


Introduction to Oceanography

Lecture 25: Benthos & Marine Resources



Coral Reef, Ras Muhammad Park, Egypt Photo by Mikhail Rogov, CC A SA Unported 3.0, [http://commons.wikimedia.org/wiki/File:Coral_reef_in_Ras_Muhammad_nature_park_\(lolanda_reef\).jpg](http://commons.wikimedia.org/wiki/File:Coral_reef_in_Ras_Muhammad_nature_park_(lolanda_reef).jpg)



Jagalchi Fish Market in Busan, South Korea.

Photo by L.W. Yang, cc-by-2.0, https://commons.wikimedia.org/wiki/File:Korea-Busan-Jagalchi_Fish_Market-03.jpg

Announcements

Lab Finals this Week

in 3820 Geology

Lecture Final

Thur., December 14,
3:00p-6:00p Dodd 147

Extra Credit Video

Wednesday, 3:00-3:50p,
Young CS76

Lecture Final

Review Session

Thursday, 3:00-3:50pm,
Young CS24

**Course Evaluations
until Friday!**

Extra Credits due Friday!

Beyond EPSS 15...

Earth, Planetary, & Space Sciences (*Earth & Environmental Science B.A., Earth & Environmental Science minor*)

Advisor: Lauri Holbrook
3683a Geology (310) 825-3917
holbrook@ess.ucla.edu

Atmospheric & Oceanic Sciences (*AOS minor*)

Student Affairs Officer: Kimberly Perez
7127 Math Sciences (310) 825-1954
kperez@atmos.ucla.edu

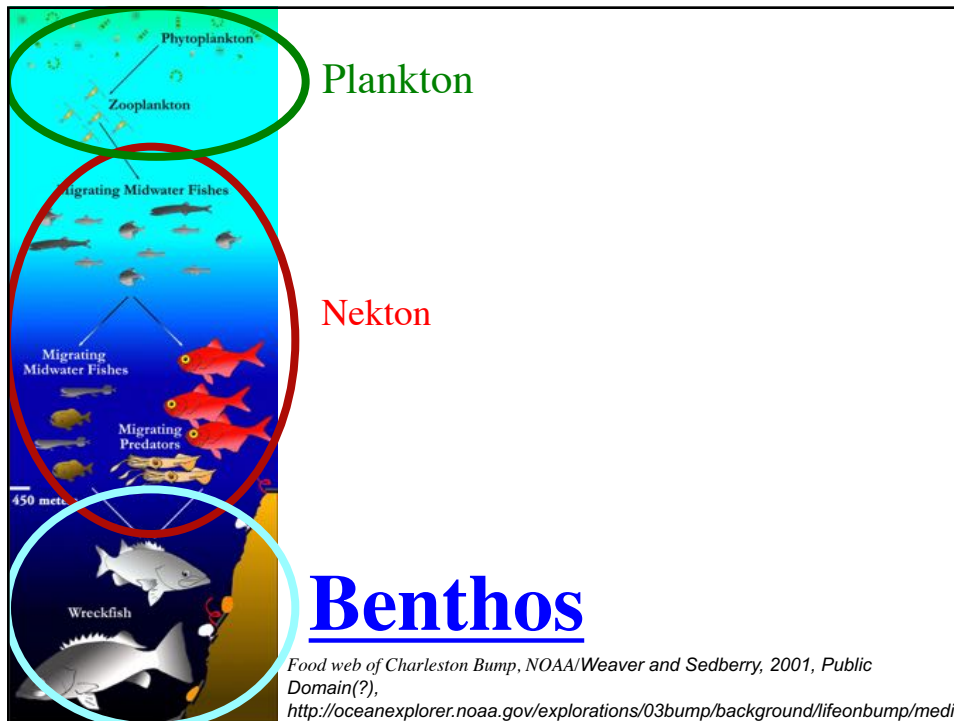
Ecology and Evolutionary Biology (*Marine Biology BS*)

Advisors: Jessica Angus, Jessica Gonzalez & Eileen Mansoorian
Hershey Hall 101 (310) 825-1680
eebundergrad@lifesci.ucla.edu

Institute of the Environment & Sustainability

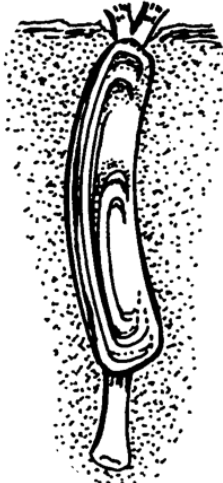
(Environmental Sci. B.S.: *Earth and Environmental Science minor*)
Non-majors: *Environmental Systems and Society minor*)
Student Affairs Officer: Royce Dieckmann
La Kretz 300, (310) 206-9193
rdieckmann@ioe.ucla.edu

* **Red type** indicates minors & majors where EPSS 15 counts towards a program requirement.



