Lecture 19, 25 October 2005
Global Climate Change

Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2005

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Conservation Biology 406R/506R

1. Global Climate Change
   Implications for Conservation Biology

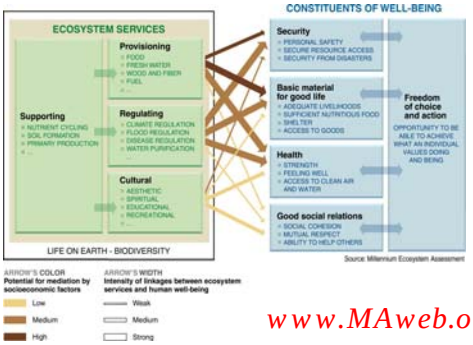
2. Thank Bill Mannan

Exam two on Thursday in lecture
same format as before

2

Millenium Ecosystem Assessment

Focus: Consequences of Ecosystem Change for Human Well-being



www.MAweb.org

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ENVIRONMENT

States Sue Over Global Warming

In a legal gambit aimed against global warming, the attorneys general of eight states last week sued the five largest emitters of carbon dioxide in the United States for creating a public nuisance. The states are asking that the electric utility companies cut emissions by 3% each year for a decade. Legal experts predict the states' case will be an uphill battle.

Carbon dioxide litigation is heating up. In 2002, environmental groups sued the Overseas Private Investment Corp. and the Export-Import Bank of the United States for not conducting environmental reviews on the power plants they financed. And last year, Maine, Massachusetts, and Connecticut sued the Environmental Protection Agency for not regulating CO_2 as a pollutant under the Clean Air Act. Now, the states have taken the first legal action directly against CO_2 emitters.

The plaintiffs—California, Connecticut, Iowa, New Jersey, New York, Rhode Island, Vermont, and Wisconsin, along with the City of New York—claim that the CO_2 that utility companies release contributes to global warming, which will harm state residents. The alleged ills include increased numbers of deaths from heat waves, more asthma from smog, beach erosion, contamination of groundwater from rising sea level, and more droughts and floods. "The harm to our states is increasing daily," Eliot Spitzer, the attorney general of New York state, said at a press conference.

The defendants together spew about 650 million tons of CO_2 a year. Their 174 fossil fuel–burning plants contribute roughly 10% of the anthropogenic CO_2 in the United States. The suit maintains that annual cuts of 3% are feasible through making plants more efficient, promoting conservation, and using wind and solar power—without substantially raising electric bills. "All that is now lacking is action," Spitzer said.

That claim irks American Electric Power of Columbus, Ohio, a defendant. Spokesperson Melissa McHenry says that the company had already committed to reducing its emissions by 10% by 2006. "Filing lawsuits is not constructive," she says. "It's a global issue that can't be addressed by a small group of companies."

It will also be a tough suit to win, says Richard Brooks of Vermont Law School in South Royalton, who studies the legal issues of air pollution. The fact that global warming is a planetwide phenomenon will make it difficult to establish how much these companies are contributing to the claimed harm. And under public-nuisance law, the plaintiffs must show that their citizens are suffering significantly more than the nation as a whole. "I would be totally amazed if the court gave this a serious response," Brooks says. "This makes me imagine that this is more of a symbolic suit."

—ERIK STOKSTAD

590 30 JULY 2004 VOL 305 SCIENCE www.sciencemag.org

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http://www.acia.uaf.edu/

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U.S. wants to bury CO_2 to slow global warming

AZDStar 25 Jan 2004

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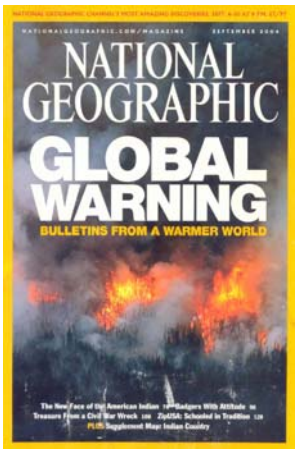

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Global Climate Change

GeoSigns, EcoSigns, Time Signs
National Geographic September 2004

We are changing our planet's climate and the evidence is to be found in the geological, biological, and climatological records available for study.

-Carbon Dioxide, Methane, Nitrous Oxide

-Deforestation, etc.

