Bringing Climate Change Home

How do we know it is happening & what does it mean for ecosystems & species?

Dr. Heidi Roop
UW Climate Impacts Group

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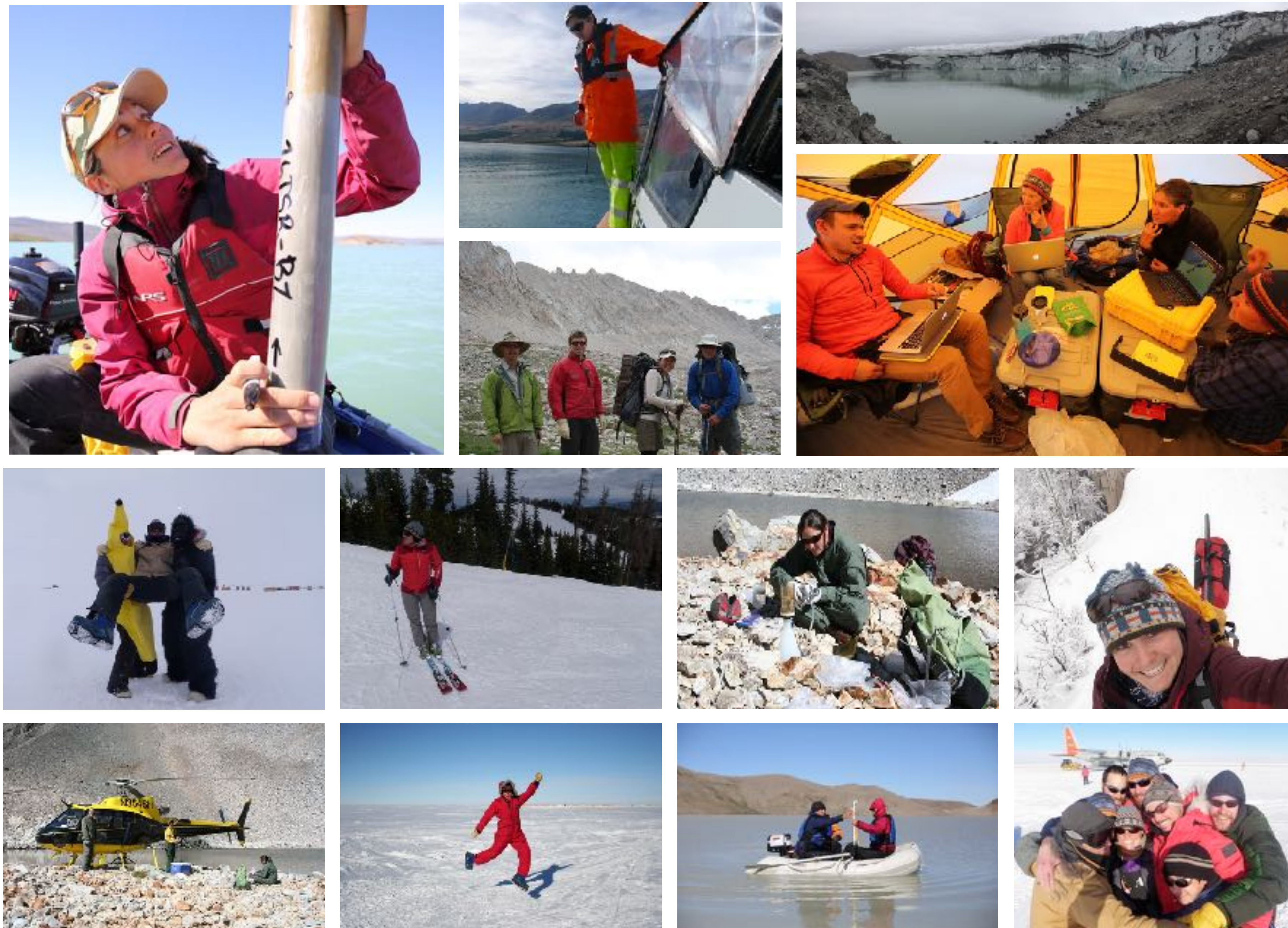
Earth Scientist.



Photos: H. Roop

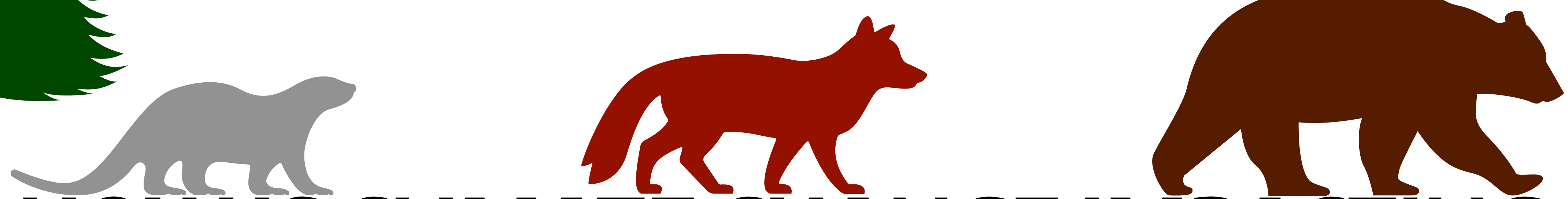
Established 1995

The **Climate Impacts Group** supports the development of climate resilience by ***advancing understanding*** and ***awareness*** of climate risks. We work closely with public & private entities ***to apply*** this information as they act to shape ***society’s future.***

COLLEGE OF THE ENVIRONMENT
UNIVERSITY *of* WASHINGTON

"Nature and its vital contributions to people, which together embody biodiversity and ecosystem functions and services, are deteriorating worldwide."

Diaz et al., 2019; UNIPBES Report



HOW IS CLIMATE CHANGE IMPACTING ECOSYSTEMS & SPECIES?

H. Roop, Climate Impacts Group

"Climate change is a direct driver that is increasingly exacerbating the impact of other drivers on nature & human well-being...

These changes have contributed to widespread impacts in many aspects of biodiversity, including species distributions, phenology, population dynamics, community structure & ecosystem function..."

Diaz et al., 2019; UNIPBES Report

Impacts on species and ecosystems

Changes in the timing of biological events

Direct and indirect loss of habitat

Changes in species distributions

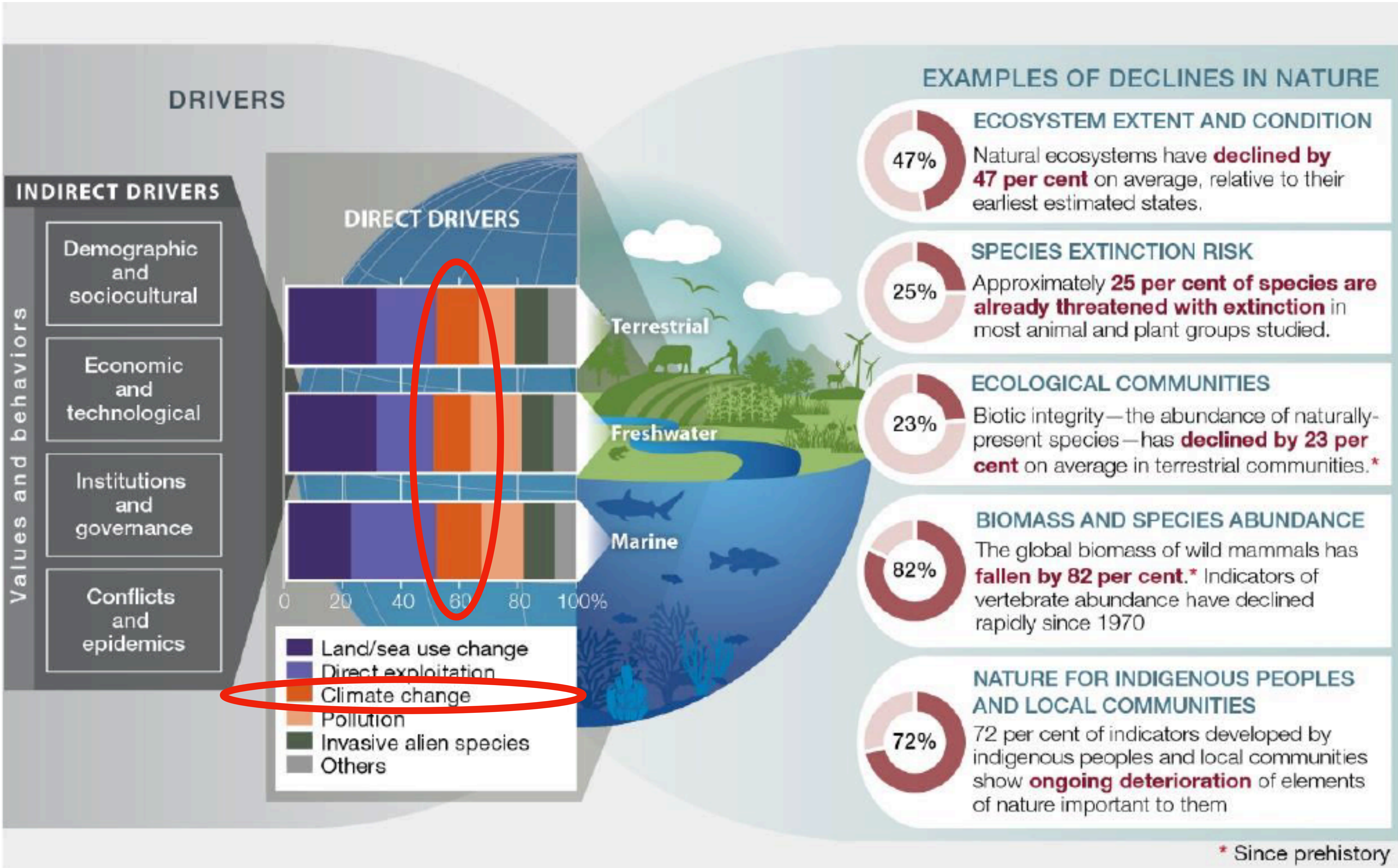
Disease and Parasites

Changes in species interactions

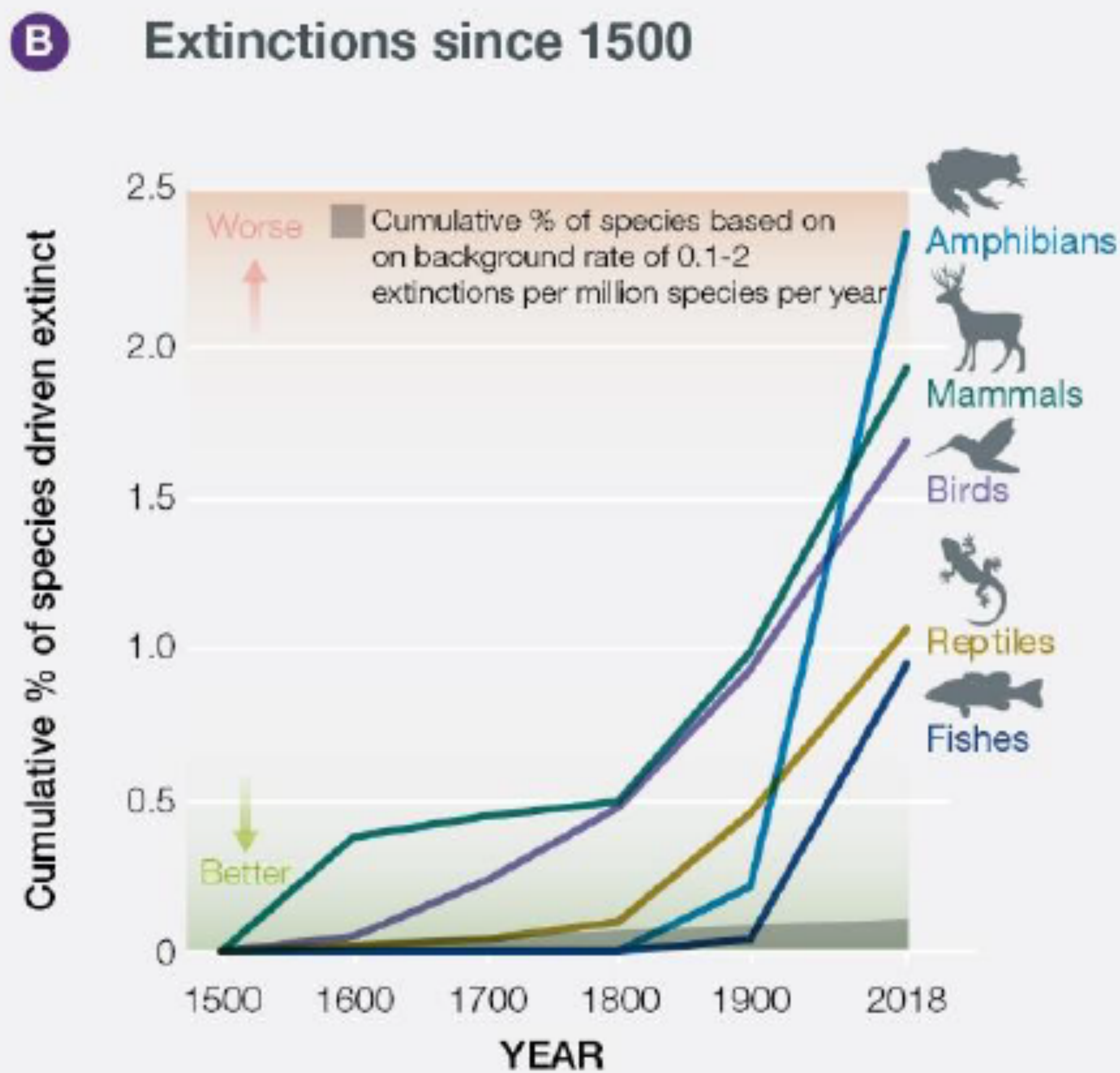
The rate of global change in nature over the past 50 years is unprecedented in human history. The direct drivers of change in nature with the largest global impact have been:

- **changes in land & sea use**
- **direct exploitation of organisms**
- **climate change**
- **pollution**
- **invasion of alien species**

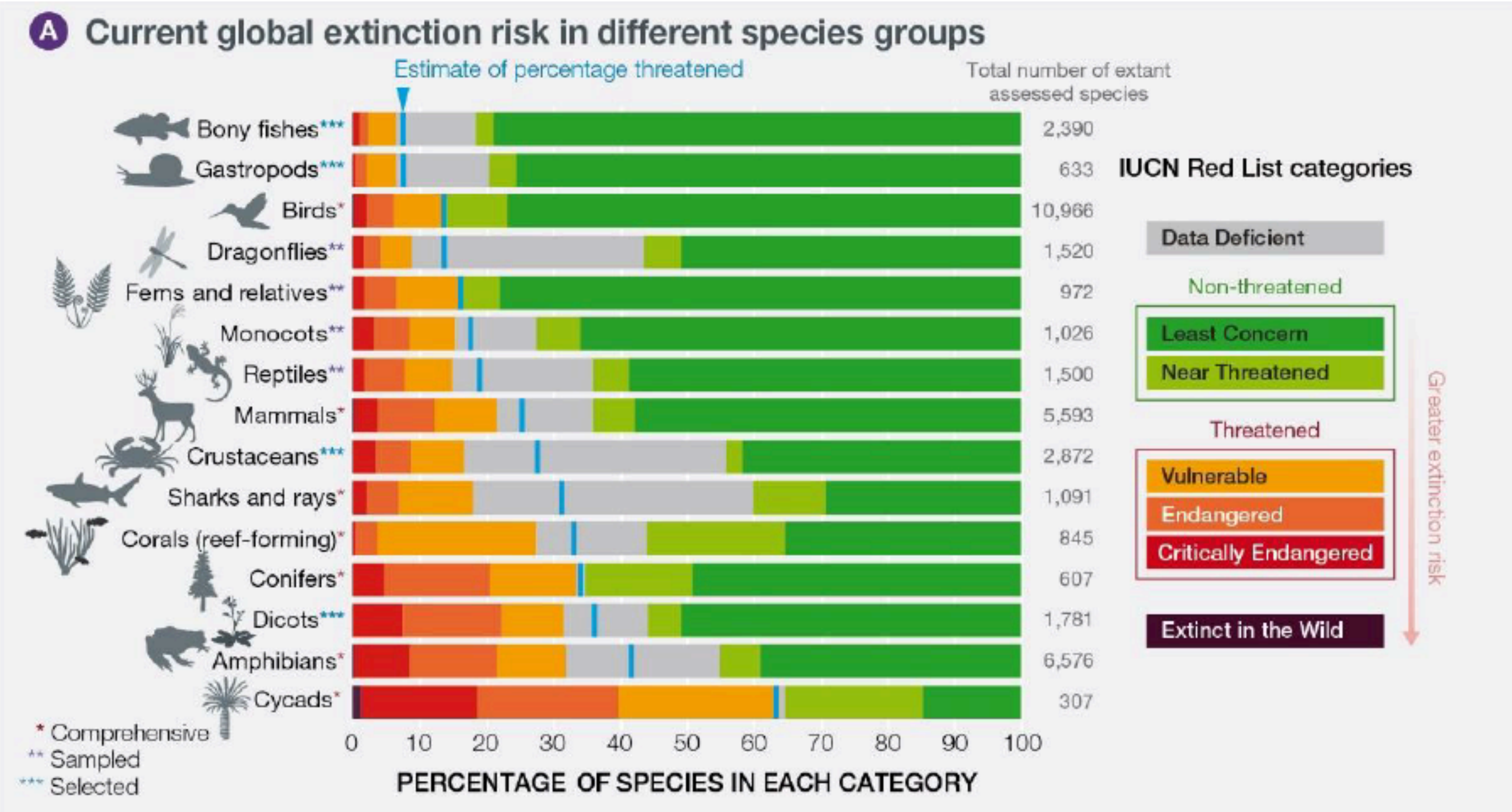
Modified from Diaz et al., 2019; UNIPBES Report