Habitats

Infauna: Live in sediment and rocks



Drawing from City of Barnstable, Mass.
<http://www.town.barnstable.ma.us/Images/ShellfishPics/razrclam.gif>

Razor clams burrow into the sand or mud



Photo by David Ansley, Wikimedia Commons,
Creative Commons A 2.5,
http://en.wikipedia.org/wiki/File:Jackknife_clam.JPG

Habitats

Epifauna: Live on the surface

Sea anemone



Photo by Esculapio, Wikimedia Commons, Creative Commons A S-A 3.0,
http://en.wikipedia.org/wiki/File:Actinia_equina_0009.J

Purple Sea Urchin



Photo by Tomasz Sienicki, Wikimedia Commons,
Creative Commons A S-A 3.0,
<http://commons.wikimedia.org/wiki/File:Woda->

Habitats

Nektobenthos: Swimmers living on the bottom

Examples: Octopus, shrimp, halibut



Horn shark, La Jolla, CA, photo by Magnus Kjaergaard, Wikimedia Commons, Creative Commons A S-A 3.0, http://en.wikipedia.org/wiki/File:Horn_shark.JPG



Nutrition

Autotrophs are the base of the food web:

Photosynthesizers
(usually)

Algae live in the photic zone (not found below the photic zone)

– Kelp beds: autotrophic benthic algae

*High productivity or low productivity?
Neritic or Oceanic?*

*Photo by Stef Maruch, Flickr,
Creative Commons A S-A 2.0,
<http://www.flickr.com/photos/79257269@N00/1228333269/>*

Nutrition

Heterotrophs: Eat others to live

Eating Styles of Benthic Heterotrophs

- Suspension Feeders
- Filter Feeders
- Deposit Feeders
- Active Herbivores
- Active Carnivores

Crinoid, a suspension feeder, photo by Richard Ling, Wikimedia Commons, Creative Commons A S-A 3.0, http://upload.wikimedia.org/wikipedia/commons/f/f6/Ptilometra_australis_Passion_Flower_feather_star.jpg



Nutrition

Suspension/Filter Feeders- use appendages or siphon to strain particulate food matter from the water

Sponge, photo by Mila Zinkova, Creative Commons A S-A 3.0, http://en.wikipedia.org/wiki/File:Sponge_in_papua_new_guinea.jpg

Coral, photo by Nick Hobgood, Creative Commons A S-A 3.0, http://commons.wikimedia.org/wiki/File:Euphyllia_glabrescens_%28Hard_coral%29_with_polyps_extended.jpg



Nutrition

Deposit Feeders- process mud, removing food particles

Sand dollars- plow through sediment, food particles stick to their mucous coating and are moved towards the mouth by cilia/podia



Sand dollars, *Dendraster excentricus*,
photo by Tewy, Wikimedia Commons,
Creative Commons A S-A 3.0,
http://commons.wikimedia.org/wiki/File:Sand_dollar_%28Dendraster_excentricus%29_01.jpg

Nutrition

Active Herbivores (grazers)- seek out primary producers as food

Sea urchin



Photo by Kenny Kandola, Wikimedia Commons
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<http://commons.wikimedia.org/wiki/File:Seeigel-Saugfuesse%28Galicien2005%29.jpg>

