Unit 3
Oceans Habitats: Organisms to Ecosystems

Learning Goals

1. Describe the ecological roles that organisms play within complex ecosystems (coral reefs as an example).

2. Give examples how diversity links with ecosystem resilience in coral reefs.

3. Examine how global climate change (e.g. increased ocean temperature) jeopardizes the sustainability of coral reefs worldwide.

4. Explain how changes in diversity and food web regime shifts affect people who depend on sustainable ocean resources from coral reefs.

Coral reefs


"Coral reef PloS", Photo courtesy of T. Hughes

are most diverse marine habitats

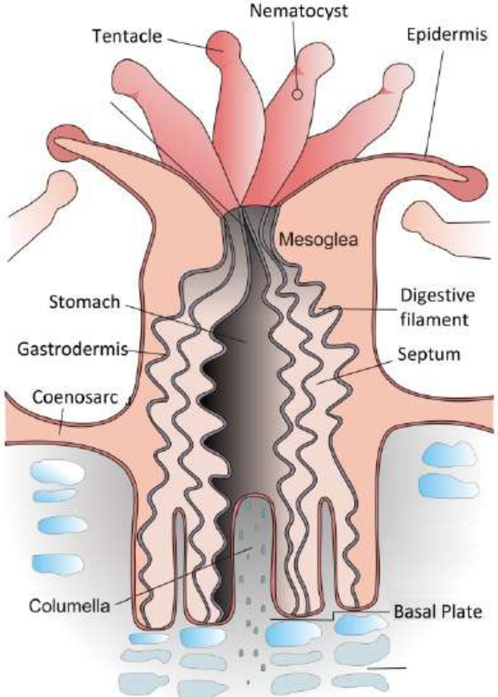
cover ~1% of the ocean floor but support ~25% of all marine species (e.g., 30–60 coral species, 500–800 coral fish species, >3000 invertebrate species)

largest living structures (e.g., Great Barrier Reef >1,200 miles)

Biological interactions (coral symbiosis) as ecosystem foundation

Reef-building corals secrete skeletons of calcium carbonate (aragonite) with help of algal endosymbionts or **zooxanthellae**.

The algae photosynthesize and provide the coral with energy that facilitates high calcification rates. The algae benefit from the coral's excreted nutrients and are protected inside the polyp's tissue. The loss off zooxanthellae can be triggered by environmental stressors (**coral bleaching**).



Anatomical diagram coral polyp

Polyp with zooxanthellae

Coral bleaching causes corals to lose their colored symbionts

Coral Reef Facts

What environments do reef-building corals prefer?

Warm waters (typically 23 to 29ºC), high light, low turbidity, low nutrient waters, "open water" marine salinities (32 to 42 psu)

Why live on a reef?

Food, living space (numerous ecological niches), protection (from waves or predators), mates, mutualistic opportunities ("cleaning stations")

How do organisms make a living – trophic modes?

- autotrophs – capable of photosynthesis
- herbivores – feeding on plant matter
- carnivores – feeding on other animals,
- omnivores – feeding on plants and other organisms
- piscivores – feeding on fish

Reef community members are interconnected.

Trophic Levels within the Food Web:

