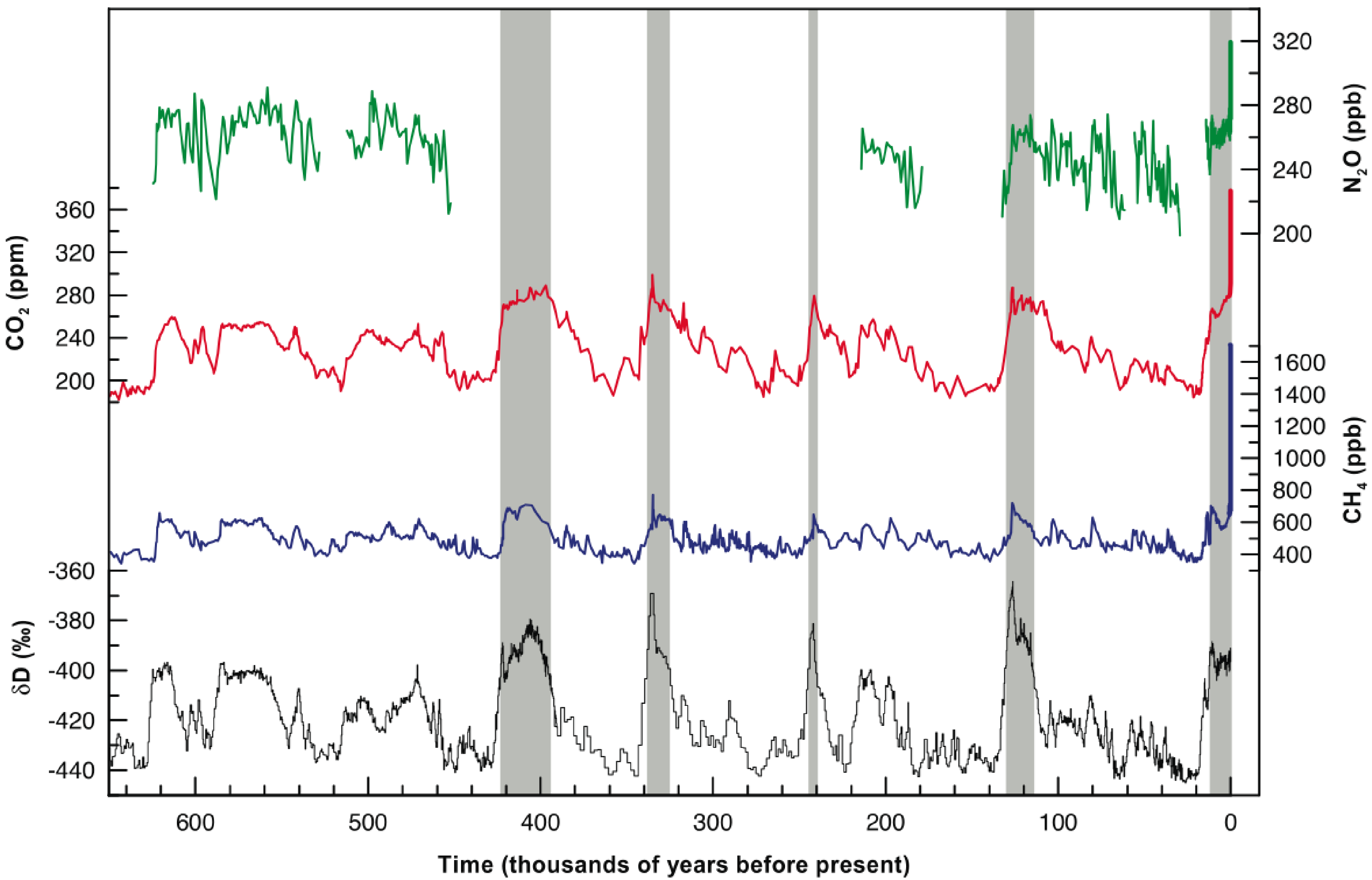
Climate-Change and Wildlife



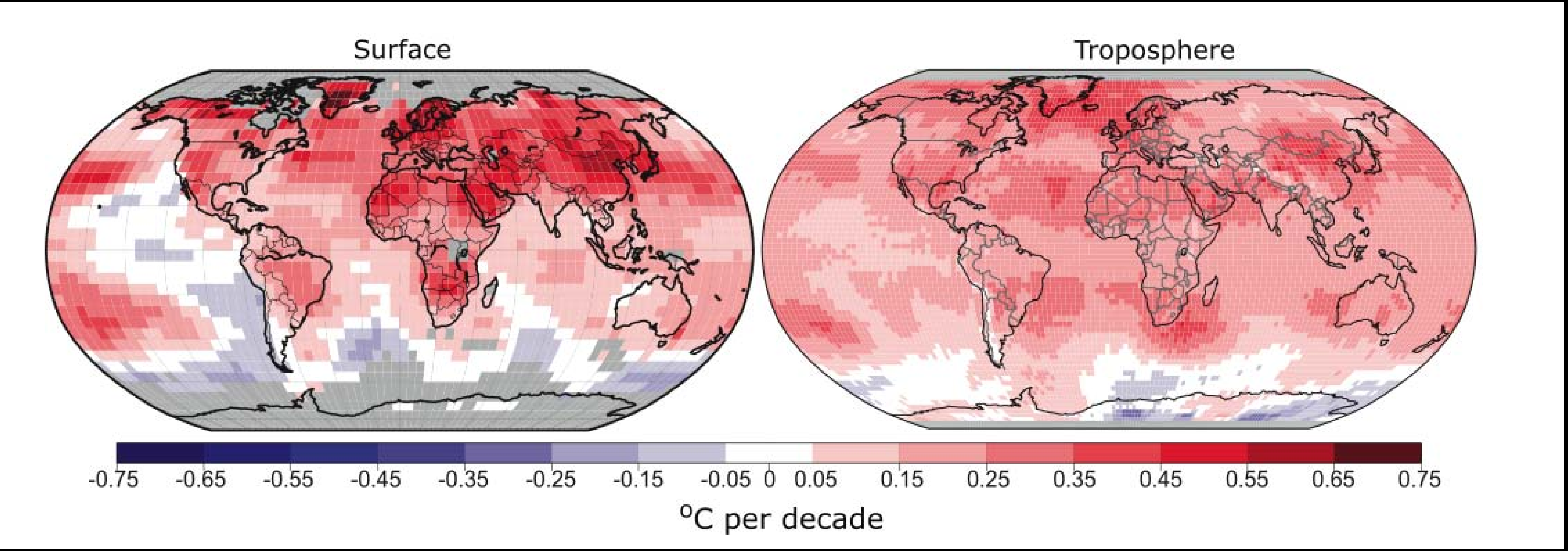

Climate Change, Wildlife, and Wildlife Habitat
North Cascadia Adaptation Partnership
January 30-31, 2011

Joshua Lawler, University of Washington

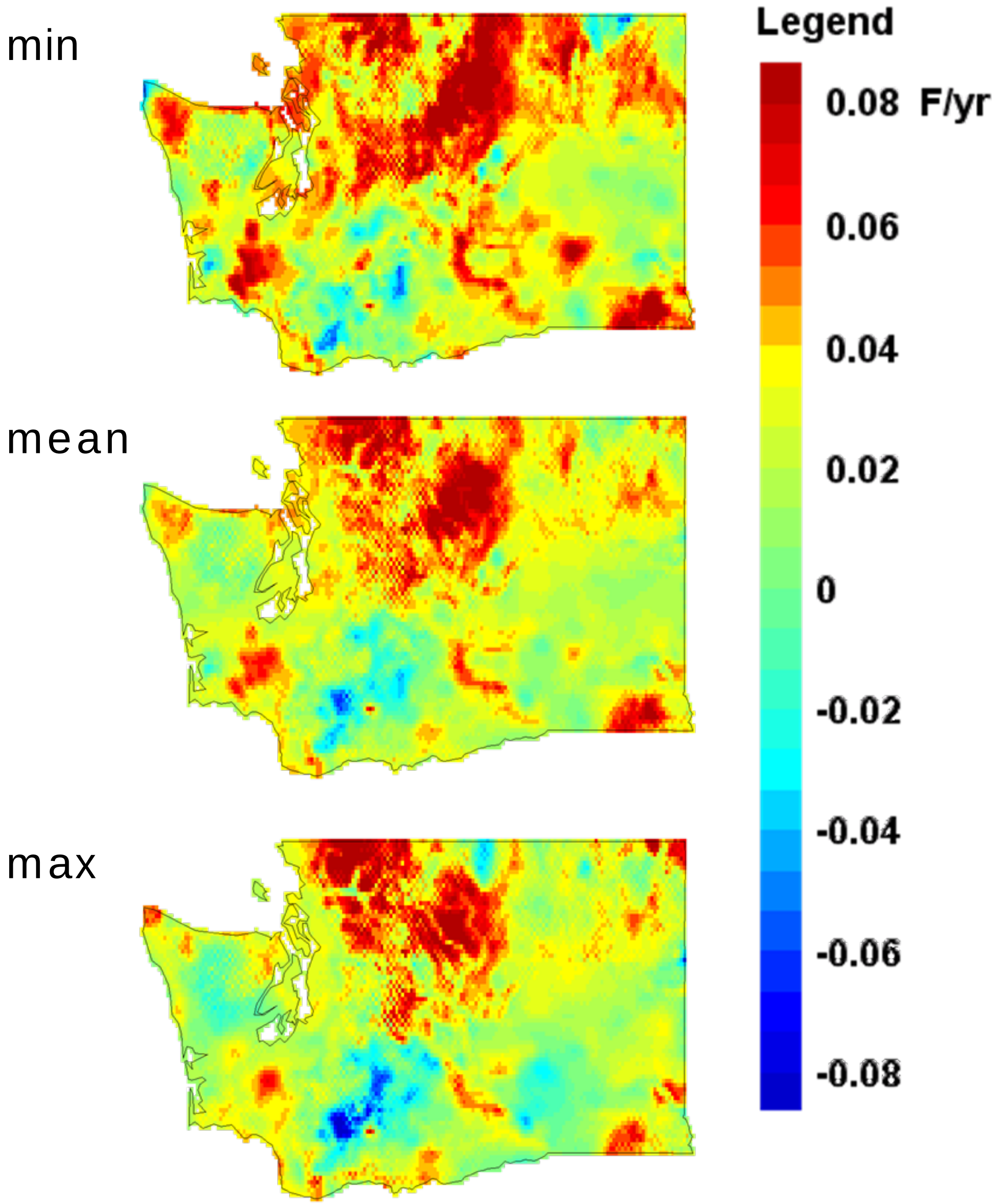
Climate Change


320
280
240
200
N_2O (ppb)
360
320
280
240
200
CO_2 (ppm)
1600
1400
1200
1000
800
600
400
CH_4 (ppb)
-360
-380
-400
-420
-440
δD (‰)
600
500
400
300
200
100
0
Time (thousands of years before present)

IPCC 20

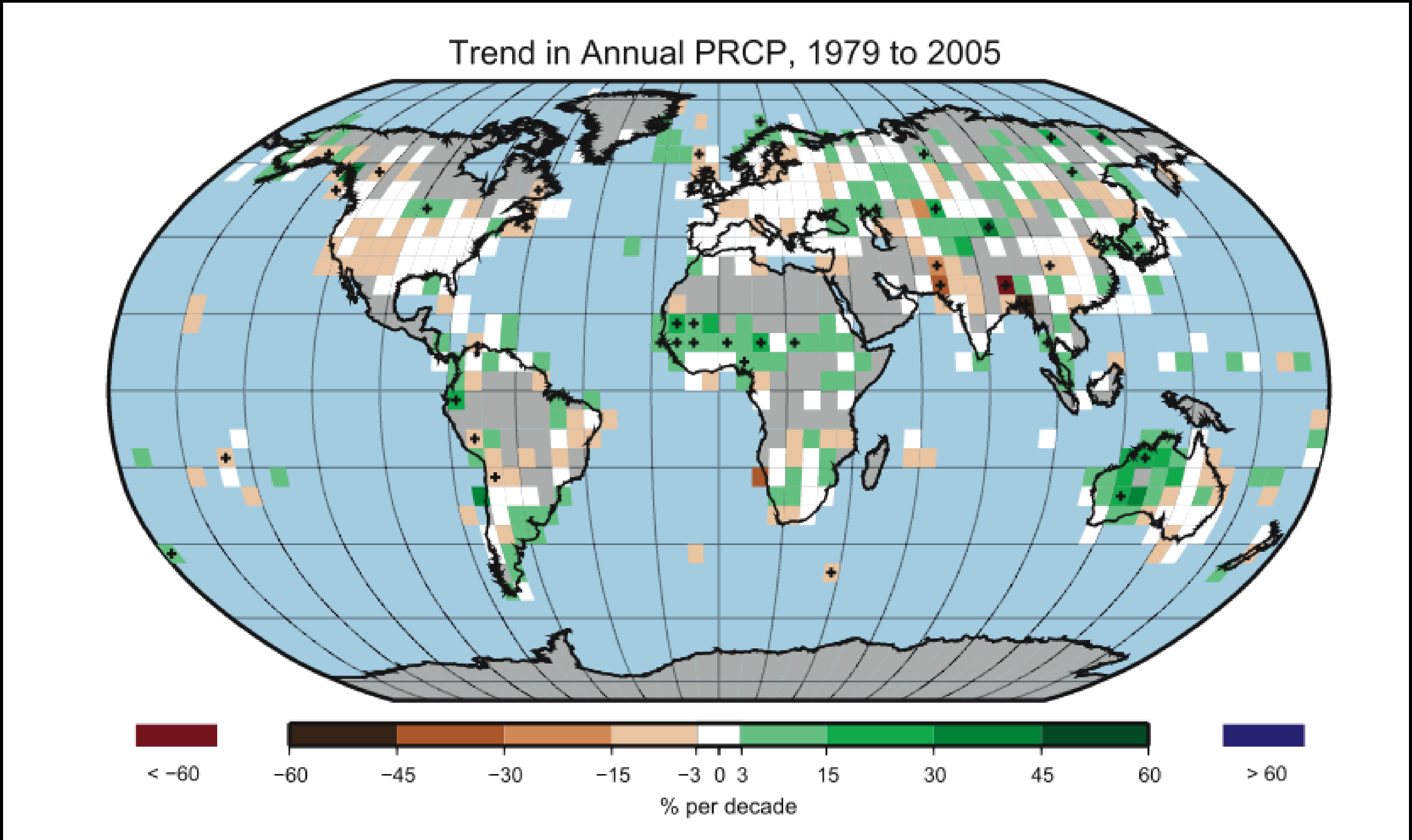


Surface
Troposphere
-0.75
-0.65
-0.55
-0.45
-0.35
-0.25
-0.15
-0.05
0
0.05
0.15
0.25
0.35
0.45
0.55
0.65
0.75
°C per decade



