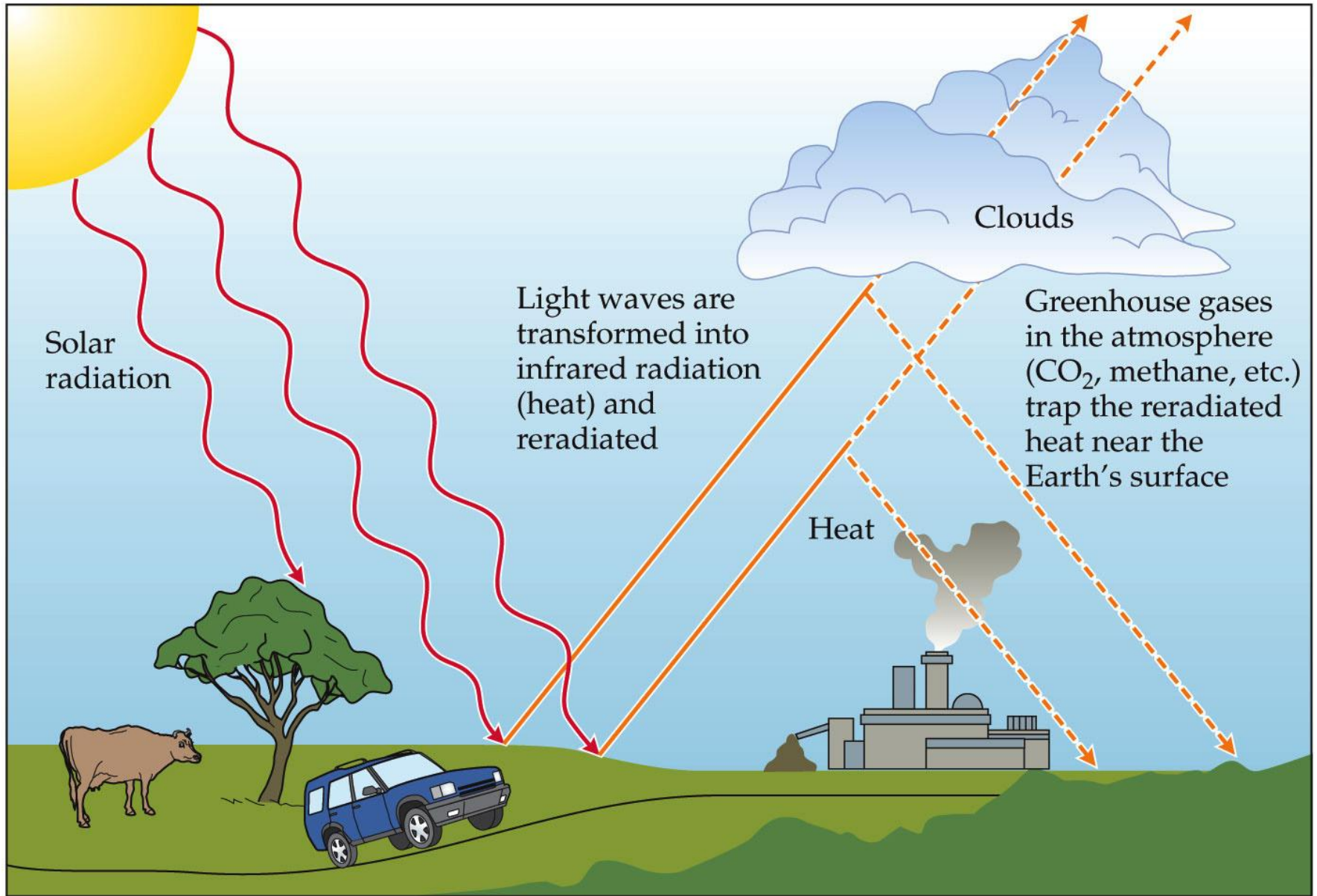
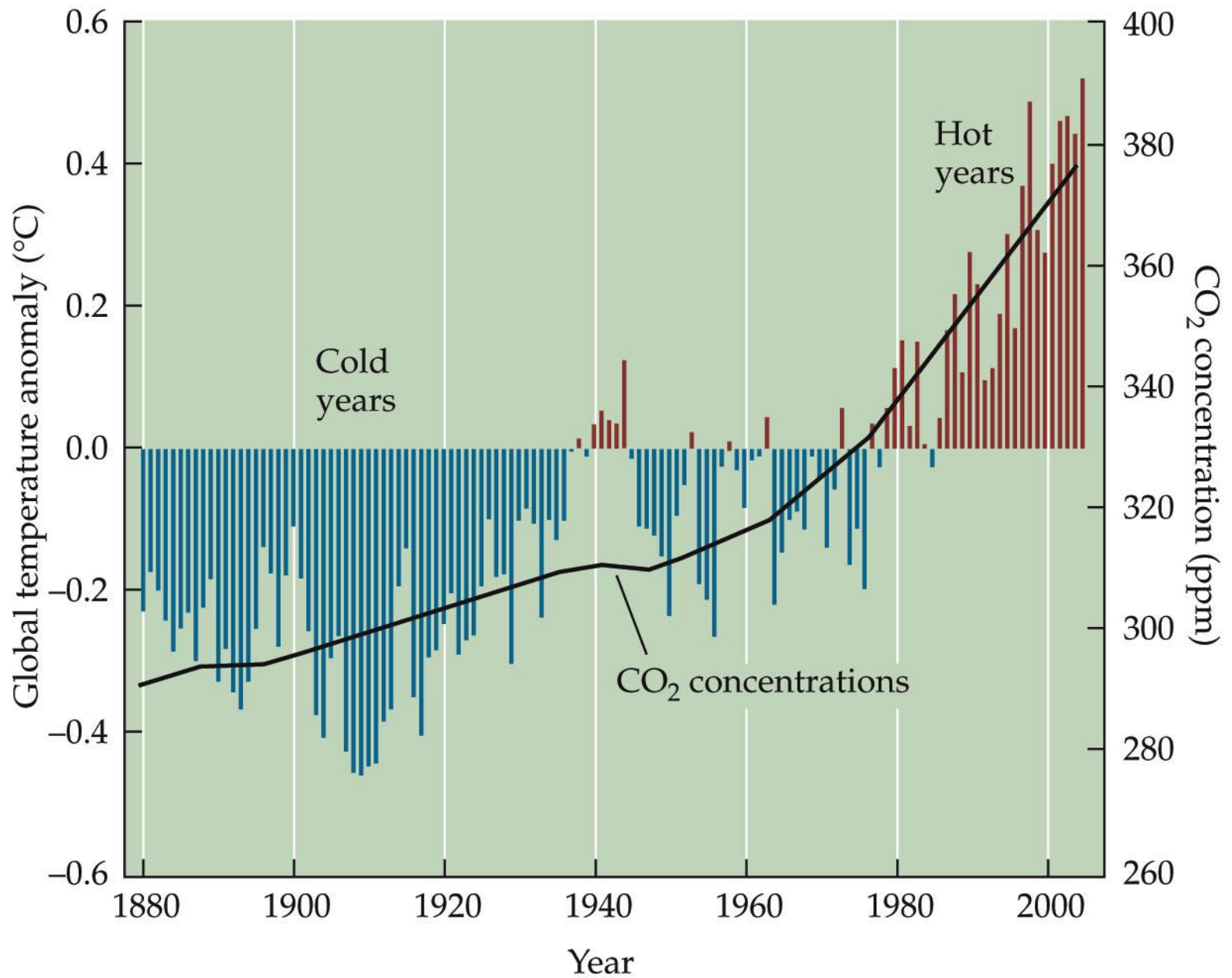


Climate Change: The Crisis of Our Times



How can we reduce impacts to native species?