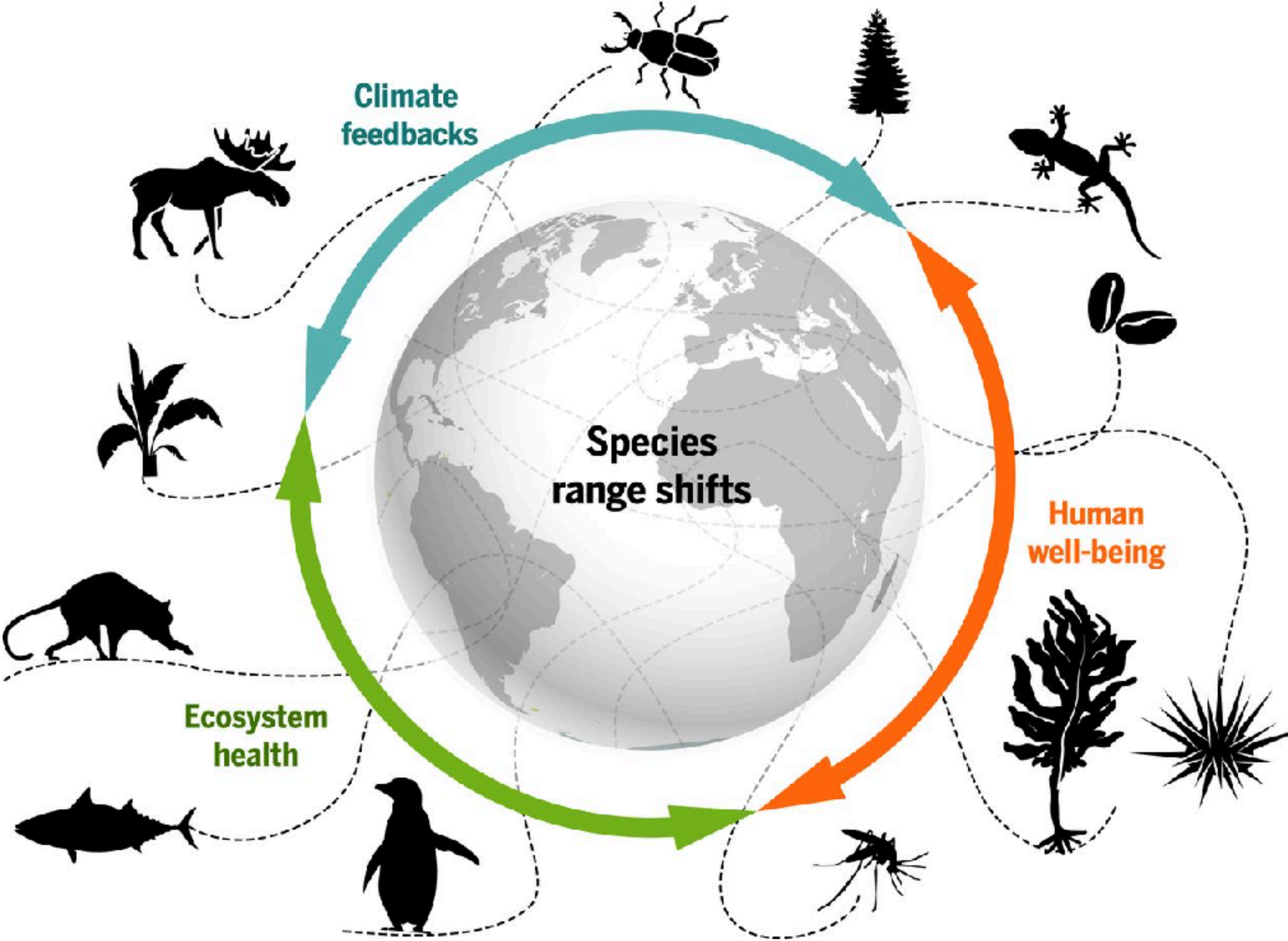
Diaz et al., 2019; UNIPBES Report



Diaz et al., 2019;
UNIPBES Report



Diaz et al., 2019;
UNIPBES Report



Pecl et al., 2017, Science

Projected changes in temperature & precipitation in the Puget Sound:

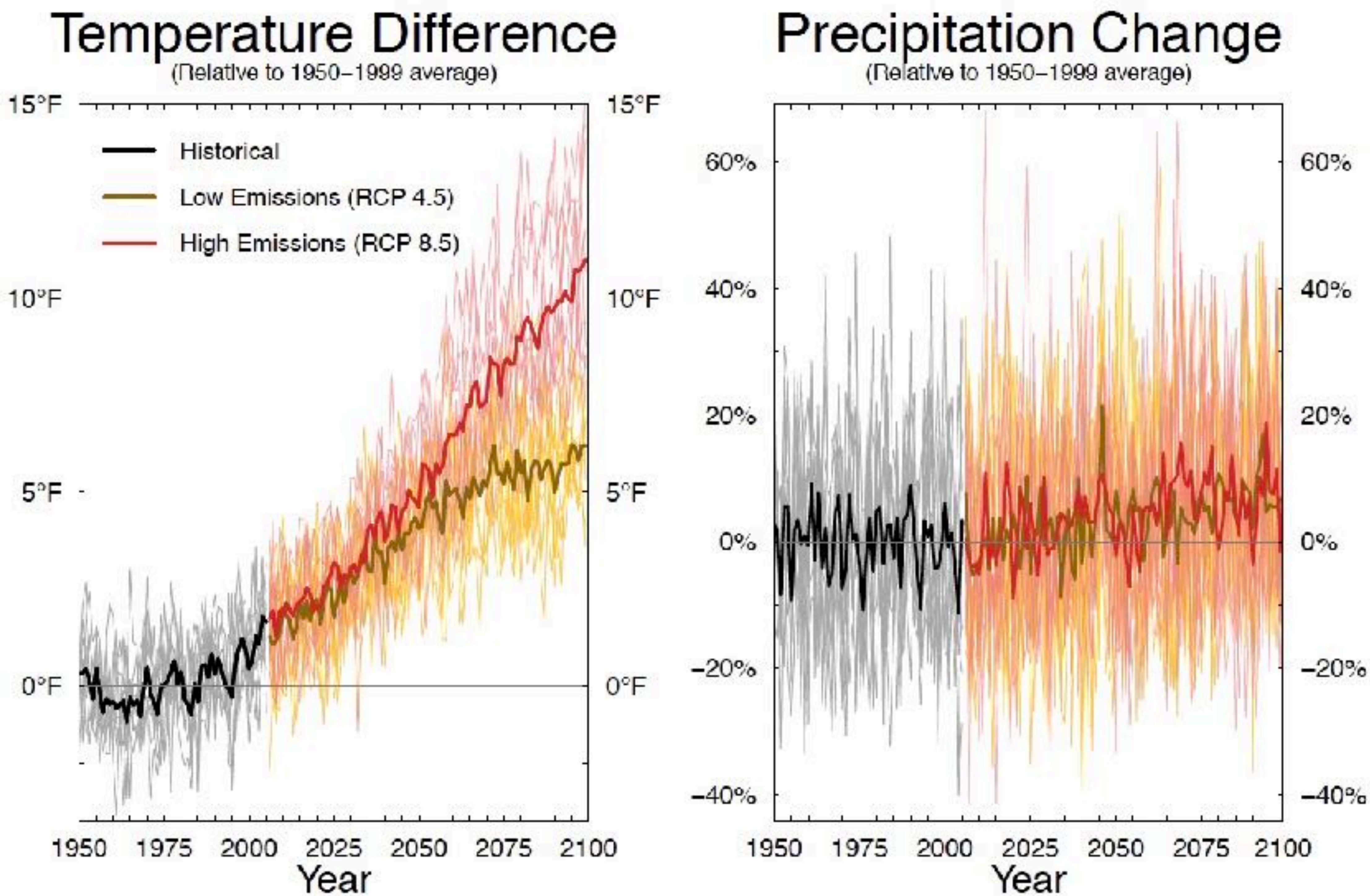
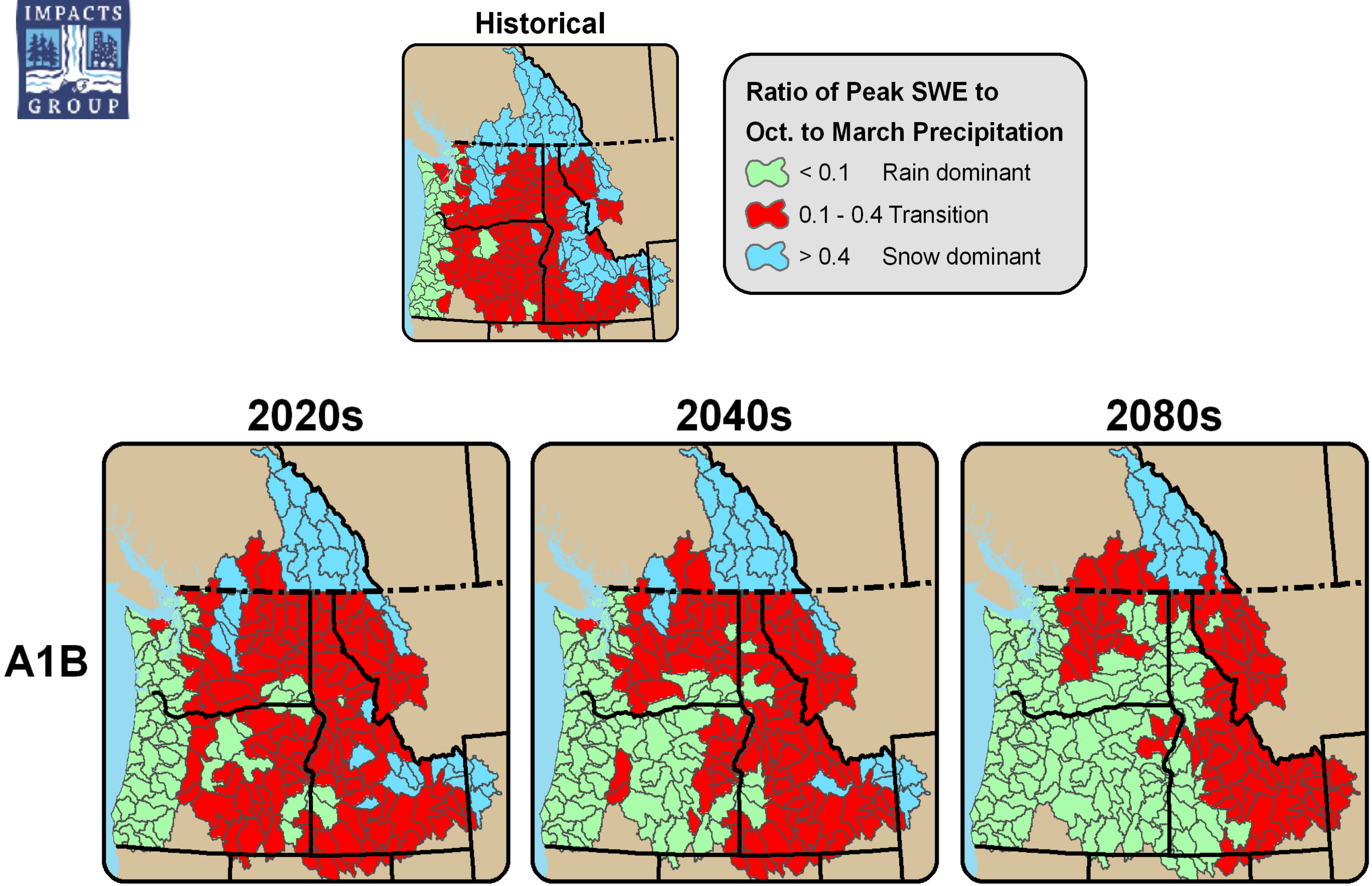


Figure 2-2. All scenarios project warming in the Puget Sound region for the 21st century; projected changes in annual precipitation are small compared to year-to-year variability.

Mauger et al., 2015

Basin Transformations: Shifting from snow to rain



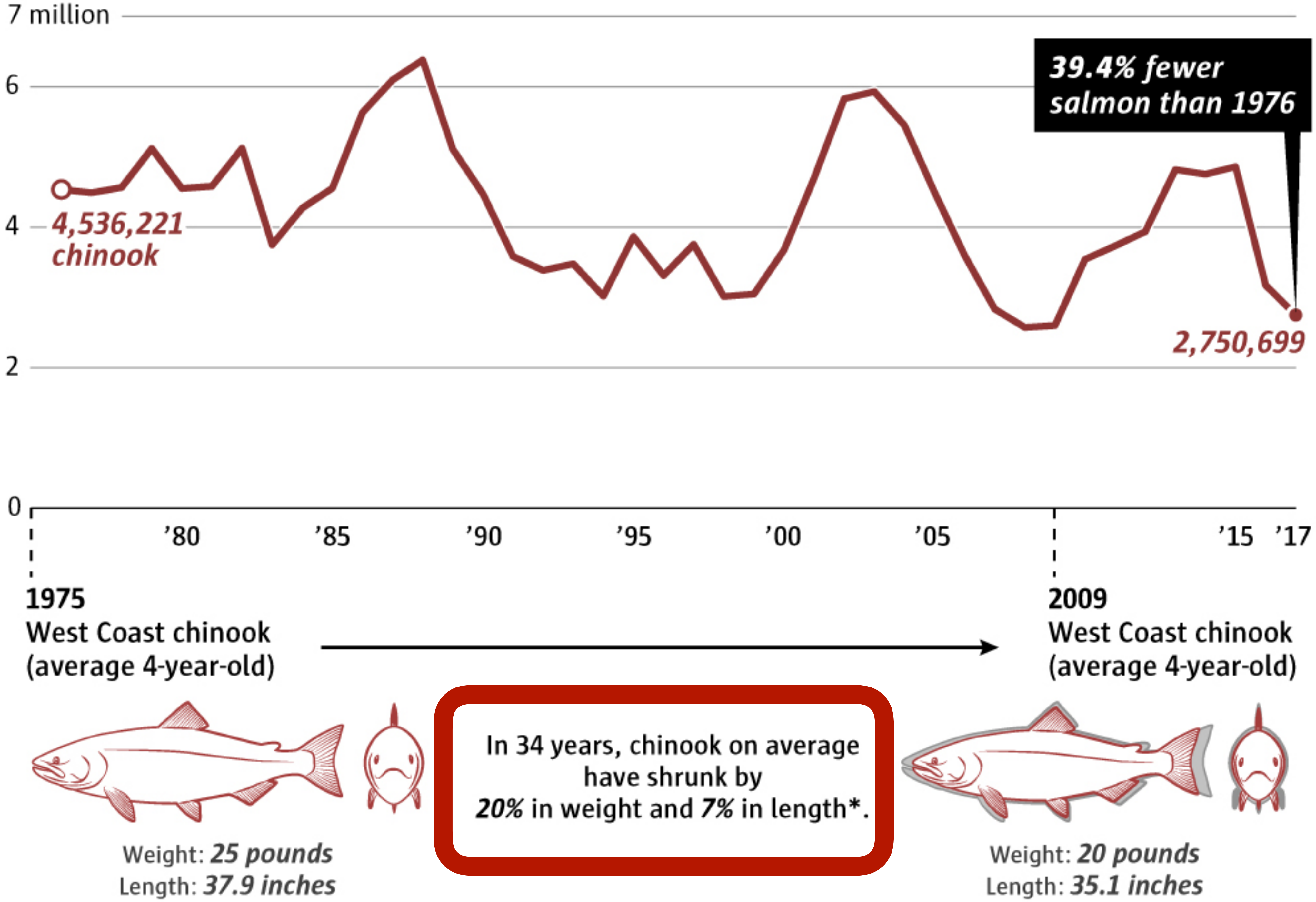
A1B: Medium emissions scenario

Mauger et al., 2015

Salmon declining in abundance and size

Chinook populations up and down the West Coast have slowly been decreasing since the 1980s. Not only are there fewer fish in regional waters, but individuals are shrinking in average size and weight, with the older, fatter salmon making up less and less of the population.