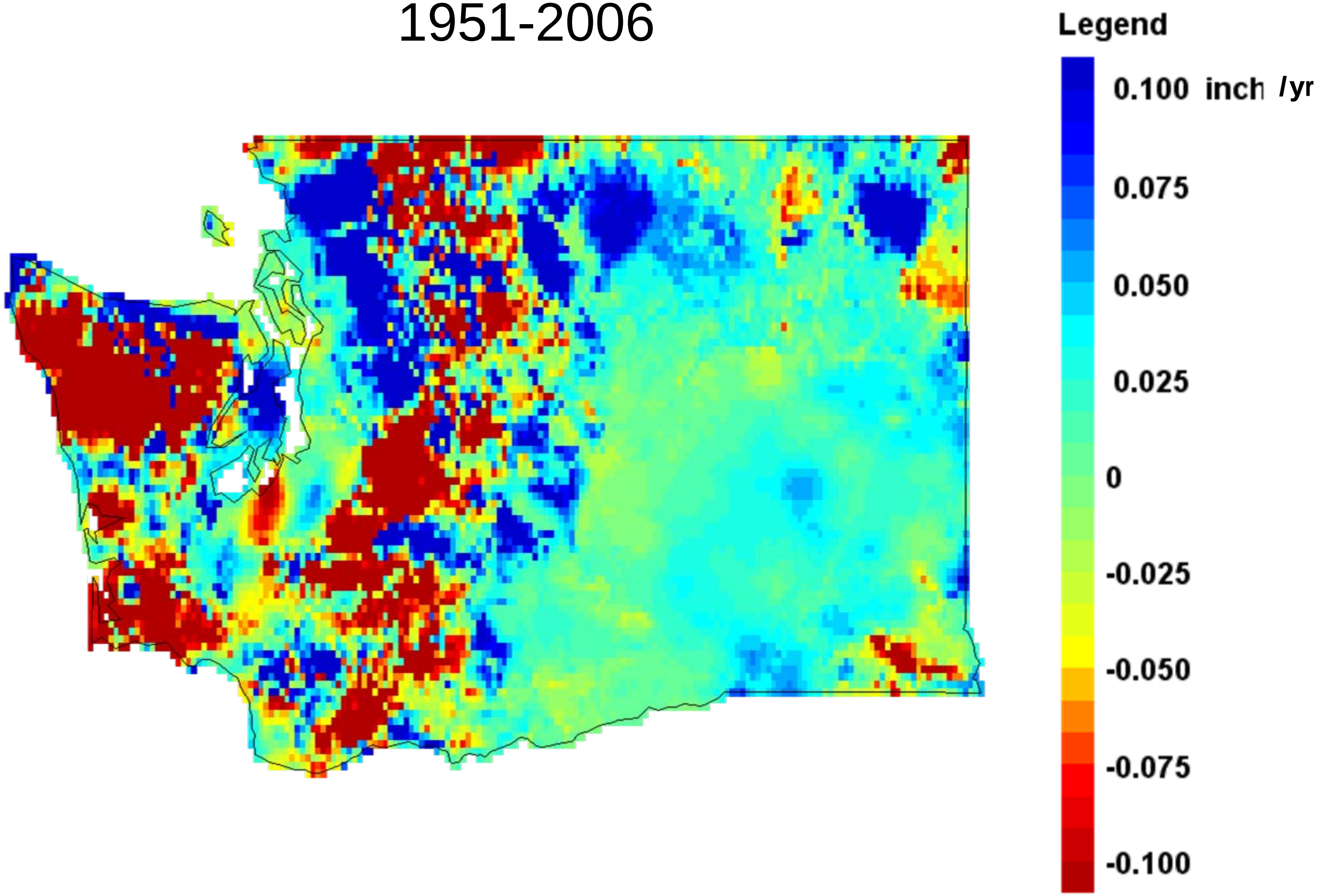
Trends in Annual Temperatures 1951-2006

PRISM Data, Chris Daly, OSU



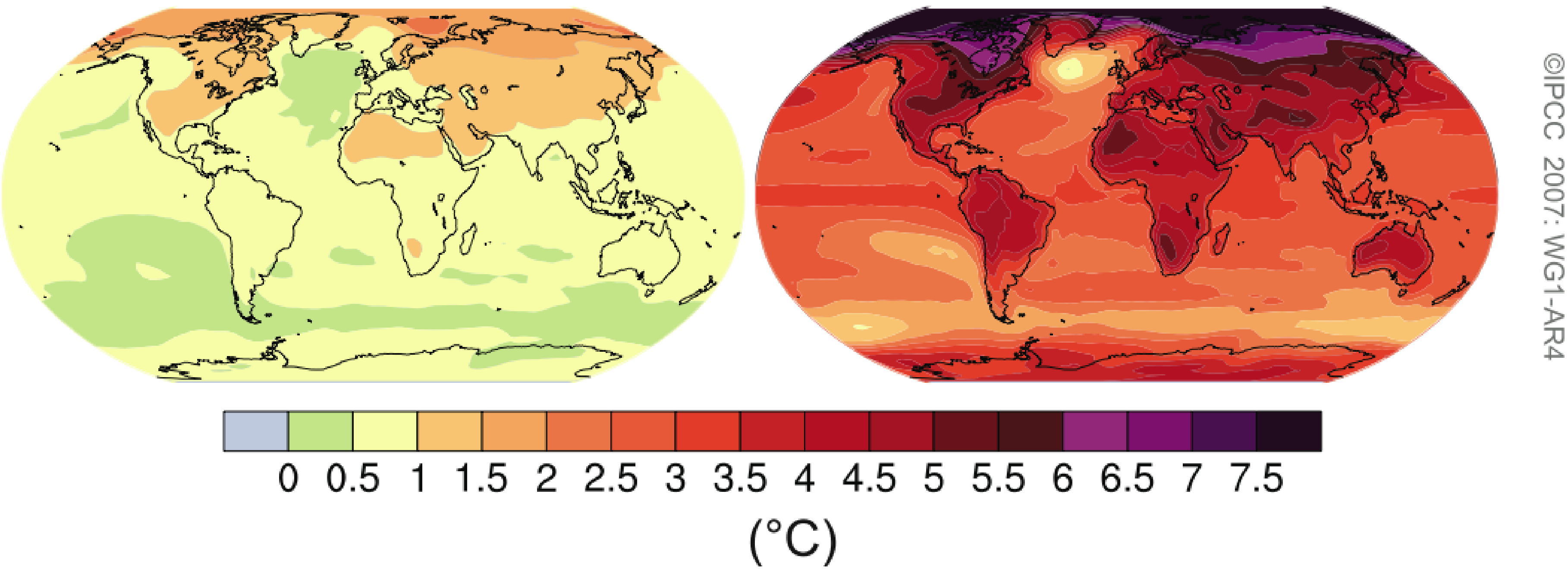
Trend in Annual PRCP, 1979 to 2005
< −60
−60
−45
−30
−15
−3
0
3
15
30
45
60
> 60
% per decade

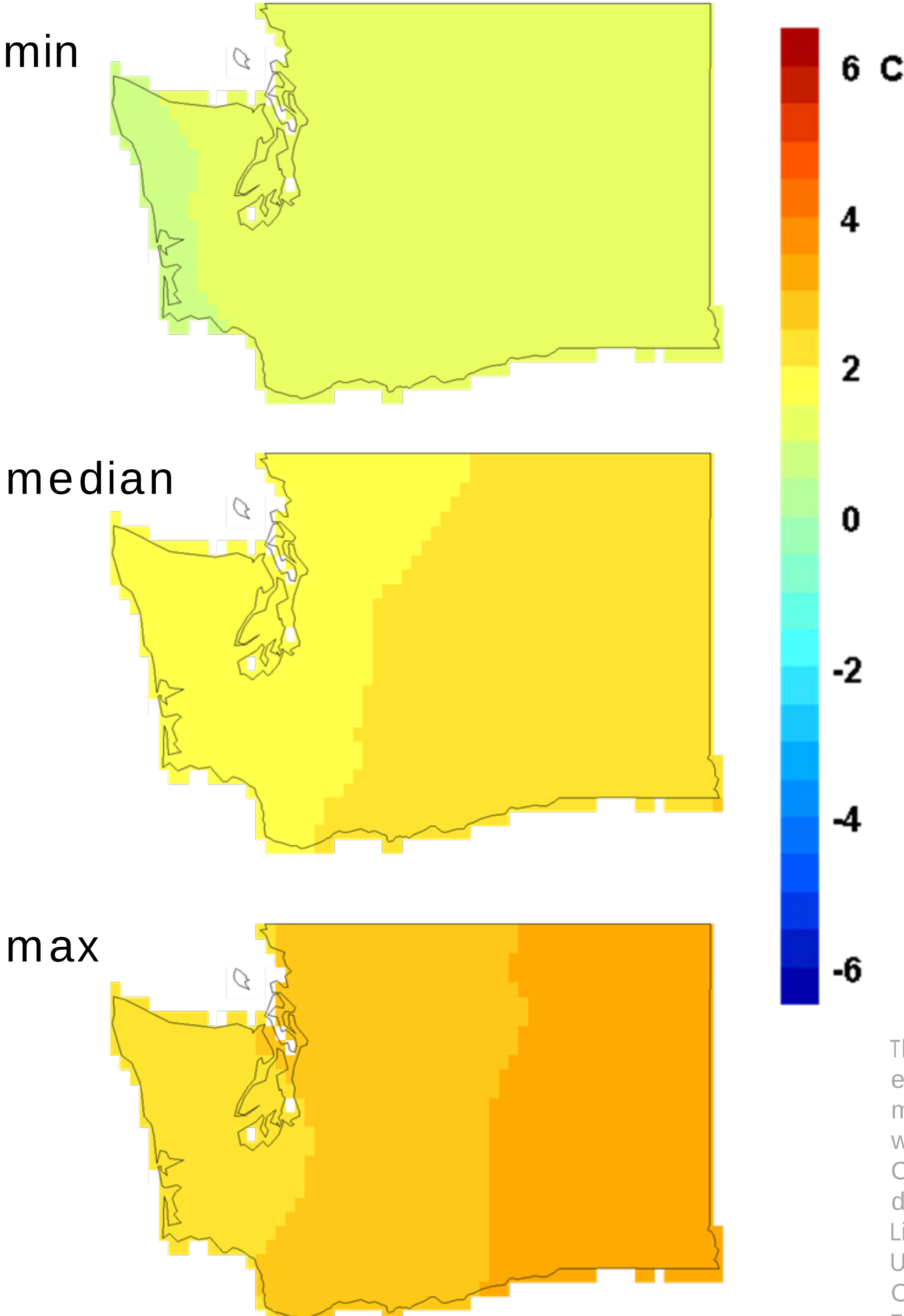
Trends in Total Annual Precipitation 1951-2006