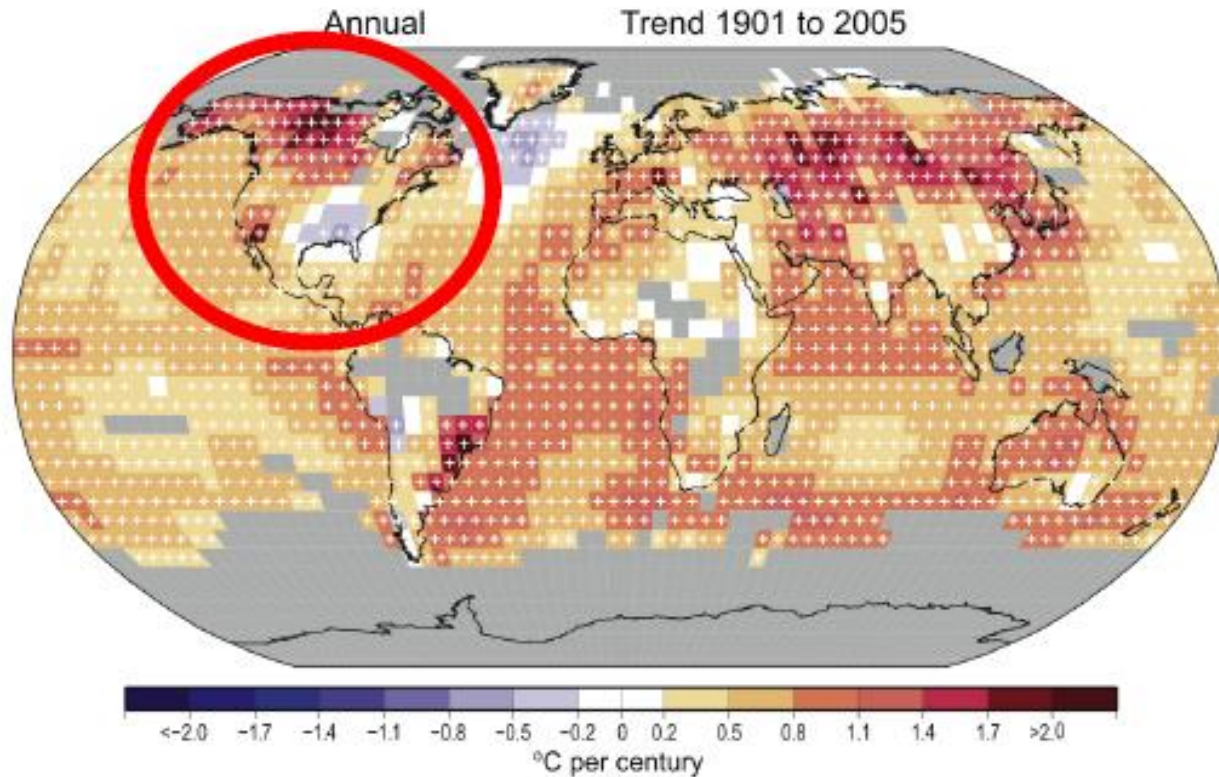




ESSENTIALS OF CONSERVATION BIOLOGY, 5e, Figure 9.25

Temperature Trends

1901 to 2005



- Average 0.74°C increase in temperature in past 100 years, 0.65°C in past 50 years – warming not uniform.

One Issue, Two Perspectives

•“Two thousand scientists, in a hundred countries, engaged in the most elaborate, well organized scientific collaboration in the history of humankind, have produced long-since a consensus that we will face a string of terrible catastrophes unless we act to prepare ourselves and deal with the underlying causes of global warming.” --**Al Gore**

•“The whole (global warming) thing is created to destroy America's free enterprise system and our economic stability” --**Jerry Falwell**

"According to a new U.N. report, the global warming outlook is much worse than originally predicted. Which is pretty bad when they originally predicted it would destroy the planet."

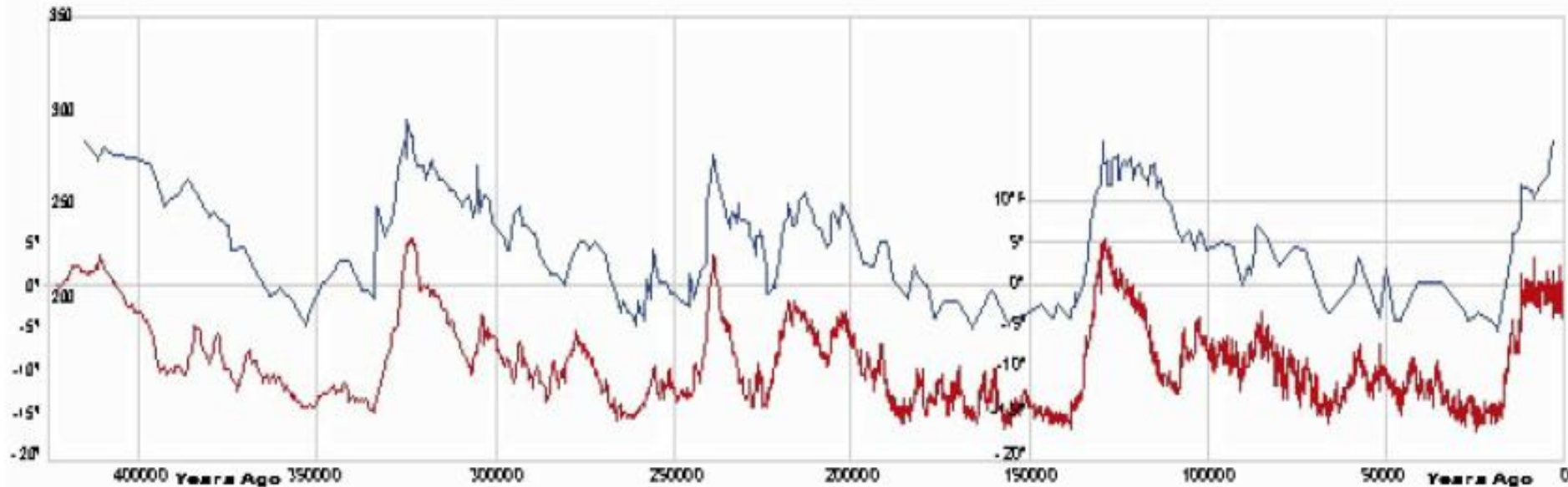
--Jay Leno

Scientists say because of global warming they expect the world's oceans to rise four and a half feet. The scientists say this can mean only one thing: Gary Coleman is going to drown." --**Conan O'Brien**

Past 400,000 Years:

379 ppm

400,000 Years of Antarctic CO₂ and Temperature Change



Upper, blue line = CO₂ level

Lower, red line = temperature

Temperature and CO₂ record from Vostok, Antarctica ice core project

(Petit *et al.* 1999)

TABLE 9.3 Some Evidence for Global Warming (*Part 1*)

1. Increased temperatures and incidence of heat waves

Examples: 2007 was the warmest year worldwide over the past 125 years; previously the warmest year was 2005. An August 2003 heat wave in France killed over 10,000 people as temperatures reached 40°C (104°F).

2. Melting of glaciers and polar ice

Examples: Arctic Sea summer ice has declined by 15% in area over the past 25 years. Since 1850, glaciers in the European Alps have disappeared from more than 30%–40% of their former range.

3. Rising sea levels

Example: Since 1938, one-third of the coastal marshes in a wildlife refuge in Chesapeake Bay have been submerged by rising seawater.

Source: Union of Concerned Scientists (www.ucsusa.org) and NASA.

TABLE 9.3 Some Evidence for Global Warming (*Part 2*)

4. Earlier flowering of plants

Example: Two-thirds of plant species are now flowering earlier than they did several decades ago.

5. Earlier spring activity

Example: One-third of English birds are now laying eggs earlier in the year than they did 30 years ago, and oak trees are now leafing out earlier than they did 40 years ago.