Primary producers – autotrophs

Primary consumers – feed on primary producers

Secondary Consumers – feed on primary consumers

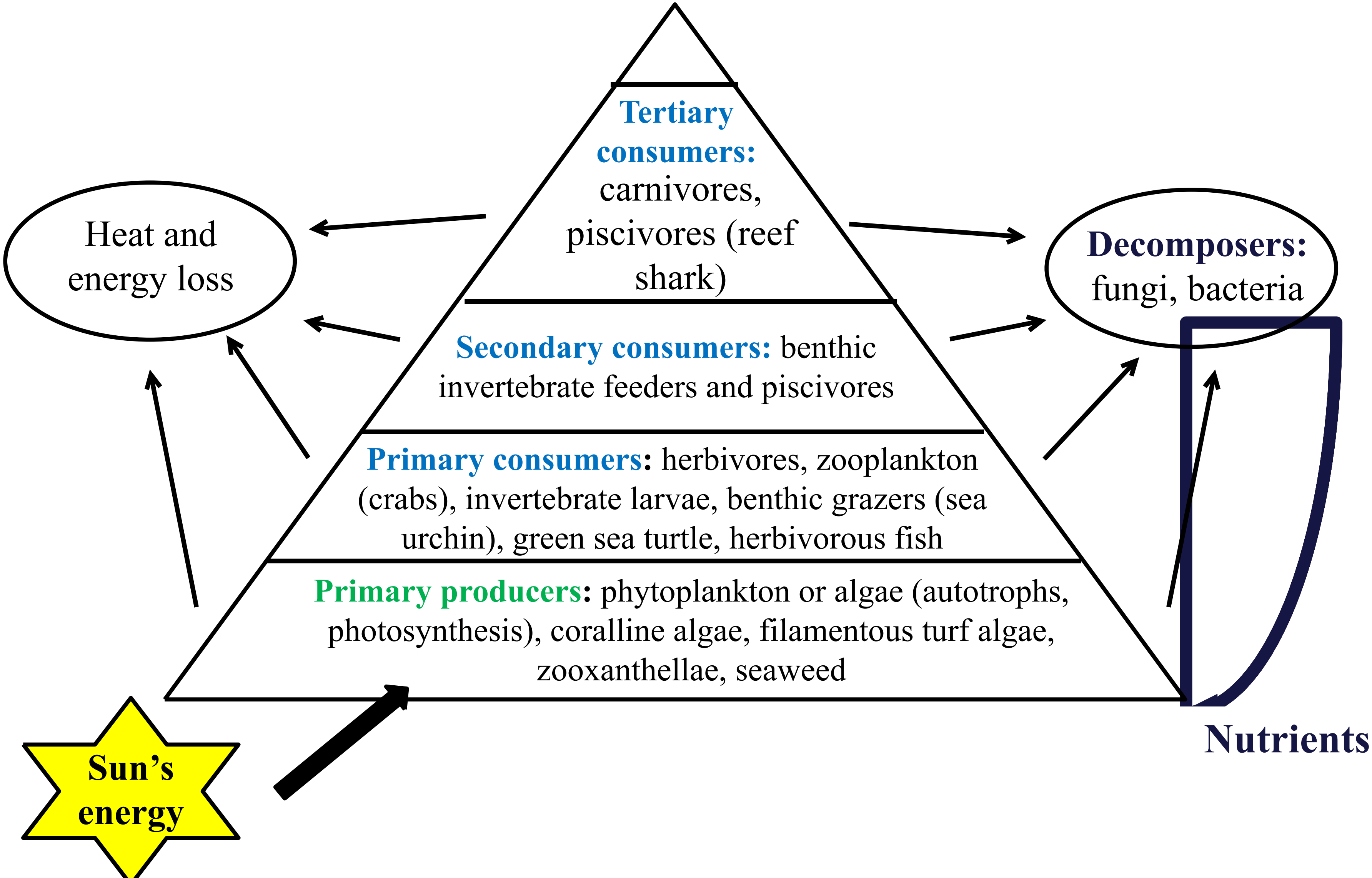
Tertiary Consumers – feed on secondary consumers

Changes on one trophic level affect other trophic levels = ***trophic cascade***.

Coral reef health and resilience depends on balance among ***functional groups***.

Key players cannot be replaced, including reef-building corals, as ***foundation species***.