PRISM data, Chris Daly, OSU

Future climate projections

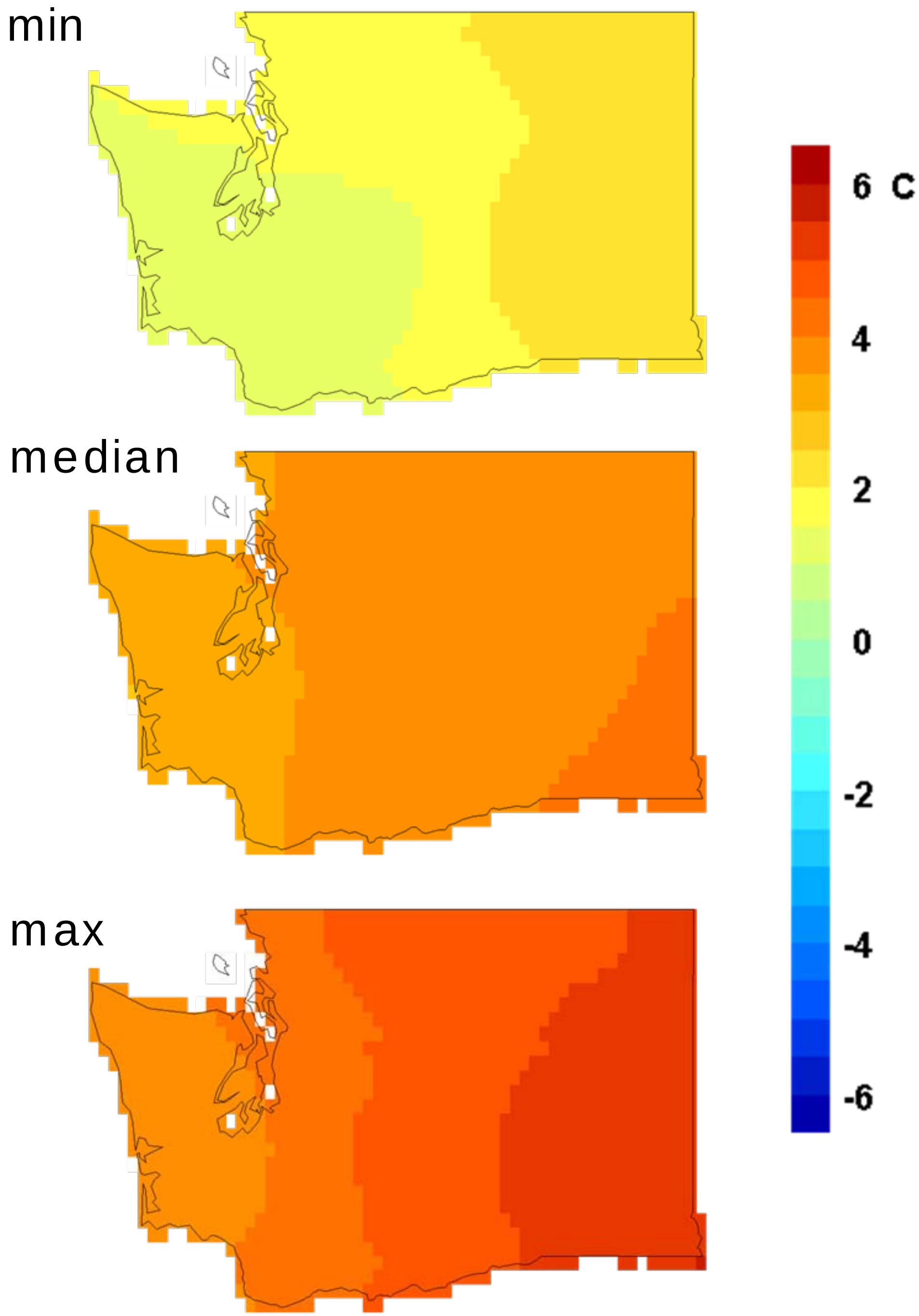

0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5
(°C)
©IPCC 2007: WG1-AR4



Projected Changes in Mean Annual Temperatures

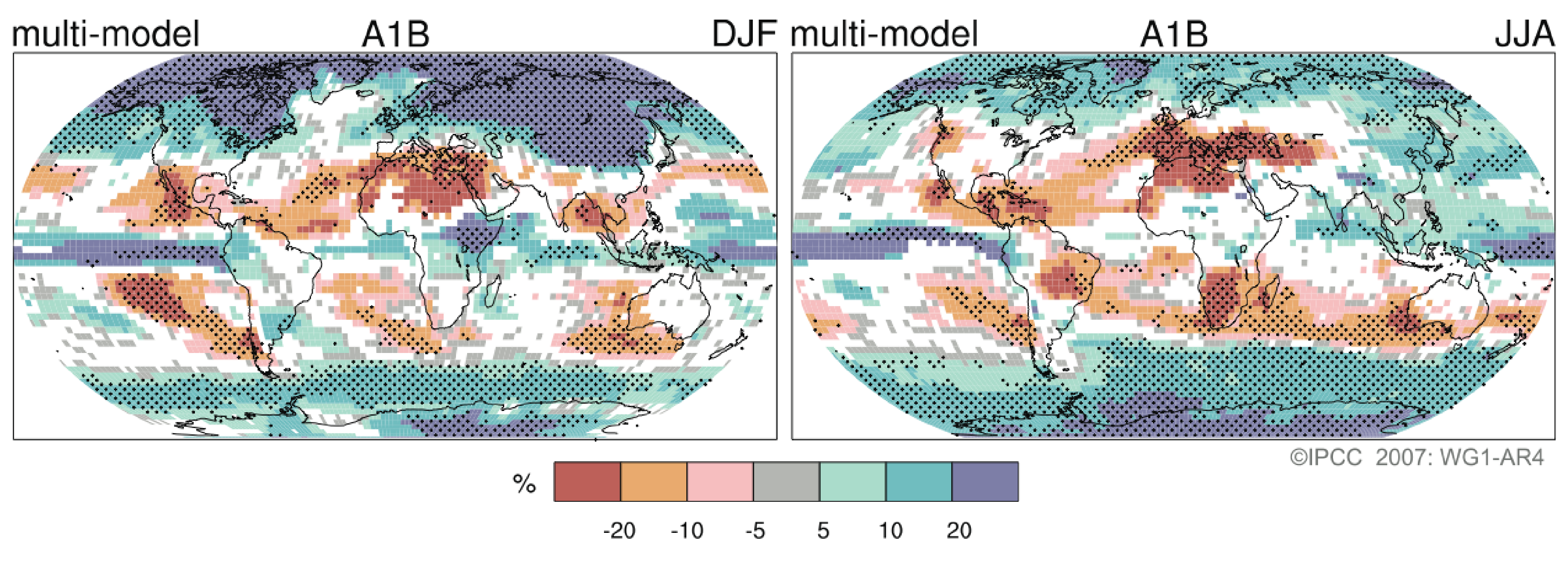
1961-1990 to 2040-2069

The projections are minimum, median, and maximum values from an ensemble of simulations from16 general circulation models run for a mid-high (SRES A2) emissions scenario. The original climate projections were taken from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) multi-model dataset. These projections were then downscaled by the Lawrence Livermore National Laboratory (LLNL), Reclamation, and Santa Clara University (SCU) and are stored and served at the LLNL Green Data Oasis. The climate change analyses and maps were prepared by Dr. Evan Girvetz (College of Forest Resources, University of Washington).

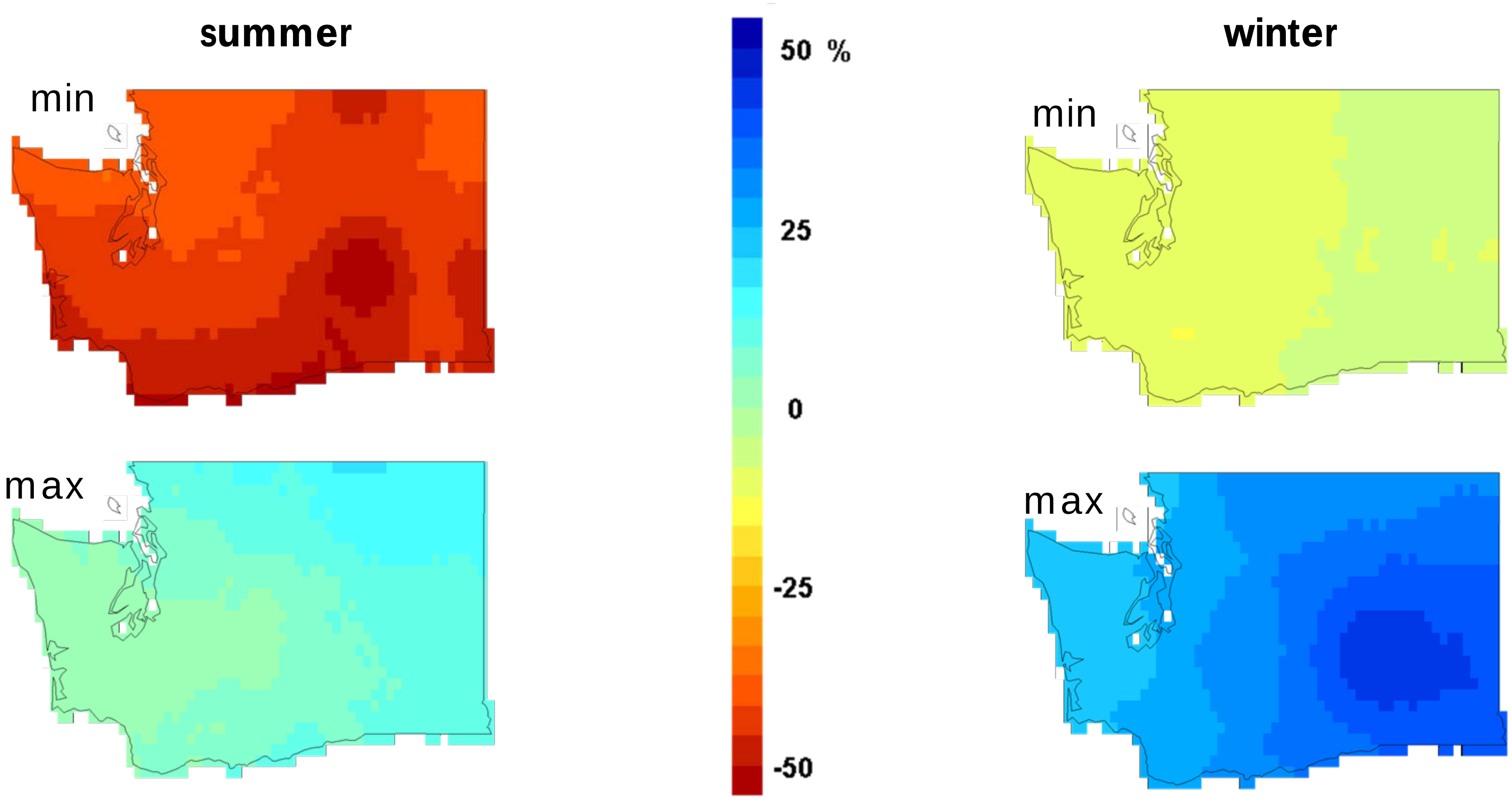


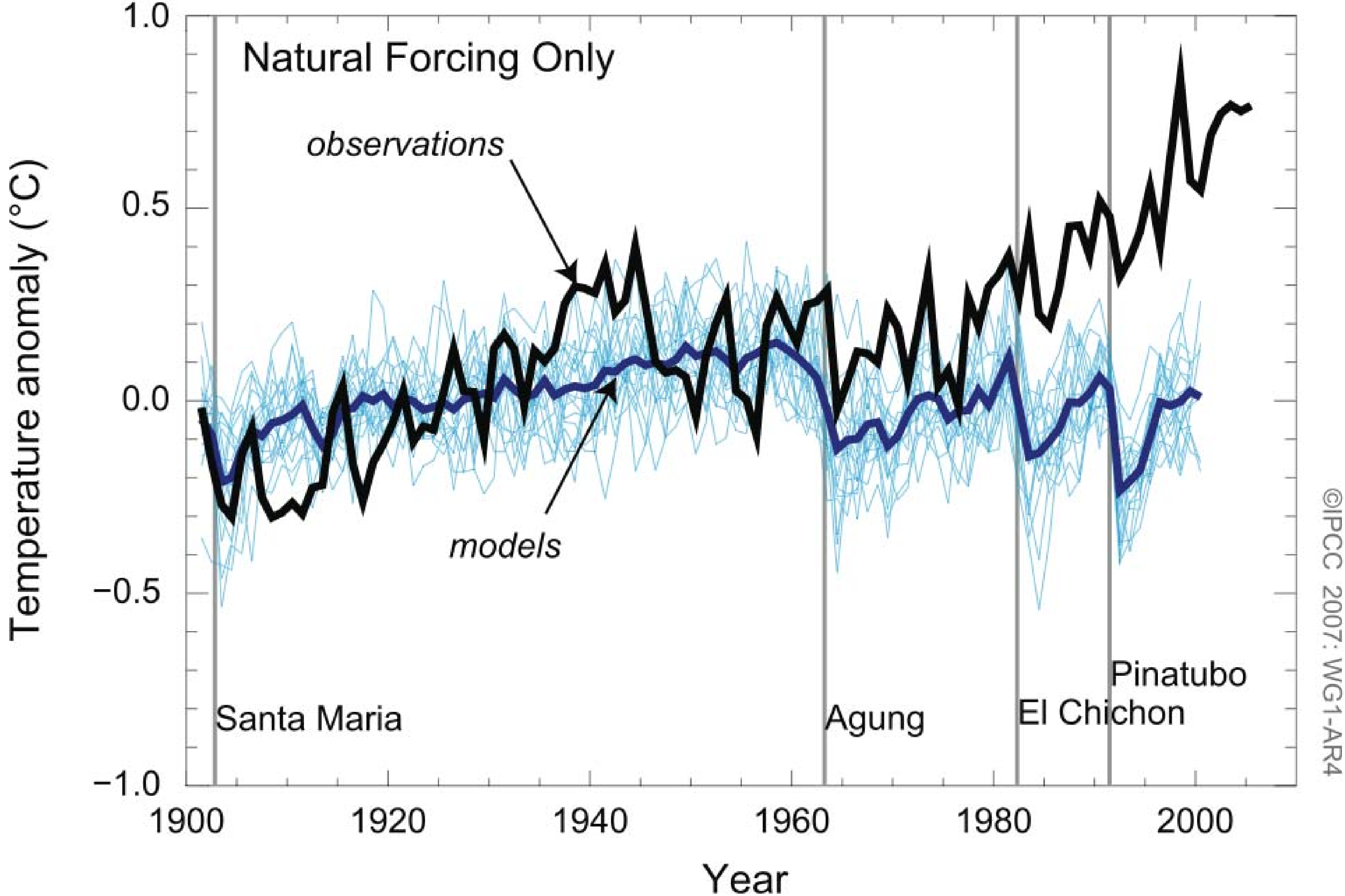
Projected Changes in Mean Annual Temperatures