6. Shifts in species ranges

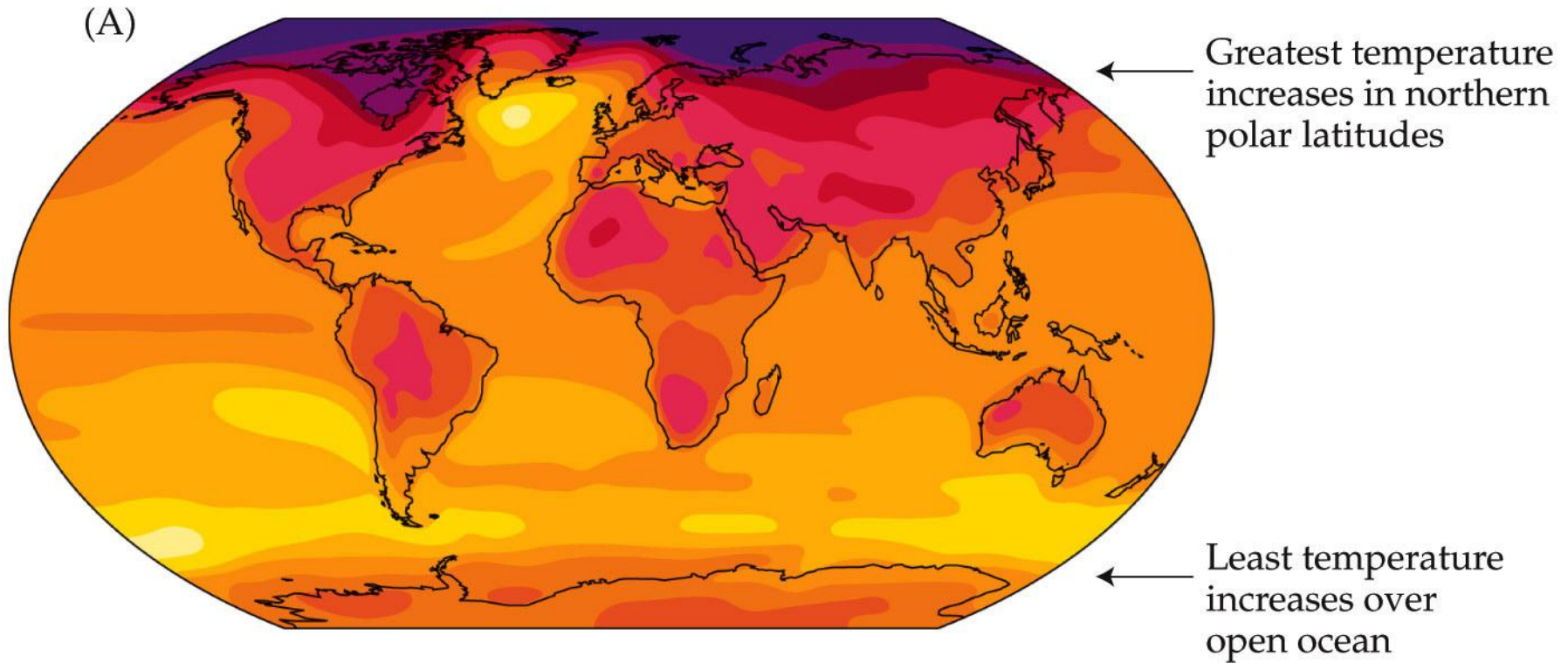
Example: Two-thirds of European butterfly species studied are now found farther north by 35 to 250 km than recorded several decades ago.

7. Population declines

Example: Adélie penguin populations have declined over the past 25 years as their Antarctic sea ice habitat melts away.

Source: Union of Concerned Scientists (www.ucsusa.org) and NASA.

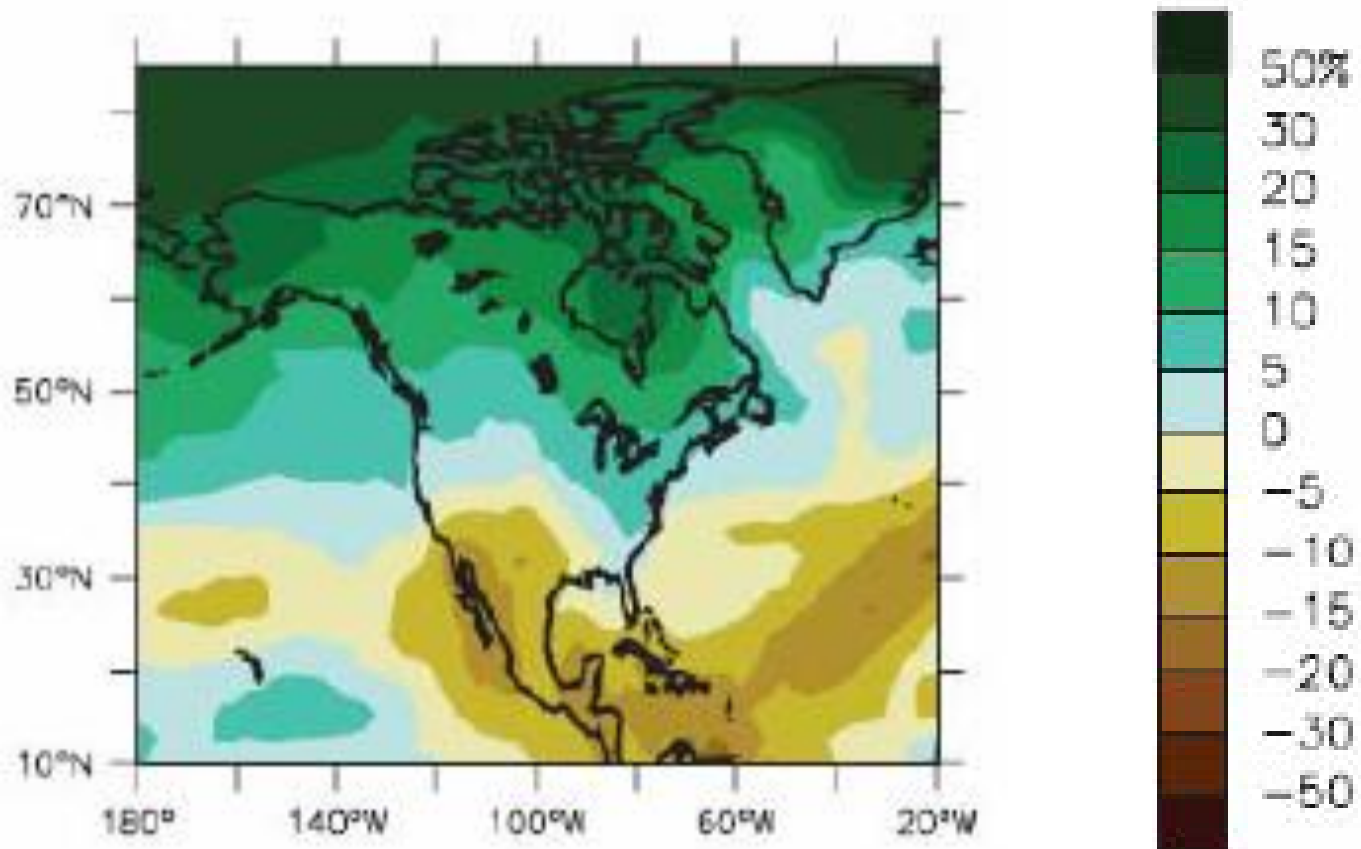
Greater Increases in Temperature Are Expected