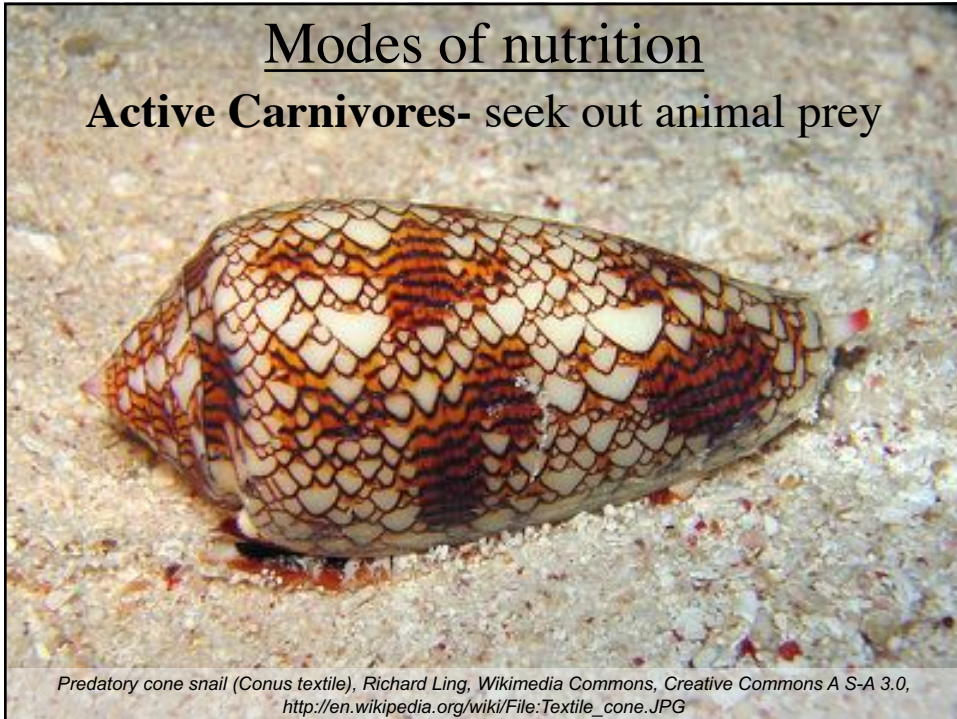
Snails



Photo by Takahashi, Wikimedia Commons, Public Domain,
http://commons.wikimedia.org/wiki/File:Euhadra_quaesita_grazing_scar1.jpg

Modes of nutrition

Active Carnivores- seek out animal prey



Predatory cone snail (Conus textile), Richard Ling, Wikimedia Commons, Creative Commons A S-A 3.0, http://en.wikipedia.org/wiki/File:Textile_cone.JPG

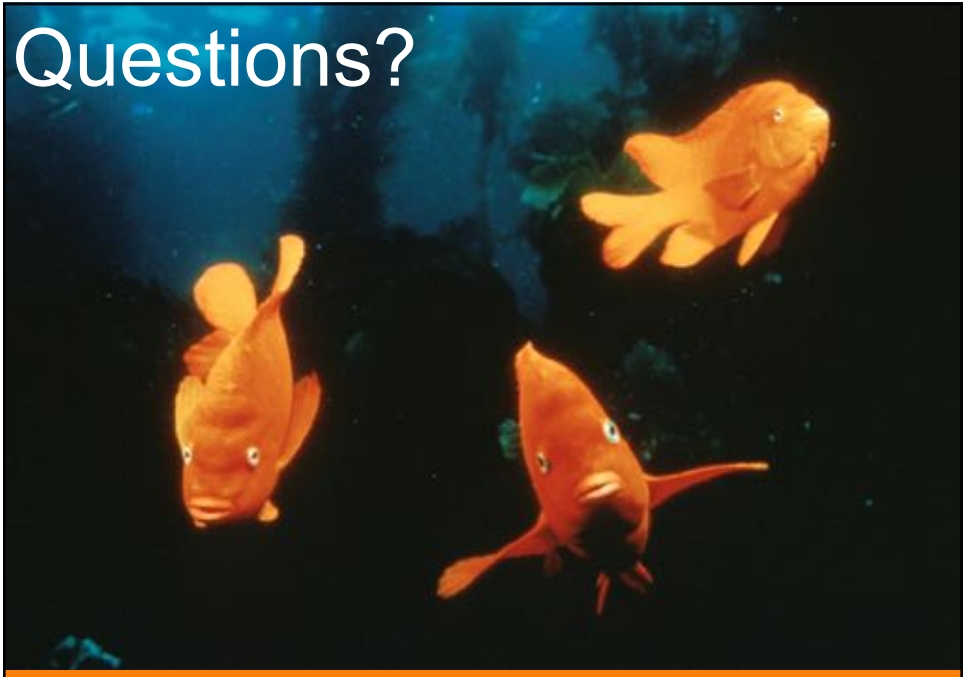
Nutrition

Active Carnivores- seek out animal prey



Cone snail stalking fish in an aquarium, video by theconesnail, Youtube, http://www.youtube.com/watch?v=AG_As8H8G3Y

Questions?



