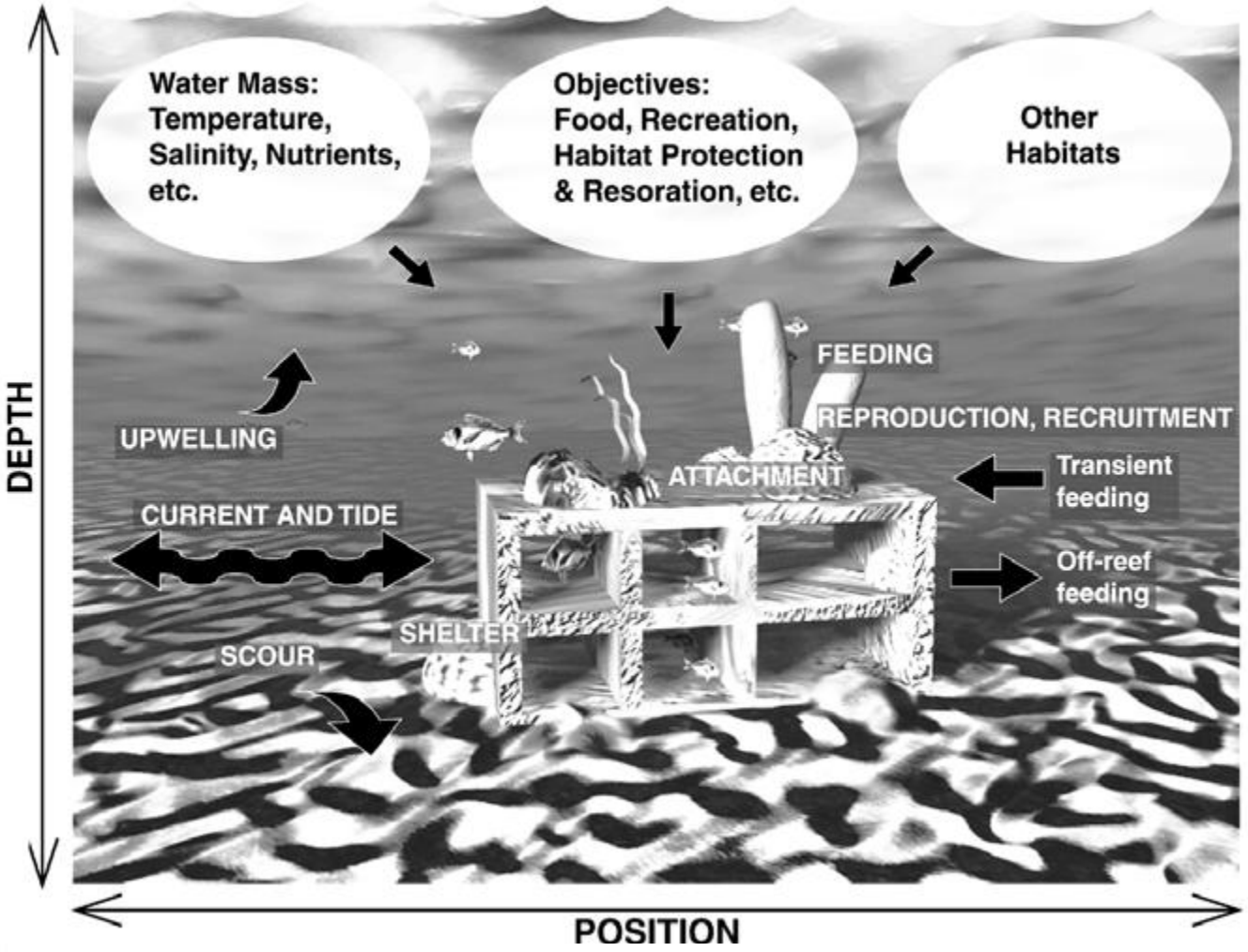
Items used in reef construction add vertical profile to the benthic environment.




Artificial reefs are influenced by, and influence, natural and human forces in the aquatic environment. Evaluation depends on the objectives for the reef as defined by user interests and may address physical, chemical, biological, and economic factors.