CHINOOK ABUNDANCE FROM ALASKA THROUGH CALIFORNIA

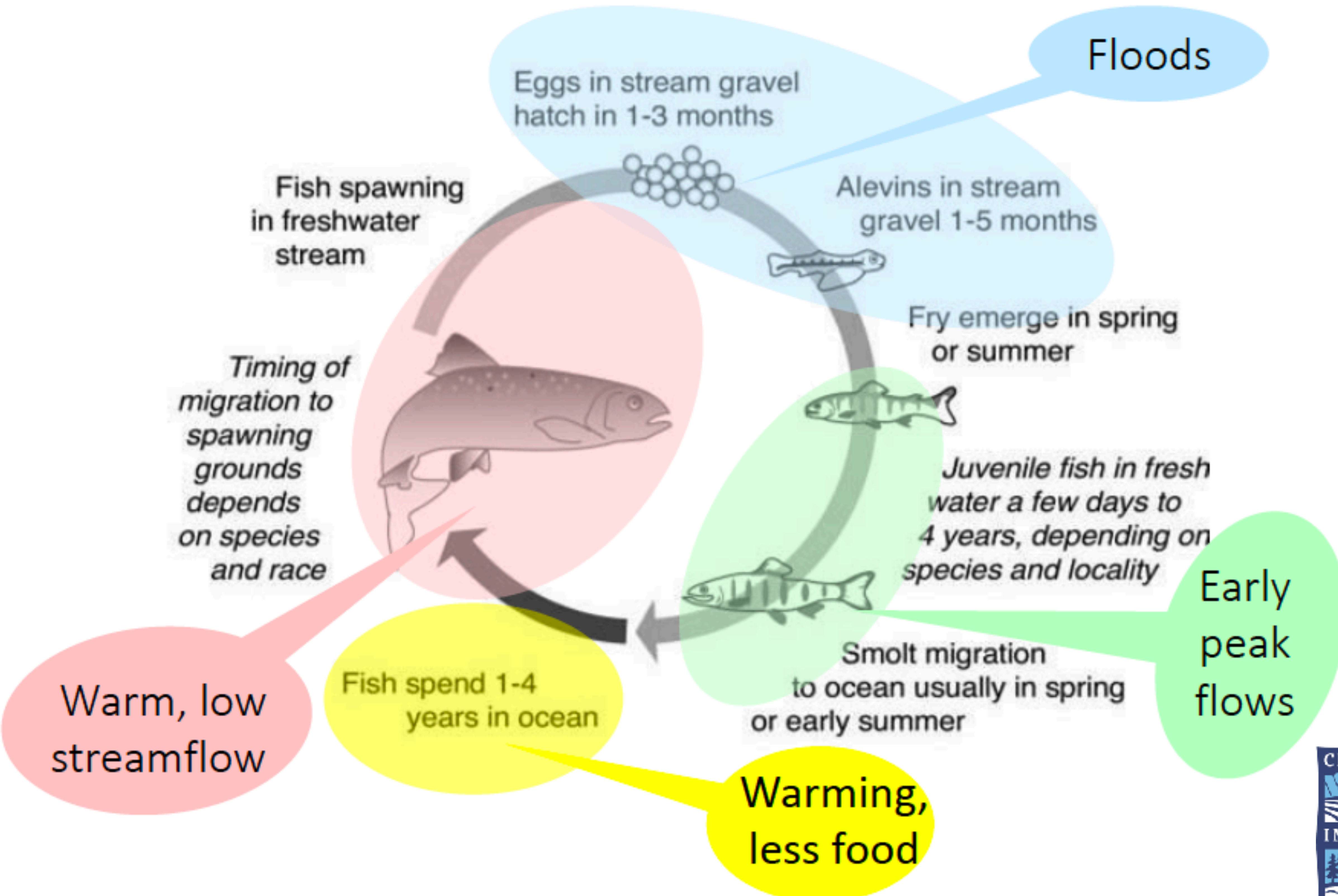


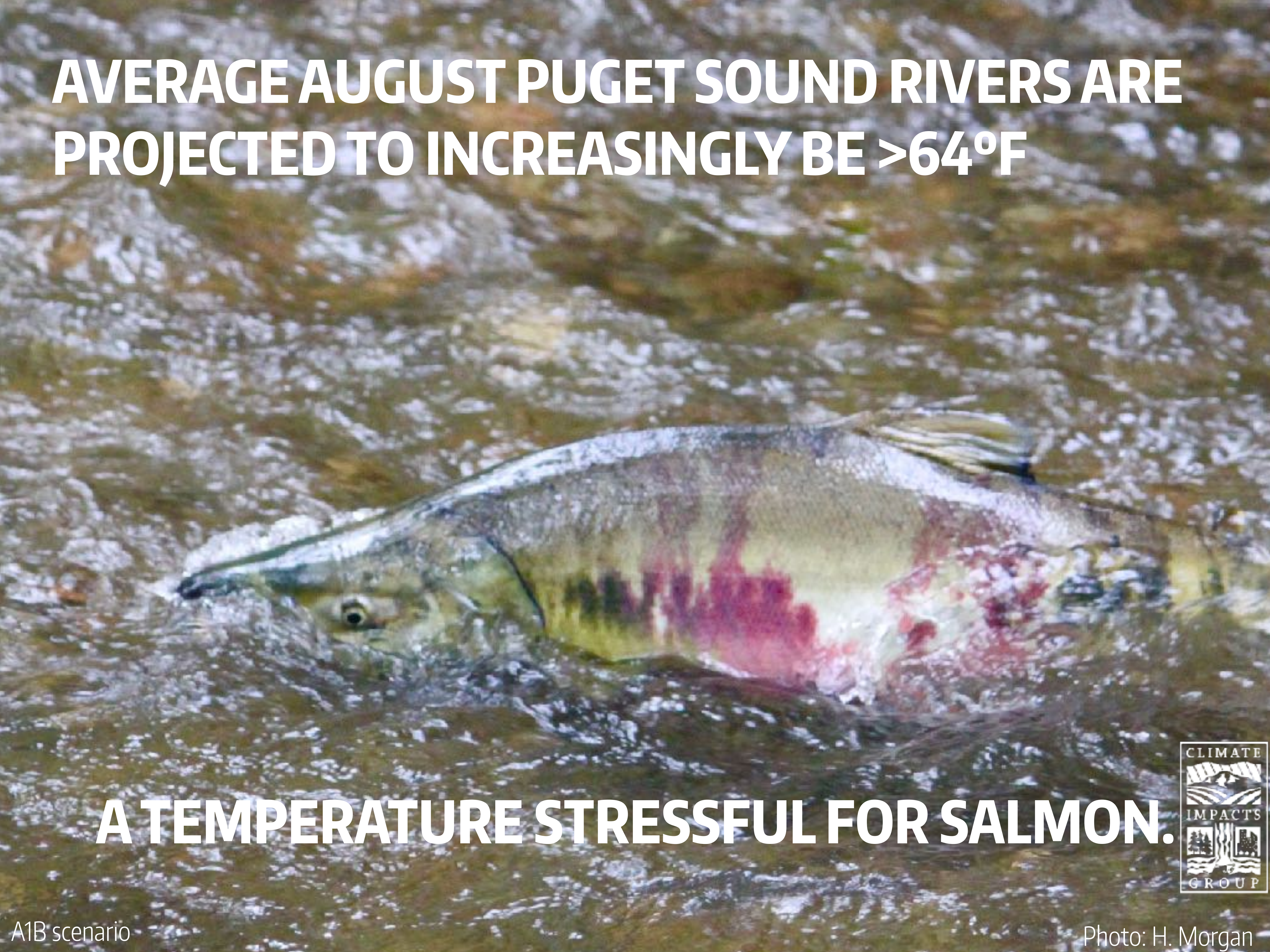
Weight and length measured for 4-year-old ocean chinook from multiple salmon runs from Alaska to California.

Sources: Ohlberger, Jan, et. al, "Demographic changes in Chinook salmon across the Northeast Pacific Ocean," Fish and Fisheries, Center for Whale Research, Pacific Fishery Management Council (2018), NOAA Technical Memorandum NMFS-NWFSC-123 (July 2013), Pacific Salmon Commission (2018)

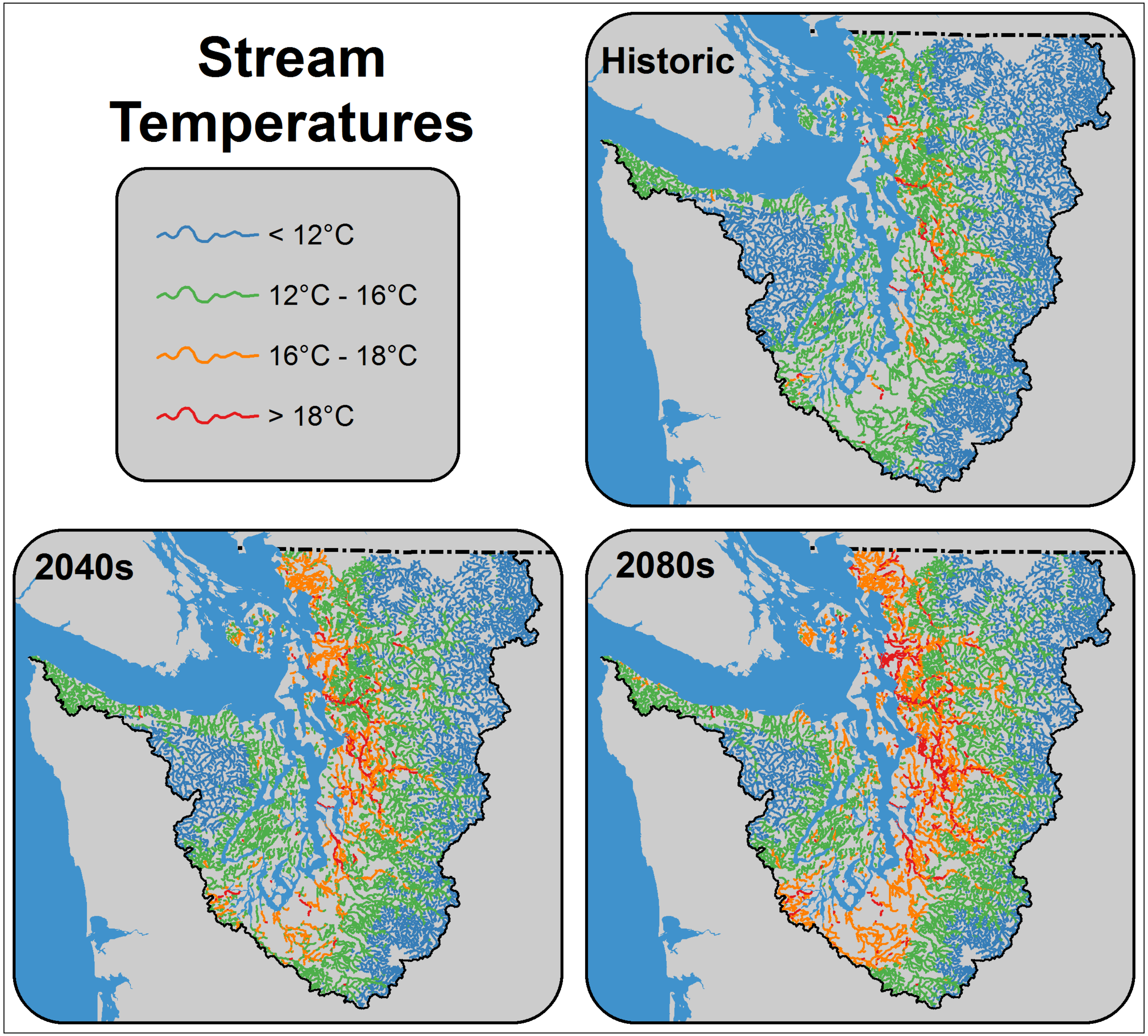
EMILY M. ENG / THE SEATTLE TIMES

Impacts to salmon will occur across their lifecycle

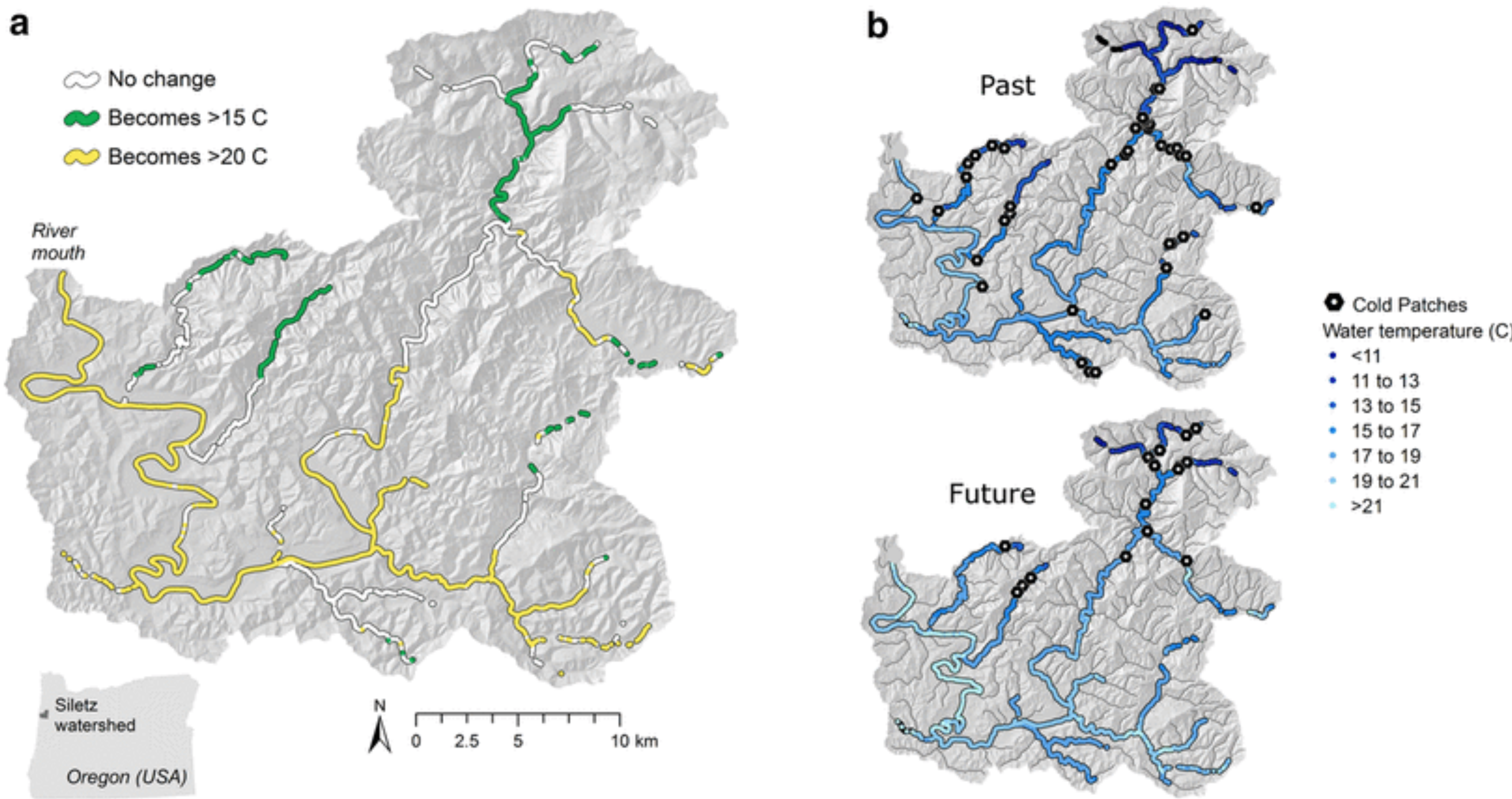



AVERAGE AUGUST PUGET SOUND RIVERS ARE PROJECTED TO INCREASINGLY BE >64ºF
A TEMPERATURE STRESSFUL FOR SALMON.
CLIMATE IMPACTS GROUP
A1B scenario
Photo: H. Morgan

August Stream Temperature under a moderate emissions scenario



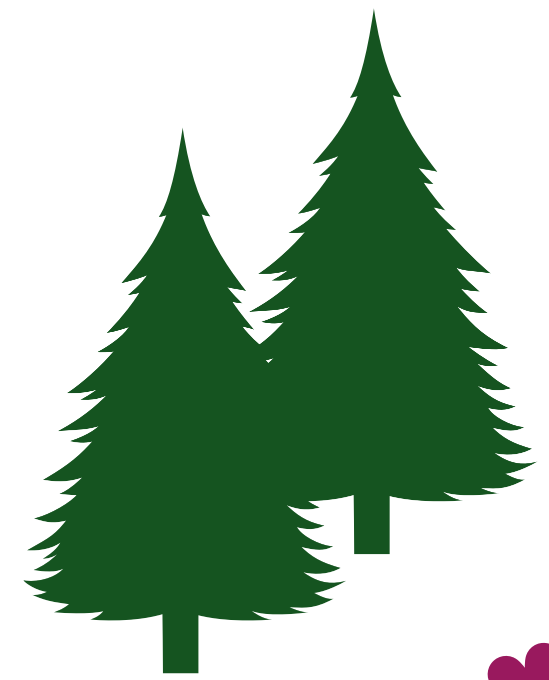
Climate Impacts Group/U.S. Forest Service