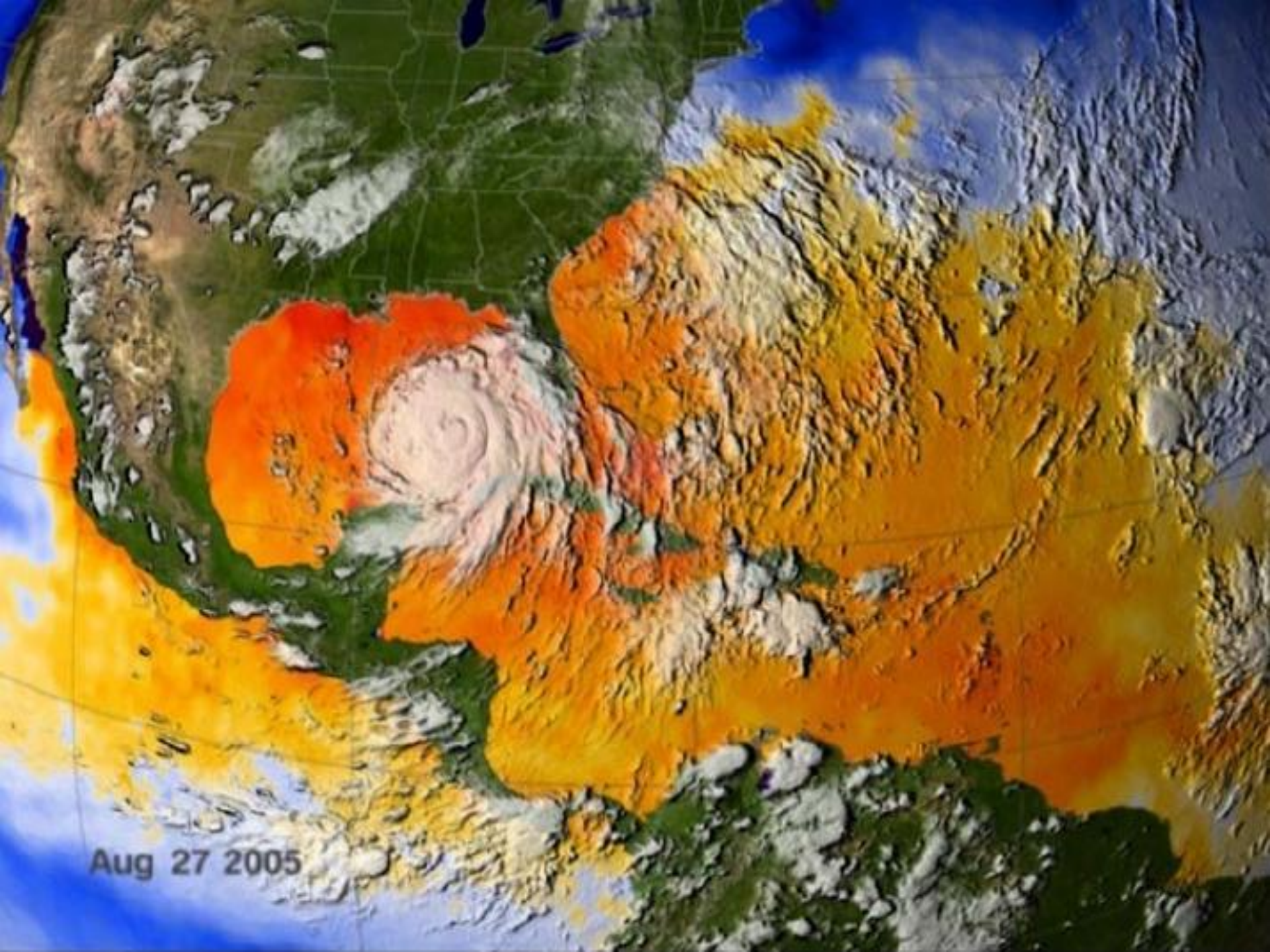


Change from average mean surface temperature 1980–1999 (°C)



Predicted Changes in Precipitation





Aug 27 2005

Climate Change and Affected Habitats

- Low-lying coastal areas
- Wetlands (especially freshwater)
- Coral reefs
- Arid lands
- High altitude ecosystems
- Glacial fed regions
- Arctic ecosystems

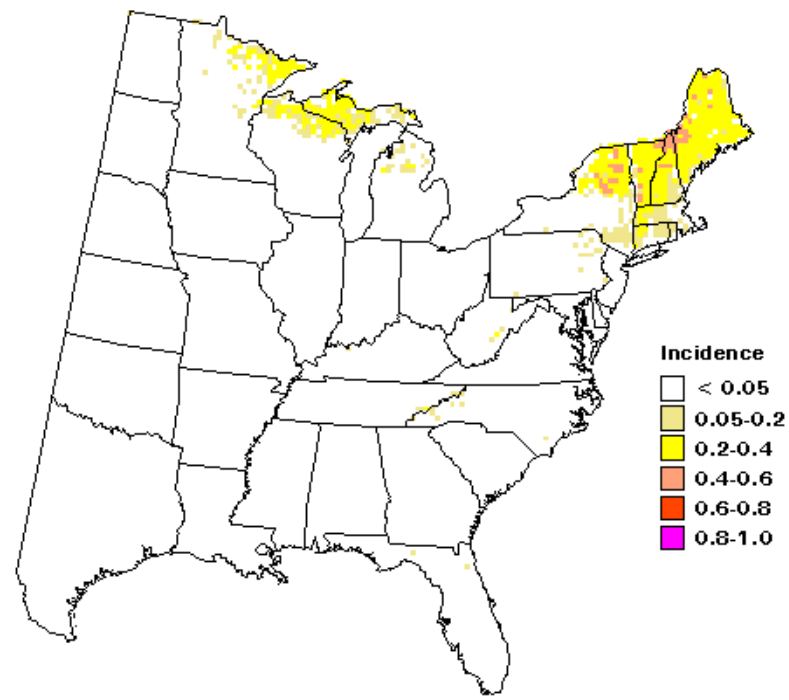
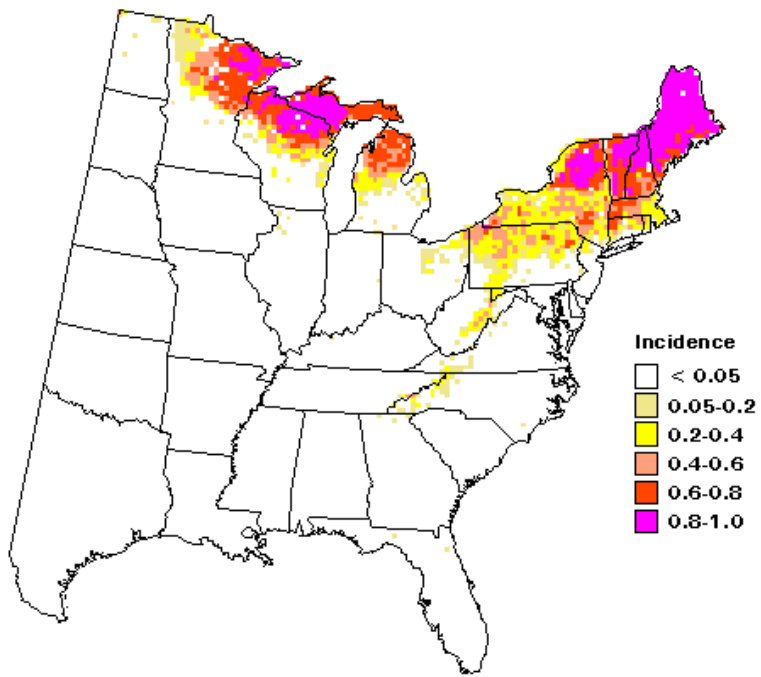


Potential Responses to Changing Habitats

- **Acclimatization:** morphological, behavioral, or physiological changes during an organisms lifetime
- **Adaptation:** species evolve new traits over a number of generations to cope with altered environments
- **Disperse:** follow shifting habitats, which depends on dispersal ability and barriers
- **Go extinct**