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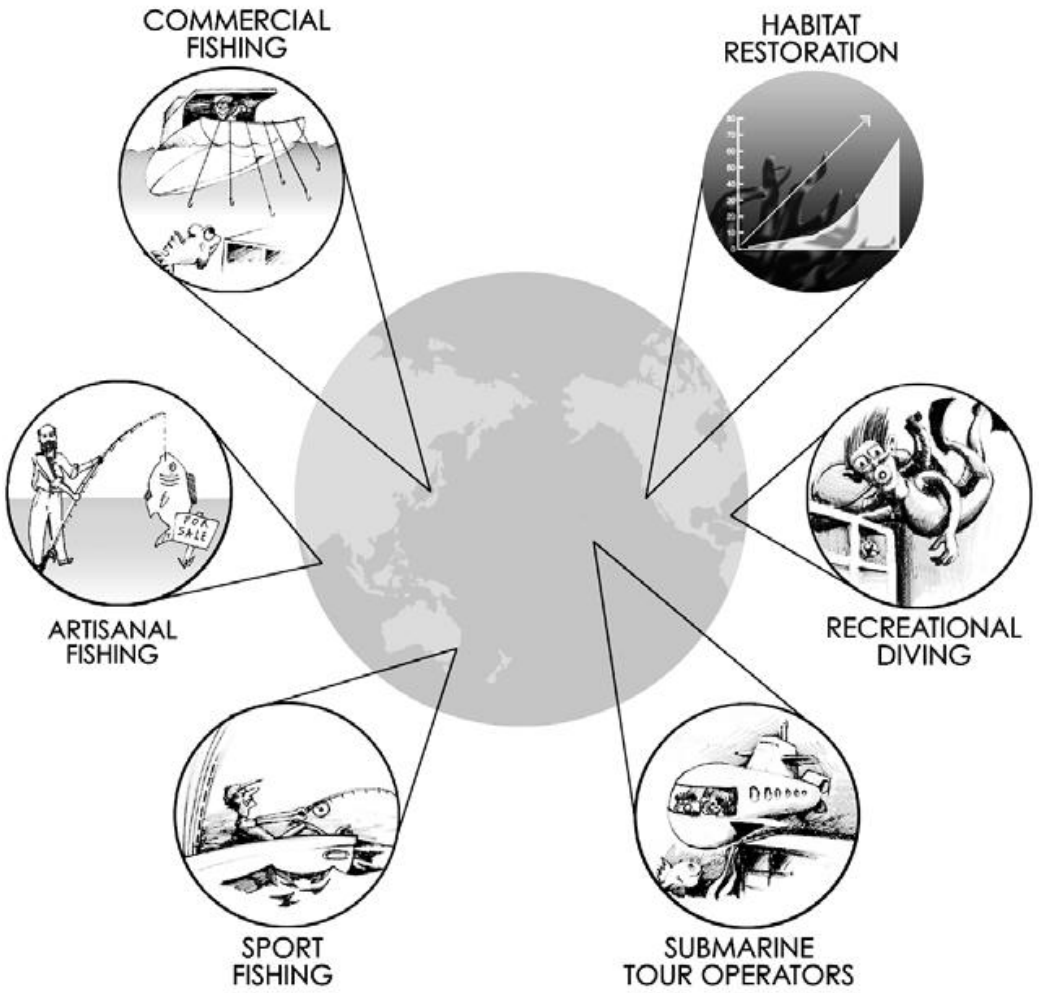


A diverse group of interests have need to evaluate the performance of artificial reefs for various economic, social, and ecological purposes.

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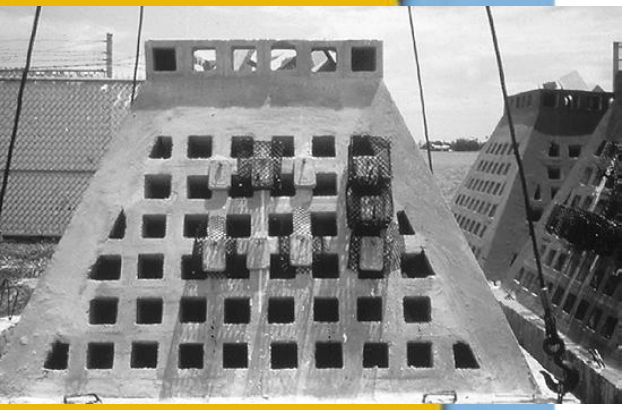