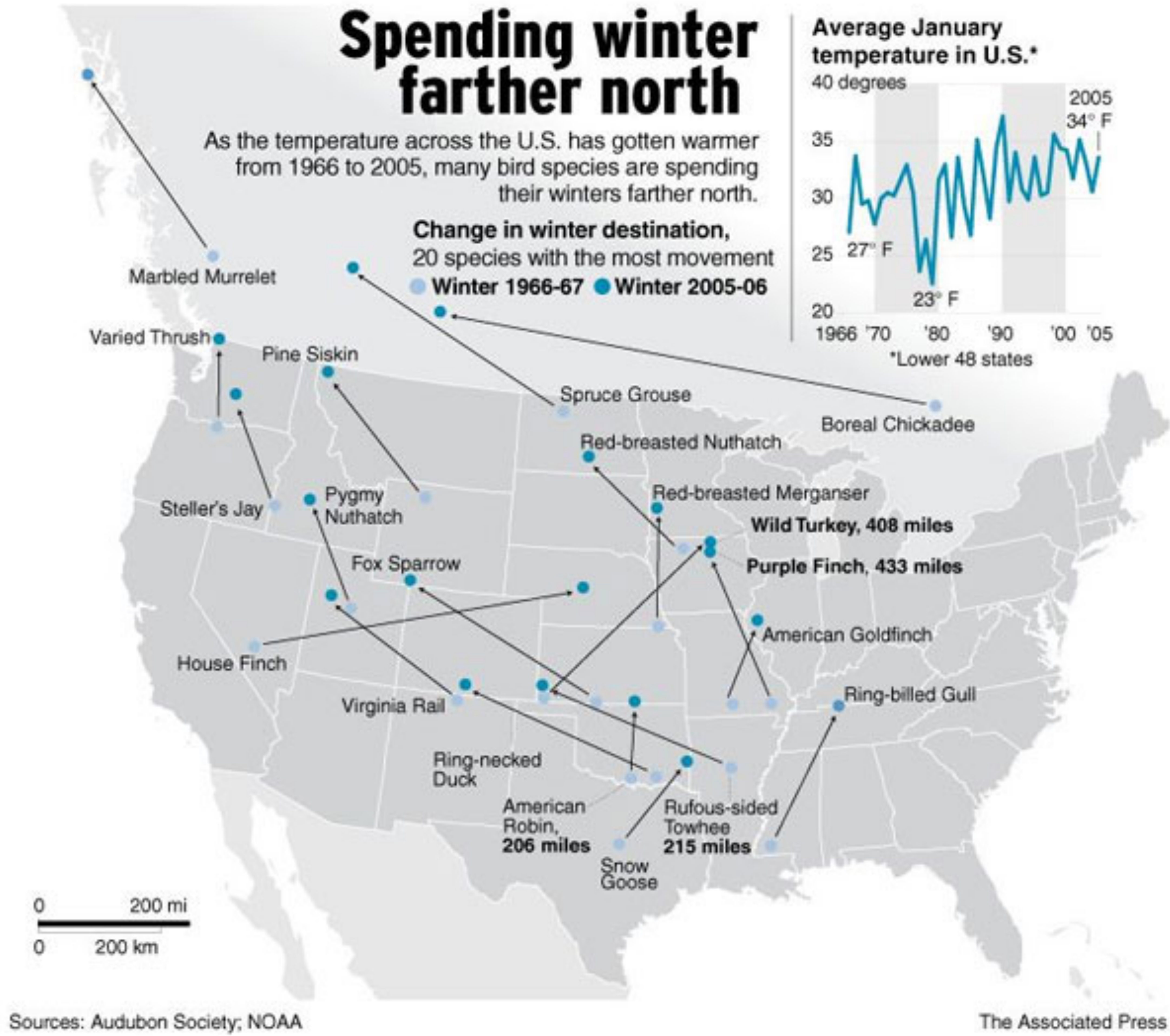


Potential effect of climate change on thermal zones and cold patches in the Siletz River watershed, Oregon (USA) based on thermal infrared data collected on 5–7 August 2001. **a** Reaches where thermal zones would change if water temperature increases by 2 °C simultaneously. **b** Distribution of cool (< 15 °C) patches in the past (August 2001) and if water temperature increases by 2 °C in the future

Fullerton et al., 2017

Shifting…
ranges,
timing,
ecosystems





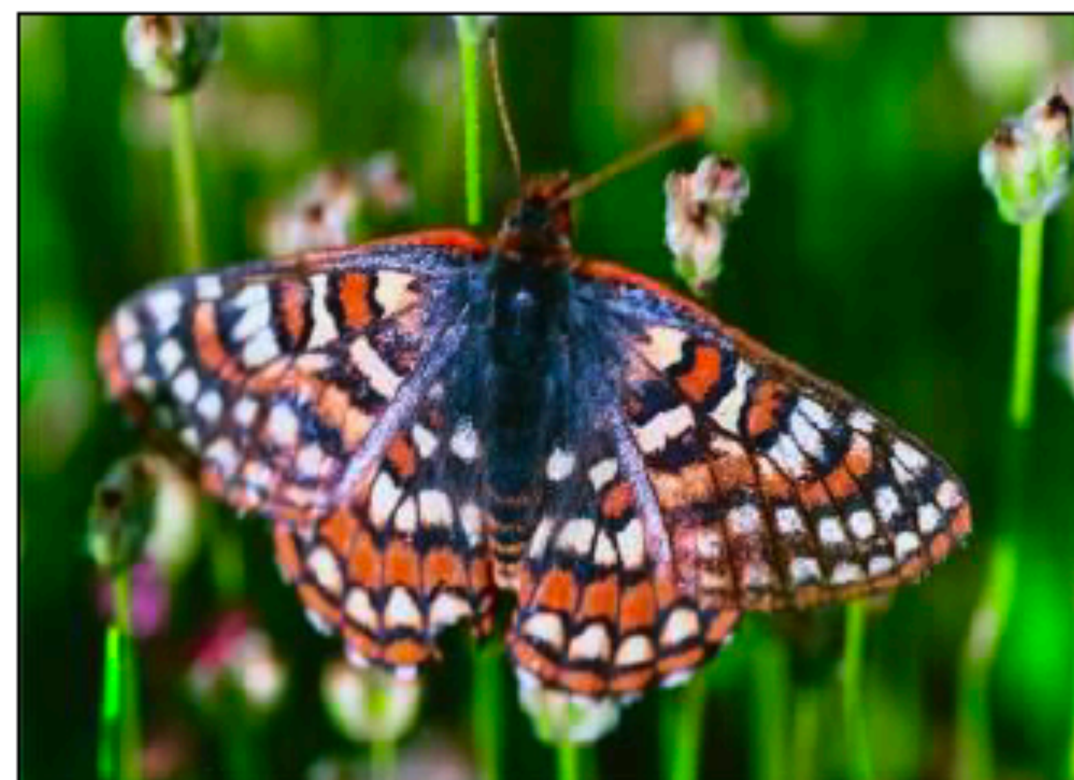
Spending winter farther north
As the temperature across the U.S. has gotten warmer from 1966 to 2005, many bird species are spending their winters farther north.
Change in winter destination,
20 species with the most movement
Winter 1966-67
Winter 2005-06
Average January temperature in U.S.*
40 degrees
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
House Finch
American Goldfinch
Ring-billed Gull
Virginia Rail
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

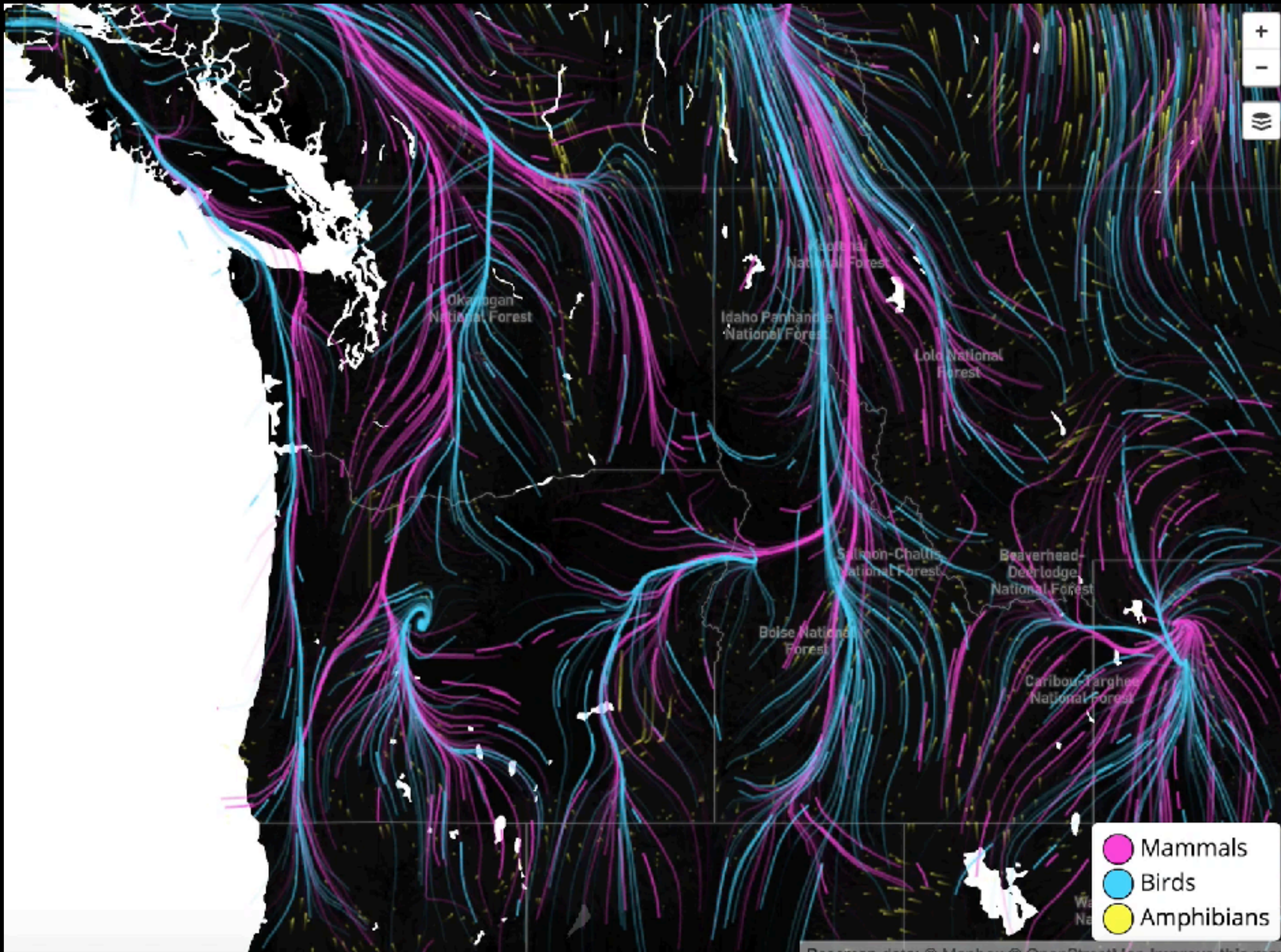
Species respond to climate change by adjusting their geographic ranges

Average range shift over past century (globally):

- Upward ~11m /decade
- Poleward ~17km /decade

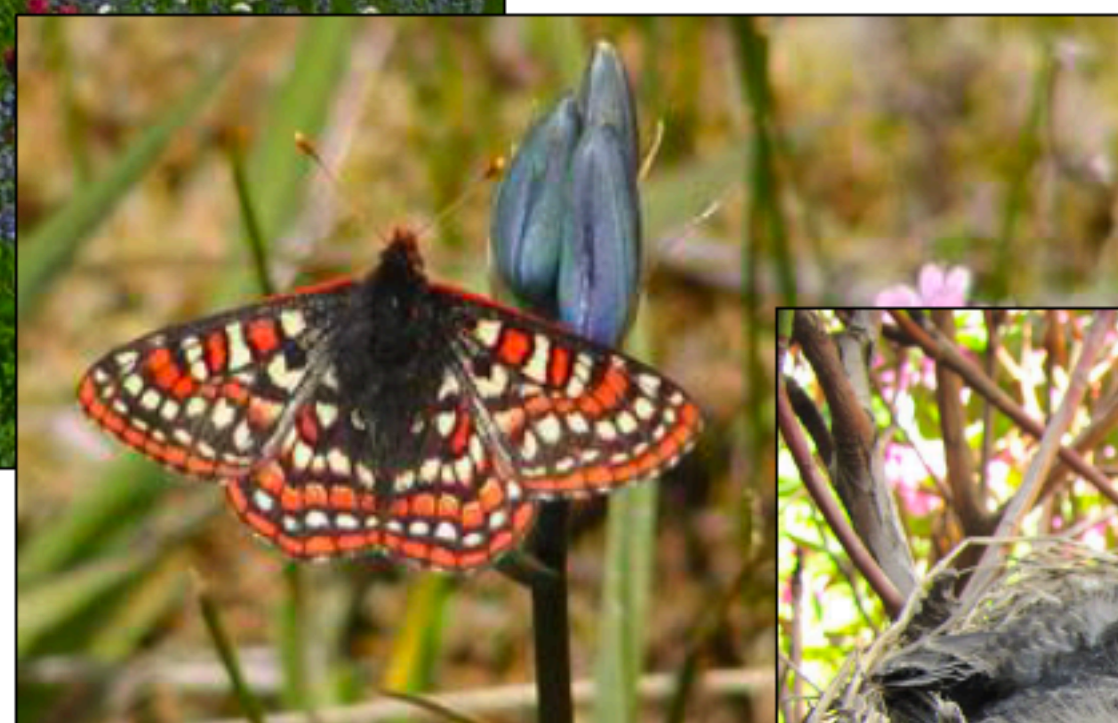
*Regional example: Edith's checkerspot butterfly. Range has shifted northward and to higher elevations over 40+ years





The Nature Conservancy

Changes in the timing of biological events



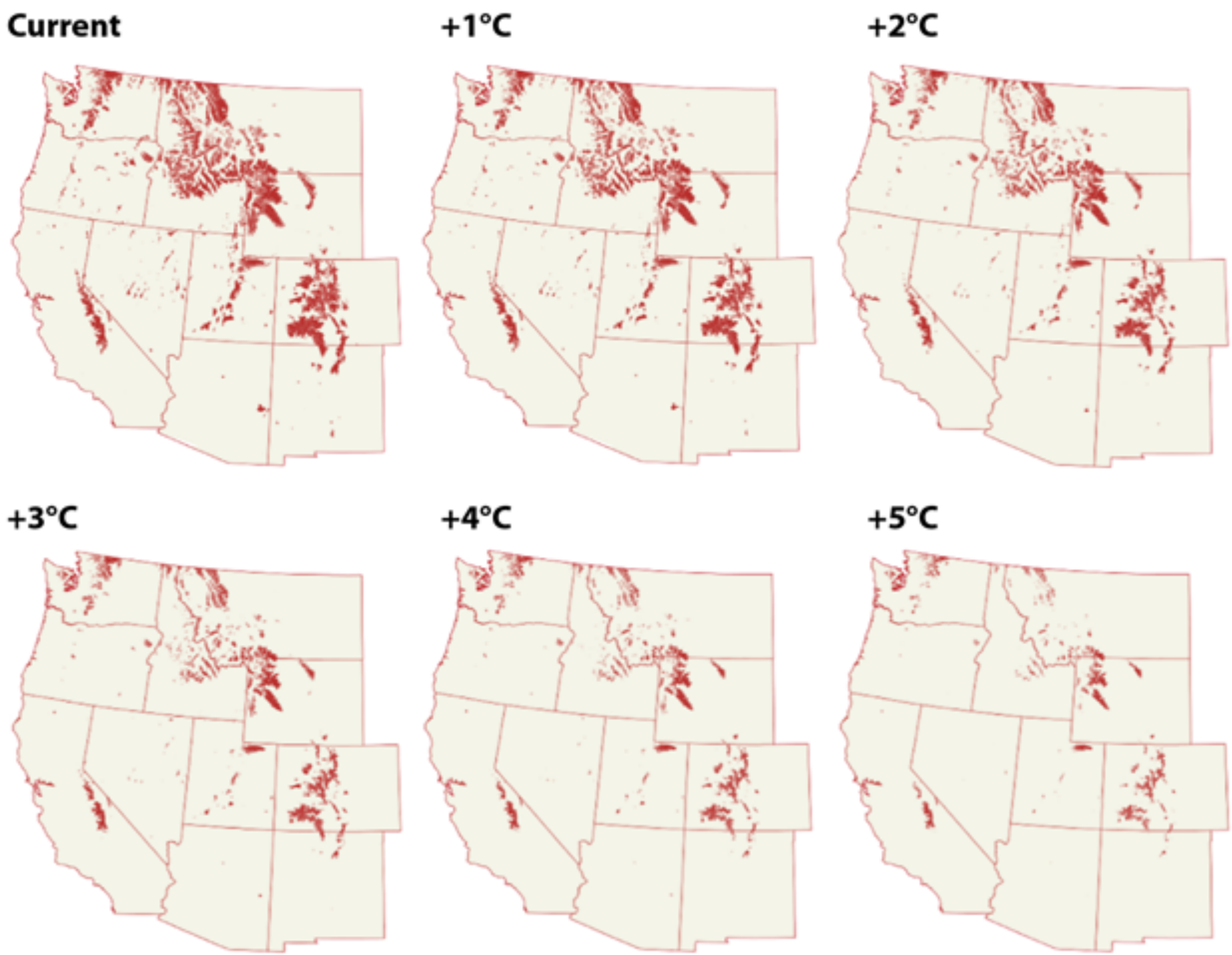
Habitat & Habitat Fragmentation

The American Pika's Dwindling Habitat

Climate change is projected to shrink the American pika's range. The maps below show predicted suitable habitat today and as temperatures warm.

AMERICAN PIKA PREDICTED DISTRIBUTIONS

Current and increased temperature scenarios



SOURCE: Michael T. Calkins, et al.

