

Threats to Coral Reefs

#1 Overfishing & destructive fishing

Destructive fishing

- Bottom Trawling
- Blast-fishing – SE Asia
- high bycatch and collateral damage

Aquarium fish trade

- poorly regulated
- 60% to U.S.
- >90% mortality!
- Marine Aquariums Council




From despair to repair: Dramatic decline of Caribbean corals can be reversed

02 July 2014 | News story

With only about one-sixth of the original coral cover left, most Caribbean coral reefs may disappear in the next 20 years, primarily due to the loss of grazers in the region, according to the latest report by the Global Coral Reef Monitoring Network (GCRMN), the International Union for Conservation of Nature (IUCN) and the United Nations Environment Programme (UNEP).

The report, *Status and Trends of Caribbean Coral Reefs: 1970-2012*, is the most detailed and comprehensive study of its kind published to date – the result of the work of 90 experts over the course of three years. It contains the analysis of more than 35,000 surveys conducted at 80 Caribbean locations since 1970, including studies of corals, sponges, grazing sea urchins and fish.

The results show that the Caribbean corals have declined by more than 50% since the 1970s. But according to the authors, restoring grazer populations and improving other management strategies, such as protection from overfishing and excessive coastal pollution, could help the reefs recover and make them more resilient to future climate change impacts.

“The rate at which the Caribbean corals have been declining is truly alarming,” says Carl Gustaf Lundin, Director of IUCN’s Global Marine and Polar Programme. “But this study brings some very encouraging news: the fate of Caribbean corals is not beyond our control and there are some very concrete steps that we can take to help them recover.”

Climate change has long been thought to be the main culprit in coral degradation. While it does pose a serious threat by making oceans more acidic and raising coral bleaching, the report shows that the loss of grazer populations is the

Restore grazer populations



#2 Land-based Threats

Erosion & Sedimentation

- deforestation
- loss of coastal vegetation
- dredging (water-based)
- up to 50 mg/cm²/day = 50X normal rates

Effects

- blocks light
- clogs polyps
- increased disease
- coral bleaching
- eutrophication**



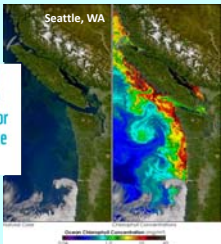




Eutrophication

Nutrient Pollution

- increases phytoplankton and algae growth
- algal blooms → decomposition → ▼ O₂

Land-based sources are responsible for 80% of marine pollution


Confined Animal Feeding Operations (CAFOs)

release millions of tons of manure containing pathogenic organisms & veterinary drugs into U.S. waters every year




Eutrophication - Dead Zones

Commercial Nitrogen Fertilizer Runoff Vulnerability Index




2011: 6,785 square miles (2002 record: 8,500 square miles)

Feedlots too!
Non-point source pollution



Hypoxia → Anoxia
made worse by warming water temps



Eutrophication - Dead Zones

405 global Dead Zones (#1 Baltic Sea, #2 Gulf of MX)
 Lethal effects: Anoxia, toxic H₂S gas
 Sub-lethal effects: hypoxia, reduced gonad size, sex hormones, # eggs, disease

Dead zones threaten coral reefs

Eutrophication - SOLUTIONS

Limit Runoff

- Clean Water Act 1972
 - National Pollutant Discharge Elimination System
 - requires permits, latest tech to treat effluents
 - Waters of the U.S. – Obama 2015
- Setting ponds, No-till, cover crops, riparian buffers

Limit Inputs

- reduce fertilizer use / eliminate subsidies
- fallows, residue management, N-fixers

Eutrophication - SOLUTIONS

Remove Nutrients
 Protect & restore estuaries, littoral ecosystems & sea grasses

Threats to Coral Reefs

Tourism

- 96 countries; for 23 >15% GDP
- coastal development
- boat anchors, trampling
- sewage, sunscreen, trash

Ex.: Maldives
 snorkelers damaged 17% branched coral, 7% of all coral

- Airport construction**: Increased sedimentation from dredging and infilling
- Resort development**: Increased sedimentation, resort operation, sewage disposal, habitat destruction
- Cruise ships**: Nutrient enrichment from illegal sewage disposal. Litter from illegal or accidental solid waste disposal
- Marinas**: Pollution from oils and paint residues, pollution from fuelling
- Artificial beaches**: Increased sedimentation (from sand removal or from beach instability)
- Seafood consumption**: Over-exploitation of high-priced resource species (snapper, grouper, spiny lobster, conch)
- Motor boating and yachting**: Nutrient enrichment from sewage disposal. Pollution from fuelling
- Scuba diving and snorkeling**: Physical damage. Kicking up sediment
- Fishing**: Overexploitation of reef fish stocks
- Demand for marine curiosities**: Exploitation of rare, endangered or vulnerable species such as shells, black coral, turtles