1961-1990 to 2070-2099


multi-model
A1B
DJF
multi-model
A1B
JJA
©IPCC 2007: WG1-AR4
%
-20
-10
-5
5
10
20

Projected % change in precipitation 1961-1990 to 2040-2069





Natural Forcing Only
observations
models
Temperature anomaly (°C)
1.0
0.5
0.0
−0.5
−1.0
1900
1920
1940
1960
1980
2000
Year
Santa Maria
Agung
El Chichon
Pinatubo
©IPCC 2007: WG1-AR4

IPCC 2007

Impacts

Photos: Northern Guardian News Paper

Blair Wolf, UNM

Phenology

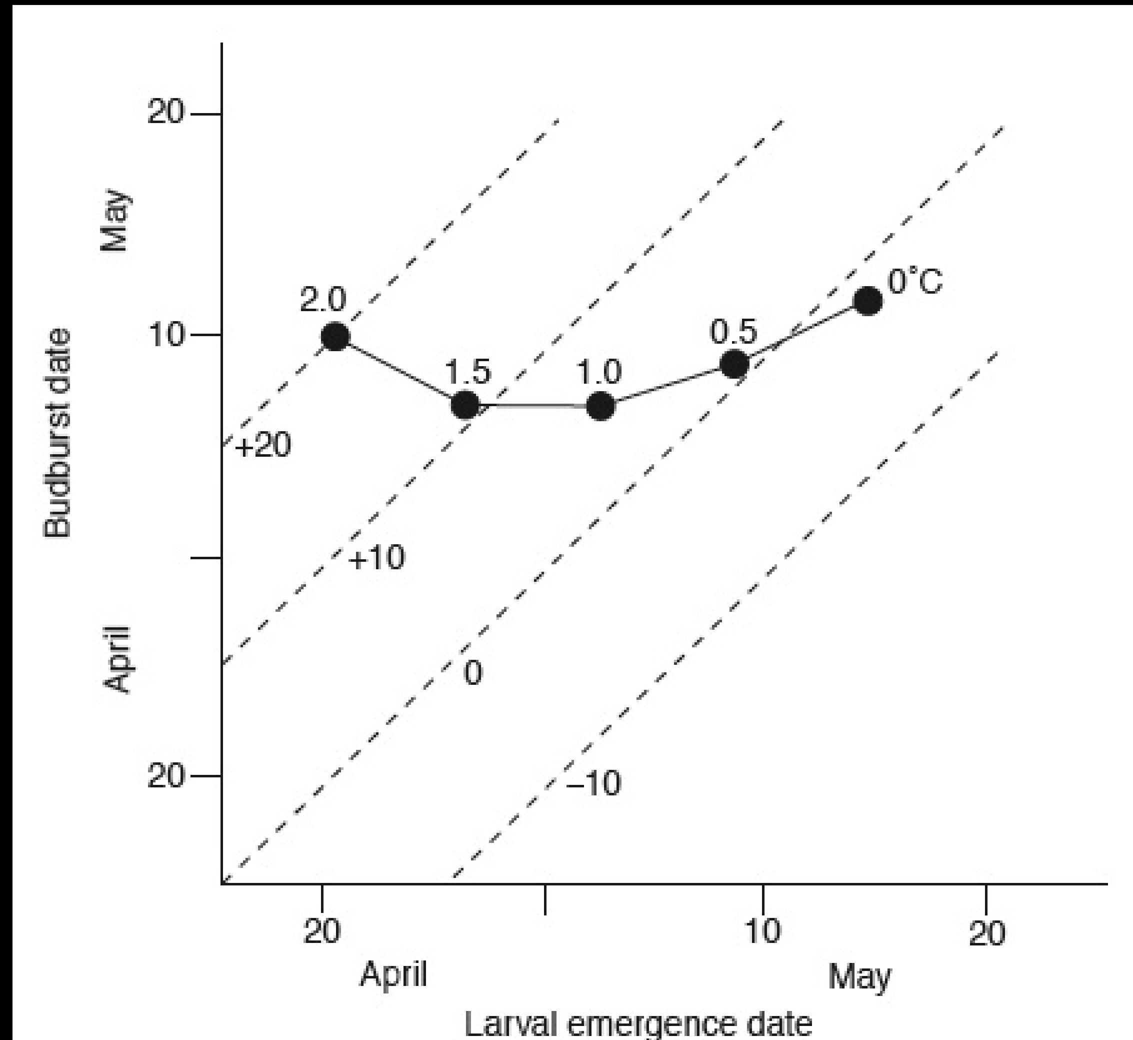
Earlier spring events

Earlier spring events

High-elevation species may show advancement in spring flowering due to warming temperature

Low elevation plants may exhibit delayed flowering due to reduced precipitation and lack of chilling.

Crimmins et al. 2010



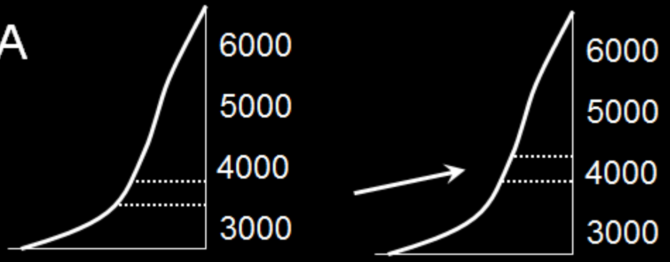
Dewar & Watt 1992

Shifts in distributions

Species moving up slope

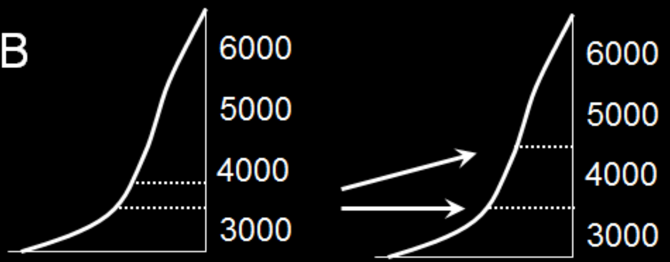
Finger Rock Trail Phenology : 93 species (26%) show change in flowering range with elevation with warmer summers

A



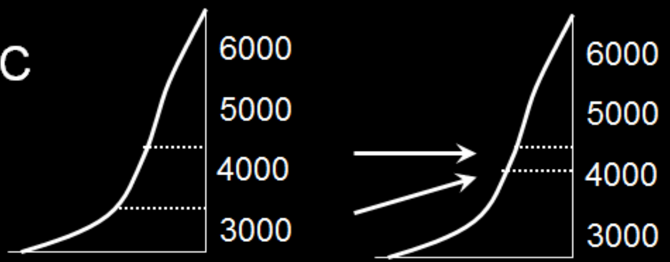
12 species exhibited flowering range shift upslope

B



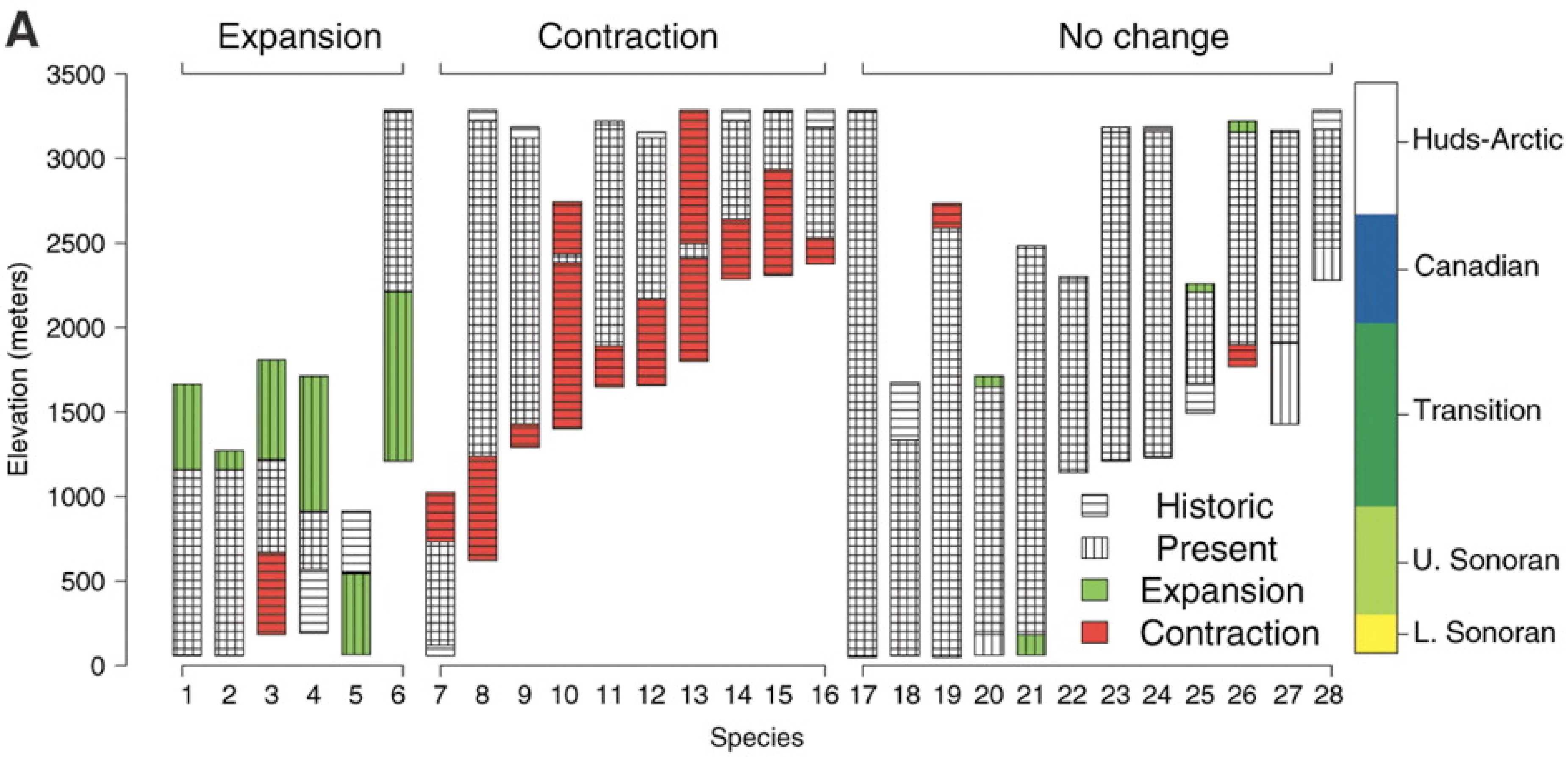
34 species exhibited flowering range expansion upslope