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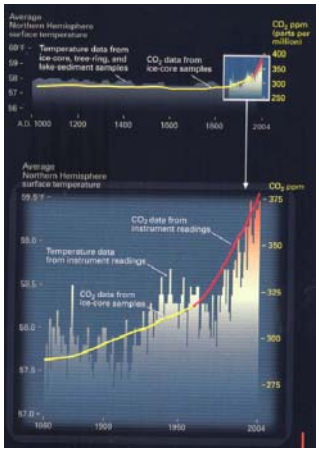

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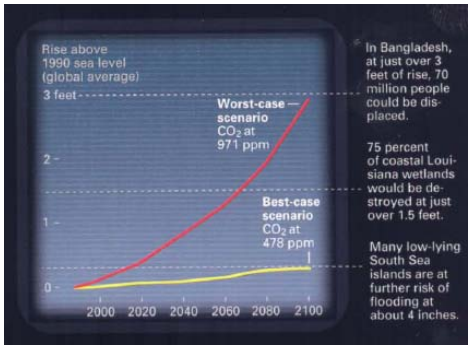

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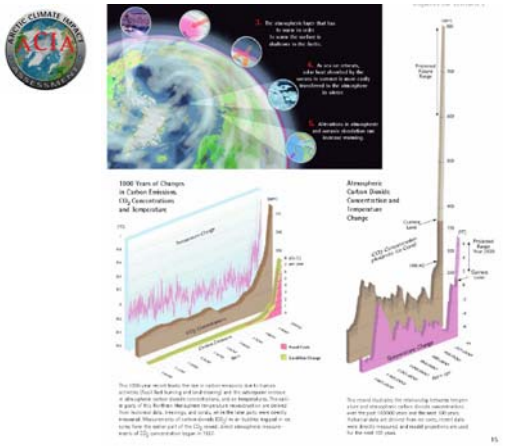

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Selected Greenhouse Gases

- **Carbon Dioxide (CO_2)**
  - Source: Fossil fuel burning, deforestation
  - Anthropogenic increase: **30%**
  - Average atmospheric residence time: **500 years**
- **Methane (CH_4)**
  - Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining
  - Anthropogenic increase: **145%**
  - Average atmospheric residence time: **7-10 years**
- **Nitrous oxide (N_2O)**
  - Source: Industry and agriculture (fertilizers)
  - Anthropogenic increase: **15%**
  - Average atmospheric residence time: **140-190 years**

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GeoSigns

Glaciers
(disappearing; water and electricity for humans)

Sea Level
(>100 million people live within 3' mean sea level)
(1" sea level → 8' beach loss)

Permafrost
(melting and causing subsidence; drunken forests)

Rate of Change

GeoSigns

Hottest Years on Record
1. 1998
2. 2002
3. 2003
4. 2001
5. 1997

Albedo Feedback
(poles changing more rapidly [7-9 F]; 1 F globally)

North Atlantic Thermohaline Circulation
(transfers heat around planet, keeps Europe warm)

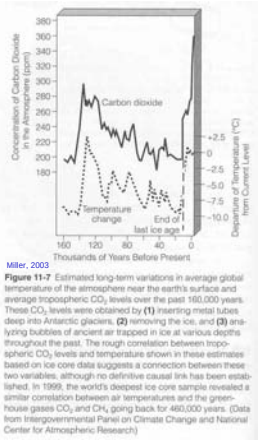
Global Warming

[CO2] higher than in past 420,000 years

20th Century hottest in last 10

Temperature has increased 0.5 C since 1950

Since 1861, 9 of the 10 warmest years occurred since 1990



Miller, 2003

Figure 11-7 Estimated long-term variations in average global temperature of the atmosphere near the earth's surface and average tropospheric CO_2 levels over the past 160,000 years. These CO_2 levels were obtained by **(1)** inserting metal tubes deep into Antarctic glaciers, **(2)** removing the ice, and **(3)** analyzing bubbles of ancient air trapped in ice at various depths throughout the past. The rough correlation between tropospheric CO_2 levels and temperature shown in these estimates based on ice core data suggests a connection between these two variables, although no definitive causal link has been established. In 1999, the world's deepest ice core sample revealed a similar correlation between air temperatures and the greenhouse gases CO_2 and CH_4 going back for 460,000 years. (Data from Intergovernmental Panel on Climate Change and National Center for Atmospheric Research)