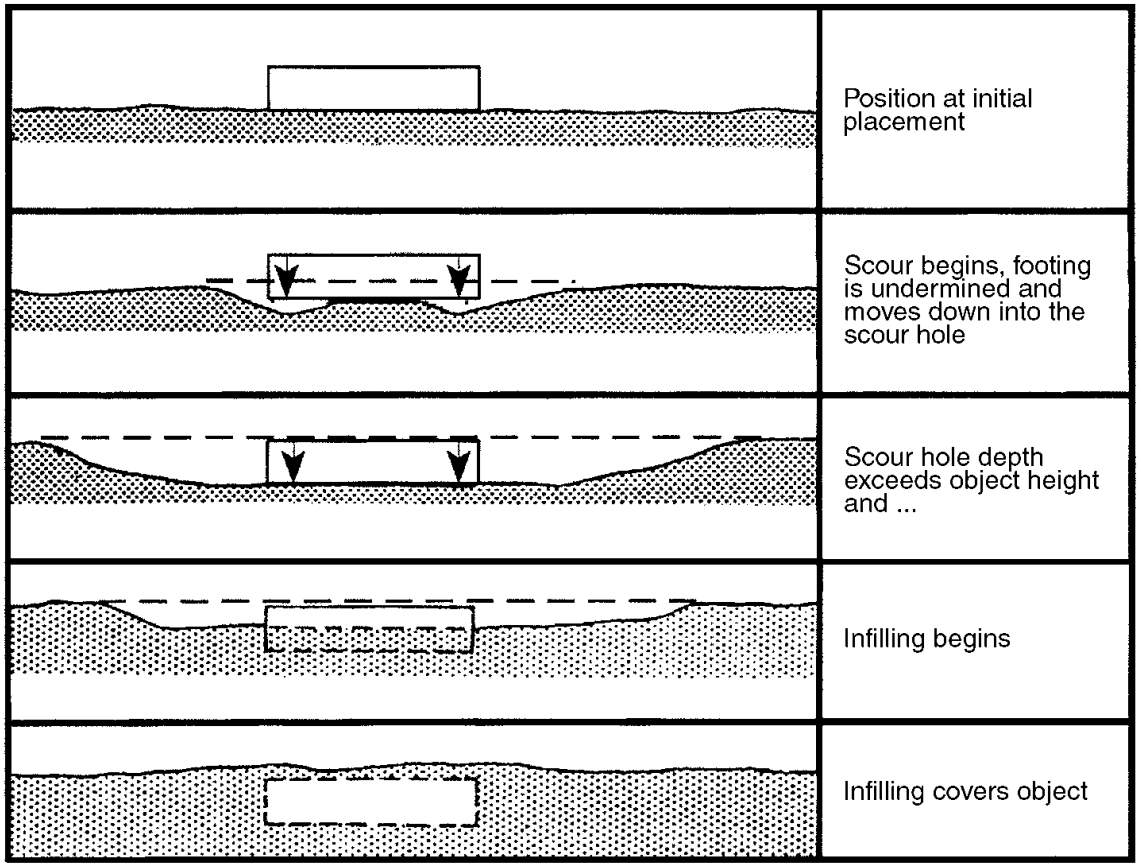


Possible “burial” mechanism for small structures subject to scouring (adapted from Tian 1994).

# A New Home

- Corals now have a choice of where to live
- Corals are very sensitive and are rapidly dying
- People are trying to help by creating artificial reefs

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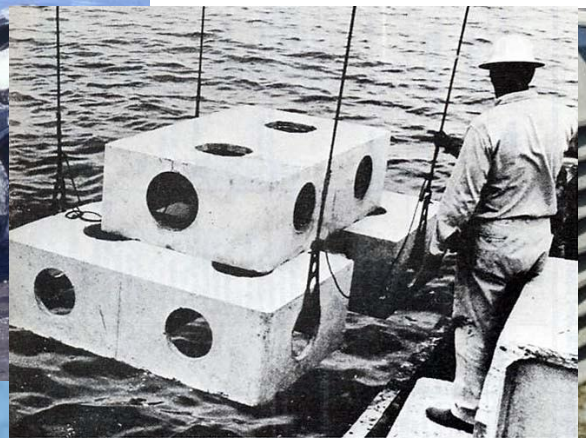
# Artificial reefs materials