Trophic Pyramid



Ecosystem regime shifts under stress

Nutrient pollution and macroalgal growth

Destructive fishing or overfishing

Activity 1 – 10 minutes, groups of ~5 students, add all names, assign notetaker

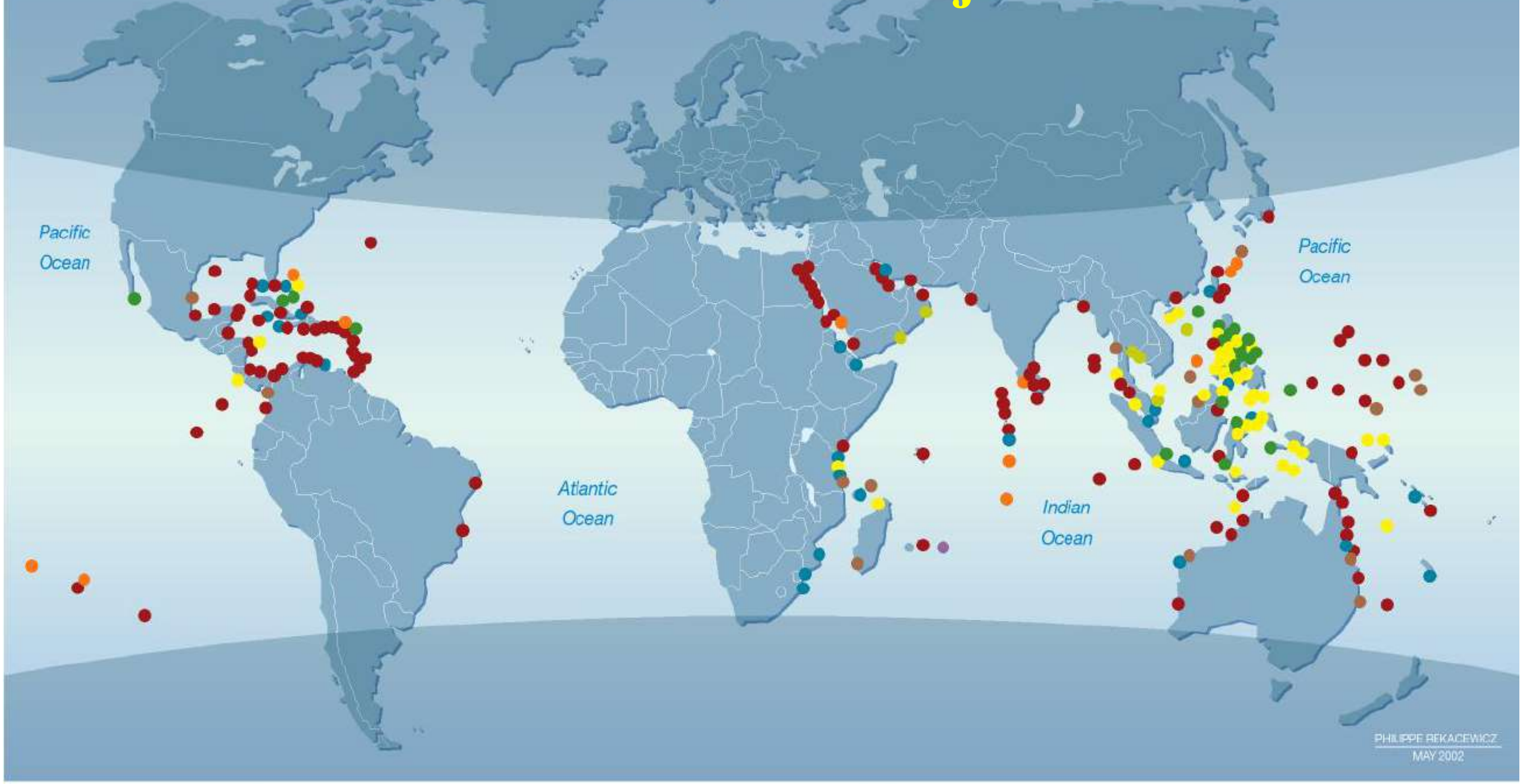
Students names:

Activity 1: Working as a group fill in the missing information "Trophic Mode", "Trophic Level", "Stressors" and "Predicted Impact on Reef". Choose your answers from the options at the bottom of the table**.** For Trophic mode and Trophic level only one term can be selected; for the the other columns multiple selections may fit. Use the lecture material, including the trophic pyramid diagram, to complete this table.