EcoSigns

Adelie Penguins, Polar Bears
(ice shelves for nesting and foraging on krill)
(thinner bears b/c feeding season shortened)

Timing of Migration, Reproduction (incl. TSD)

Shifting Ranges
(sky islands, invasives, decoupled food webs)

Anthropogenic Barriers
(restrict movements)

Coral Bleaching
(1998, 16% corals killed or bleached)

Health & Science

Report: Warming dooms Great Barrier Reef's coral

SYDNEY — Australia's Great Barrier Reef will lose most of its coral cover by 2050 and, at worst, the world's largest coral system could collapse by 2100 because of global warming, a study released on Saturday said.

The study by Queensland University's Centre for Marine Studies, commissioned by the Worldwide Fund for Nature, said the destruction of coral on the Great Barrier Reef is inevitable due to global warming.

"Under the worst-case scenario, coral populations will collapse by 2100 and the reestablishment of coral reefs will be highly unlikely over the following 200-500 years," said the report titled "Implications of Climate Change for Australia's Great Barrier Reef."

The Great Barrier Reef is the world's largest living reef formation, stretching 1,300 miles north to south along Australia's northeast coast.

"Only if global average temperature change is kept to below 2 degrees Celsius can the reef have any chance of recovering from the predicted damage," the report said.

Coral has a narrow comfort zone and is highly stressed by a temperature rise of less than 1 degree Celsius.

Water temperature increases of less than 1 degree coincided with the world's worst recorded coral bleaching episode in 1998. With bleaching, the warmer water forces out the algae that give coral its color and, if all are lost, the coral dies and the reef will crumble.

In 1998, 16 percent of the world's coral died, with 46 percent of the Indian Ocean coral destroyed.

Scientists project water temperatures to rise this century by 2 and 6 degrees Celsius.

The Australian report said that by 2050 the Great Barrier Reef would annually experience stress levels higher than those of 1998 and, by 2100, stress levels globally for coral would be several times higher than 1998.

"Coral cover will decrease to less than 5 percent on most reefs (in the Great Barrier Reef) by the middle of the century under even the most favorable assumptions," said the report.

"Reefs will not disappear but they will be devoid of coral and dominated by other less appealing species, such as seaweed."

Global Climate Change

TimeSigns

Stalagmites, Coral Rings
(evidence of cave flooding; annual variability)

Tree Rings
(sophisticated recorders of environmental fluctuations)

Ice Cores
(data going back >100,000 years)
(ice cores as conservation tools?)

Sediment Cores
(mud, pollen)

Pack Rat Middens
(hoarders, urinaters, climate fluctuation)

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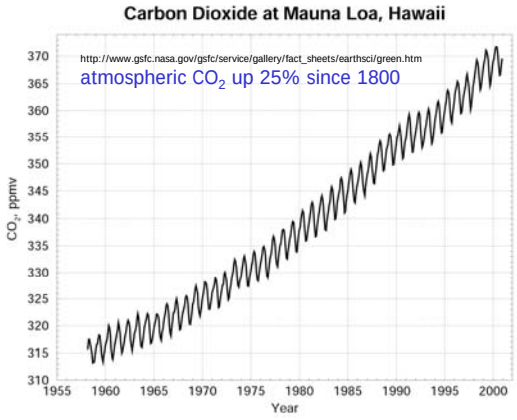

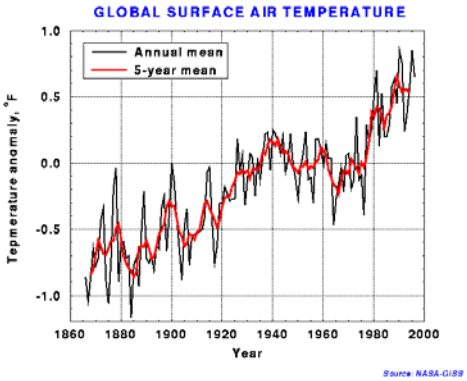

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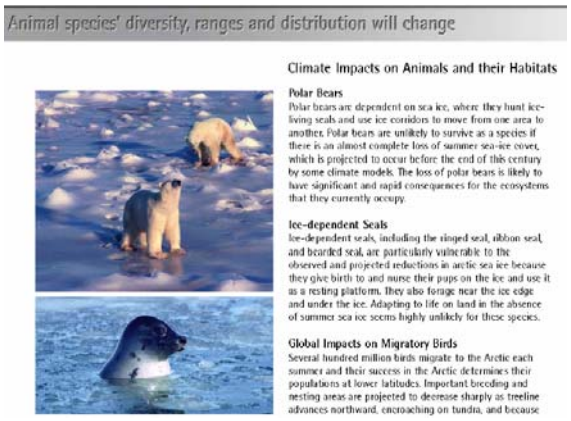