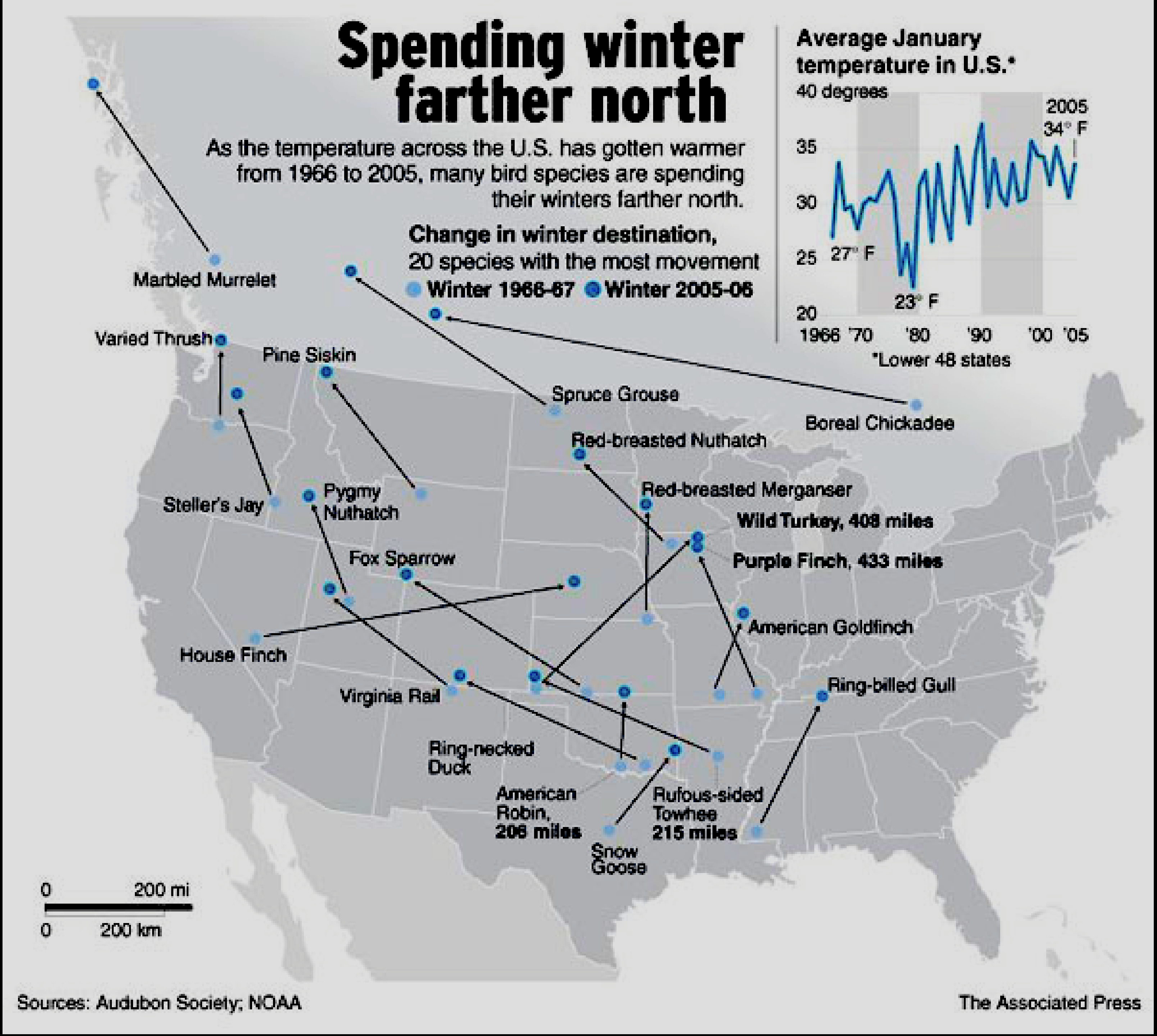
C



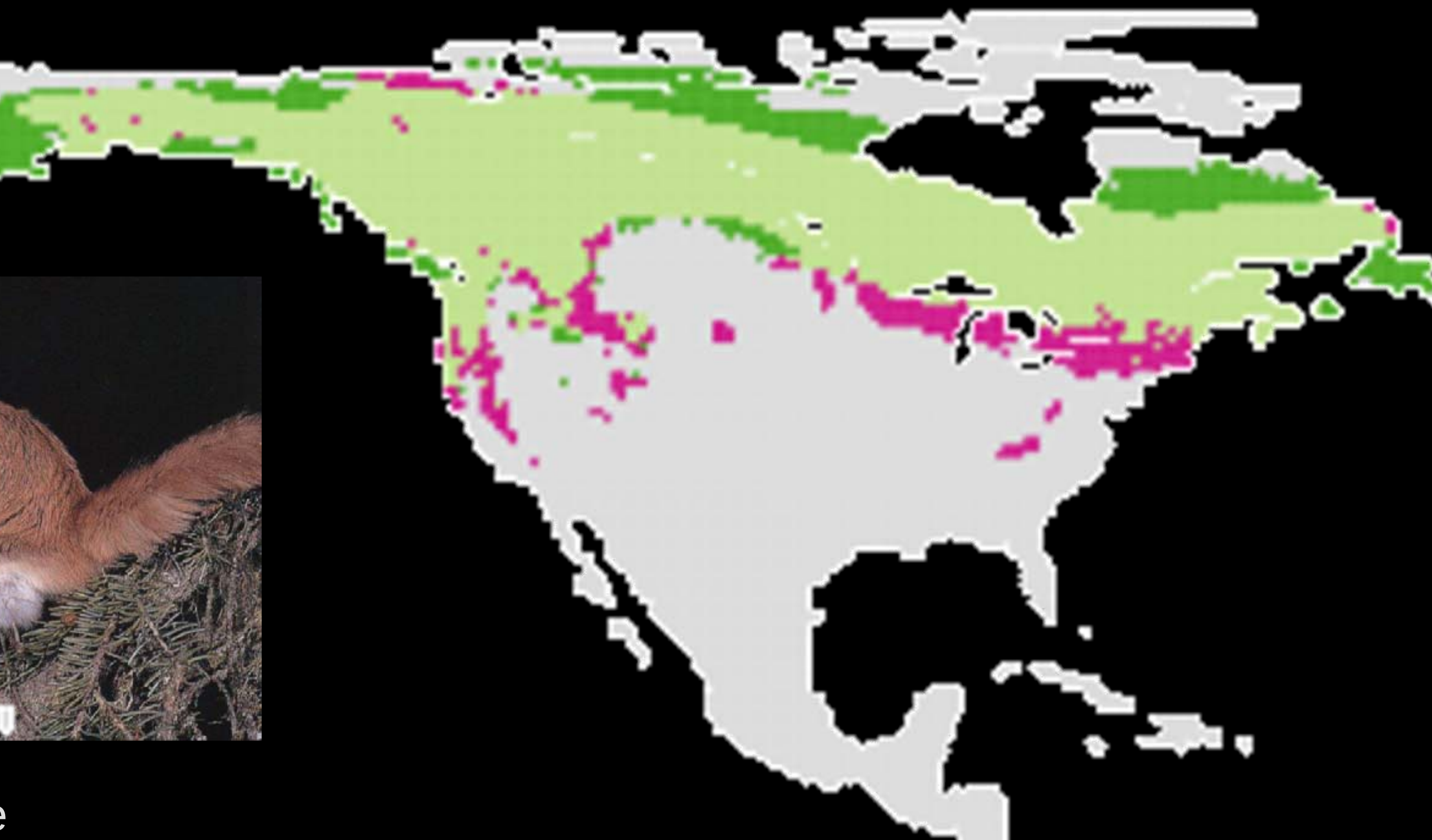
23 species exhibited flowering range contraction upslope

Species moving up slope




Spending winter farther north
As the temperature across the U.S. has gotten warmer from 1966 to 2005, many bird species are spending their winters farther north.
Change in winter destination, 20 species with the most movement
Winter 1966-67
Winter 2005-06
Average January temperature in U.S.*
40 degrees
35
30
25
20
2005
34° F
27° F
23° F
1966
'70
'80
'90
'00
'05
*Lower 48 states
Marbled Murrelet
Varied Thrush
Pine Siskin
Spruce Grouse
Boreal Chickadee
Red-breasted Nuthatch
Red-breasted Merganser
Wild Turkey, 408 miles
Purple Finch, 433 miles
Steller's Jay
Pygmy Nuthatch
Fox Sparrow
American Goldfinch
House Finch
Virginia Rail
Ring-billed Gull
Ring-necked Duck
American Robin, 206 miles
Rufous-sided Towhee 215 miles
Snow Goose
0
200 mi
0
200 km
Sources: Audubon Society; NOAA
The Associated Press

Northern Flying Squirrel (HADCM3 A1B)



stable

expansion

contraction

Northern Goshawk (HADCM3 A1B)

stable
expansion
contraction

Douglas Squirrel (HADCM3 A1B)