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# Easy deployment

A

B

C


D

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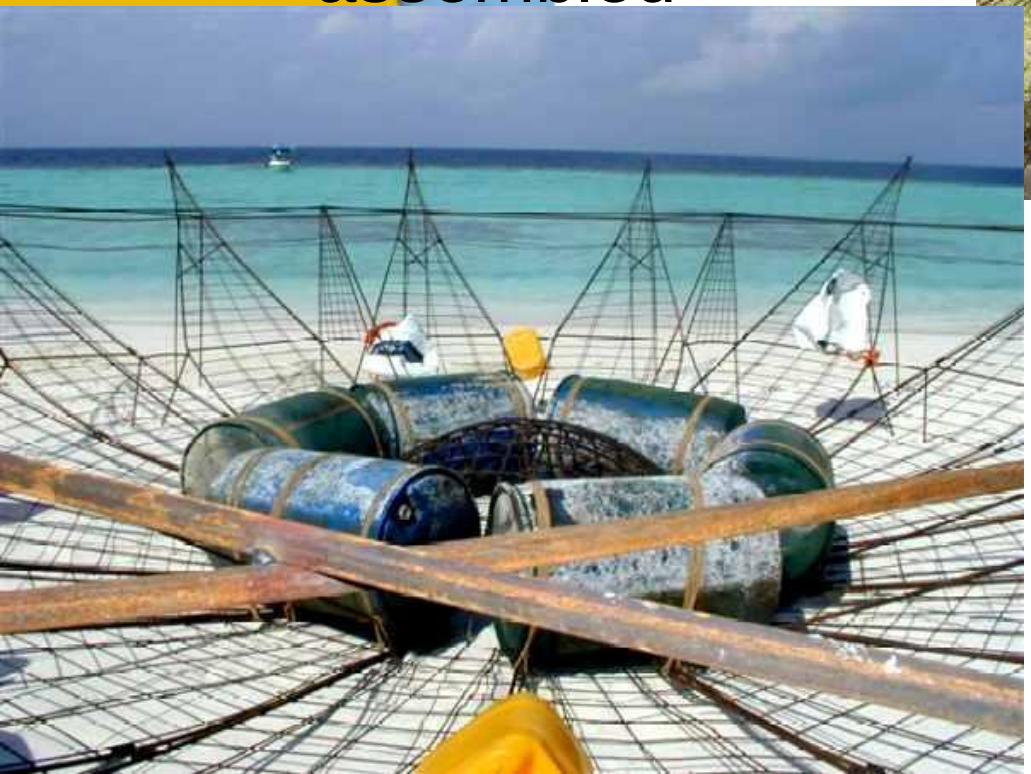
When the materials are fully assembled



Rebar can be welded in any shape

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# Floating reef into position

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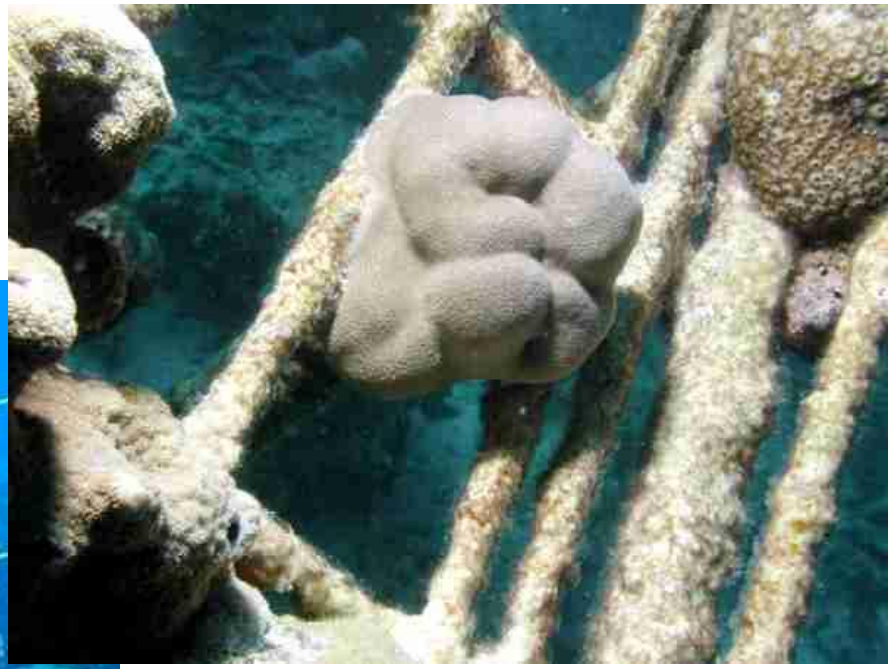
Calcium carbonate quickly forms on the structure