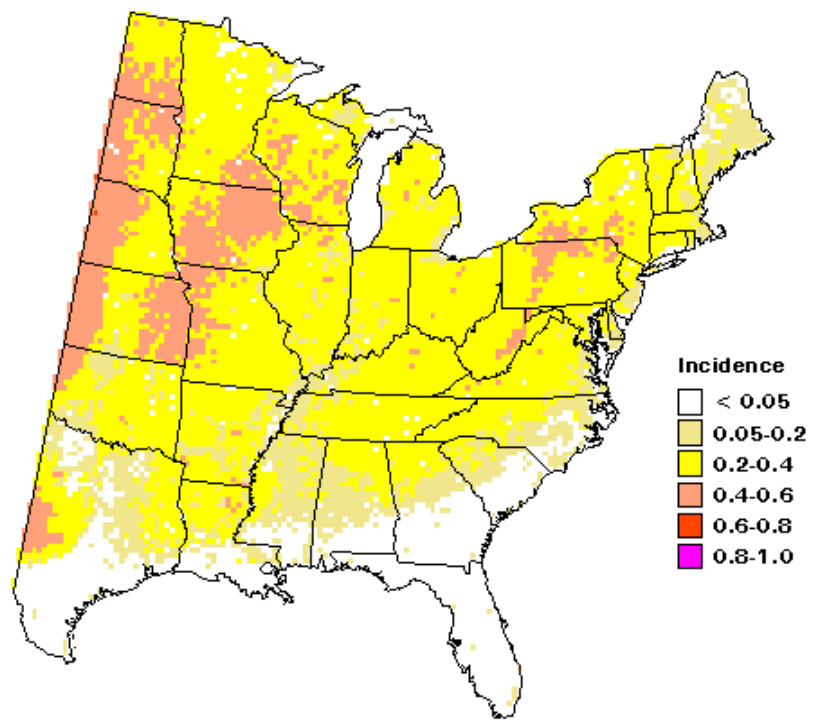
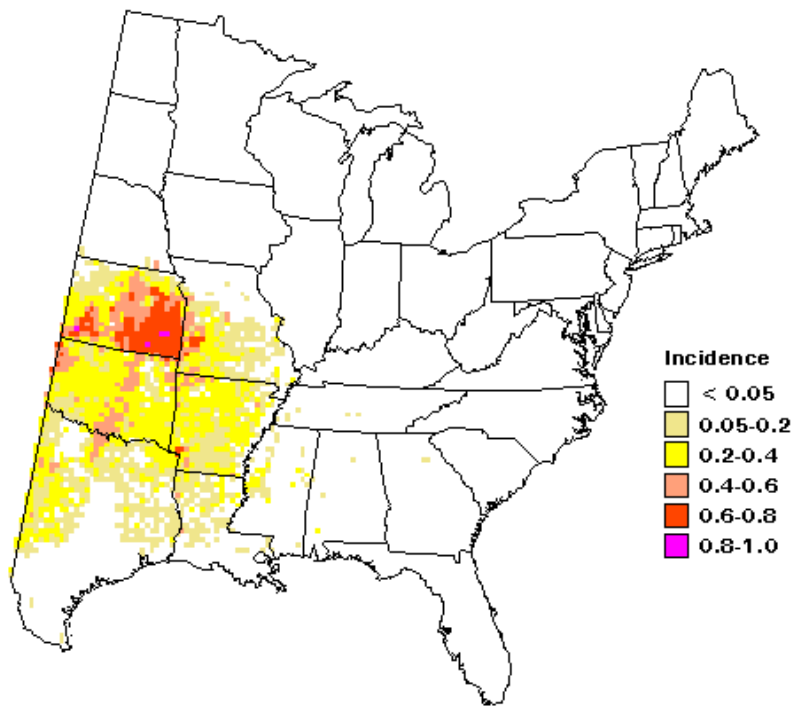
Latitudinal Range Shifts in Native Birds

- **Moving northward (and out of northern Wisconsin?)**
 - Gray Jay 10.7 km/yr
 - Boreal Chickadee 11.8 km/yr
 - White-throated Sparrow 20.6 km/yr
 - Swainson's Thrush 54.5 km/yr
- **Moving northward into and through Wisconsin**
 - Carolina Wren 10.6 km/yr
 - Carolina Chickadee 53.8 km/yr
 - Northern Mockingbird 94.6 km/yr
 - Kentucky Warbler 48.4 km/yr



PURPLE FINCH

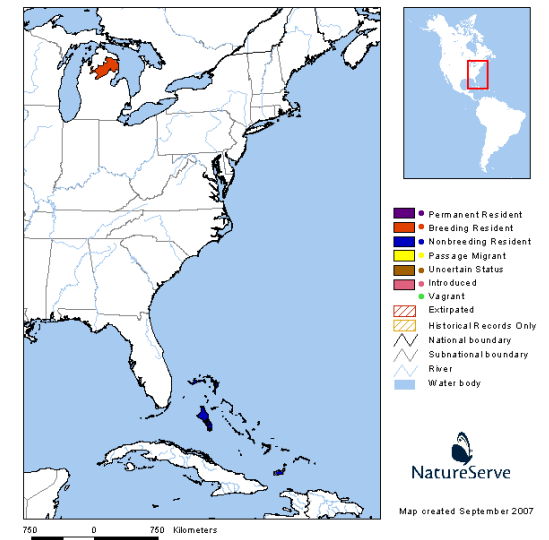
Steve Matthews, Louis R Iverson, Anantha M Prasad, Matt Peters
 NRS-4151, USDA Forest Service, Northern Research Station, Delaware, Ohio



SCISSOR-TAILED FLYCATCHER

ARE EXTINCTIONS POSSIBLE?

- Kirtland's Warbler in a spatial predicament
 - Small geographic range
 - Restricted to Jack Pine forests on sandy soil
 - Northward range shift of Jack Pine onto non-sandy soils may make habitat unsuitable



Spotted Owls and Climate Change



IPCC Emission Scenario

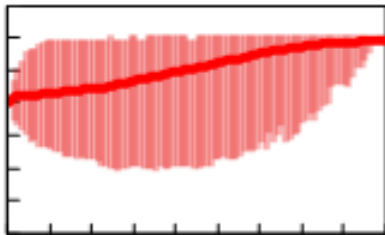
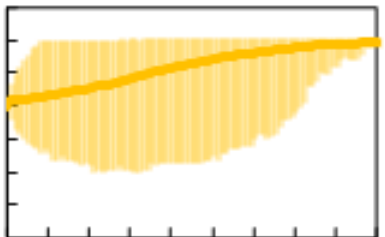
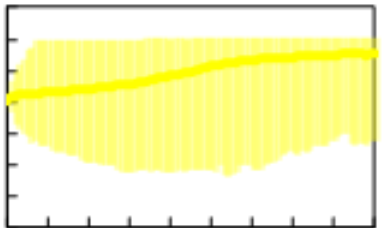
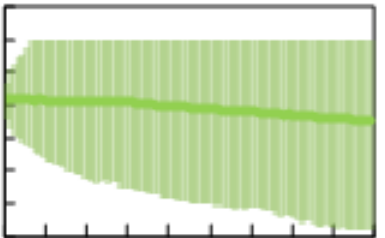
Current
Climate

B1

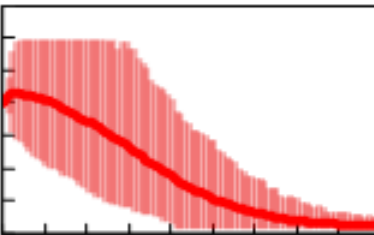
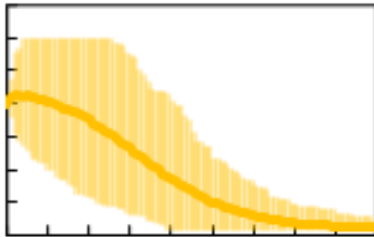
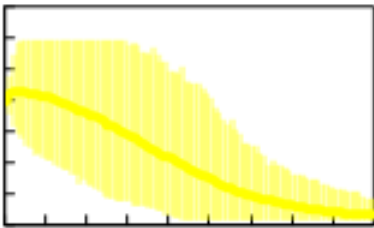
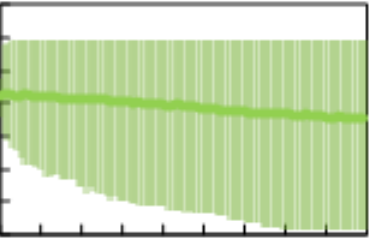
A1B

A2

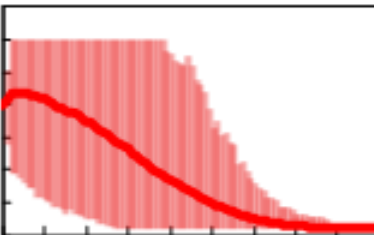
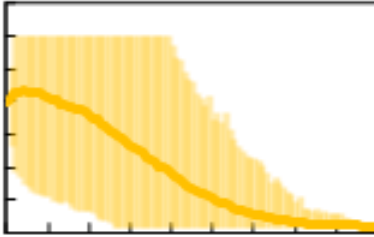
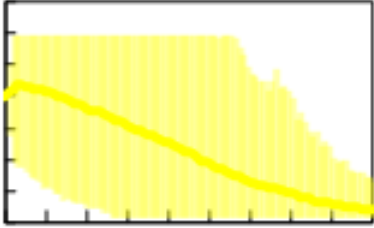
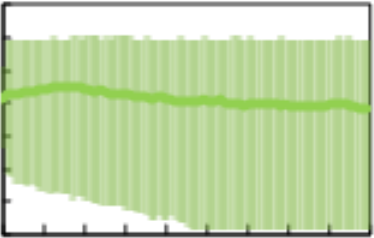
Southern California