Garibaldis, NOAA image, Public Domain, http://upload.wikimedia.org/wikipedia/commons/7/73/Garibaldi_300.jpg

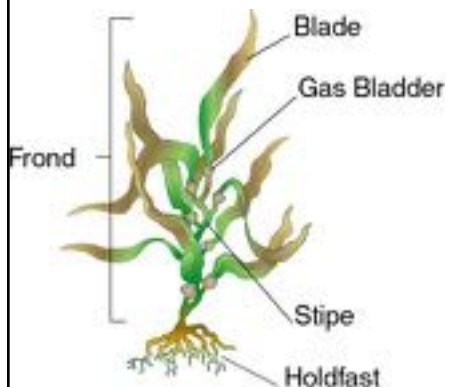
Kelp Forest Ecosystems



Photo by Fastily, Wikimedia Commons, Creative Commons A S-A 3.0, <http://en.wikipedia.org/wiki/File:Kelpforest12500ppx.JPG>

Kelp Forest Ecosystem Dynamics

Kelp forests are home to many species of fish and are crucial for the protection of juvenile fish.

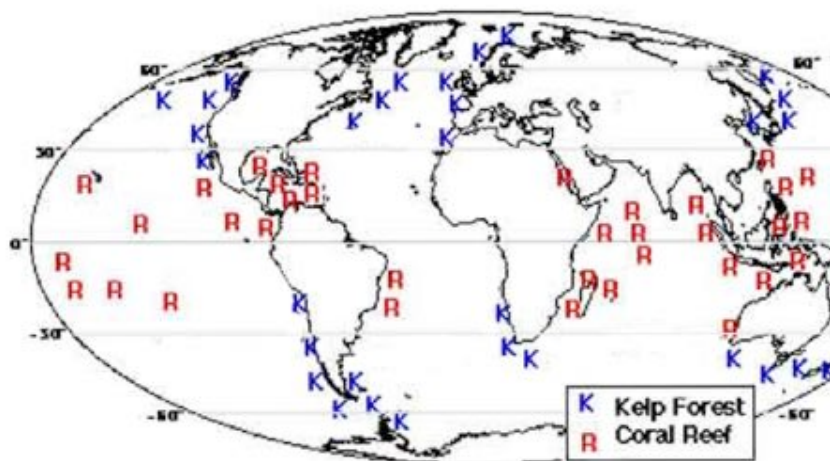


Unlike trees, kelp has no vascular system.

Holdfasts provide anchorage & are NOT a plant root system

Image from Kelp Watch, U. Tasmania,
http://www.geol.utas.edu.au/kelpwatch/facts_b.htm#top

Kelp (& coral reef) geography

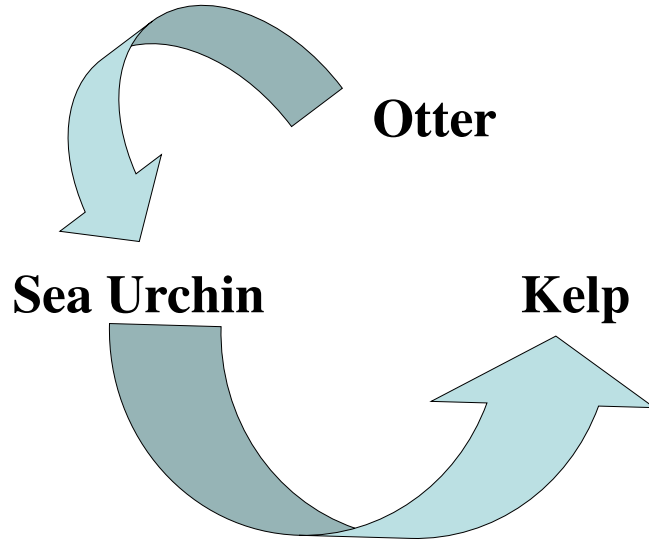


5/11/2004 10:03:03 AM

Map courtesy of Dr. André Freiwald
Friedrich-Alexander University Erlangen-Nürnberg
<http://www.pat.uni-erlangen.de/exp/owc/>

UCLA Marine Science Center, http://www.msc.ucla.edu/oceanglobe/pdf/Kelp_Forests/Kelp_Entire.pdf