PAUL HORN / InsideClimate News

Wolverine Habitat

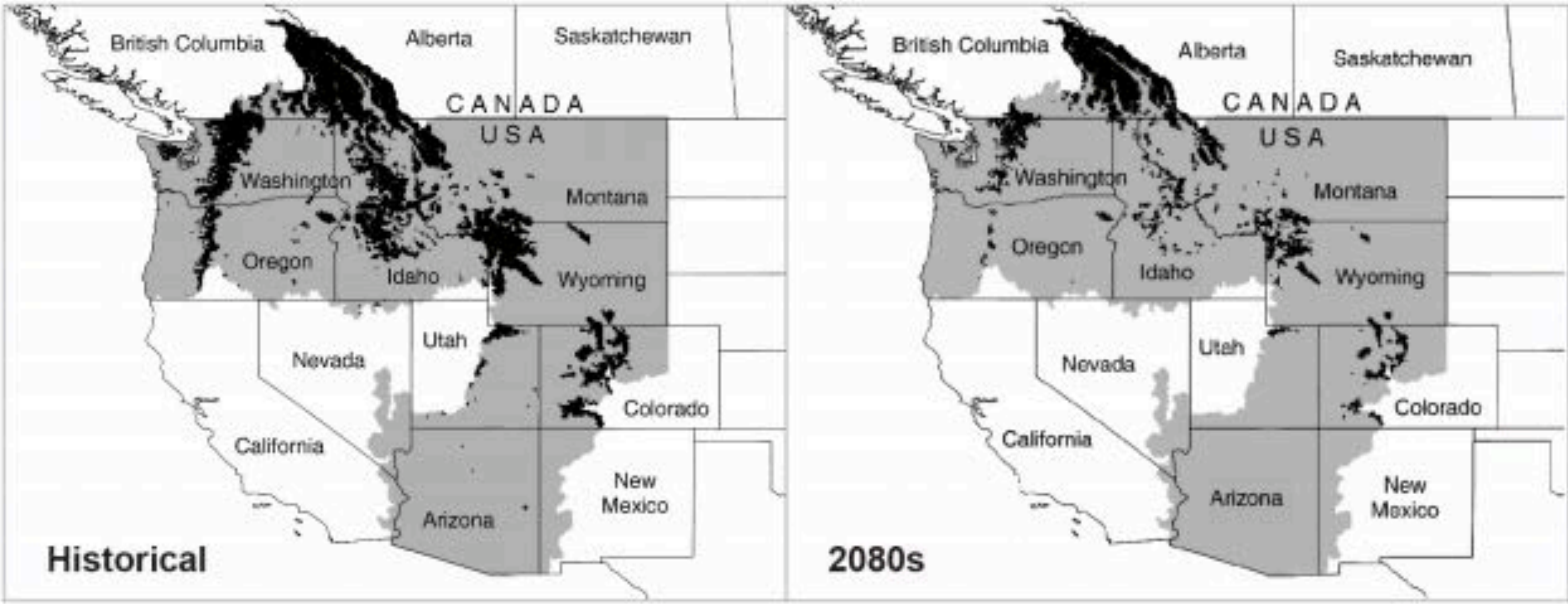
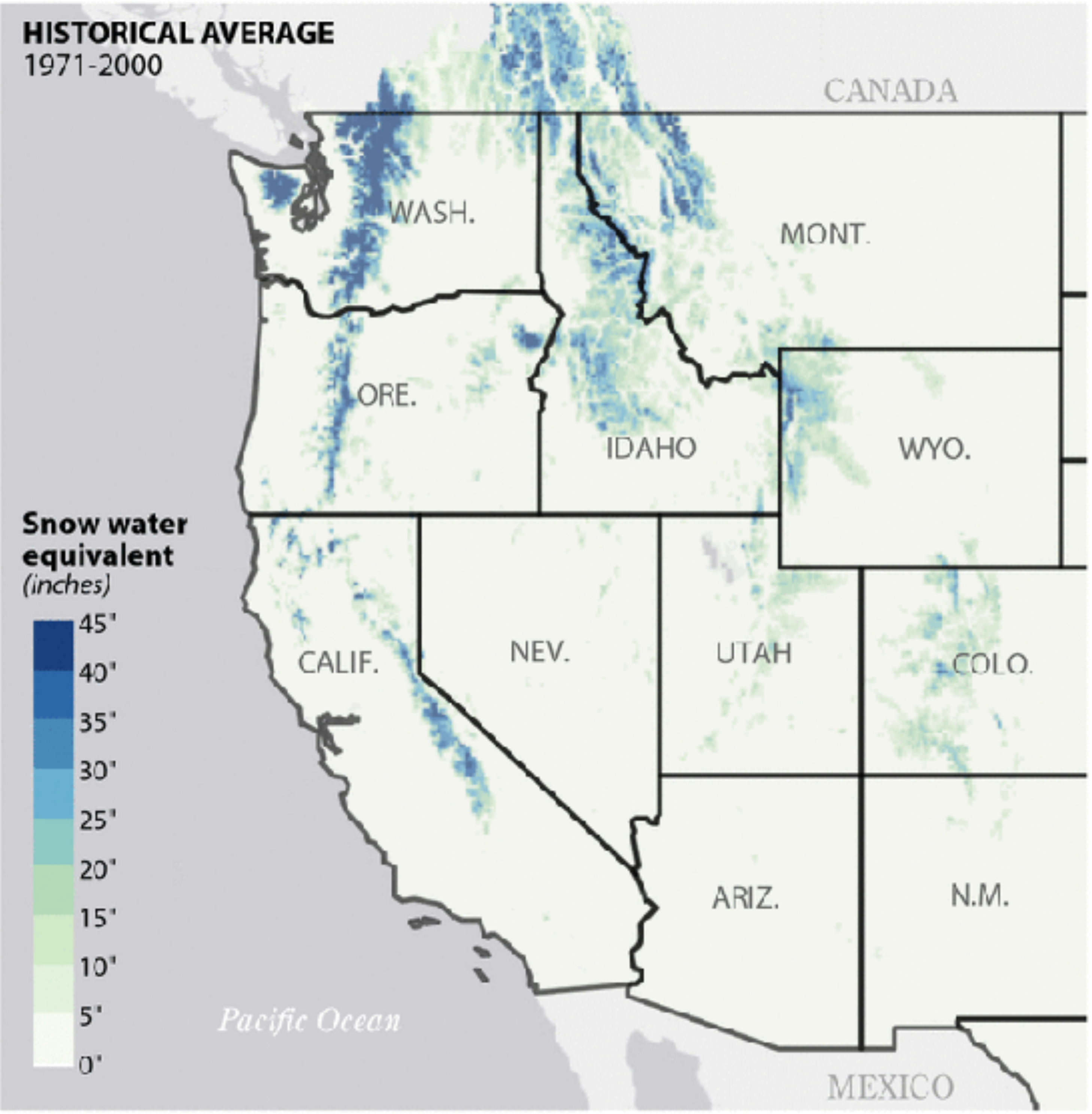


Figure 9-1. Declining Wolverine habitat with increasing temperatures. Maps show the extent of snowcover historically (1916-2006, left) and simulated for the 2080s (2070-2099, right) for a moderate (A1B) greenhouse gas scenario. The study area is shown in gray, and snow cover is black. The authors classified each point as wolverine habitat if snow depth exceeded 13 cm (about 5 inches) through 15 May. *Figure Source: McKelvey et al. 2011.*[C,11] *Reproduced with permission.*

From: Mauger et al., 2015

How Climate Change Will Reduce Snowpack

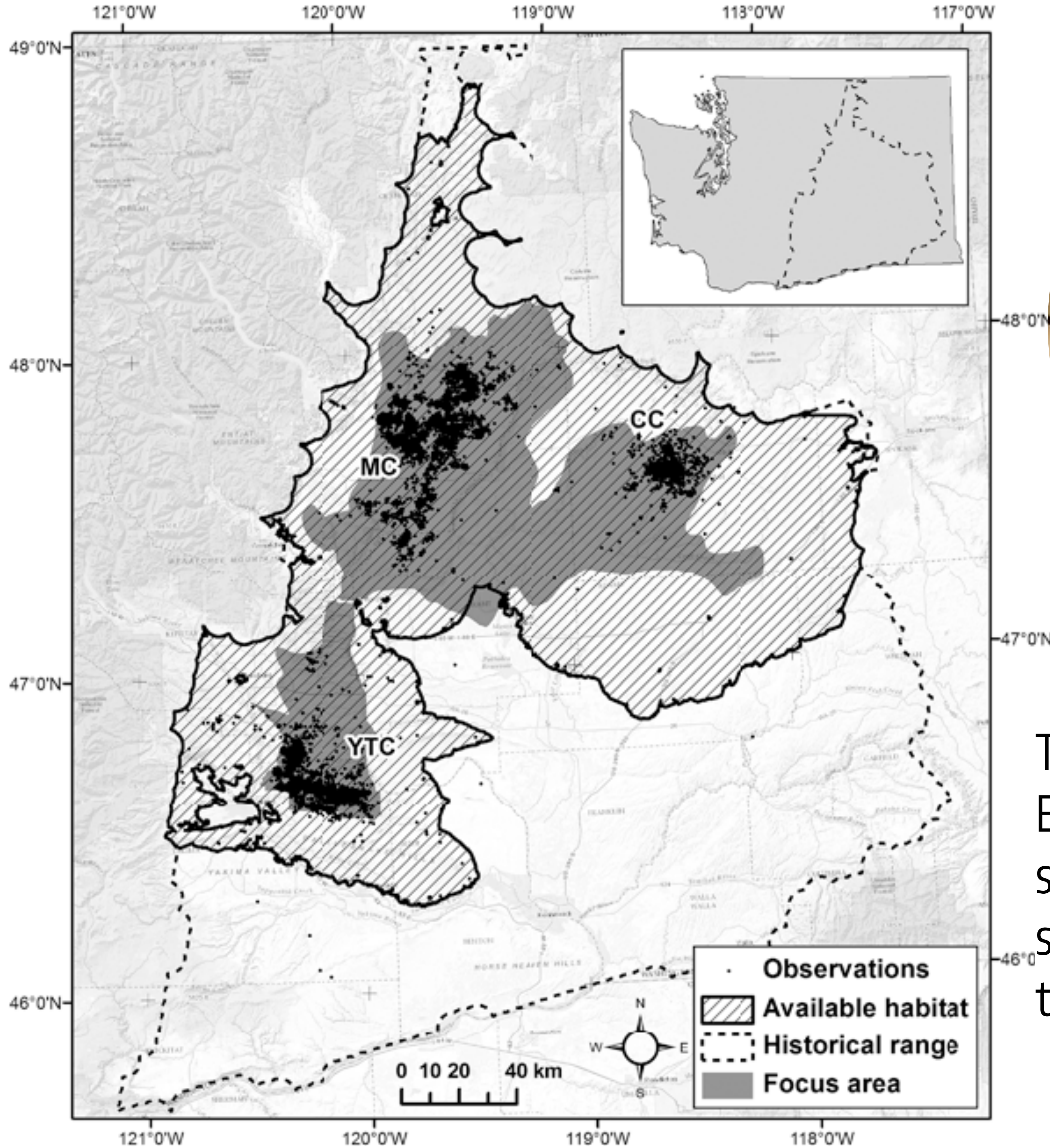
Rising temperatures will mean less precipitation will fall as snow in the U.S. West, and the snow will melt faster. These maps compare the average water content of the snowpack on April 1 at the end of the last century to projections for the end of this century under two scenarios for future greenhouse gas emissions, one with lower emissions (RCP 4.5) and one with high emissions (RCP 8.5).



SOURCE: climatetoolbox.org

PAUL HORN / InsideClimate News

Sage Grouse



The historical range for sage grouse in Eastern Washington, dotted lines, has shrunk to the shaded areas. Sage grouse sightings are shown with black dots, in three remaining subpopulations.

Shirk et al., 2017; photo: BLM

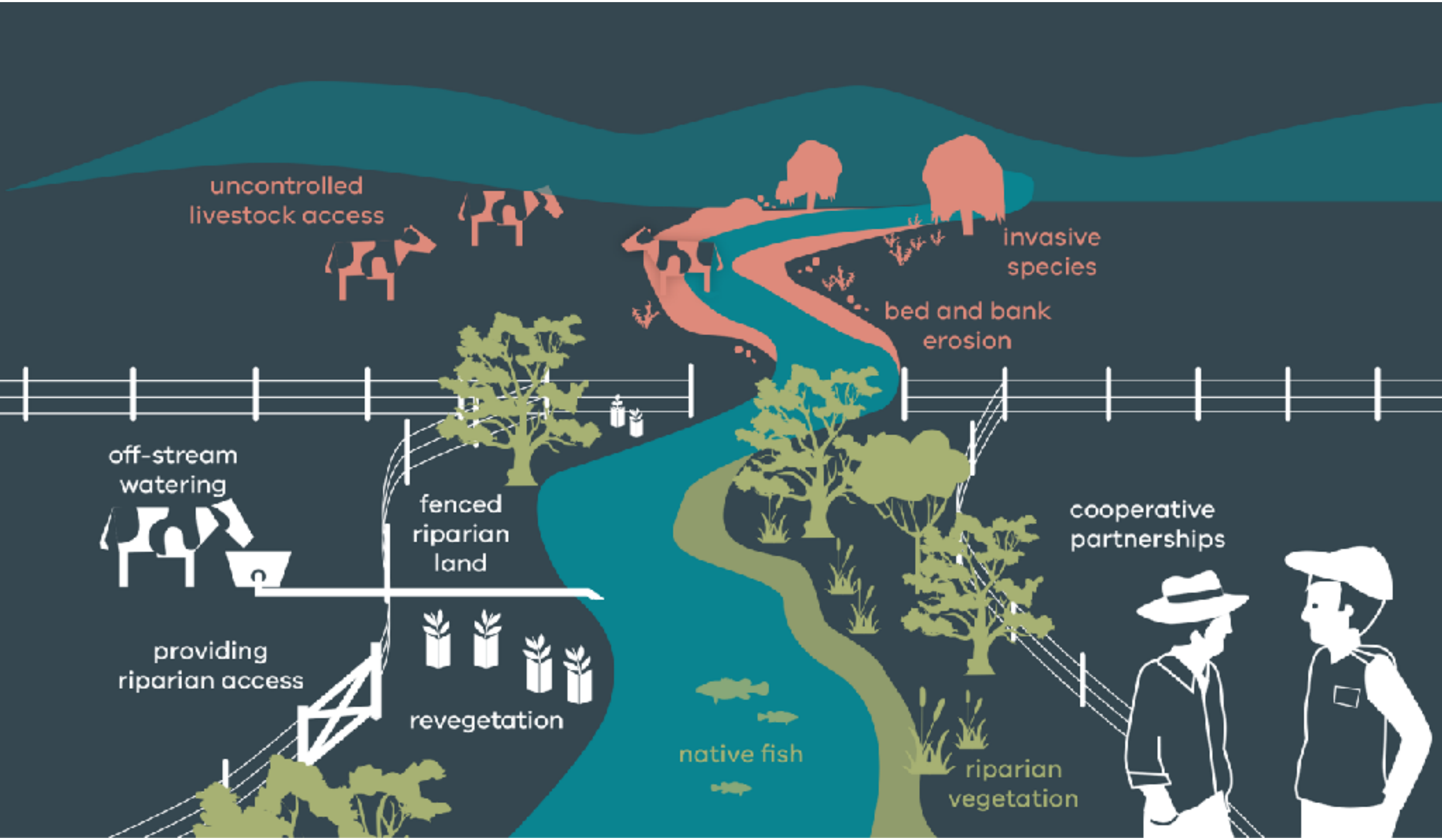
"As the climate changes, species need to be able to move across the landscape to track their habitat. Sage grouse habitat is likely to shift under climate change, and yet barriers like major roads and power lines may limit the ability of this species to migrate accordingly.

If there was a strategic vision for how Conservation Reserve Program land was allocated, some of it could be used to facilitate the movement of sage grouse and other species over time to track their climate niche."

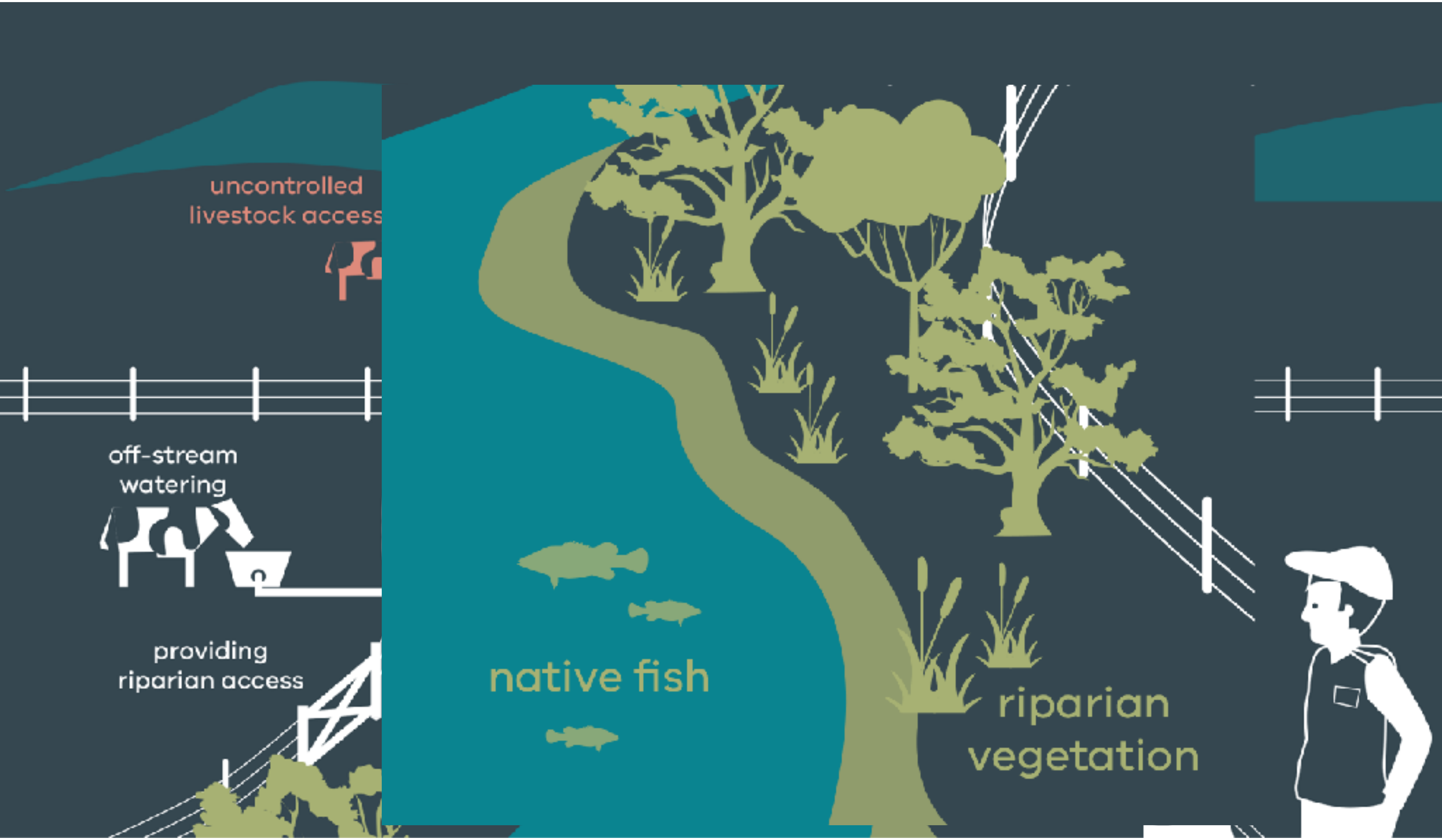
Shirk et al., 2017; photo: BLM

Construction continues on the wildlife crossing over Interstate 90 near Snoqualmie Pass.