New Mexico



Arizona



Mean Population Size (71% CL)

20 18 16 14 12 10 8 6 4 2 0

2000 2010 2020 2030 2040 2050 2060 2070 2080 2090

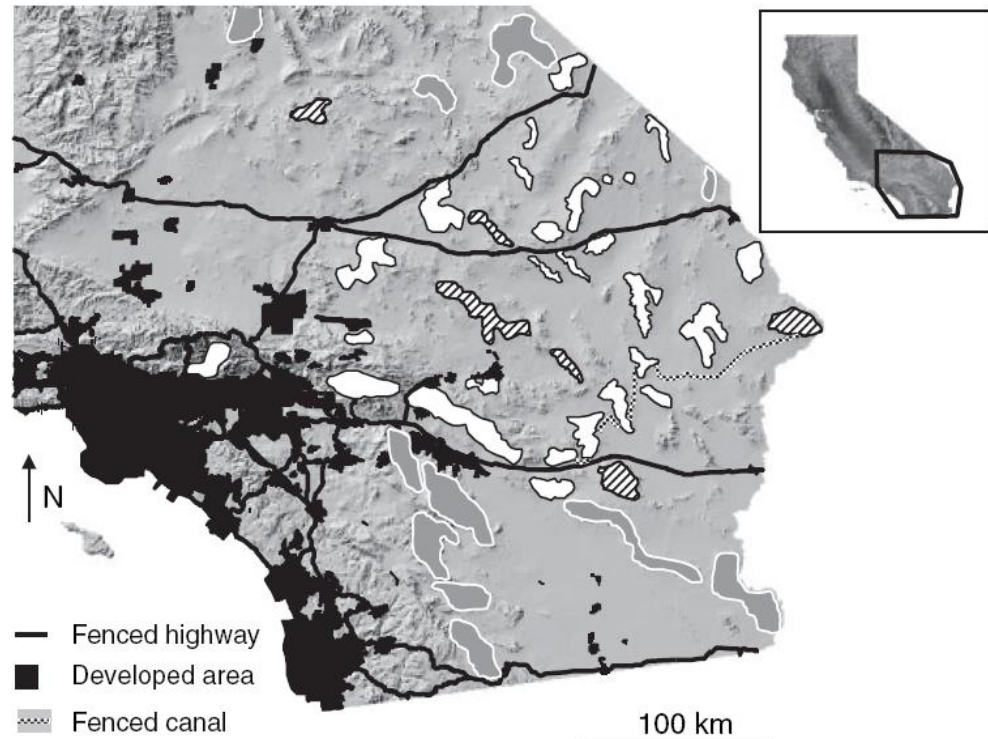
2000 2010 2020 2030 2040 2050 2060 2070 2080 2090

2000 2010 2020 2030 2040 2050 2060 2070 2080 2090

Year

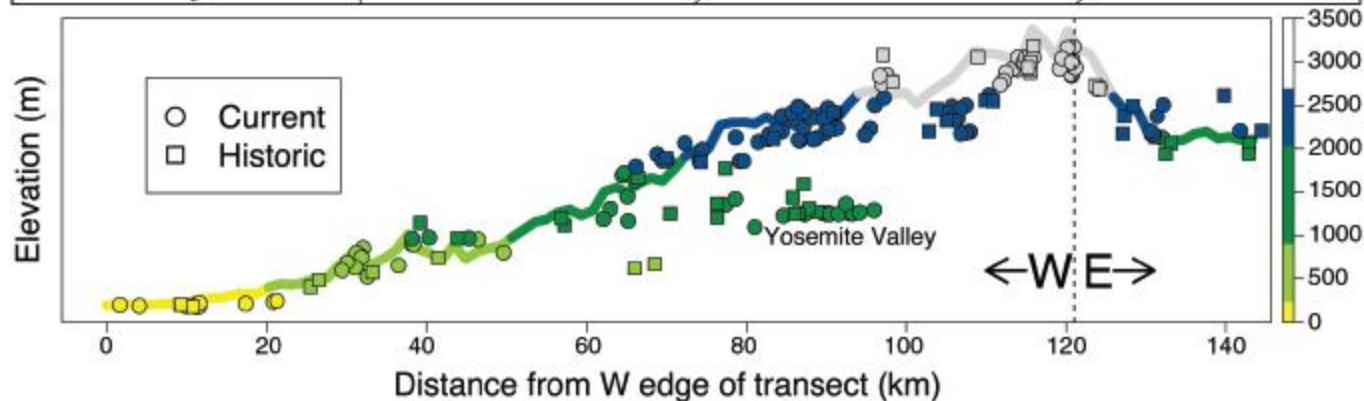
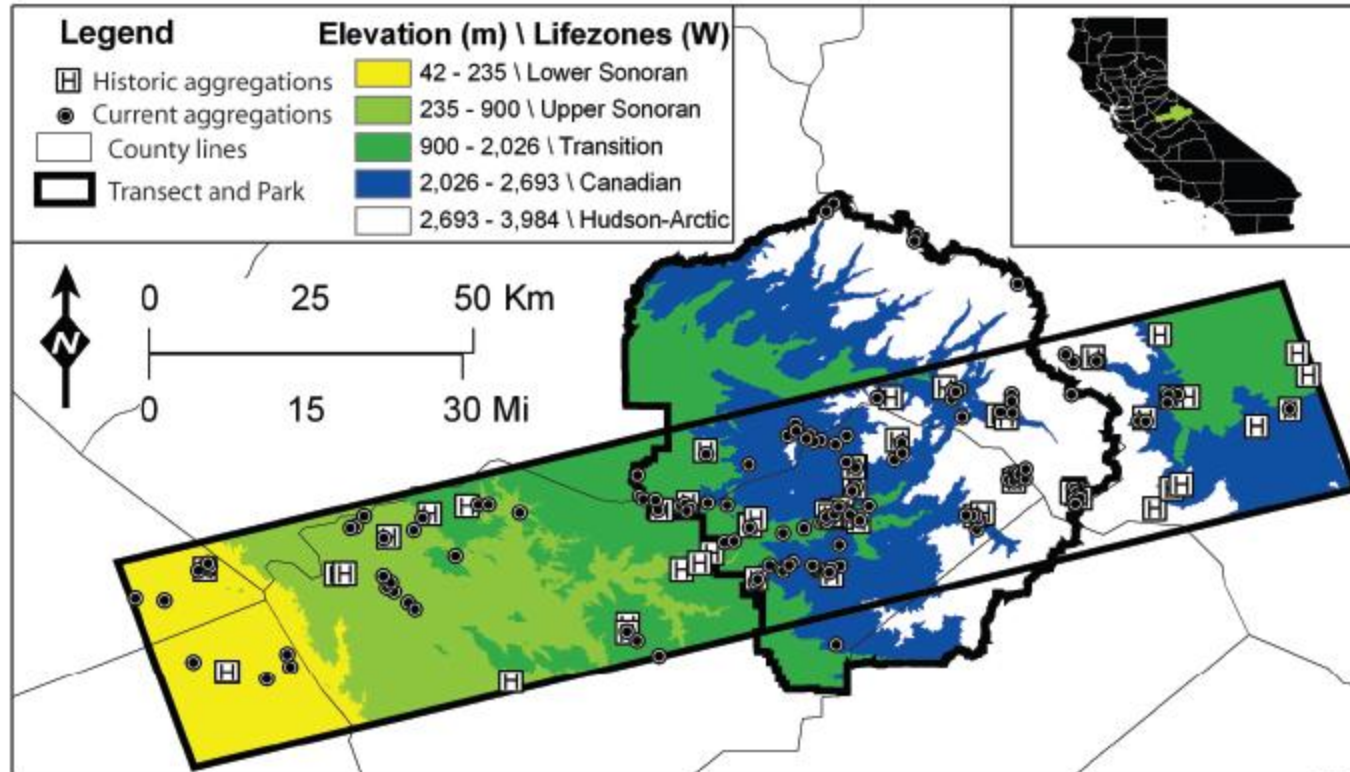
Roads as Barriers to Dispersal