Kelp Forest Ecosystem Dynamics



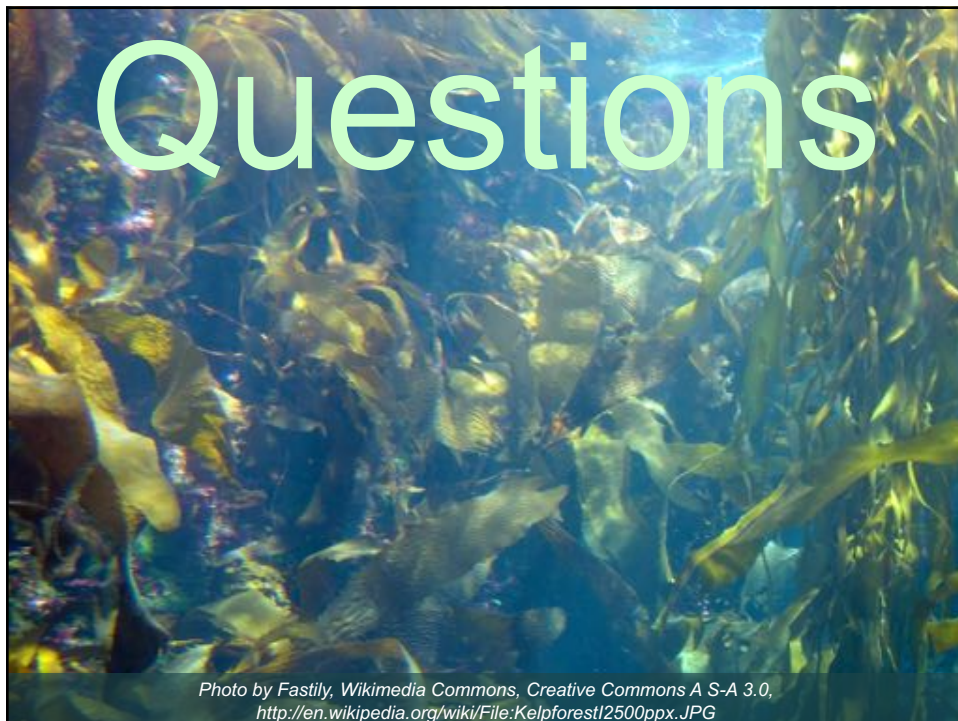
Kelp Forest Ecosystem Dynamics

Otters eat sea
urchins

*Photo by Matt Knoth,
Flickr, Creative Commons A 2.0,
<http://www.flickr.com/photos/18158503@N00/1066160826/>*

Kelp Forest Ecosystem Dynamics

- Otters indirectly controls health of kelp forests
 - Competition with fishing industry
 - Incredibly thick, warm furs
- Remove otters & then sea urchins grow out of control, destroying the kelp beds
- CA waters: otters and kelp forests are trying to make come-backs



Coral Reef Communities

Diversity and productivity
“hotspots” in warm,
tropical surface waters.

Most warm tropical surface waters
are nutrient poor

- Equator -- upwelling, lots
of nutrients, but cold!

---> Not much phytoplankton

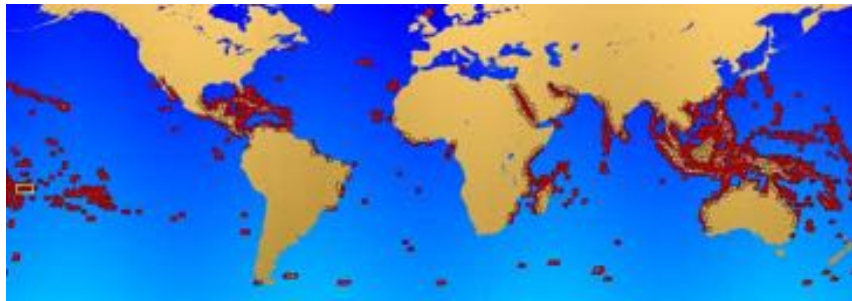
---> Generally clear water, perfect
for resorts!

(Hawaii, Cabo, Bahamas, Tahiti,
Australia)



*Coral reef, East Timor, photo by Nick Hobgood,
Wikimedia Commons, Creative Commons A S-A 3.0,
http://commons.wikimedia.org/wiki/File:Timor_Coral_Reef.jpg*

Geography of Coral Reefs



*Coral reef localities studied by Landsat. NASA image, Public Domain,
at.pl*



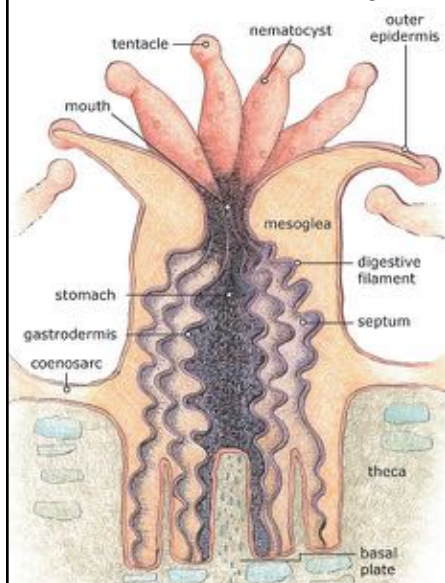
$\geq 20^{\circ}\text{C}$ surface
temperatures in the
ocean

*Adapted from CIA World Factbook,
Public Domain,
http://en.wikipedia.org/wiki/File:20_Grad_Isotherme.pn*

Coral Polyps



Anatomy of a coral polyp



Corals are cnidarians, relatives of jellyfish. These organisms have special stinging cells they use to trap food.