Seattle Times, 2018



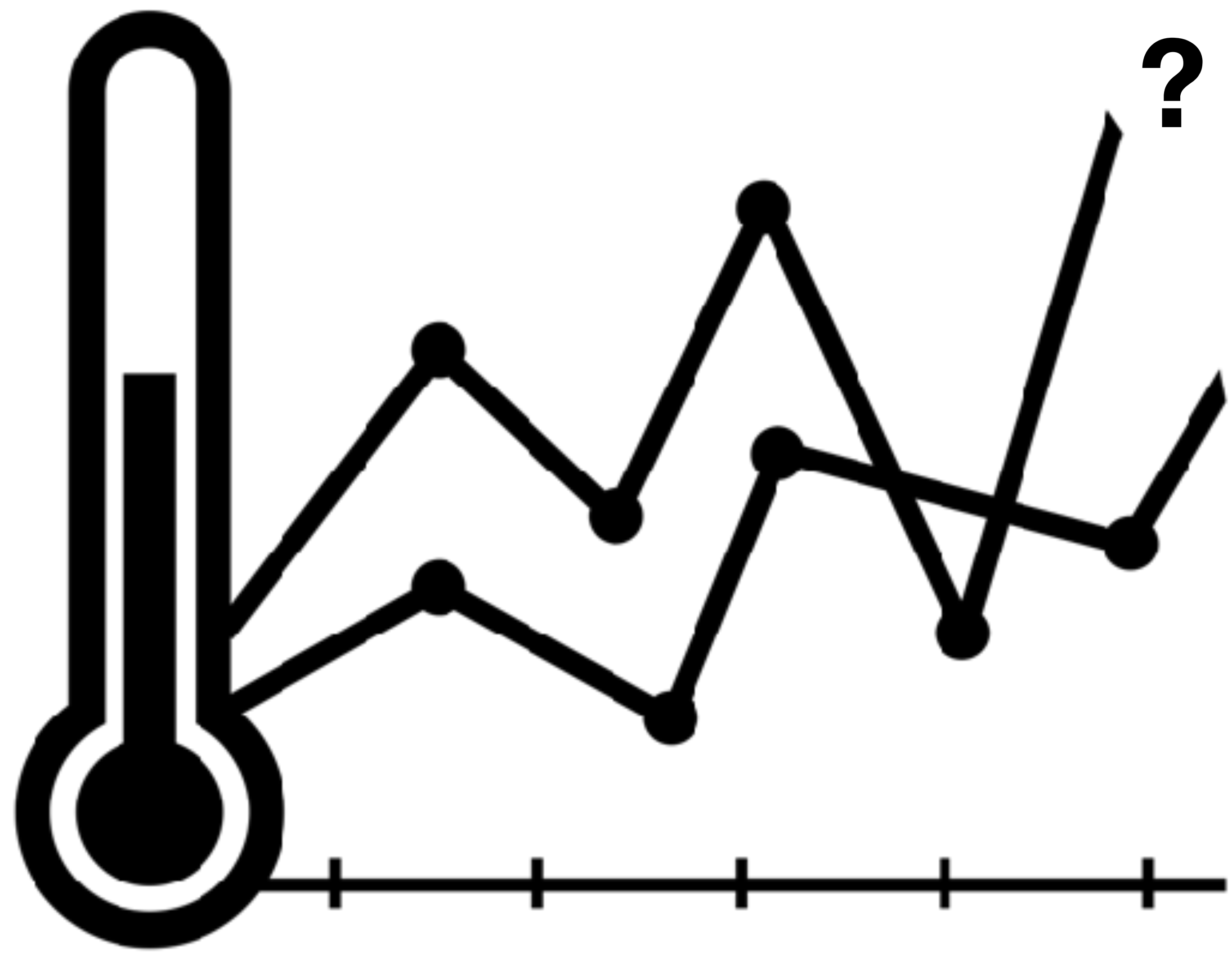
www.water.vic.gov.au


uncontrolled
livestock access
off-stream
watering
providing
riparian access
native fish
riparian
vegetation

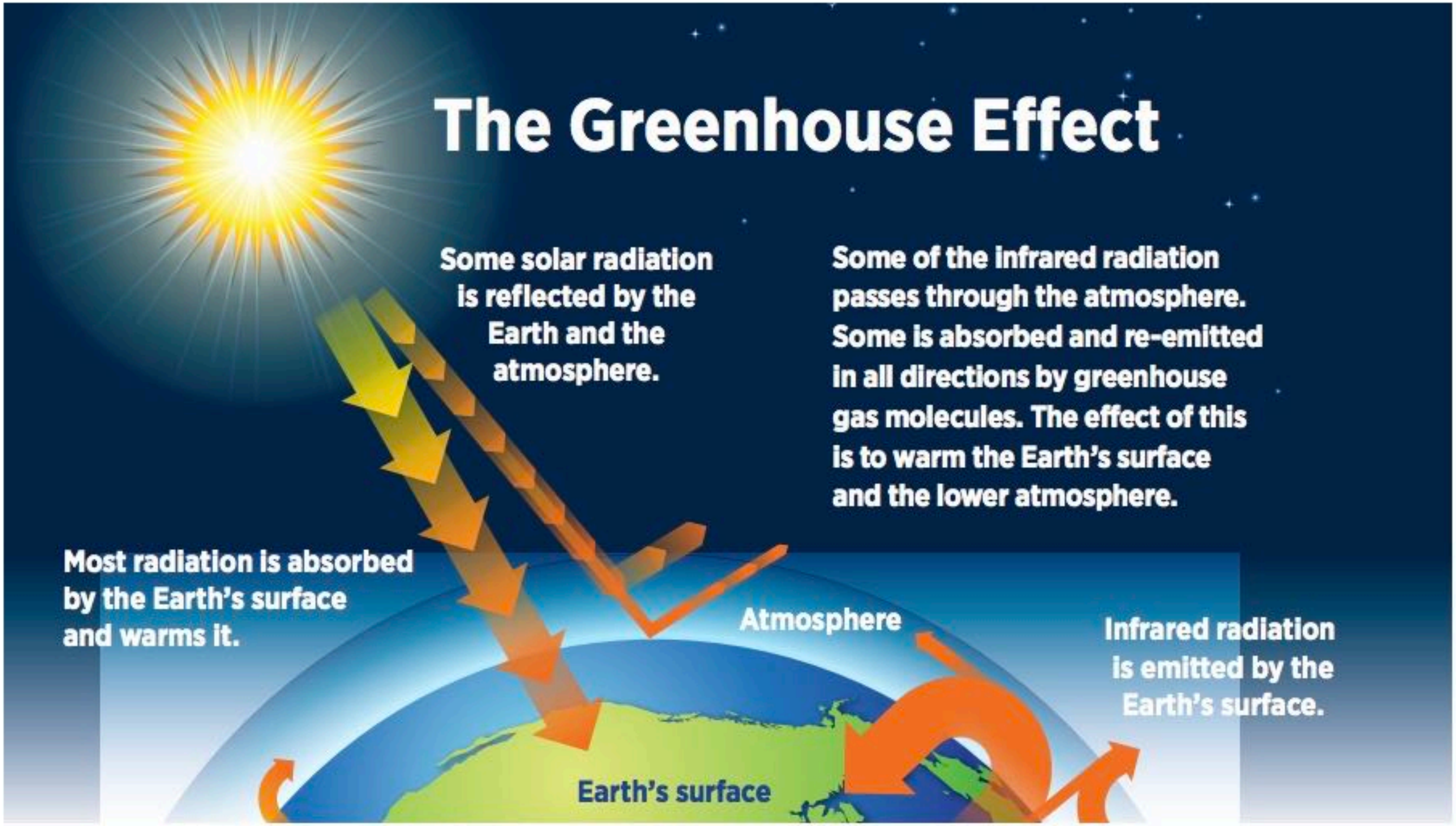
The Owyhee River Canyon in Oregon shows the difference between shadier riverside habitat and the hotter, dryer upland areas.

BLM/Flickr; Krosby et al., 2019

WHERE DOES THE HEAT COME FROM?



Greenhouse gases create Earth's "duvet".



From: EPA

GHG = Greenhouse Gas

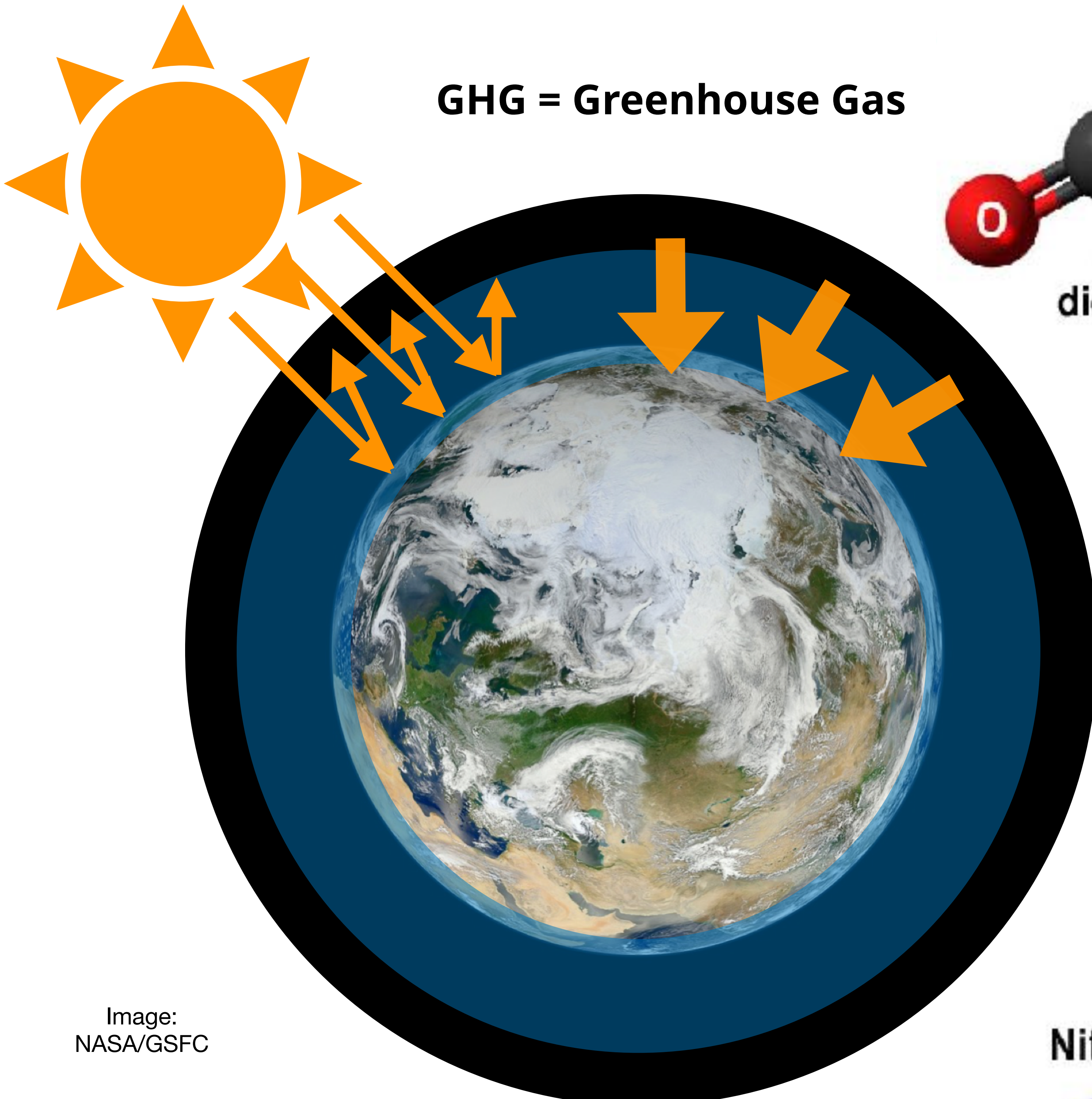
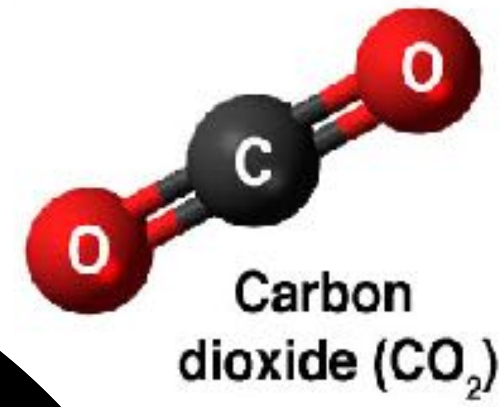
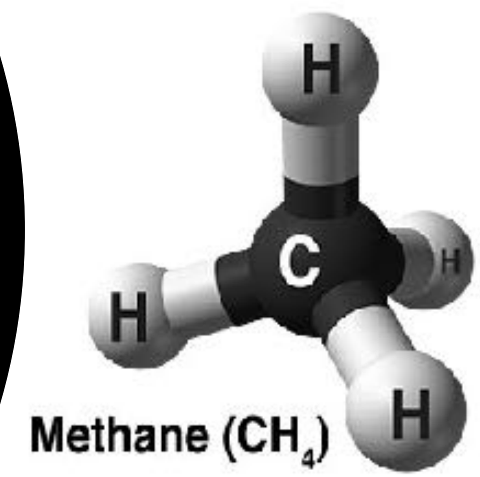


Image: NASA/GSFC

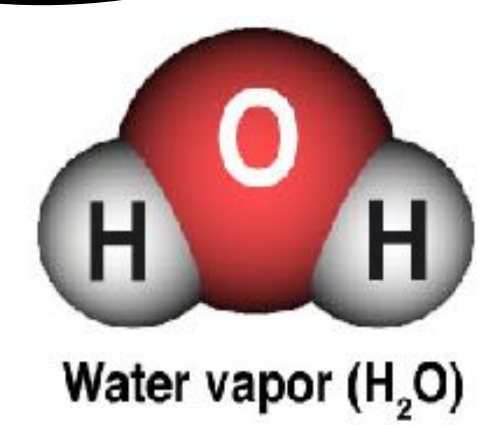


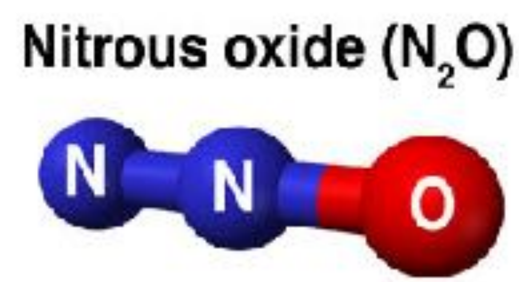
Released through natural (volcanic eruptions) & human activities (deforestation, land use changes & burning fossil fuels).



Produced by natural sources & human activities, including the decomposition of waste in landfills, agriculture, rice cultivation, and ruminant digestion.