A: 90 ≤ 100%
B: 80 ≤ 90%
C: 70 ≤ 80%
D: 60 ≤ 70%

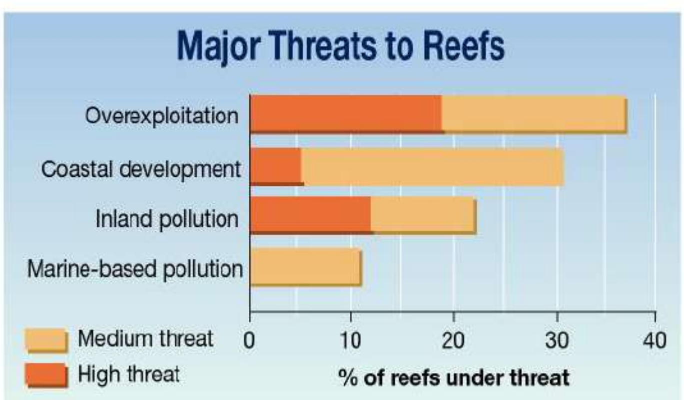
Taxa	Trophic Mode	Trophic Level / Ecological Role	Stressors that Directly Impact Organisms (besides trophic shifts)	Predicted Impact on Reef (direct and indirect effects)
zooxanthellae in coral (photosynthesizers)		primary producer		
coral without zooxanthellae (eats herbivores)				
parrot fish (eats coral w/ zooxanthellae)	herbivore	primary consumer	overfishing and harmful fishing practices	trophic shifts cause unbalance in consumer communities, no new creation of recolonizable space on reef, overgrowth by filamentous algae
barracuda (eats herbivores)				
reef shark (eats carnivores)			disease and overfishing	
	Trophic Modes (pick one for each, best fit)	**Trophic Level / Ecological Role**	**Known Stressors** (There are many correct answers. Choose TWO)	**Predicted Impact on Reef** (direct and indirect effects)
Available Terms	- autotroph - herbivore - piscivore - carnivore	- primary producer - primary consumer - secondary consumer - tertiary consumer	- overfishing / harmful fishing practices - pollution (eutrophication) - disease - thermal stress - salinity change (sessile versus mobile) - sea-level rise (dependence on light) - ocean acidification (calcifying organisms)	- stunted coral growth / reef growth - no new creation of recolonizable space on reef - trophic shift causing unbalance in consumer - overgrowth by filamentous algae

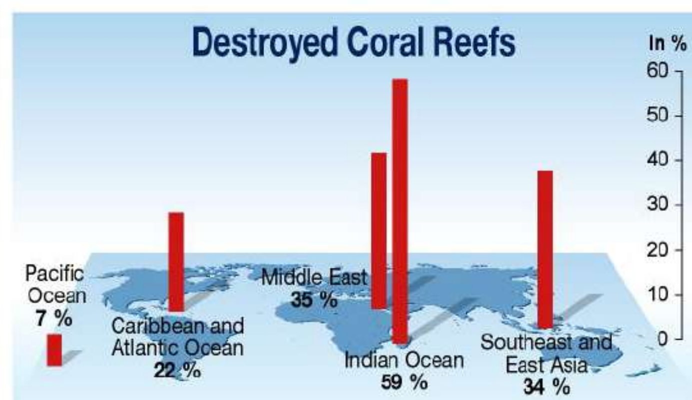
Status of World's Reefs and Major Threats



Categories

- Tourism
- Poison fishing
- Overexploitation
- Sedimentation
- Coral harvesting
- Dynamite fishing
- Pollution