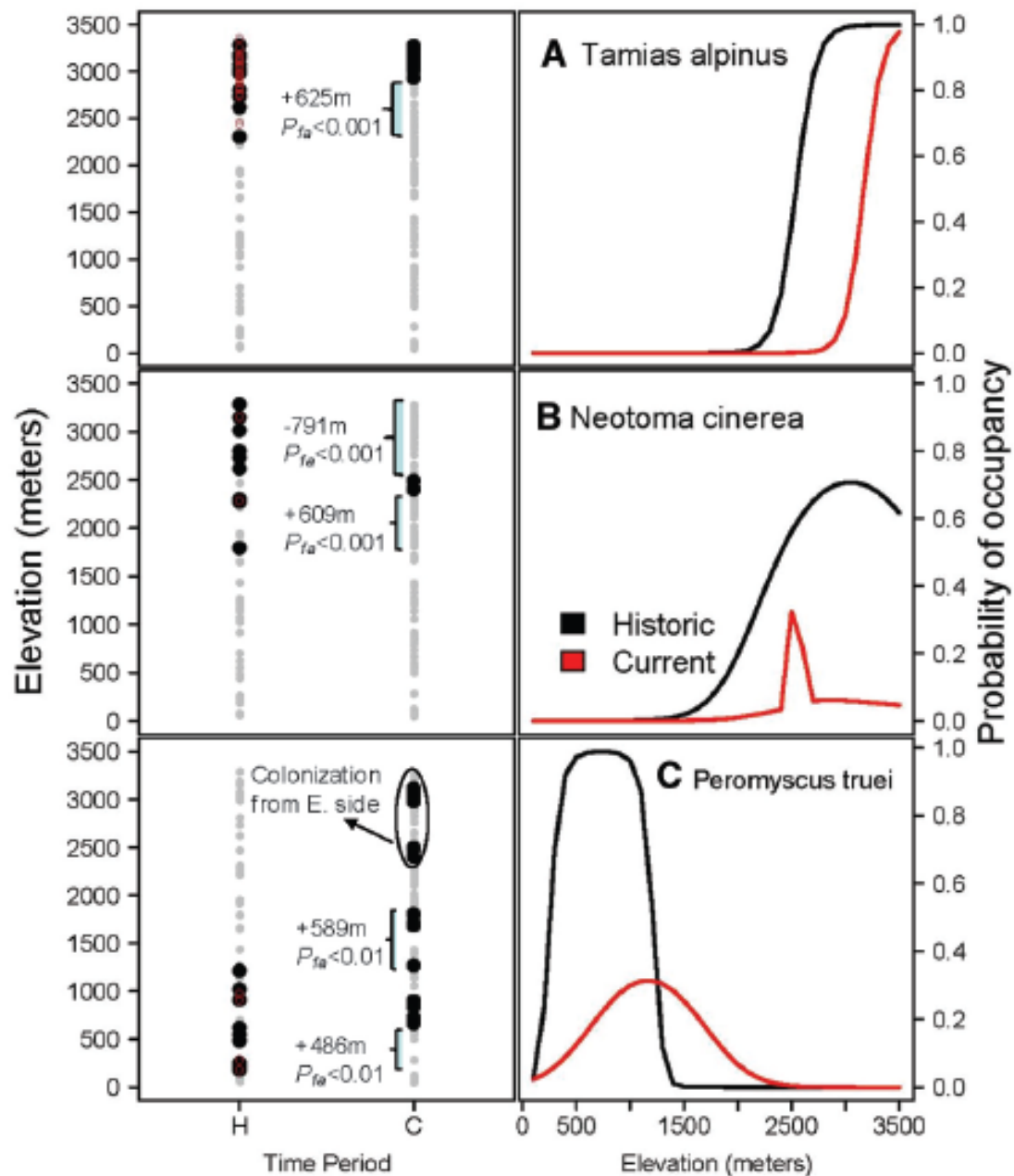
Will desert bighorn sheep be able to track a shifting climate?

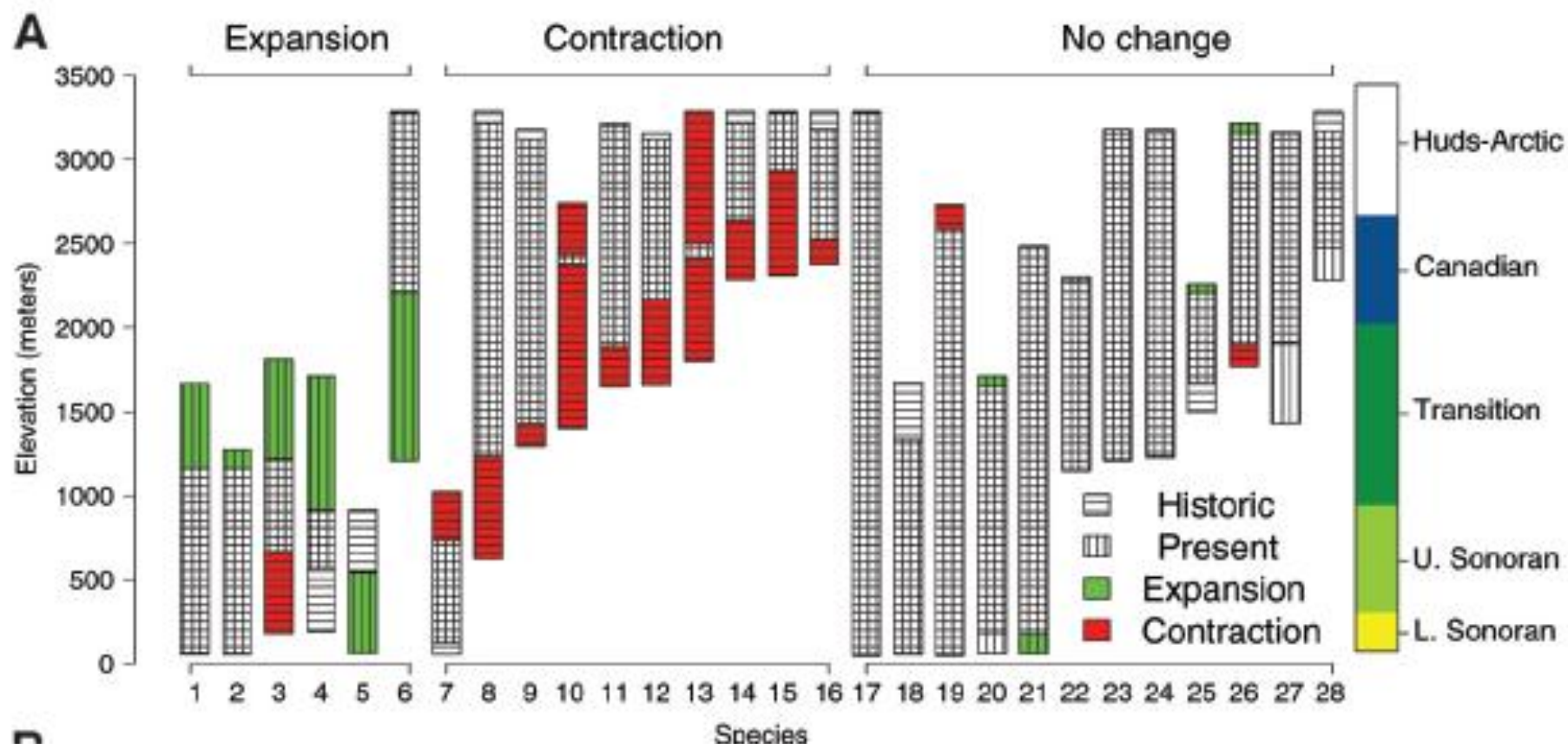


Climate Change and Elevational Shifts

(Moritz et al. 2008, Science)