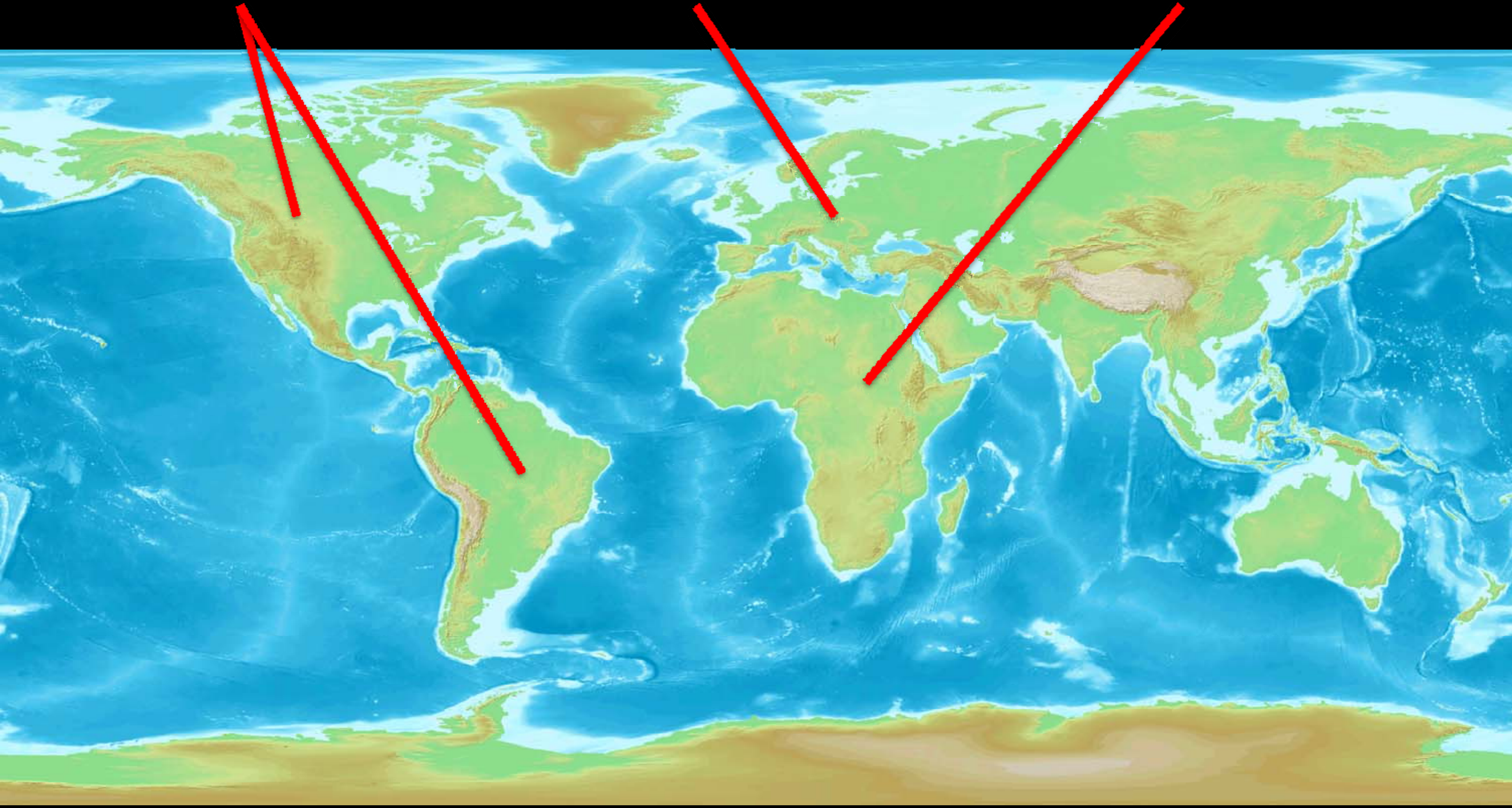
stable
expansion
contraction

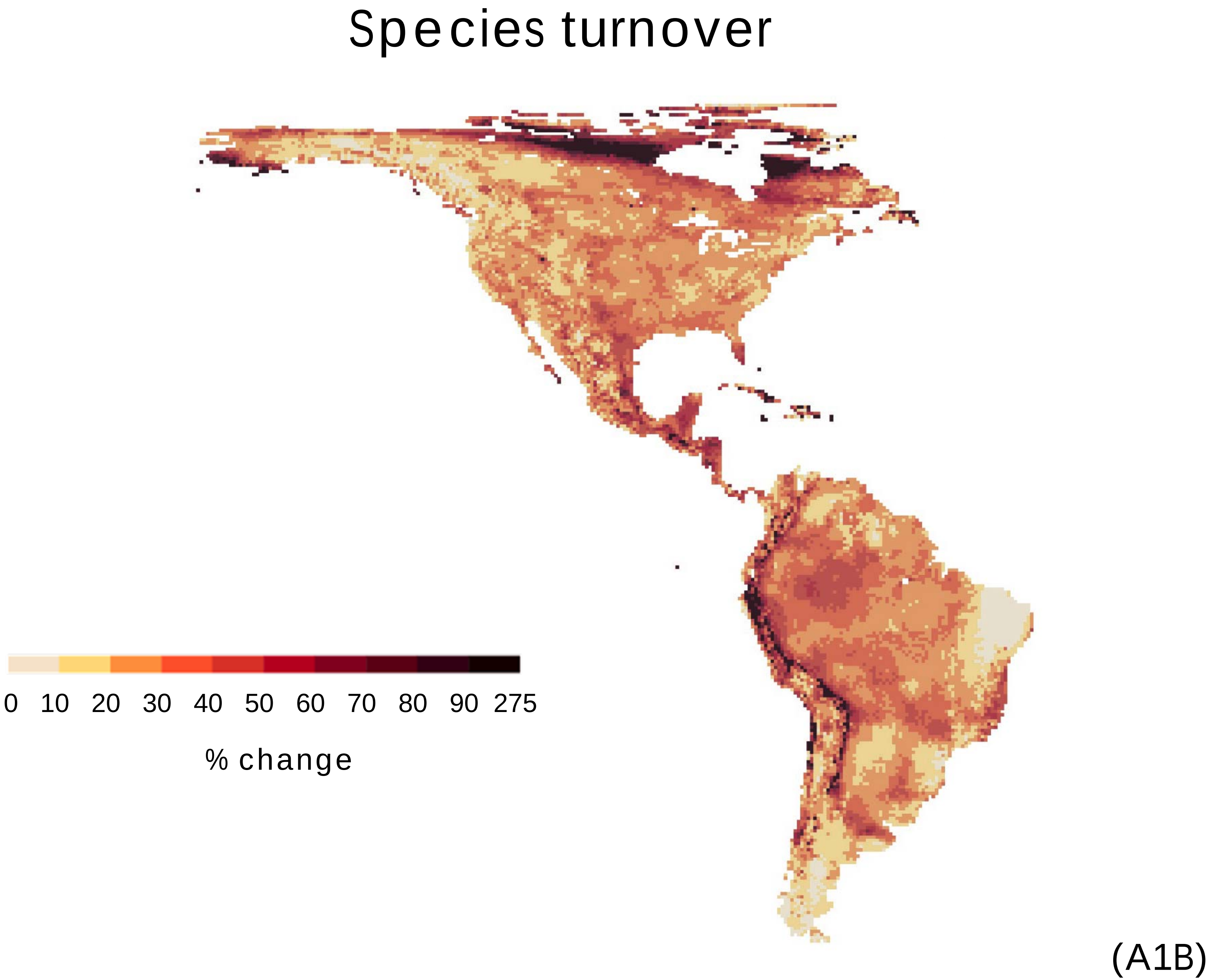
Turnover

vertebrates
25% to 38%

plants
45% to 63%

protected birds
20% to 26%



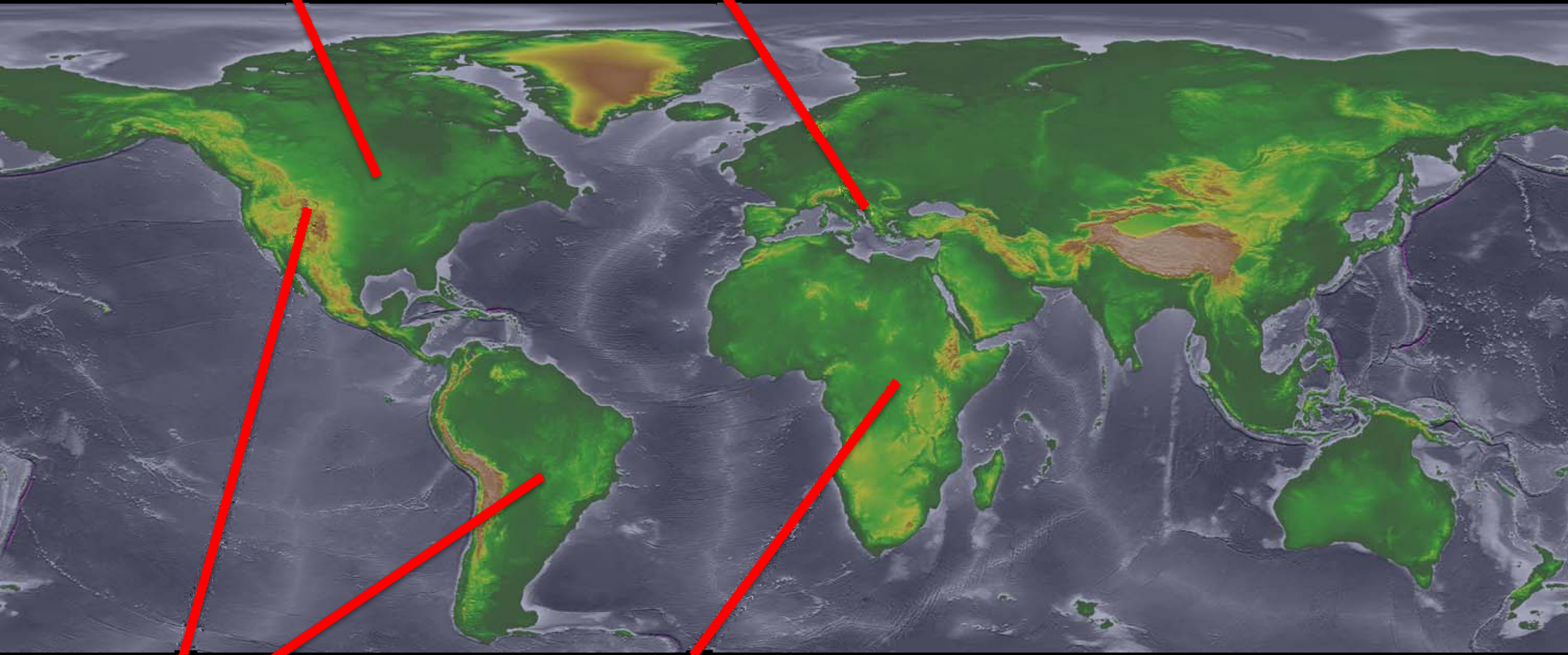


Species turnover
0 10 20 30 40 50 60 70 80 90 275
% change
(A1B)

Protected Areas

mammals:
8.3% lost from
parks

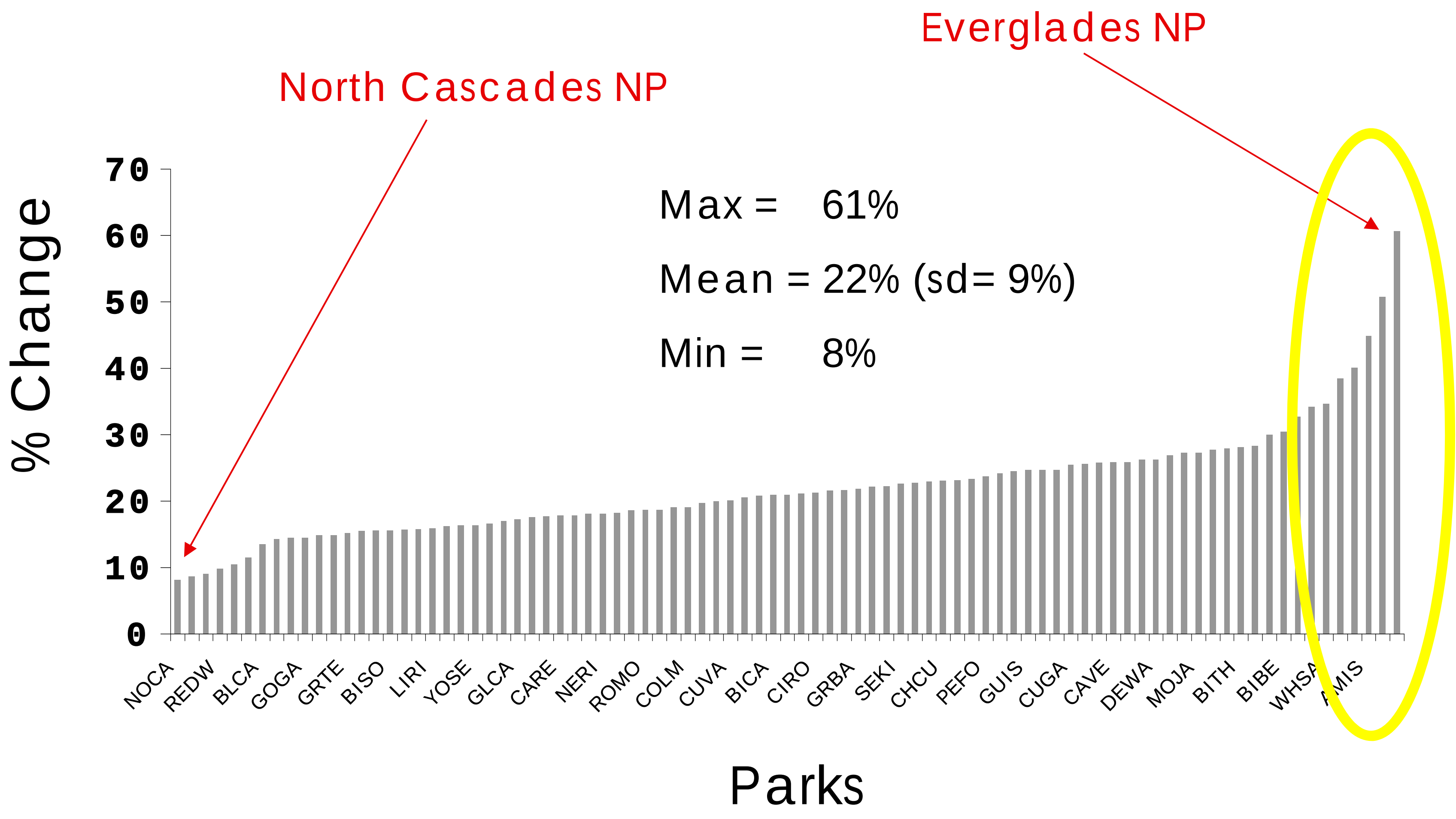
plants and vertebrates: 58% will lose
protection