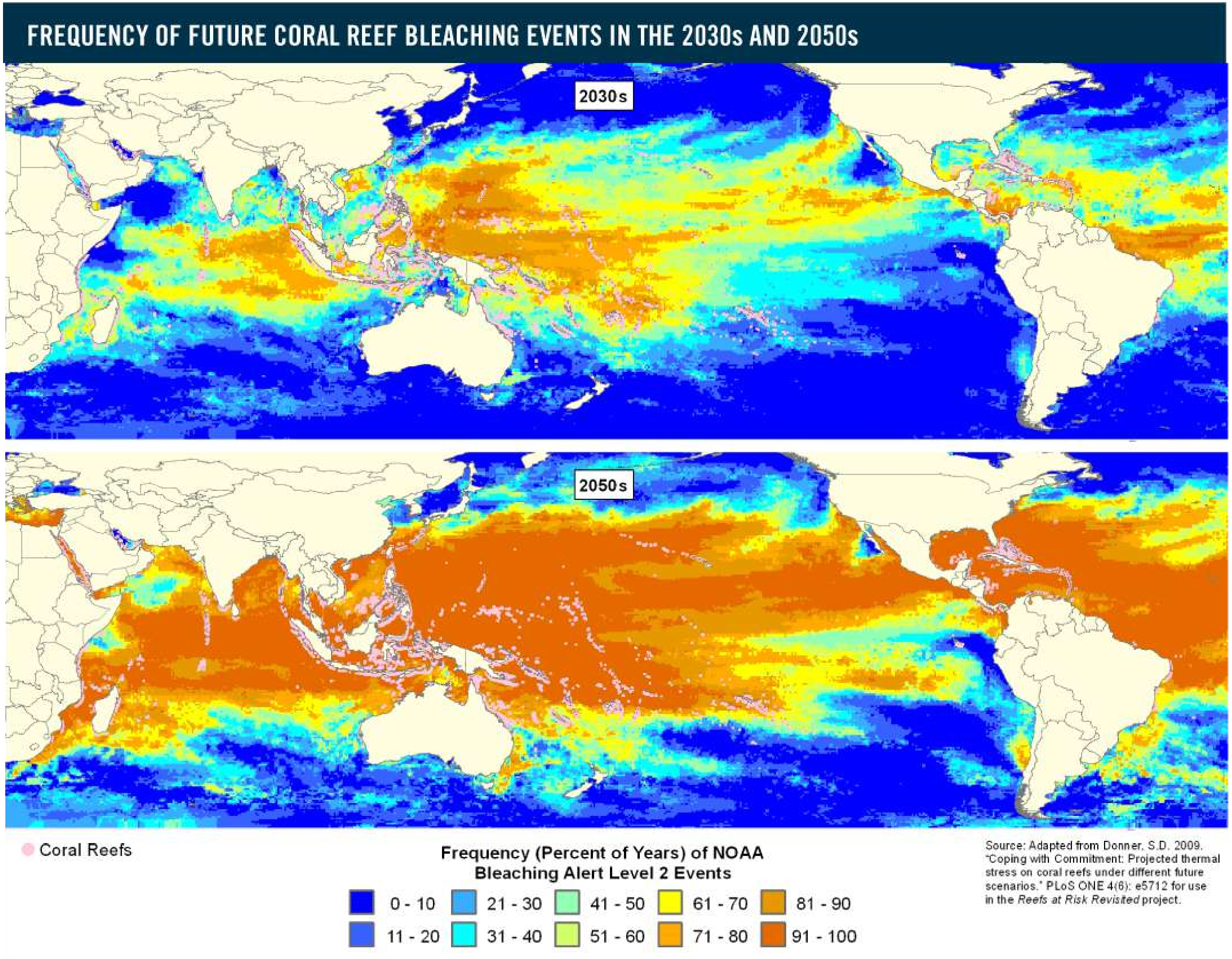


A multidimensional issue: top 10 emerging threats for coral reefs

Global Change Threats	• Coral bleaching—caused by elevated sea surface temperatures due to global climate change; • Rising levels of CO_2 • Diseases, Plagues and Invasives—linked to human disturbances in the environment.
Direct Human Pressures	• Over-fishing (and global market pressures) —including the use of damaging practices (bomb and cyanide fishing); • Sediments—from poor land use, deforestation, and dredging; • Nutrients and Chemical pollution • Development of coastal areas—for urban, industrial, transport and tourism developments, including reclamation and mining of coral reef rock and sand beyond sustainable limits.
The Human Dimension — Governance, Awareness and Political Will	• Rising poverty, increasing populations, alienation from the land • Poor capacity for management and lack of resources • Lack of Political Will, and Oceans Governance

Coral reef services worldwide have an average annual value estimated at $172 billion (economist Pavan Sukhdev of UNEP).

Climate change and coral reefs – thermal stress



Scientific Challenges in Global Climate Change Research

What are synergistic and antagonistic effects (i.e., temperature increase and ocean acidification)?

Why does the complexity of interactions complicate interpretation?

Are there winners and losers — ecosystem regime shifts?

Can we predict change that will occur over decades in short-term scientific experiments?

Homework

In class:

Familiarize yourself with the questions/themes on the homework sheet before watching a 9-minute movie on "Sea Change: The Pacific's Perilous Turn."

Ask questions and as a class discuss possible answers, take individual notes.

At home:

Review the video and associated article as needed.

http://apps.seattletimes.com/reports/sea-change/2013/sep/11/pacific-ocean-perilous-turn-overview/

Use your notes from class and fill in the questions. Submit before beginning of next class.