Cnidarians are consumers - but live symbiotically with primary producers!

(Reef building, or hermatypic coral)

NOAA drawing, Public Domain, http://oceanservice.noaa.gov/education/kits/corals/media/coral01a_462.jpg

Coral Reefs: ZOOXANTHELLAE

Modified dinoflagellates, called **zooxanthellae**, are imbedded in the outer tissues of coral polyps

Symbiotic relationship: mutually interdependent

Zooxanthellae get stable environs, protection from predation, supply of nutrients (corals waste products)

Coral gets: local oxygen supply, food source & waste removal system.

Very highly productive, under favorable conditions.

Susceptible to disturbance

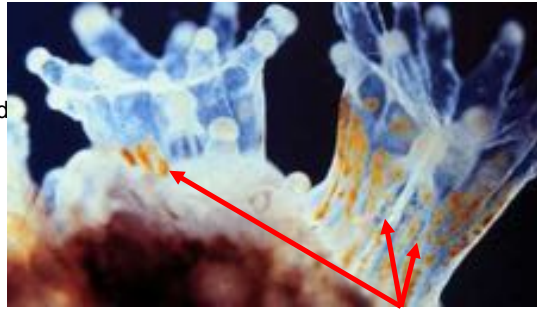


Photo from U. Michigan Department of Molecular, Cellular and Developmental Biology, <http://www.biology.lsa.umich.edu/courses/bio255/zooxanthellae.jpg>

zooxanthellae

Primary Productivity in Coral Reefs is dominantly benthic, internalized within the corals themselves!

Corals may not thrive in conditions where other primary producers (esp. algae) grow quickly, they get crowded out.

Coral Reefs

Built up from CaCO_3 skeletal remains of corals

Forms limestone structures

Reefs grow from the top ---on top of the massive limestone deposits of the reef itself

Living skin that will later die and become part of the reef structure

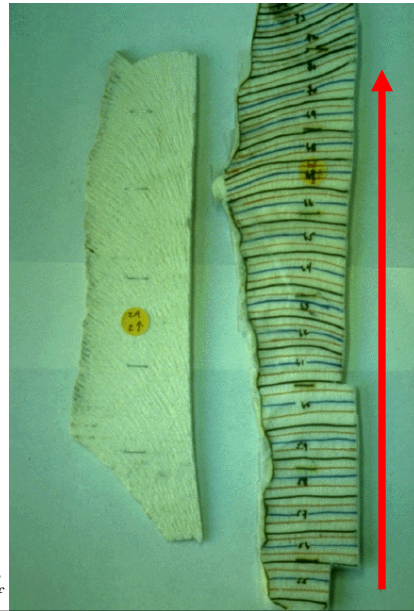
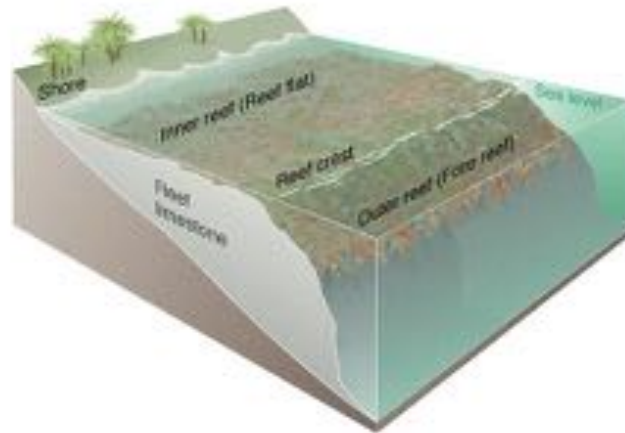


Photo by Darin Toohey, U. Colorado, <http://paos.colorado.edu/~toohey/climate11.gif>