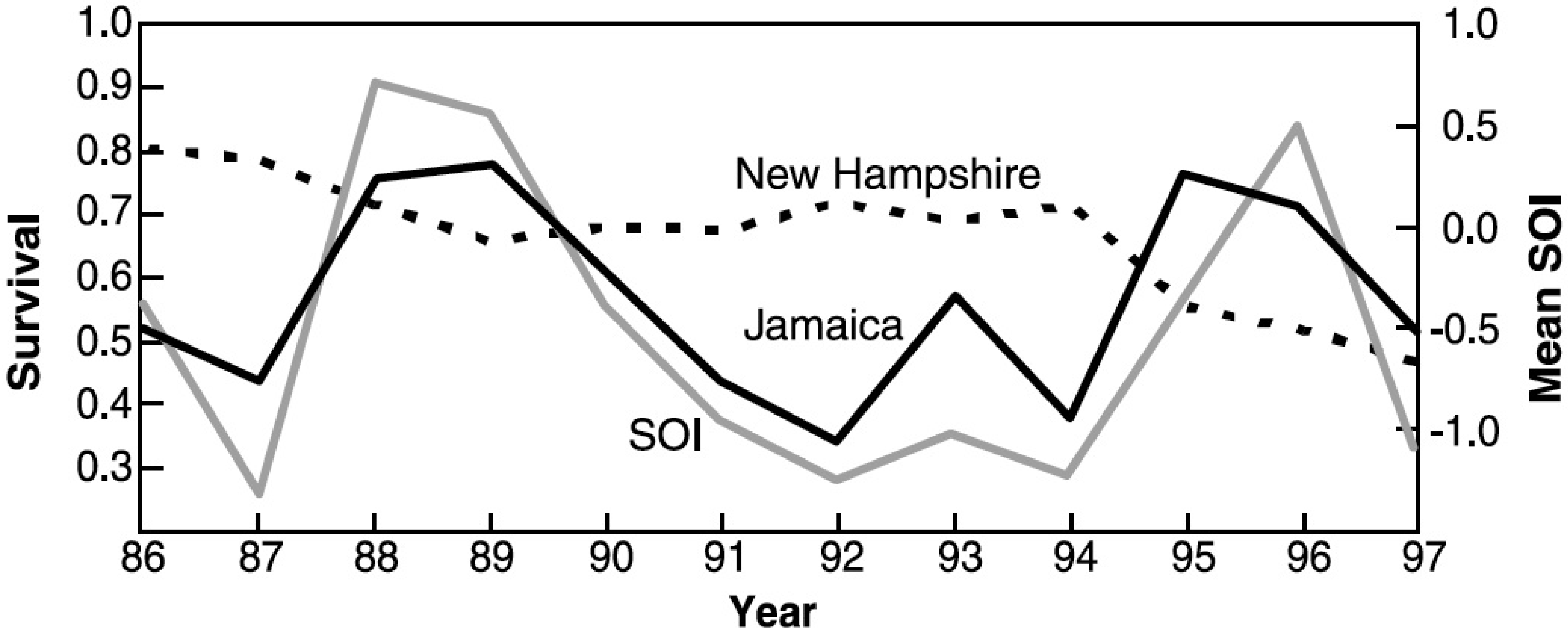
birds: 8% to 12% will lose protection

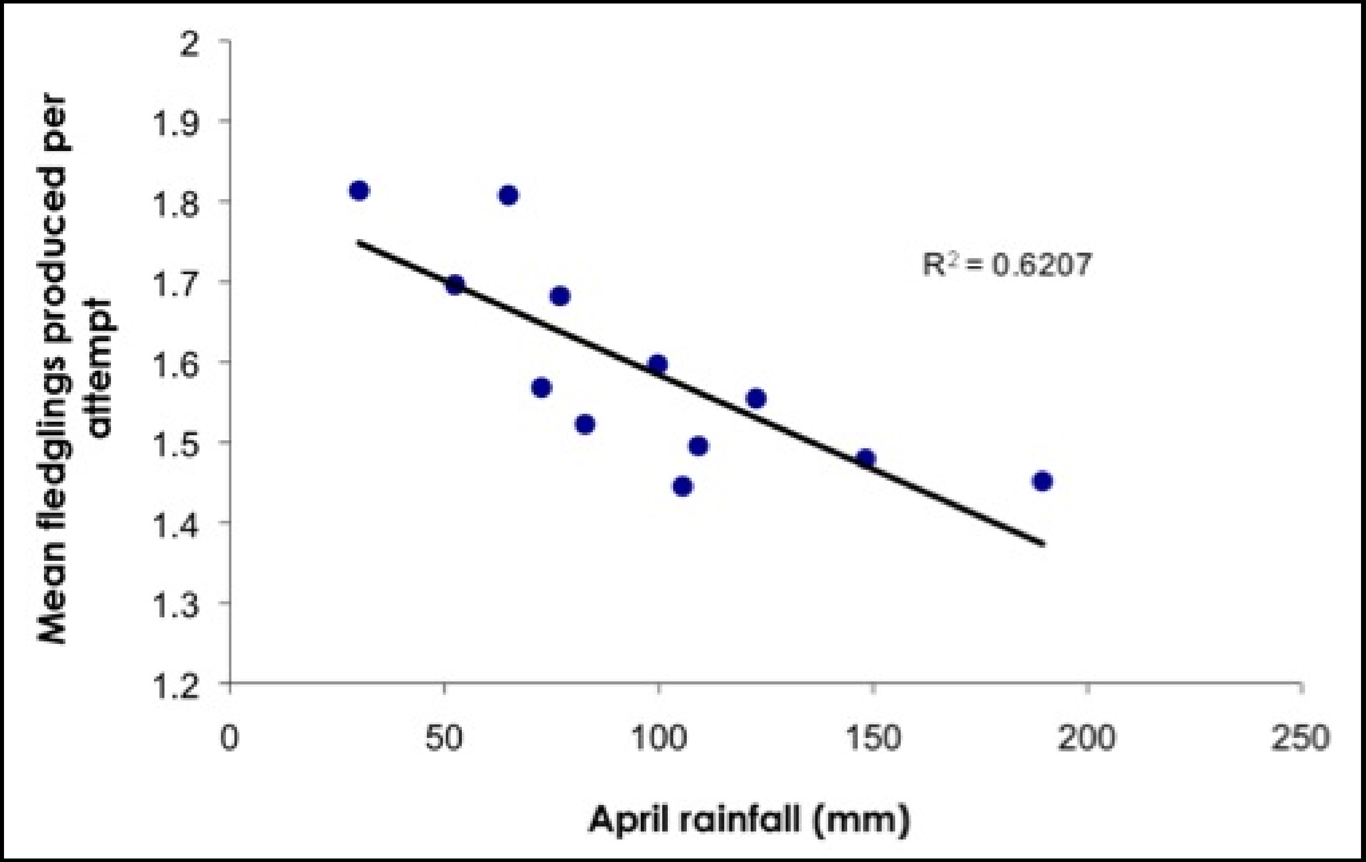
mammals: 85% will lose, on average, 46% protection

Species Change in National Parks



Sillett et al. 2000





Mean fledglings produced per attempt
April rainfall (mm)
$R^2 = 0.6207$
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
0
50
100
150
200
250





NEWS & VIEWS

EXTINCTIONS

A message from the frogs

Andrew R. Blaustein and Andy Dobson

The harlequin frogs of tropical America are at the sharp end of climate change. About two-thirds of their species have died out, and altered patterns of infection because of changes in temperature seem to be the cause.

One of the worries about global climate change is that it will raise the transmission rates of infectious diseases[1]. On page 161 of this issue, Pounds and colleagues[2] provide compelling evidence that anthropogenic climate change has already altered transmission of a pathogen that affects amphibians, leading to widespread population declines and extinctions.

According to the Global Amphibian Assessment (GAA)[3], around a third of amphibian species (1,856) are classified globally as 'threatened'. The tenuous hold these animals have on life is especially evident in tropical America, where, for example, 67% of the 110 species of harlequin frog (*Atelopus*; Fig. 1) endemic to the region have died out in the past 20 years[3]. A pathogenic chytrid fungus, *Batrachochytrium dendrobatidis*, is implicated as the primary cause of *Atelopus* population crashes and species extinctions[4,5]. Now, Pounds *et al.* offer a mechanistic explanation of how climate change encourages outbreaks of *B. dendrobatidis* in the mountainous regions of Central and South America: night-time temperatures in these areas are shifting closer to the thermal optimum of *B. dendrobatidis*, and increased daytime cloudiness prevents frogs from finding 'thermal refuges' from the pathogen.

The authors defined an 'extinction' as

F. BREM

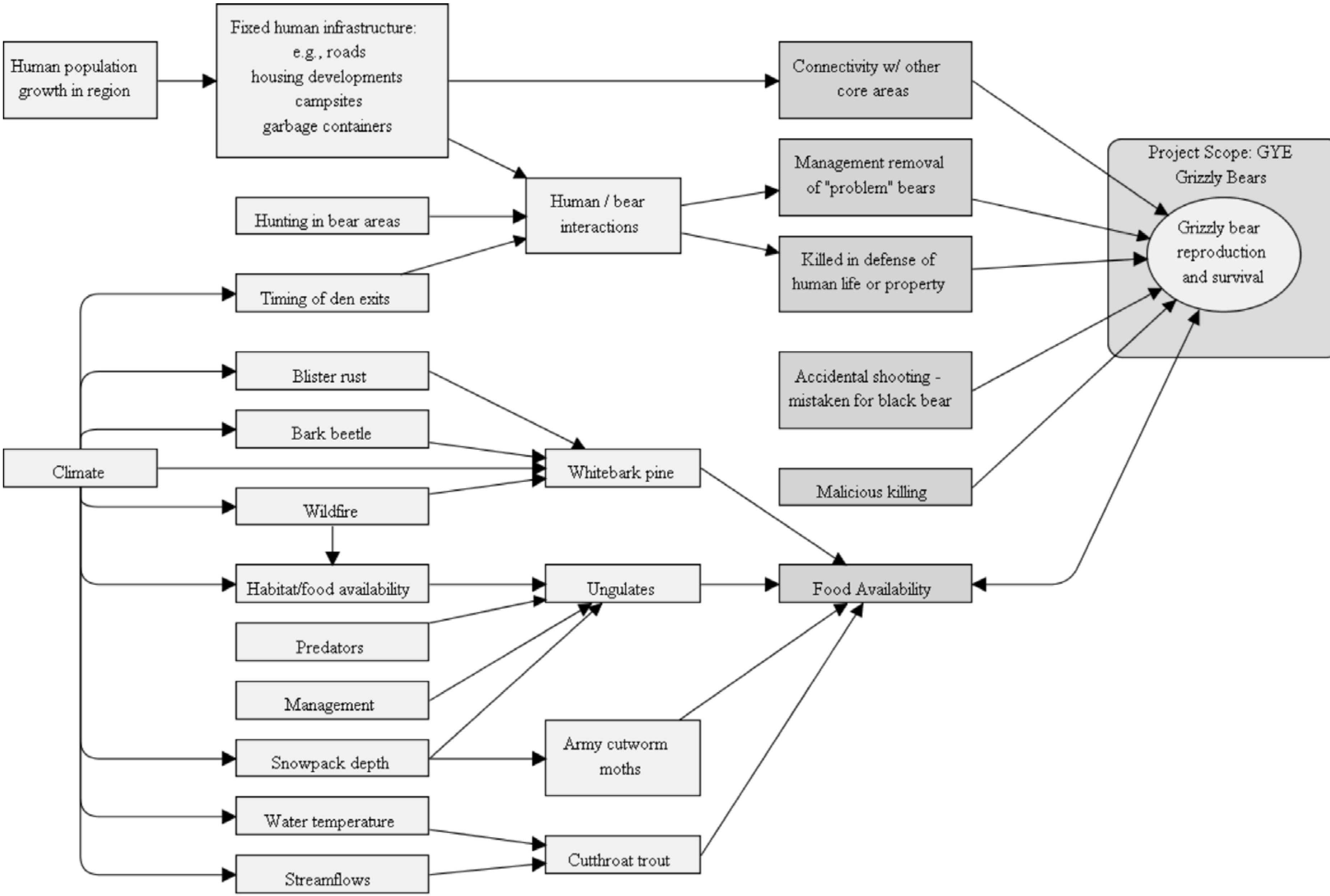
Figure 1 | Amphibian alarm call. The Panamanian golden frog is one of roughly 110 species of harlequin frog (*Atelopus*), many of which are dying out. Although this species still survives, its numbers have fallen significantly.

optimal growth of the pathogen. Mid-elevation *Atelopus* communities are not only the hardest hit by extinction, but they also harbour the most species, so biodiversity in these areas is in double jeopardy. These results corroborate the GAA findings[3] for a broad array of amphibians that the percentage of extinct or threatened species is largest at middle elevations. This is contrary to the expectation that higher-elevation species would be more prone

change had been stymied by the so-called 'climate–chytrid paradox', because the climatic conditions favouring chytrid growth seemed to be the very opposite of those created by current climate trends.

Pounds and colleagues' work[2] is a breakthrough as it resolves the paradox and offers a theory to explain the widespread 'enigmatic' declines of *Atelopus* and other amphibians[3]. The authors combine two disparate approaches into one unifying theory, simultaneously explaining how shifting temperatures are the ultimate trigger for the expansion of a pathogenic fungus, and that this infection is the direct cause of *Atelopus* extinctions.

There may be a tragic irony here. The oldest-known hosts of *Batrachochytrium* are African-clawed frogs (*Xenopus*)[7], first recorded in South Africa in 1938. Global trade in these frogs burgeoned in the 1950s following the development of pregnancy tests that used *Xenopus* tissue[7,8]. Museum records suggest that the pathogen achieved a worldwide distribution in the 1960s. So it seems that the expansion in one frog species through trade may have led to the extinction of other amphibian species — a totally unexpected, indirect consequence of human ingenuity.


Human population growth in region
Fixed human infrastructure: e.g., roads housing developments campsites garbage containers
Connectivity w/ other core areas
Project Scope: GYE Grizzly Bears
Management removal of "problem" bears
Hunting in bear areas
Human / bear interactions
Grizzly bear reproduction and survival
Killed in defense of human life or property
Timing of den exits
Blister rust
Accidental shooting - mistaken for black bear
Bark beetle
Climate
Whitebark pine
Malicious killing
Wildfire
Habitat/food availability
Ungulates
Food Availability
Predators
Management
Army cutworm moths
Snowpack depth
Water temperature
Cutthroat trout
Streamflows