the frame ready for coral

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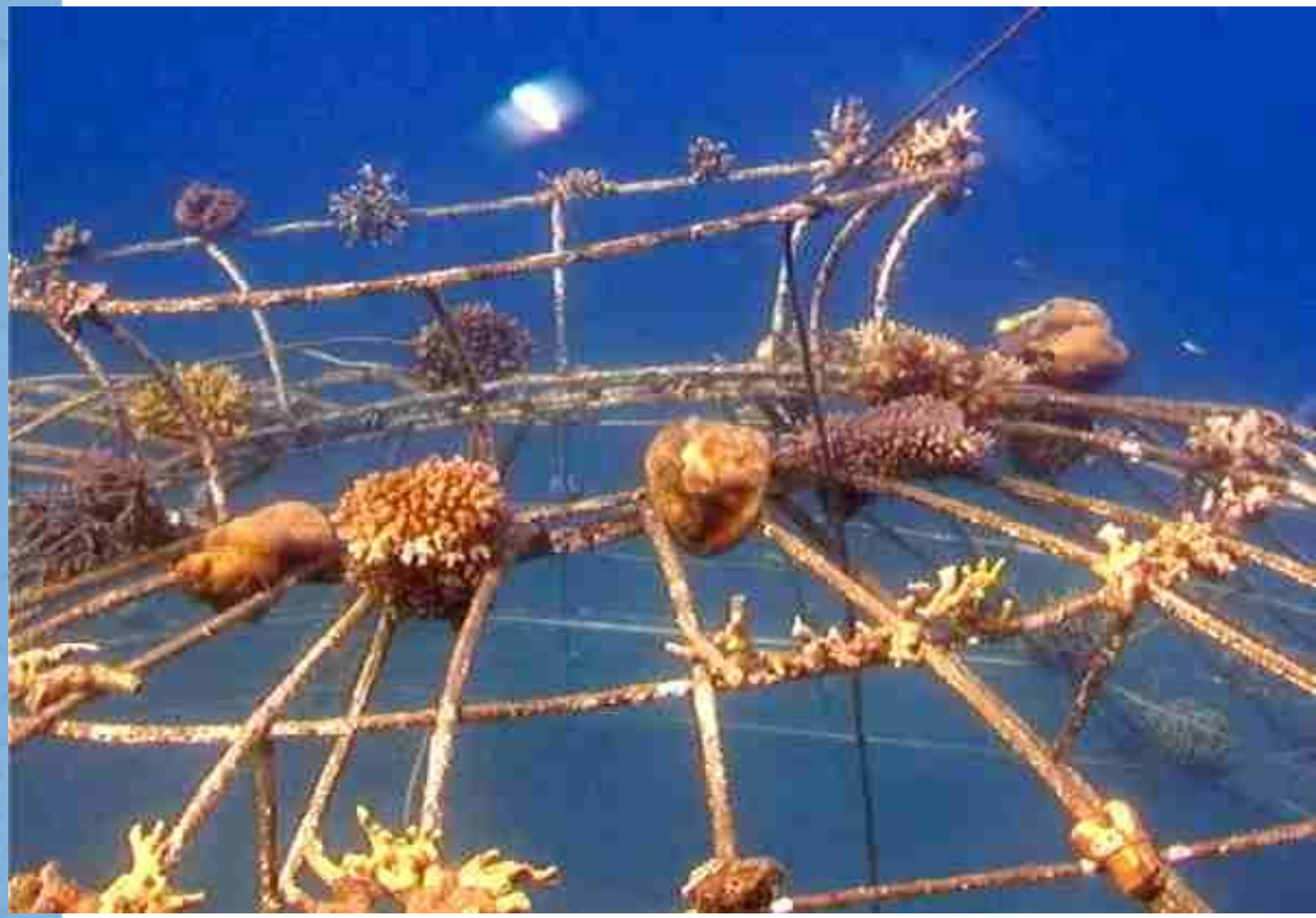
Coral fragments soon cover the frame



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# Monitoring of coral growth

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## Barnacle Reef, Maldives, 1997

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# Barnacle Reef. A year later, 1998

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# Barnacle Reef,  3 years growth

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# Corals are robust and healthy


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# Fish populations move in

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# The new marine ecosystem is both balanced and healthy