The 27-year decline of coral cover on the Great Barrier Reef and its causes

Glenn De'ath¹, Katharina E. Fabricius², Hugh Sweatman³, and Marji Puttinen³

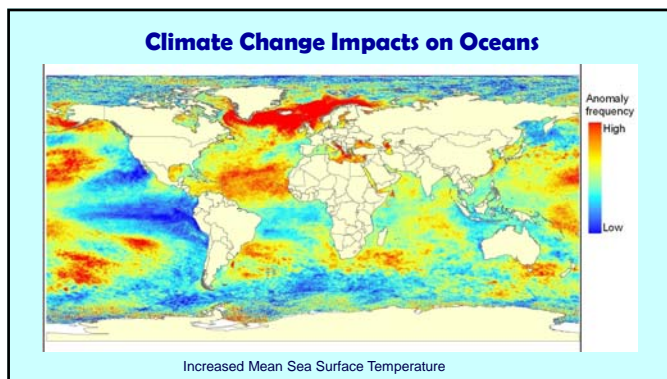
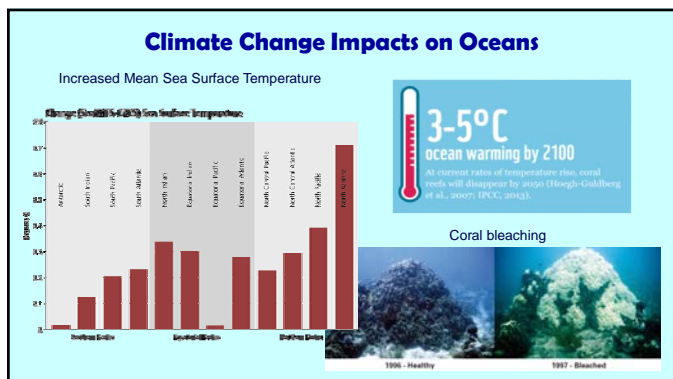
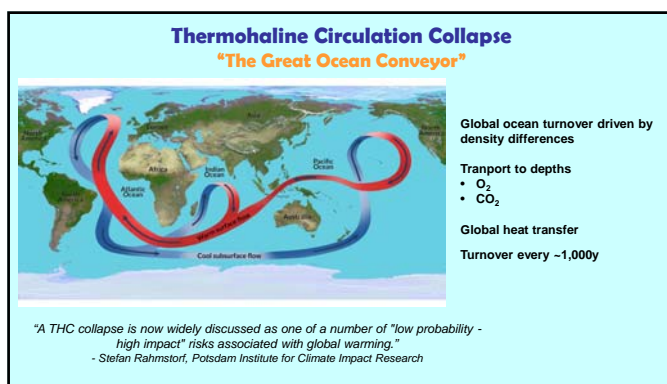
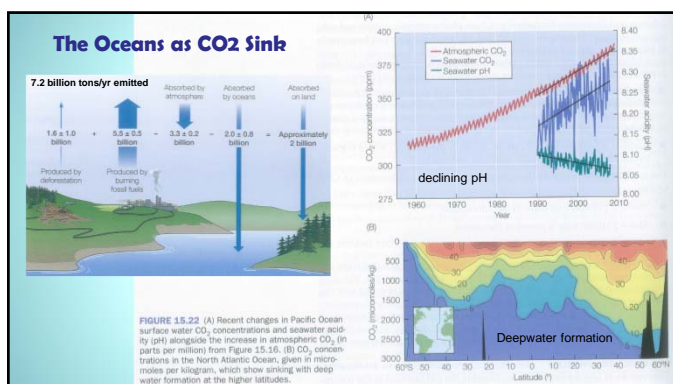
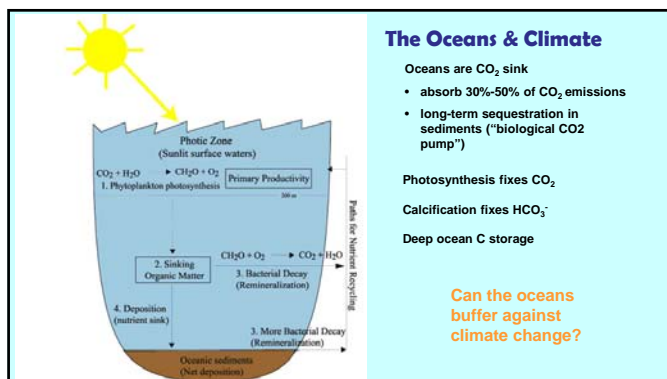
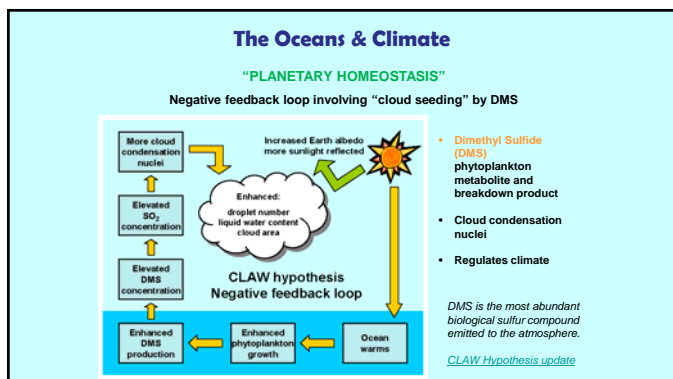
Synergisms among stressors!