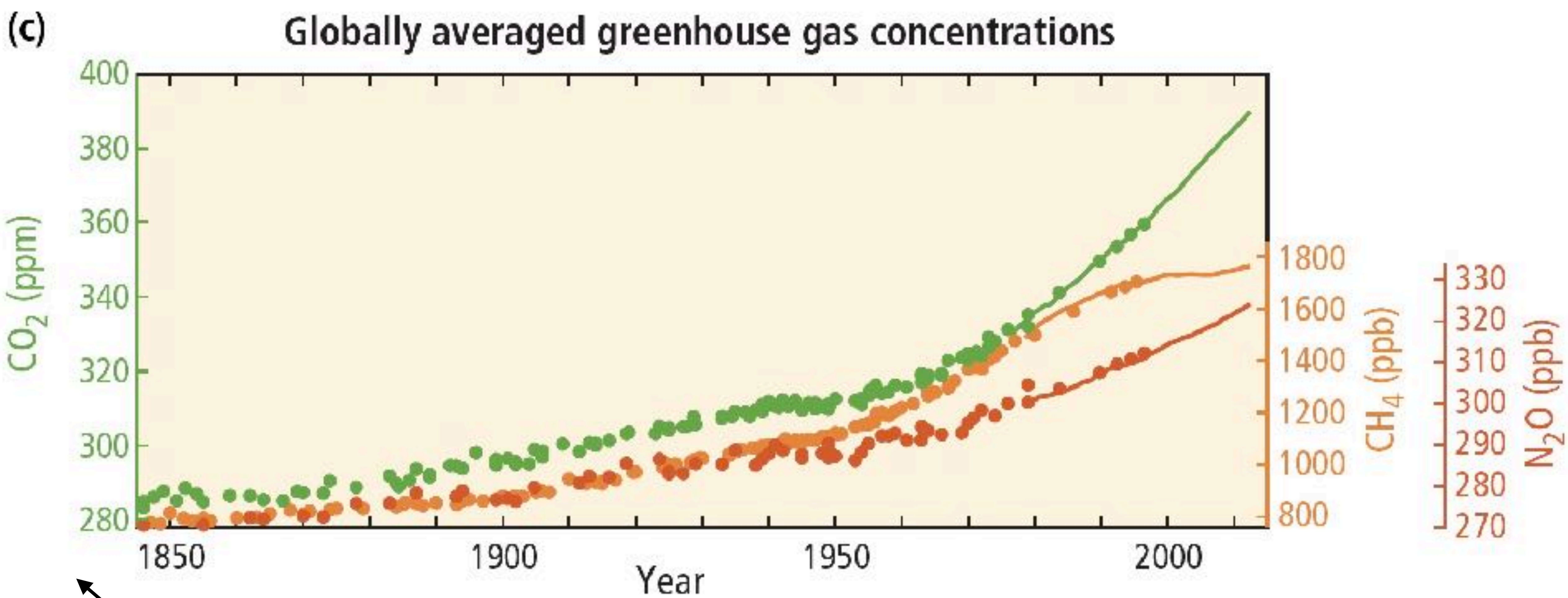
The most abundant GHG. Water vapor increases as the atmosphere warms.





Produced by the use of commercial & organic fertilizers, fossil fuel combustion, nitric acid production & biomass burning.

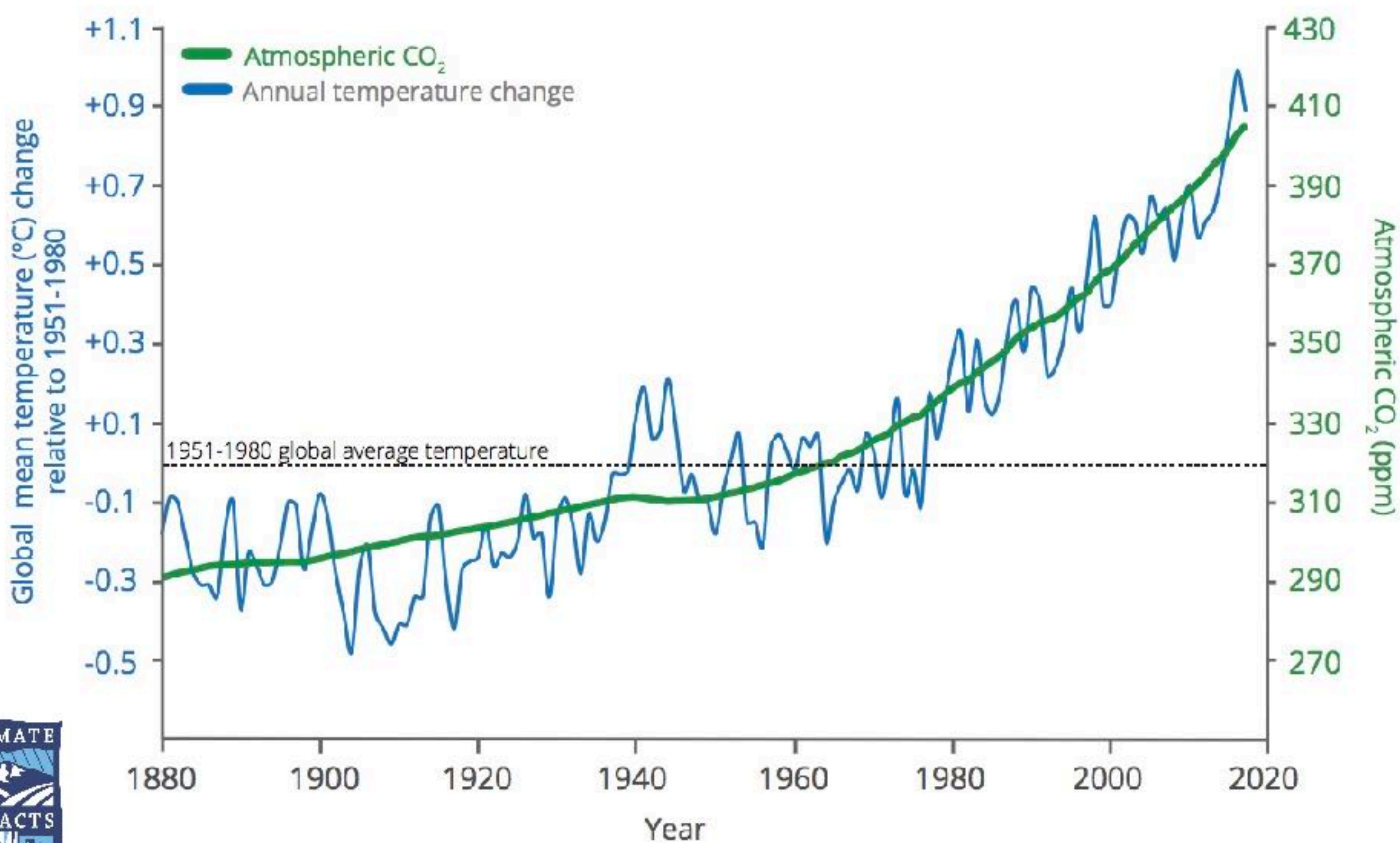
Modified from NASA.gov



We are going to look at the past later…

From: IPCC, 2014

~1.8ºF warming globally since the late 1800's



Created by H. Roop from NASA GISS, NOAA ESRL, NOAA NCEI data



There is high confidence (>95%) that human-produced greenhouse gases have caused much of the observed increase in Earth's temperature over the past 50 years.

IPCC, 2014; Images: H. Roop

Future

Uncertainty = us.

May, 2019

413 ppm

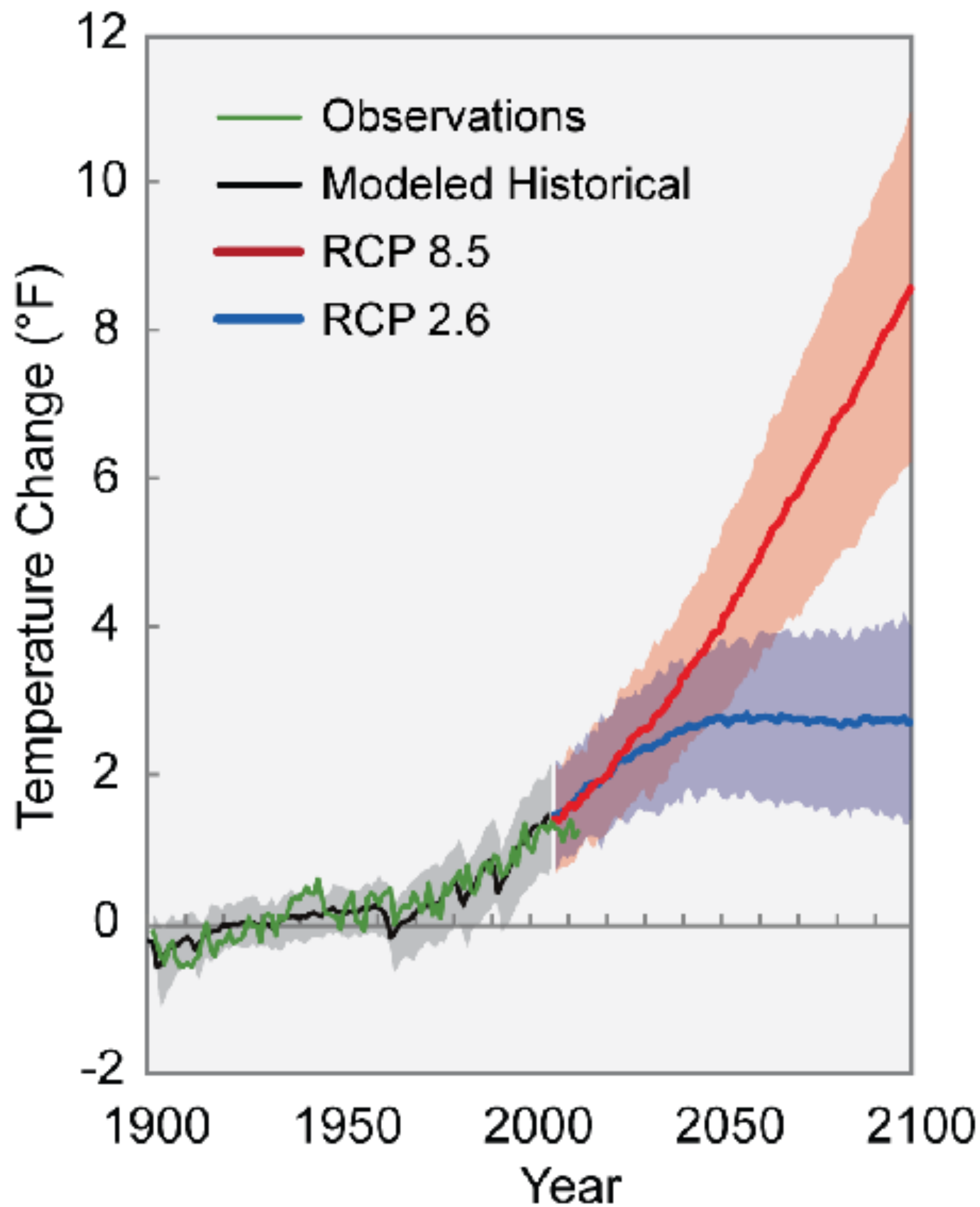
Pre-industrial

280 ppm

ppm= parts per million

Heidi Roop, UW Climate Impacts Group

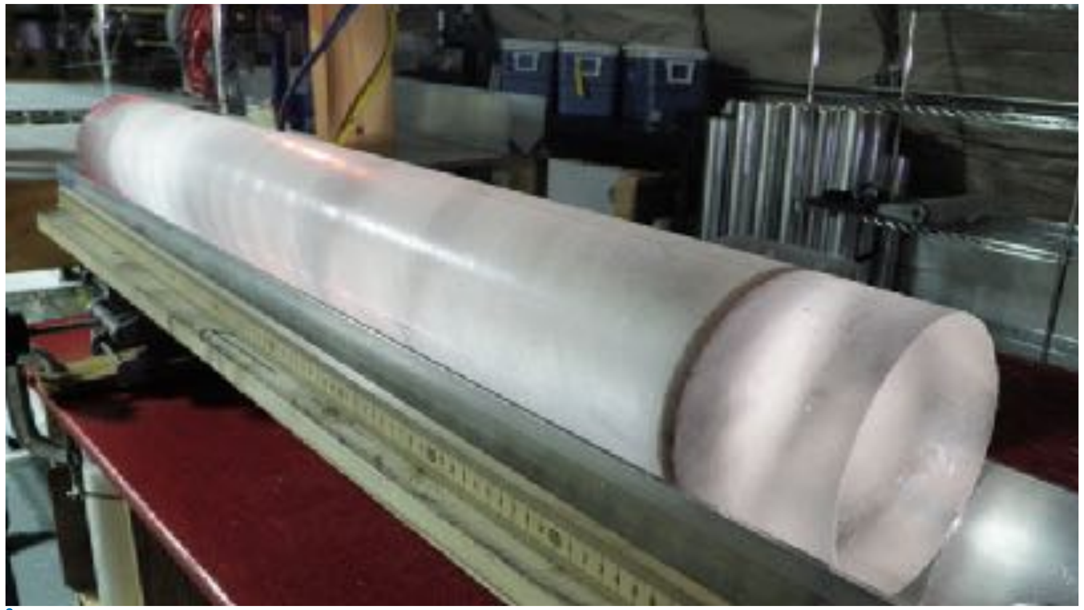
Emissions of Greenhouse Gases Determine Temperature Rises



NCA, 2018

HOW HAS CLIMATE CHANGED?

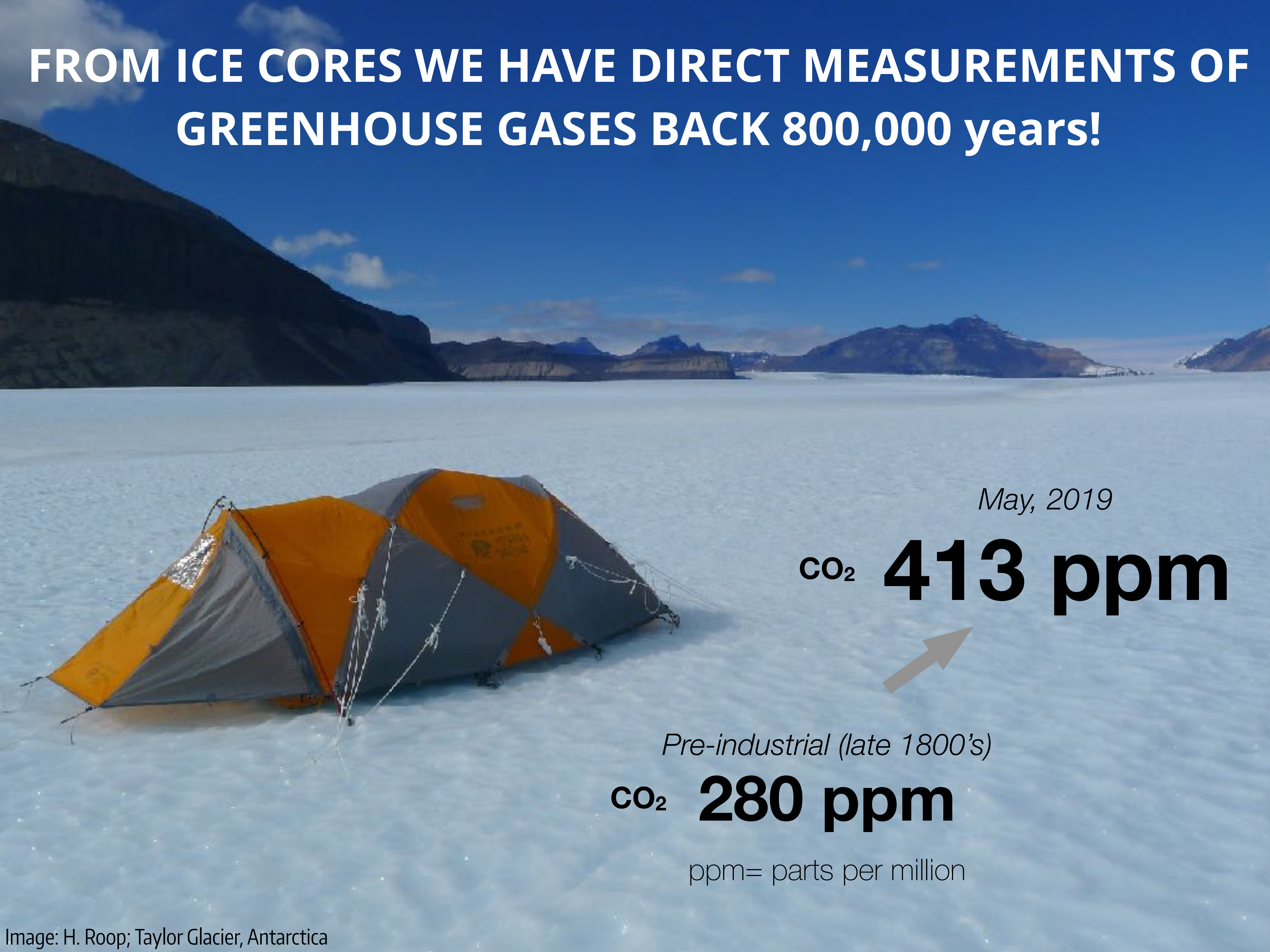
Lakes & Ice!



Ice!

H. Roop, Climate Impacts Group

FROM ICE CORES WE HAVE DIRECT MEASUREMENTS OF GREENHOUSE GASES BACK 800,000 years!