Coral Reefs



USGS image, Public Domain, <http://pubs.usgs.gov/fs/2002/fs025-02/>

Geological evolution of Coral Reefs

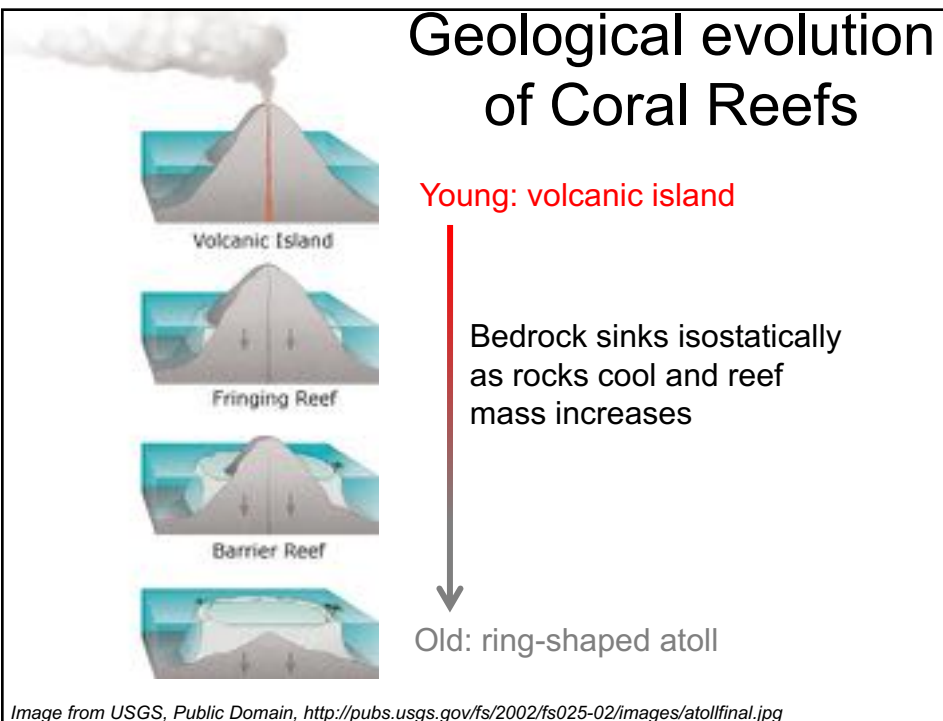


Image from USGS, Public Domain, <http://pubs.usgs.gov/fs/2002/fs025-02/images/atollfinal.jpg>

Geology of Coral Reefs

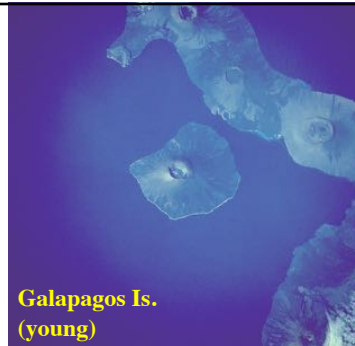
Fringing reef around new island
isostatic subsidence of island



**Bora Bora,
French Polynesia
(middle)**

Barrier Reef

Island subsides
and erodes into
seamount



**Galapagos Is.
(young)**

NASA image,
<http://eol.jsc.nasa.gov/sseop/EFIS/photoinfo.pl?PHOTO=STS51J-41-32>

Atoll

NASA image,
<http://eol.jsc.nasa.gov/scripts/sseop/photo.pl?mission=ISS004&roll=E&frame=6730>

NASA image,
<http://photojournal.jpl.nasa.gov/catalog/PIA06660>



Mururoa, French Polynesia (old)

Coral Reefs in Global Decline

- **Recent & Ongoing Reef Loss:**
 1. Increasing global temperatures
 2. Habitat disturbance through tourism, fishing.
 3. Pollution.
 4. Increased exposure to ultraviolet light.

↑
**Band advances
mm-cm per day**

Photo by Andy
Bruckner, NOAA,
Public Domain,
http://oceanservice.noaa.gov/education/kits/corals/coral10_diseases.html



*Black band
disease,
discovered in
1972 in
Florida*

*Bacterial
Consortium*



Coral Reef Bleaching

In response to stress, especially high temperature, corals can consume or expel their zooxanthellae.

The remaining coral organism is nearly colorless and transparent.



NOAA image, Public Domain,
http://www.noaanews.noaa.gov/stories2008/20081009_coralbleaching.html

Photo by Andy Bruckner, NOAA, Public Domain,
<http://coris.noaa.gov/about/diseases/#coral%20bleaching>

White carbonate coral skeletons become visible

Loss of primary productivity undercuts coral food supply, over time can lead to colony death.