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Edited by Paul G. Falkowski, Rutgers, The State University of New Jersey, New Brunswick, NJ, and approved September 5, 2012 (received for review May 25, 2012)

The world's coral reefs are being degraded, and the need to reduce local pressures to offset the effects of increasing global pressures is now widely recognized. This study investigates the spatial and temporal dynamics of coral cover, identifies the main drivers of coral mortality, and quantifies the rates of potential recovery of the Great Barrier Reef. Based on the world's most extensive time series data on reef condition (2,258 surveys of 214 reefs over 1985–2012), we show a major decline in coral cover from 28.6% to 13.8% (0.53% y⁻¹), a loss of 50.7% of initial coral cover. Tropical cyclones, coral predation by crown-of-thorns starfish (COTS), and coral bleaching accounted for 48%, 42%, and 10% of the respective estimated losses, amounting to 3.38% y⁻¹ mortality rate. Importantly, the relatively pristine northern region showed no overall decline. The estimated rate of increase in coral cover in the absence of cyclones, COTS, and bleaching was 2.85% y⁻¹, demonstrating substantial capacity for recovery of reefs. In the absence of COTS, coral cover would increase at 0.89% y⁻¹, despite ongoing losses due to cyclones and bleaching. Thus, reducing COTS populations, by improving water quality and developing alternative control measures, could prevent further coral decline and improve the outlook for the Great Barrier Reef. Such strategies can, however, only be successful if climatic conditions are stabilized, as losses due to bleaching and cyclones will otherwise increase.

anchor damage, vessel groundings, oil spills) had minor adverse effects on the GBR to date. Fishing, although intense near the coast and urban centers, is banned in 33% of the GBR and is regulated elsewhere (11). Nonetheless, the GBR has been subject to severe disturbances, including COTS outbreaks, mass coral bleaching and declining growth rates of coral due to increasing seawater temperatures, terrestrial runoff, tropical cyclones, and coral diseases (2, 3, 12–14). The runoff of soils, fertilizers, and pesticides from agricultural and coastal development has significantly affected inshore coral reefs (12, 15–17), and has likely increased COTS outbreak frequencies (5, 18). Conclusions of scientific studies on the condition of the GBR, based on different datasets and various time periods, have ranged from evidence for fluctuations from localized disturbances (13, 14) to ecosystem-wide declines (1, 2). The objectives of this study were threefold: (i) to investigate spatial patterns and temporal dynamics of coral cover for the whole GBR; (ii) to identify the main causes of coral mortality by combining field estimates of coral cover with observed and modeled environmental data; and (iii) to assess the capacity of reefs to recover in the absence of various disturbances and to estimate future coral cover, given that levels of disturbance remain similar to those of 1985–2012. The study is based on 2,258 reef surveys from 214



The Telegraph
 Thursday 20 March 2014

Tropical fish swimming north because of global warming
 Tropical fish are heading towards the cooler waters of the North Pole, according to the results of a new study on the impact of climate change on fish.

By Louise Gray, Environment Correspondent
 14:46 GMT 20 March 2014

Species spread at the same rate of a warming climate on the distribution of more than 1,000 species of fish around the globe.

They found that as well as their distribution by an average of more than 200 miles each decade, white sea bass found grounds will become richer, many species in coastal streams will go extinct.

Range shifts

Ocean Acidification

Adding CO₂ increases the H⁺ ion concentration in seawater:

$$\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^- \rightleftharpoons 2\text{H}^+ + \text{CO}_3^{2-}$$

Low pH: Reduces carbonate available for calcifying organisms ([link](#))
 Dissolves calcium carbonate shells

Ocean Acidification

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Science News
 from universities, journals, and other research organizations

Ocean Acidification: Impact On Key Organisms Of Oceanic Fauna May Be Worse Than Predicted

July 17, 2014 — In addition to global warming, carbon dioxide emissions cause another, less well-known but equally serious and worrying phenomenon: ocean acidification. Researchers in the Laboratory of Oceanography at Leibniz University (LUPAC) have just demonstrated that key marine organisms, such as deep-water corals and sponges (called patch reefs) will be profoundly affected by this phenomenon during the years to come.