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# Reefs attract divers

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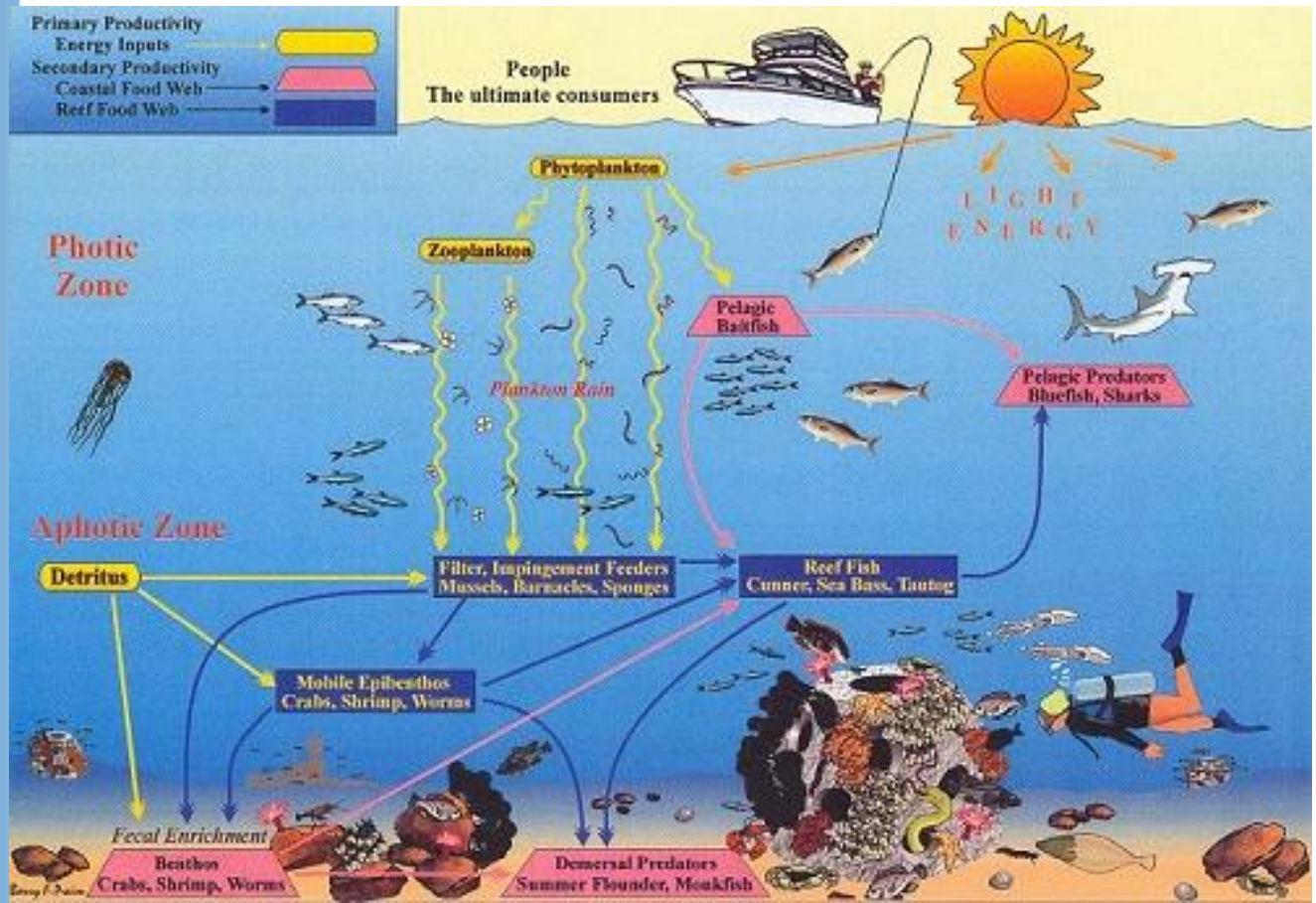
# Arguments for artificial reefs

- It can help build or rebuild a reef
- It will increase fish populations by making new habitats



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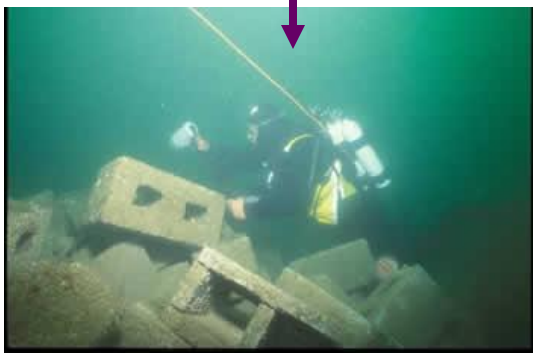
# Arguments for artificial reefs

- Moveable
- Chemical leaking and leaching into the ocean
- It does not increase fish populations but rather moves them to one location away from their natural habitat which makes them easier to catch



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