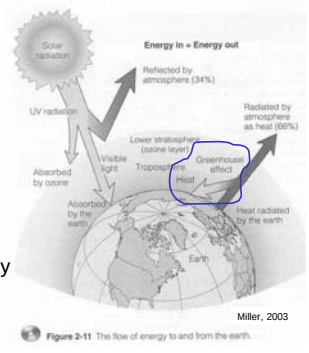
What happens to the solar radiation that reaches the earth?

-1 billionth solar output

-visible and ultraviolet (UV)

-greenhouse gases
(water vapor, CO_2, methane, nitrous oxide, ozone)

-autotrophs/primary productivty



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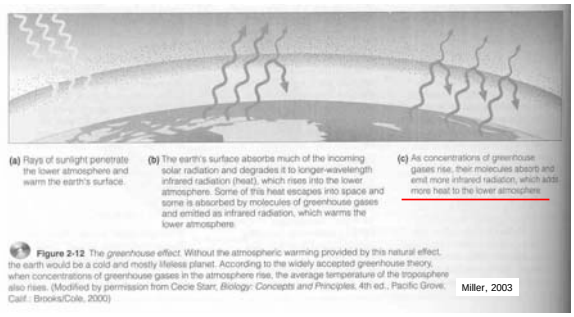
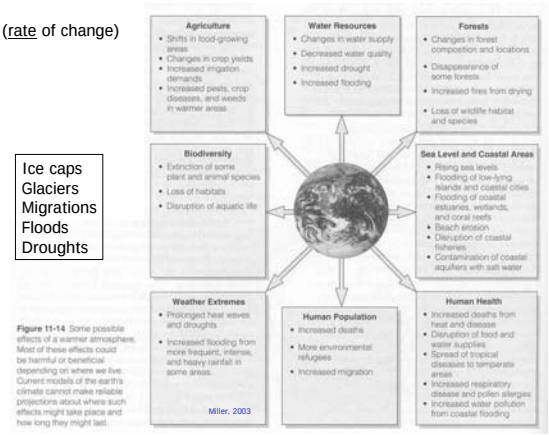
Greenhouse Effect

- earth's surface absorbs or reflects
- reflected either into space or absorbed by gases
- greenhouse gases heat up and emit infrared radiation



(rate of change)

Ice caps
Glaciers
Migrations
Floods
Droughts



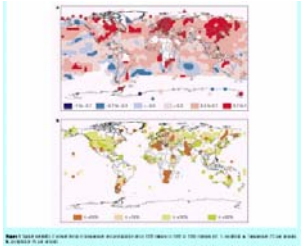
Walther et al. 2002

Ecological Responses to Recent Climate Change

Spatial Heterogeneity

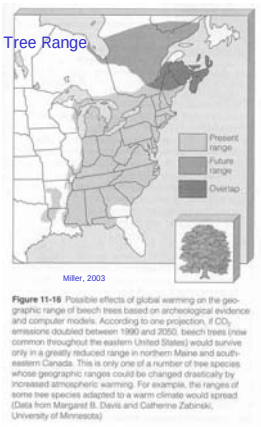
Phenology
- timing
- frost-free days
- variability

Range Shifts
1. temperature
2. precipitation
-latitude and altitude



Walther et al. 2002, Fig. 1

Beech Tree Range



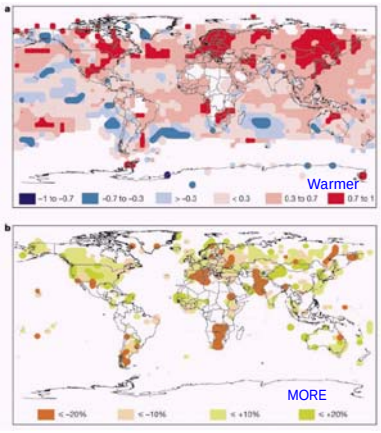
- poles will heat up relatively faster

For each 1 degree C change:
- climate belts will shift toward the poles by 100-150 km

