Ecological Impacts: Oceans

Fish Story

Fisheries Subsidies

Fish stocks of the oceans according to EU politicians...

Fish stocks according to researchers...

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1. Describe one way that ocean acidification negatively affects coral reef systems.
Vocab – Hoegh-Guldberg et al., 2007

• Rugosity – wrinkly-ness – measurement of structural complexity
• Accretion – growth by accumulation of layers
• Anomaly – difference from expectation
• Perturbation – deviation from normal process
Coastal hypoxia from N pollution

How dead zones form:

1. Fertilizers, sewage and nutrients from farming flow down rivers, such as the Mississippi, into Gulf water.
2. Nutrients stimulate massive growth of algae blooms.
3. Plankton and algae die, sink to bottom and decompose, using up oxygen in water.
4. Area becomes starved of oxygen, fish avoid areas.

Global hypoxic zones

**Fig. 1.** Global distribution of 400-plus systems that have scientifically reported accounts of being eutrophication-associated dead zones. Their distribution matches the global human footprint [the normalized human influence is expressed as a percent (41)] in the Northern Hemisphere. For the Southern Hemisphere, the occurrence of dead zones is only recently being reported. Details on each system are in tables S1 and S2.

Diaz & Rosenberg, 2008
Growing numbers of dead zones

Diaz & Rosenberg, 2008
Harmful Algal Blooms

Caused by increased nutrient loading (many of these algae are the culprits in creating hypoxic zones)

Algae can be toxic – causing massive fish kills, as well as affecting birds and marine mammals

Toxic algae consumed by shellfish can also poison people
Algal Blooms & Human Health

Paralytic shellfish poisoning events

Caused by human consumption of shellfish that have eaten toxic algae
Over-Exploitation of Ocean Resources

- Patagonian toothfish
- Chilean sea bass
- Slimehead
- Orange roughy
More fish from new fisheries at greater depth
Exploitation of new fisheries

Harvest intensity: ocean catch by half-degree cell (930 sq mi; 2,410 sq km), expressed in terms of primary production (metric tons of phytoplankton) over a five-year period.
Does anything stop me from fishing in the open ocean?

• Short answer: NO
• 200 mile EEZ (Exclusive economic zone) around countries
• Some trade regulations on certain species
Sport Fishing Impacts on Fish

12 Hour Survival Rate (percent)

- Control
- Exercise
- Exercise 30 Sec Air
- Exercise 60 Sec Air

Ferguson and Tufts 1992
Effects of Fish Capture & Handling

• Slow physiological recovery
• Impaired swimming performance
• Altered behavior
• Loss of equilibrium – inability to coordinate movements and remain upright
• Increased susceptibility to predation
Long Line *(for tuna, swordfish)* Bycatch

**Seabird bycatch:**
- 44,000 albatross
- 250,000 other seabirds
  killed annually
  (Bull 2007)

**Turtle bycatch:**
- 200,000 loggerhead
- 50,000 leatherback turtles
  killed annually
  (Lewison et al. 2004)
Ecological cascades: Loss of top ocean predators

1200 lb hammerhead caught off the coast of Australia
Ecological cascades: Loss of top ocean predators

Myers et al., 2007
Ecological cascades: Loss of top ocean predators

Major economic consequences on N. Carolina scallop fisheries

Myers et al., 2007
Ocean Invasive Species

Jellyfish invasion in Mediterranean via Suez Canal
Tunicate Invasion Near Prince Edward Island

Very fast rate of invasion

Ramsay et al., 2008
Lionfish Invasion in the Atlantic

Lionfish are native to the Pacific near southeast Asia.

Carnivorous Lionfish eat smaller reef fish.

Proportional change in native fish abundance

Benkwitt 2015

Greene & Cote, 2008
Lionfish Invasion in the Atlantic
‘Land’ cover change
Bottom Trawling: Target Species

- Pacific cod
- Rockfish
- Halibut
- Shrimp
Shrimp trawlers in the Gulf of Mexico are the main cause of sea turtle decline.

About 40% of species taken from the ocean are bycatch.
Figure 5.8. Impacts of trawling on gravel and mud habitats, Stellwagen Bank National Marine Sanctuary, Gulf of Maine. Gravel habitats protected from trawling (A₁) contain erect sponges, whereas areas open to fishing (A₂) lack such biogenic structure (a longhorn sculpin, Myoxocephalus octodecimspinosus, is visible in the center of photo A₂). Mud habitats often contain biological structure such as burrowing anemones (B₁), but trawled areas (B₂) can be devoid of such structure (note trawl gear tracks). Photos courtesy of P.J. Auster, National Undersea Research Center, University of Connecticut.
Mangrove forest loss affects fisheries

- Mangroves provide habitat for juvenile fish
- Local loss of mangrove specialist fish affects reef community

Mumby et al., 2004
Oceans & Climate Change - understudied

Marine undersampling. The number of time series from different environments included in the recent IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report differ widely. Marine systems are vastly underrepresented compared with terrestrial systems (1).
Chemistry of Ocean Acidification

As \( \text{CO}_2 \) is absorbed by the atmosphere it bonds with sea water forming carbonic acid. This acid then releases a bicarbonate ion and a hydrogen ion. The hydrogen ion bonds with free carbonate ions in the water forming another bicarbonate ion. This free carbonate would otherwise be available to marine animals for making calcium carbonate shells and skeletons.
High certainty: ocean acidification
Carbonate Life Forms in the Ocean

Corals

Calcareaous plankton

Helicosphaera
Oolithus
Emiliania
Algirosphaera
Calcisphaera
Rhabdosphaera
Calcisphaera
Oolithus
Emiliania
Algirosphaera
Braardosphaera
Cayptolithina
Coronosphaera
Gephyrocapsa
Ocean Acidification and Corals

Hoegh-Guldberg et al., 2008
Zooxanthellae have narrow thermal tolerance
Coral Bleaching – 2015 American Samoa
Coral Bleaching 2015

Very strong El Niño event in 2015-2016
<1% of world oceans are protected
Artificial reefs
Ecotourism

Coral size class

Number of coral colonies

(a) <5 cm
(b) 6 to 20 cm
(c) 21 to 40 cm
(d) >40 cm

Fishing village
Tourist resort
Uninhabited

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Moritz et al. 2017
Discuss remaining questions from Hoegh-Guldberg

2. Describe one way that warming ocean temperatures negatively affect coral reef systems.

3. How does grazing by fish influence coral growth?

4. In addition to ocean acidification and warming, name three other factors likely to affect coral reef systems at either local or global scales.

5. Describe one other piece of information you thought was interesting in this paper.