NOAA coral reef bleaching:

<https://coralreefwatch.noaa.gov/satellite/index.php>



Mururoa coral lagoon, Georges Martin, Creative Commons A 3.0,
http://commons.wikimedia.org/wiki/File:Mururoa_lagon.jpg

Marine Resources

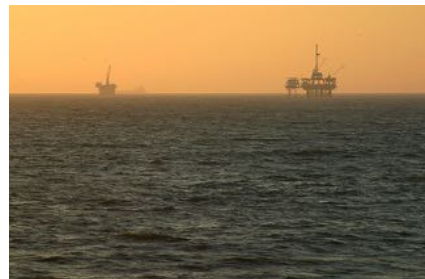


Fish market, Essaouira, Morocco. Photo by Donar Reiskoffer, Wikimedia Commons, CC A S-A 3.0, http://commons.wikimedia.org/wiki/File:Essaouira_Fish_Market.JPG

Types of Marine Resources

- Physical Resources
 - Mineral deposits, petroleum & natural gas (methane), etc
- Biological Resources
 - Animal and plant life collected for our use
- Nonextractive Resources
 - Transportation, recreation, waste disposal

Cargo ship MV Lehmann Timber. US Navy photo, http://www.navy.mil/view_single.asp?id=61335



Oil platforms, Huntington Beach CA. Photo by Aaron Logan, CC A 2.0, http://commons.wikimedia.org/wiki/File:Lightmatter_oilrigs.jpg
Jack mackerel net. Photo by C. Ortiz Rojas, NOAA, Public Domain, <http://www.photolib.noaa.gov/htmls/fish2172.htm>



Sustainability of Marine Resources

Renewable Resources

Replaceable on a relatively short timescale, if harvested responsibly
i.e., wind, seaweed



Nori seaweed nets, Japan. Made based on [[http://w3land.mlit.go.jp/WebGIS/National Land Image Information \(Color Aerial Photographs\)](http://w3land.mlit.go.jp/WebGIS/NationalLandImageInformation(ColorAerialPhotographs))], Japan Ministry of Land, Infrastructure, Transport and Tourism

Nonrenewable Resources

Present in the ocean in essentially fixed amounts on a human timescale
i.e., oil deposits

Oceanic Biological Resources

- **BIG PICTURE:**
7.44 x 10⁹ Humans as of December 2, 2017
(US Census Bureau projection model)
 - + 78 million more every year
– i.e., a 1.0% Growth Rate

One new Rose Bowl-full every 10 hours!

Many depend on food and other products of life in the ocean...



Rose Bowl image from UCLA Bands, www.uclaband.com/script_only.jpg

Oceanic & Aquatic Biological Resources

- ~20% or more of animal protein for 3.0 billion people
- at least 15% of animal protein for 4.3 billion people
- 65%* of from oceans, 35% from fresh water

Global Commercial Harvest

- 158 Million metric tons in 2012
 - increasing ~3% per year (but wild harvest stagnant!)
- Direct Human Consumption: 86%
- Other uses (e.g., feed for livestock): 14%
 - “Trash” fish: anchovies, herrings, sardines, etc.

*Most statistics are from the 2014 World Fisheries Report of the Food and Agriculture Organization of the United Nations

Global Wild Catch

WORLD CAPTURE FISHERIES AND AQUACULTURE PRODUCTION

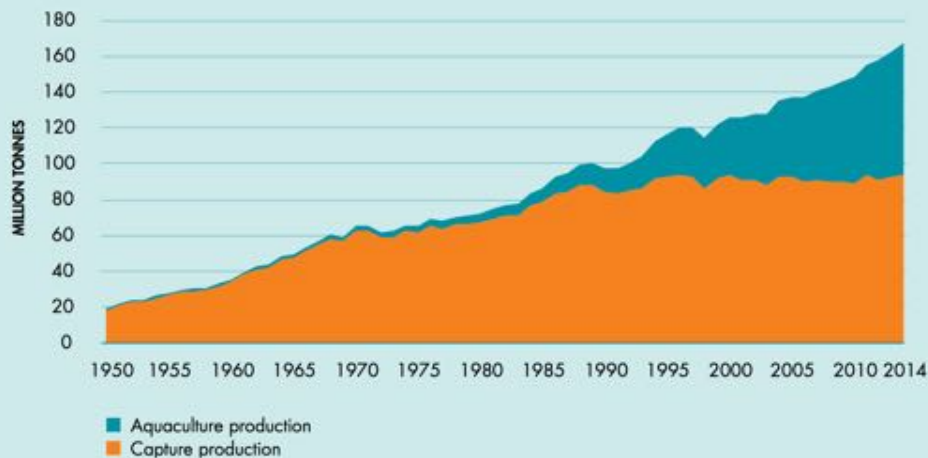


Figure from UN Food and Agriculture Organization World Review of Fisheries and Agriculture 2016, <http://www.fao.org/fishery/sofia/en>