Climate Change and Shifts in Phenology



SHORT-DISTANCE MIGRANTS

AMERICAN ROBINS ARRIVE

1935-1945: MARCH 26

1994-2004: MARCH 5



LONG-DISTANCE MIGRANTS

WOOD THRUSHES ARRIVE

1935-1945: MAY 7

1994-2004: MAY 6

Climate Change and Shifts in Phenology



← ONE WEEK →



SKUNK CABBAGE BLOOMS

1935-1945: APRIL 1

1994-2004: MARCH 18

EASTERN PHOEBES ARRIVE

1935-1945: APRIL 7

1994-2004: MARCH 24

Climate Change and Shifts in Phenology



GREAT CRESTED FLYCATCHER ARRIVAL

1935-1945: MAY 2

1994-2004: MAY 1



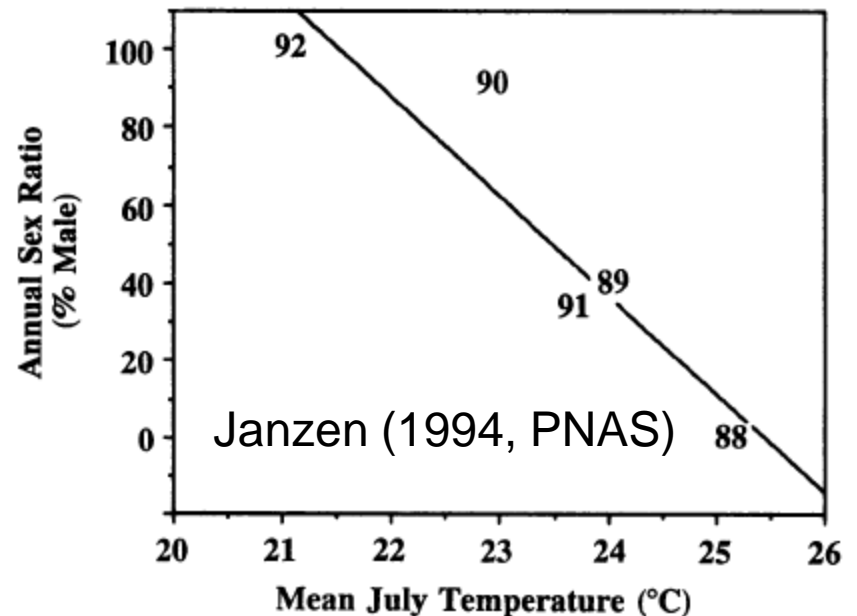
Climate Change and Disease

- 13 species of Hawaiian honeycreepers have gone extinct in part due to **avian malaria** (a plasmodium born by an introduced mosquito).
- Remaining species confined to high elevation (>4000 ft) habitats. (Most islands have max elevations <5000 ft)
- Both the mosquito vector and the plasmodia are increasing in altitude as the climate warms.



Climate Change and Skewed Sex Ratios

- Many turtle species have environmental sex determination (ESD).
- Eggs incubated above a 30°C develop into females and those below about 30°C develop into males.
- Disappearance of dinosaurs may be linked to ESD and rapid climate change.



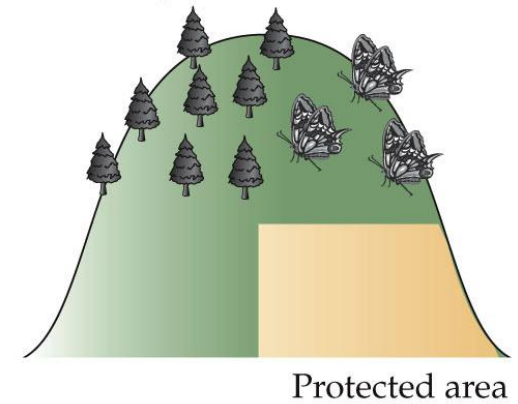
Strategies for Managing Effects of a Changing Climate on Wildlife

- Design reserves to allow for shifts in distribution of target species in elevation

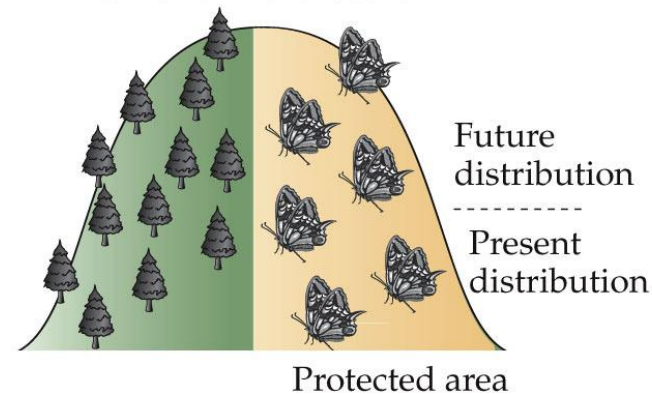
(A) Now: Butterflies protected



(B) In 100 years: Butterflies not protected

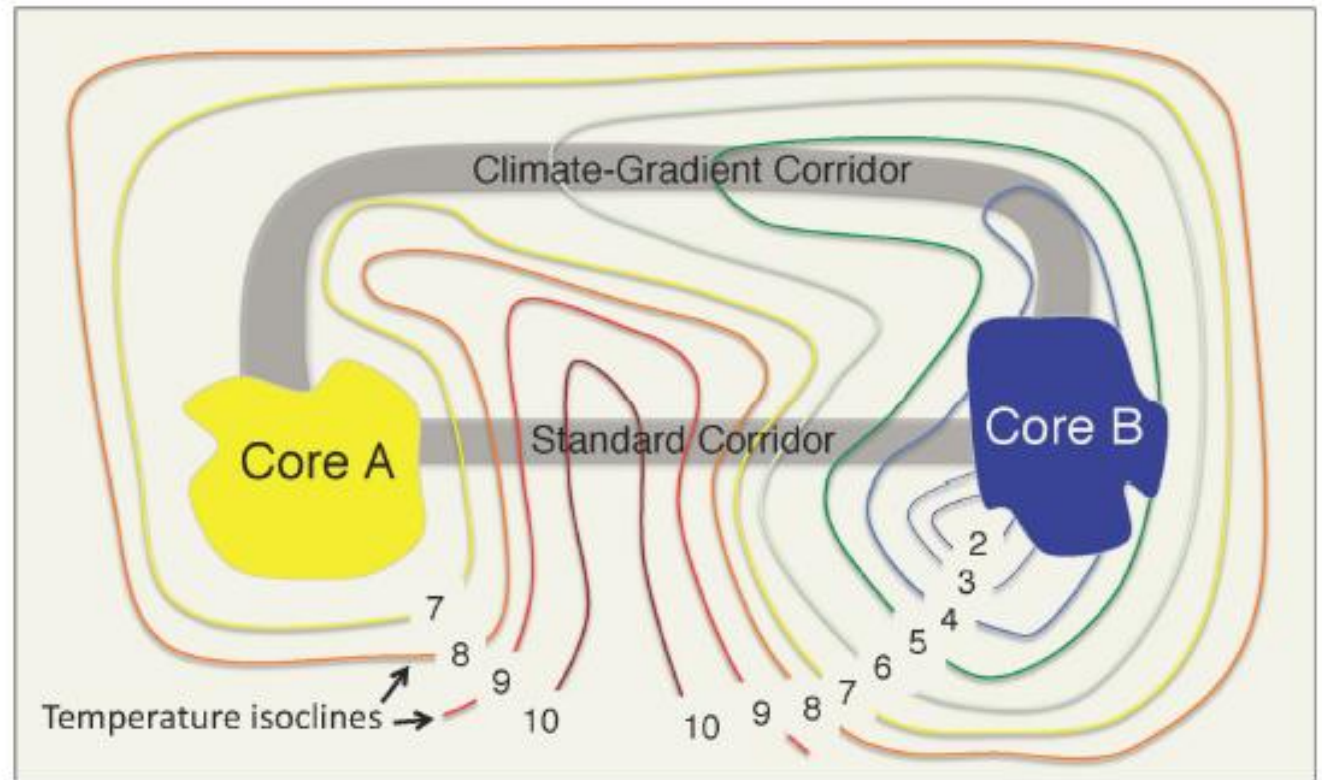


(C) Better plan: Butterflies protected now and in the future



Strategies for Managing Effects of a Changing Climate on Wildlife

- Establish habitat corridors among reserves



Other Strategies for Managing Effects to Wildlife

- Translocations
- Incorporate climate change into species risk assessments
- Alleviate effects of non-climatic stressors
- Minimize catastrophic wildfires (e.g. fuels management)
- Maintain genetically diverse populations

Policy and Climate Change

- Adaptation
- Mitigation
- Engineering