May, 2019

CO_2 413 ppm

Pre-industrial (late 1800's)

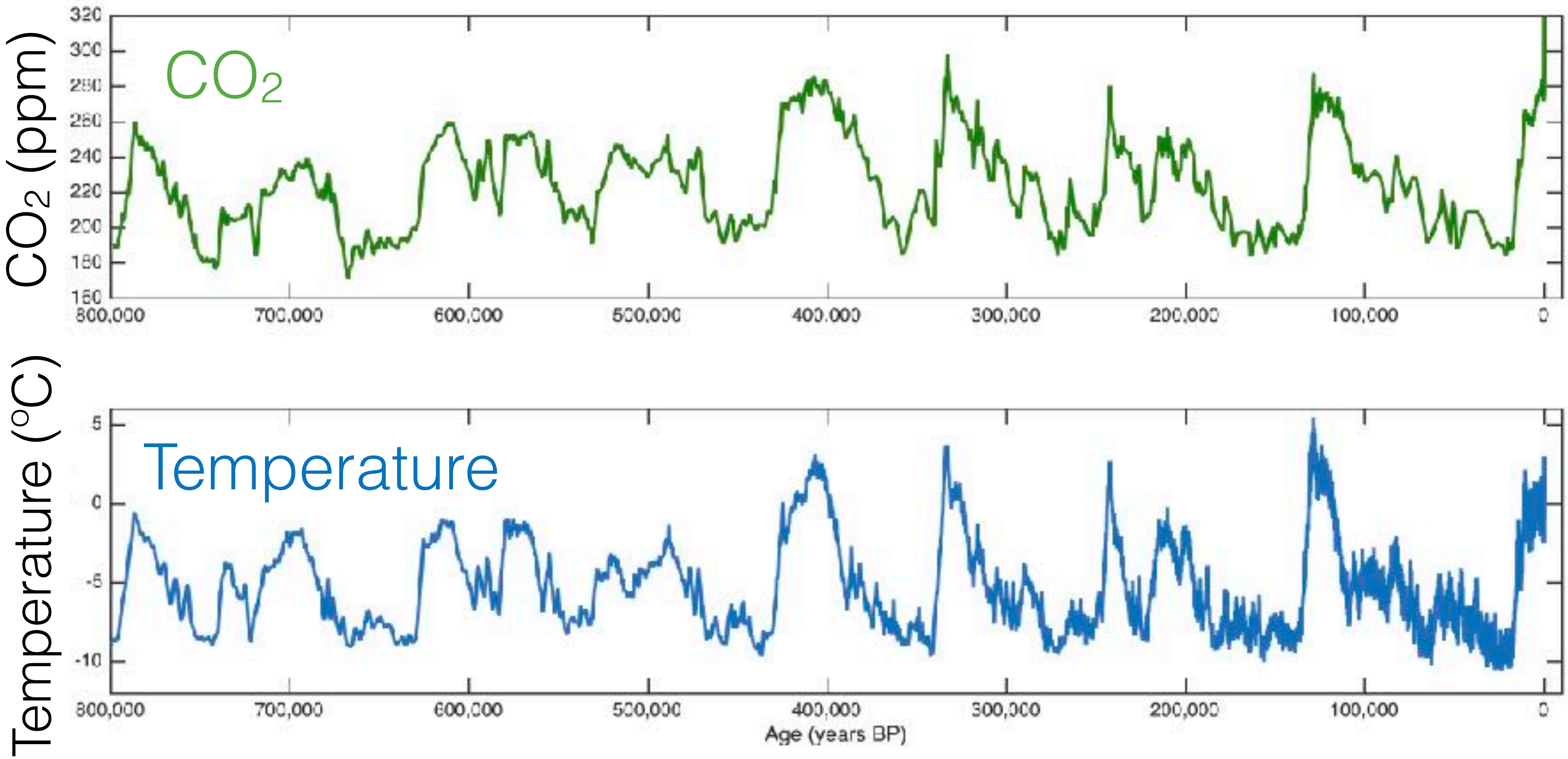
CO_2 280 ppm

ppm= parts per million

Image: H. Roop; Taylor Glacier, Antarctica


ANCIENT AIR!
Image: P. Neff

800,000 yrs of CO_2 & Temperature

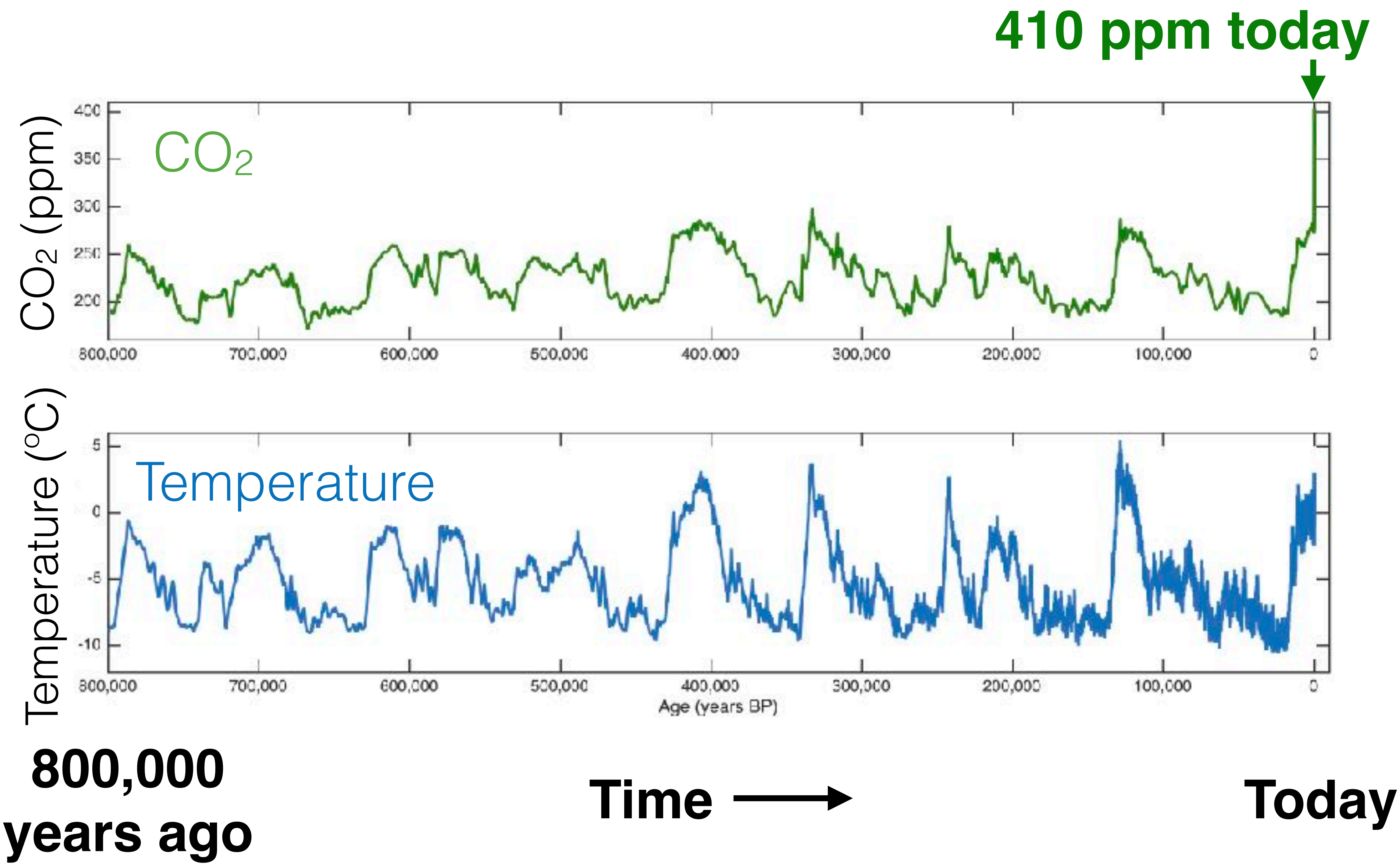


800,000 years ago **Time ⟶** **Today**

From: P. Neff; Data: Jouzel et al., 2007; Luthi et al., 2008

H. Roop, Climate Impacts Group

800,000 yrs of CO_2 & Temperature



From: P. Neff; Data: Jouzel et al., 2007; Luthi et al., 2008

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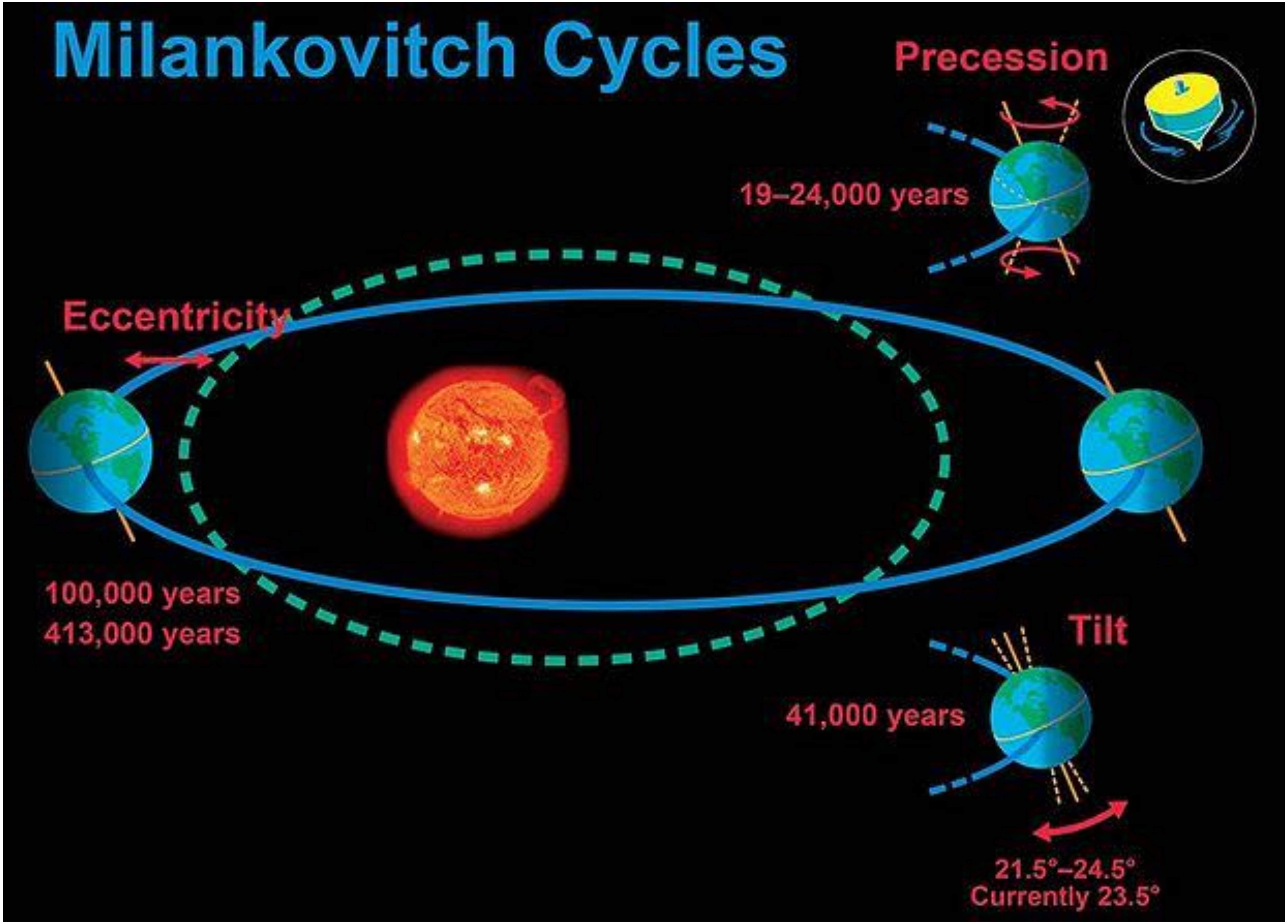
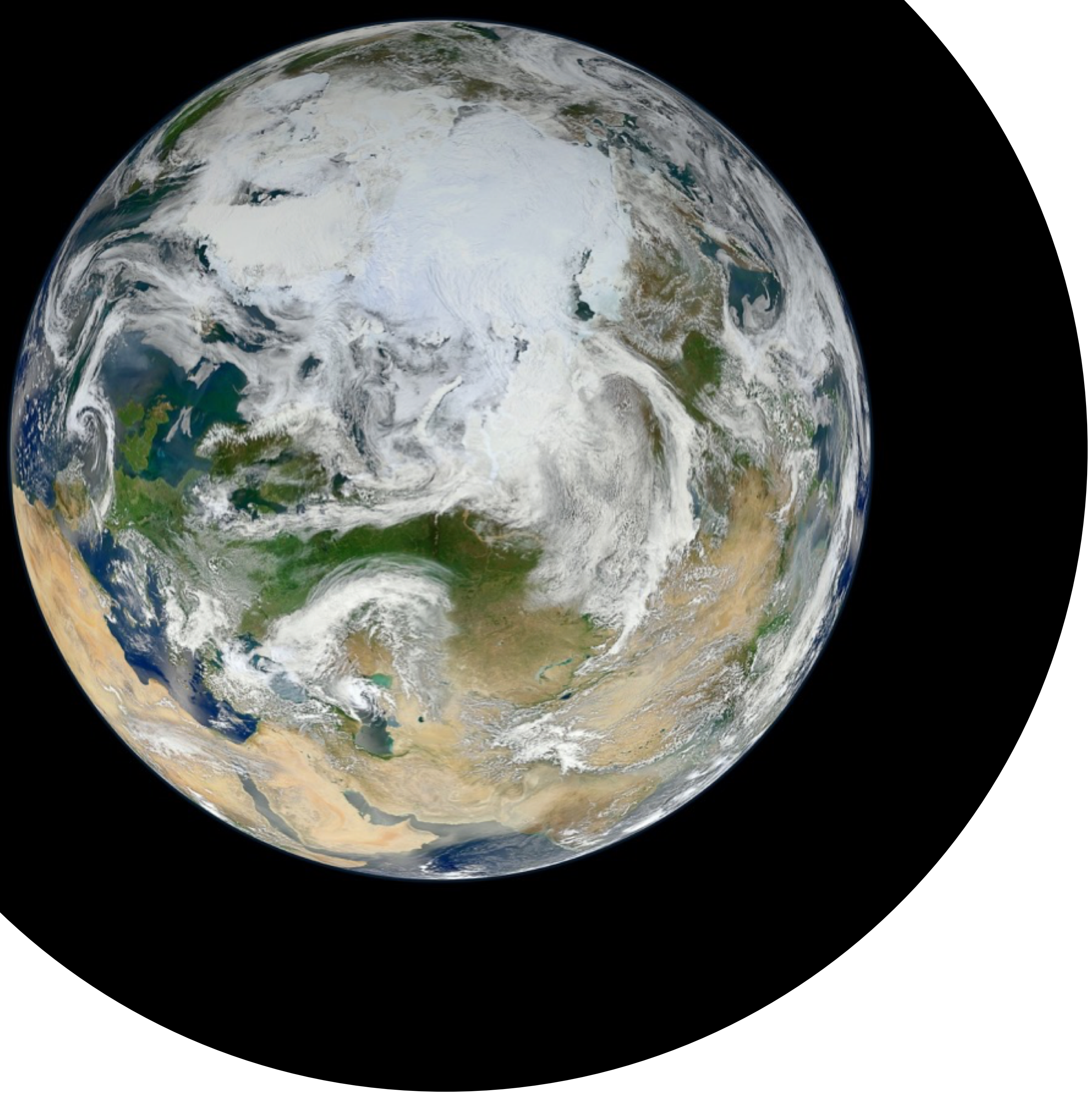


Universe Today

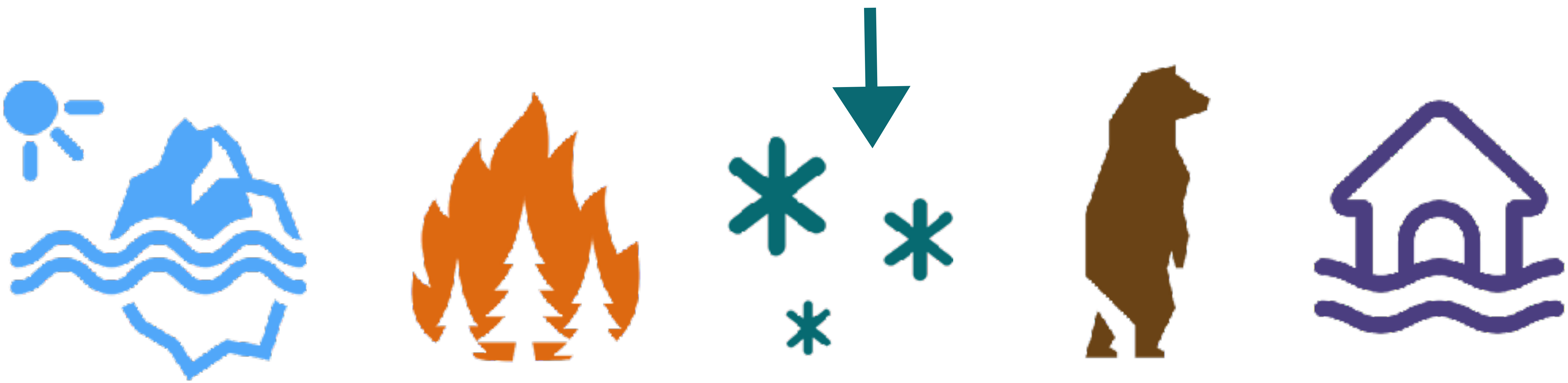


"The global climate continues to change rapidly compared to the pace of the natural variations in climate that have occurred throughout Earth's history."

- 4th National Climate Assessment
November 2017

Image: NASA/GSFC/Suomi NPP

So we have evidence that today is different.



What can we do about it?

H. Roop, Climate Impacts Group

HOW WE 'FEEL' FUTURE CLIMATE CHANGE DEPENDS ON:

Our actions **now** to reduce emissions of greenhouse gases (*mitigation*)

+

How well we **prepare** our communities & the systems we rely on (*adaptation*)

Heidi Roop, UW Climate Impacts Group


"We need to adapt to climate change even as we seek to mitigate it."
- Nives Dolsak & Aseem Prakash, 2018

Photo: H. Roop

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