Degree C per decade

(Spatial heterogeneity)

Percent change in precipitation



Walther et al. 2002, Fig. 1

Walther et al. 2002, Fig. 3

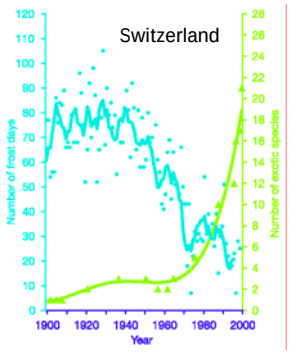
Walther et al. 2002

Ecological Responses to Recent Climate Change

Community Changes
- -Plant structure
  animal community
- -Bleaching
- -Antarctic

Ecosystem Changes
- -Recruitment
- -Trophic interactions

Synergistic Effects
(cod, coral)



Hayhoe et al. 2004
Emissions and climate change in California

-Two models
sensitive (PCM), less sensitive (HadCM3)

-Two CO_2 values
550ppm, 970ppm

Dismissed by one expert as
"another piece of climate alarmism"
(NYTimes 17 Aug 2004)

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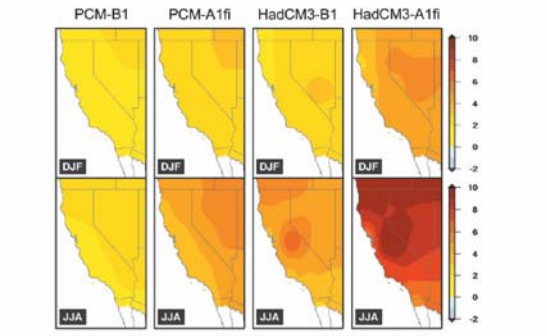

Fig. 1. Downscaled winter (DJF) and summer (JJA) temperature change (°C) for 2070–2099, relative to 1961–1990 for a 1/8° grid. Statewide, SRES B1 to A1fi winter temperature projections for the end of the century are 2.2–3°C and 2.3–4°C for PCM and HadCM3, respectively, compared with previous projections of 1.2–2.5°C and 3–3.5°C for PCM and HadCM2, respectively. End-of-century B1 to A1fi summer temperature projections are 2.2–4°C and 4.6–8.3°C for PCM and HadCM3, respectively, compared with previous projections of 1.3–3°C and 3–4°C for PCM and HadCM2, respectively (11–14).

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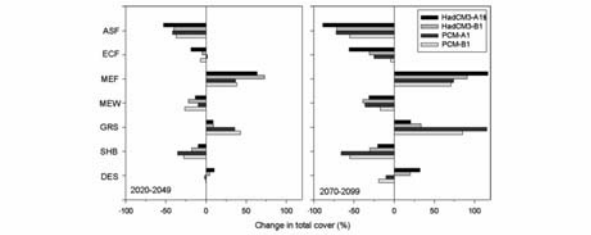

Fig. 3. Statewide change in cover of major vegetation types for 2020–2049 and 2070–2099, relative to simulated distributions for the 1961–1990 reference period. ASF, alpine/subalpine forest; ECF, evergreen conifer forest; MEF, mixed evergreen forest; MEW, mixed evergreen woodland; GRS, grassland; SHB, shrubland; DES, desert. Increasing temperatures drive the reduction in alpine/subalpine forest cover and cause mixed conifer forest to displace evergreen conifer forest in the Sierra Nevada Mountains and the North Coast. Mixed conifer forest in the South Coast expands because of increased humidity and reduced fire frequency. Because of drier conditions and increased fire frequency in inland locations, grassland displaces shrubland and woodland, particularly in the PCM simulations, whereas warmer and drier conditions under HadCM3 cause an expansion of desert cover in the southern Central Valley.

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Hayhoe et al. 2004
Emissions and climate change in California

1. Temperature (increase 1.5 – 9.0 C)
2. Precipitation (mostly decrease)
3. Heat Index (Hot in L.A. = more deaths)
4. Snowpack, Runoff, Water Reserves (trade-off)
5. Agriculture (wine grapes, milk)

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