Two studies have been published in the journal *Biogeochemistry*.

Since 1850, around 40% of anthropogenic CO₂ emissions have been absorbed by the oceans, corresponding to an annual uptake of one ton of CO₂ per person. This massive absorption has allowed to partly mitigate climate change but it has also caused a major alteration in the chemistry of seawater. Indeed, this absorbed CO₂ causes an acidification of the oceans and, at the current rate of emissions, it is estimated that their pH will fall by 0.4 units between now and 2100. This corresponds to a 100% increase of the molar acidity of the oceans, which is unprecedented during the past 20 million years. The LUPAC team, led by Jean-Pierre Gattuso,

WA lawsuit (Clean Water Act & ESA) - limit CO₂

Impacts on fish? (Munday 2010)

Sea Level Rise

Sea Level Rise & Population Impact

Projected Sea Level Rise by 2100 (feet)

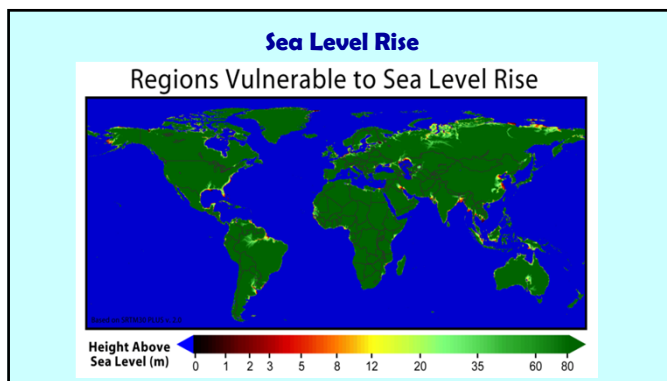
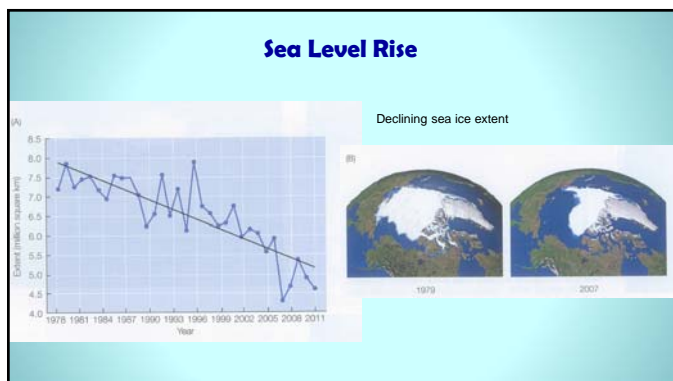
7.8 million	Highest Projection
4.7 million	Intermediate-High Projection
1.8 million	Intermediate-Low Projection
0.7 million	Lowest Projection

Today's Population Living Below Projected High-Tide Line

Recent Sea Level Rise
 23 Annual Tide Gauge Records
 Three Tide Average
 Satellite Altimetry

Rising sea level due to:

- melting ice
- thermal expansion



Climate Change Solutions?

Geoengineering

Ocean fertilization experiments (with Fe)

- Fe is limiting in ocean water; increase phytoplankton production
- Greater uptake of CO₂ – offset climate change!

Problems: unknown long-term impacts, risk of harmful algal blooms, ocean acidification, deepwater anoxia?

[International moratorium recently violated](#)

World's biggest geoengineering experiment 'violates' UN rules

Controversial US businessman's iron fertilisation off west coast of Canada contravenes two UN conventions

- What is geoengineering?
- Canadian government knew of plans to dump iron into the Pacific

Monday 16 October 2012 11:34 AM

2012

REVIEW

Geoengineering the climate: an overview and update

BY J. G. SHEPHERD*

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Key findings include the following.

- Geoengineering is not a magic bullet and not an alternative to emissions reductions.
- Cutting global greenhouse gas emissions must remain our highest priority.
 - (i) But this is proving to be difficult, and geoengineering may be useful to support it.
- Geoengineering is very likely to be technically possible.
 - (i) However, there are major uncertainties and potential risks concerning effectiveness, costs and social and environmental impacts.
- Much more research is needed, as well as public engagement and a system of regulation (for both deployment and for possible large-scale field tests).

2 main classes:

- direct CO₂ removal
- solar radiation mgmt

Climate Change Solutions?

#1 Solution is to Reduce Emissions!

#2 Facilitating Adaptation

- Natural and induced acclimatization