Invasive Species






Vulnerability

Vulnerability = sensitivity x exposure / adaptability

Sensitivity Components

Physiological factors

Sensitive habitats

Dispersal abilities

Population growth rates

Interspecific dependencies

Relative location

Sensitive disturbance regimes

Adaptive capacity

Population growth rates

Genetic variability

Phenotypic plasticity

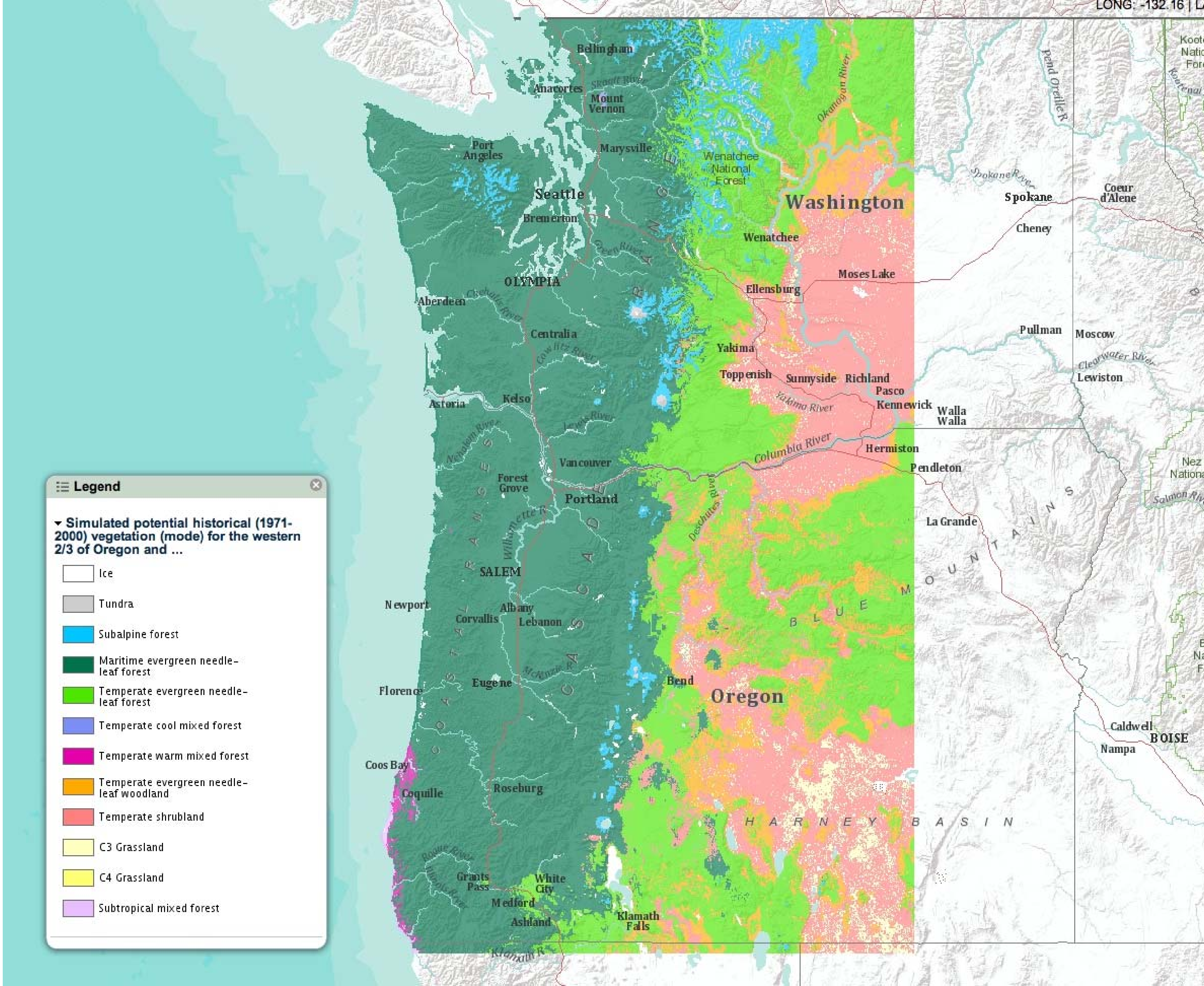
Behavioral plasticity

Dispersal abilities

Landscape permeability

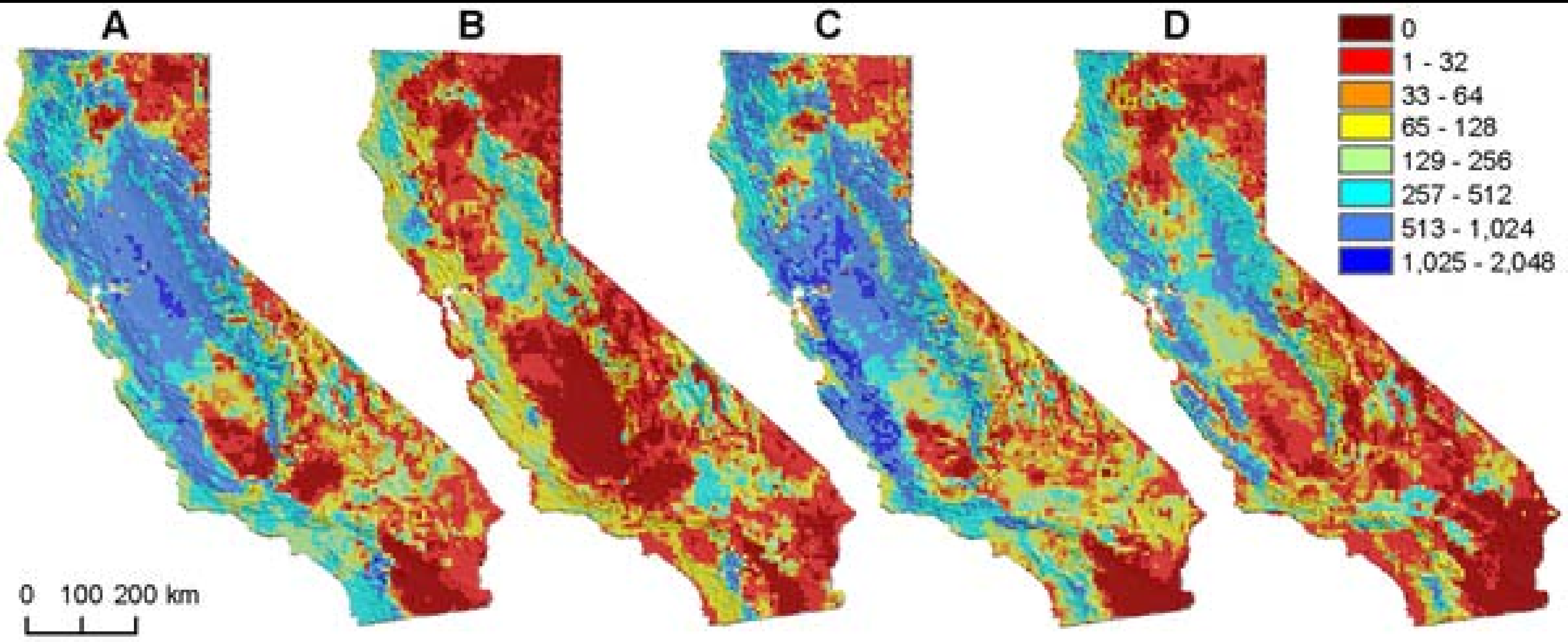
Habitats

Brendan Rogers (2009), maps courtesy of Data Basin, CBI



Community Level Impacts

No-analog communities



Number of modern analogs for predicted future bird communities across climate models and distribution-model algorithms (2038–2070).

Stralberg et al. 2009

Adaptation

larger reserves

BIOLOGICAL CONSERVATION 142 (2009) 14–32

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journal homepage: www.elsevier.com/locate/biocon

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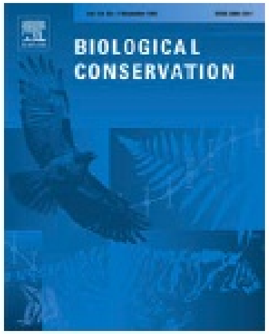


Review

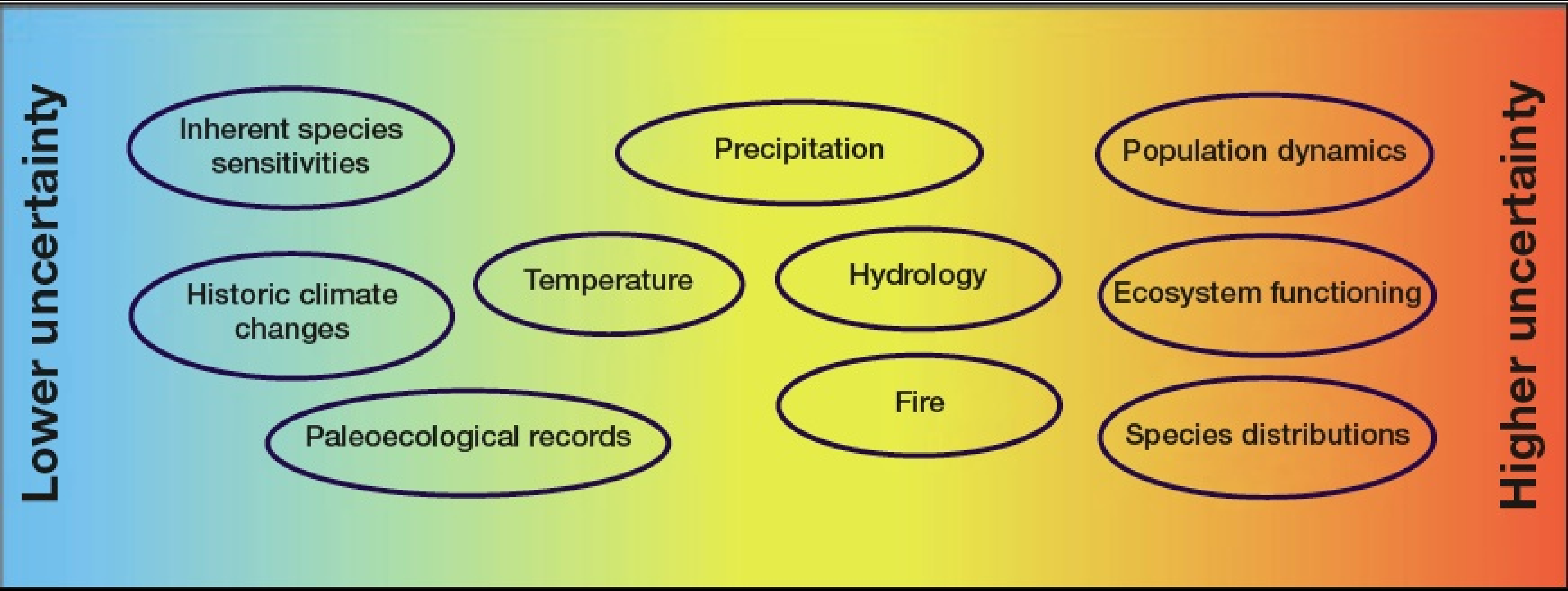
Biodiversity management in the face of climate change: A review of 22 years of recommendations

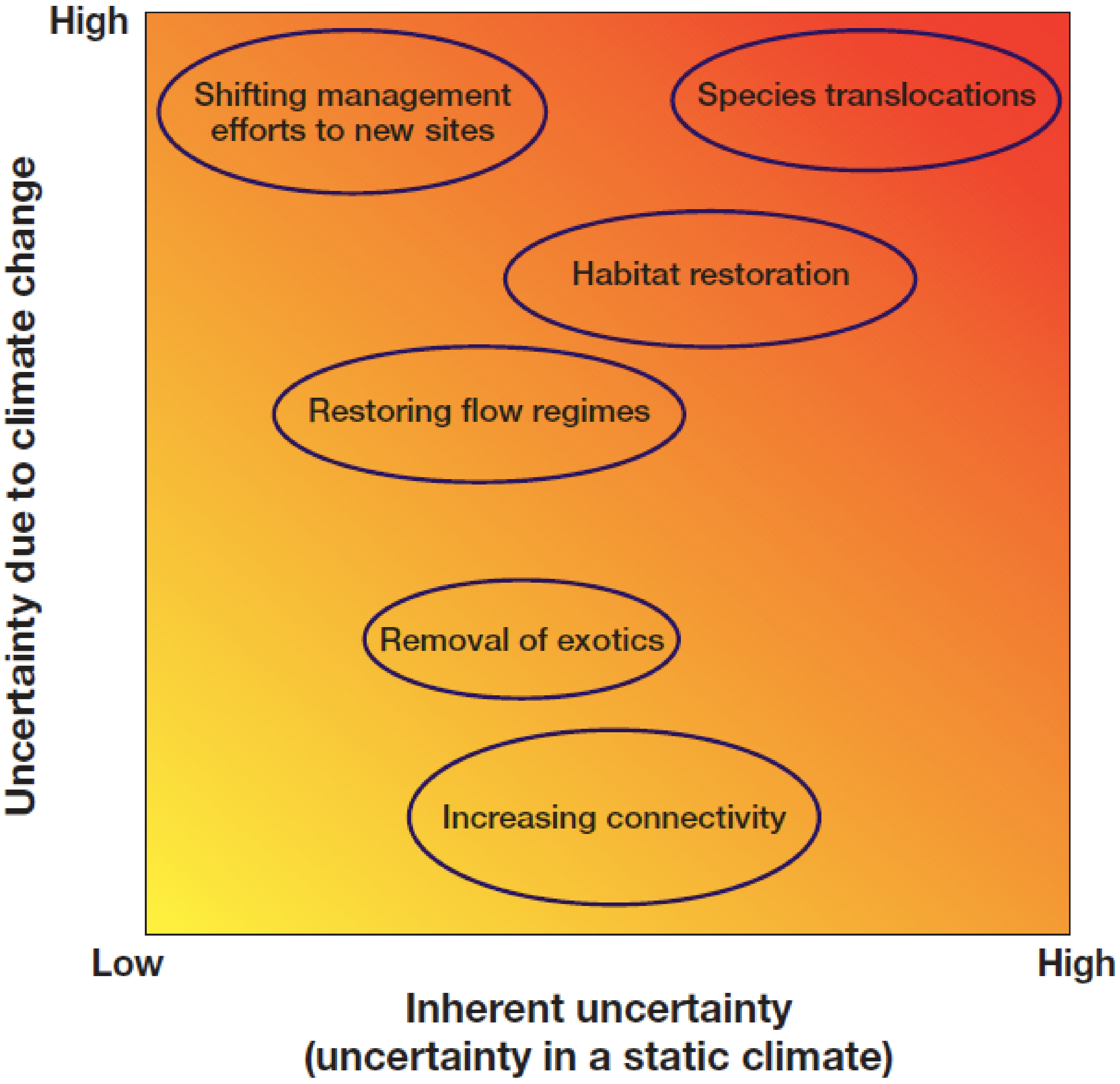
Nicole E. Heller, Erika S. Zavaleta*

Environmental Studies Department, University of California, Santa Cruz, Santa Cruz, CA 95606, United States

integrate cc into planning

increase connectivity


Lower uncertainty
Inherent species sensitivities
Historic climate changes
Paleoecological records
Temperature
Precipitation
Hydrology
Fire
Population dynamics
Ecosystem functioning
Species distributions
Higher uncertainty


High
Uncertainty due to climate change
Shifting management efforts to new sites
Species translocations
Habitat restoration
Restoring flow regimes
Removal of exotics
Increasing connectivity
Low
High
Inherent uncertainty
(uncertainty in a static climate)

Anticipating the human response