Conservation Status of Polar Bears in Relation to Projected Sea-ice Declines

Regehr, E.V., Laidre, K. L., Akçakaya, H.R., Amstrup, S., Atwood, T., Lunn, N., Obbard, M., Stern, H., Thiemann, G. & Wiig, Ø. 2016.
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Findings

1) Potential for large reductions in the global population of polar bears in 35-40 years as Arctic sea-ice loss continues:

- The probability of a reduction greater than 30% is 0.71 (range 0.20-0.95)
- The probability of a reduction greater than 50% is 0.07 (range 0-0.35)
- The probability of a reduction greater than 80% is negligible

2) Results support listing polar bears as *vulnerable* on the International Union for the Conservation of Nature's (IUCN) Red List

3) Our work demonstrates large uncertainty in statistical projections due to variable status of polar bear subpopulations and uncertainty in data

Sea ice is the primary habitat for polar bears

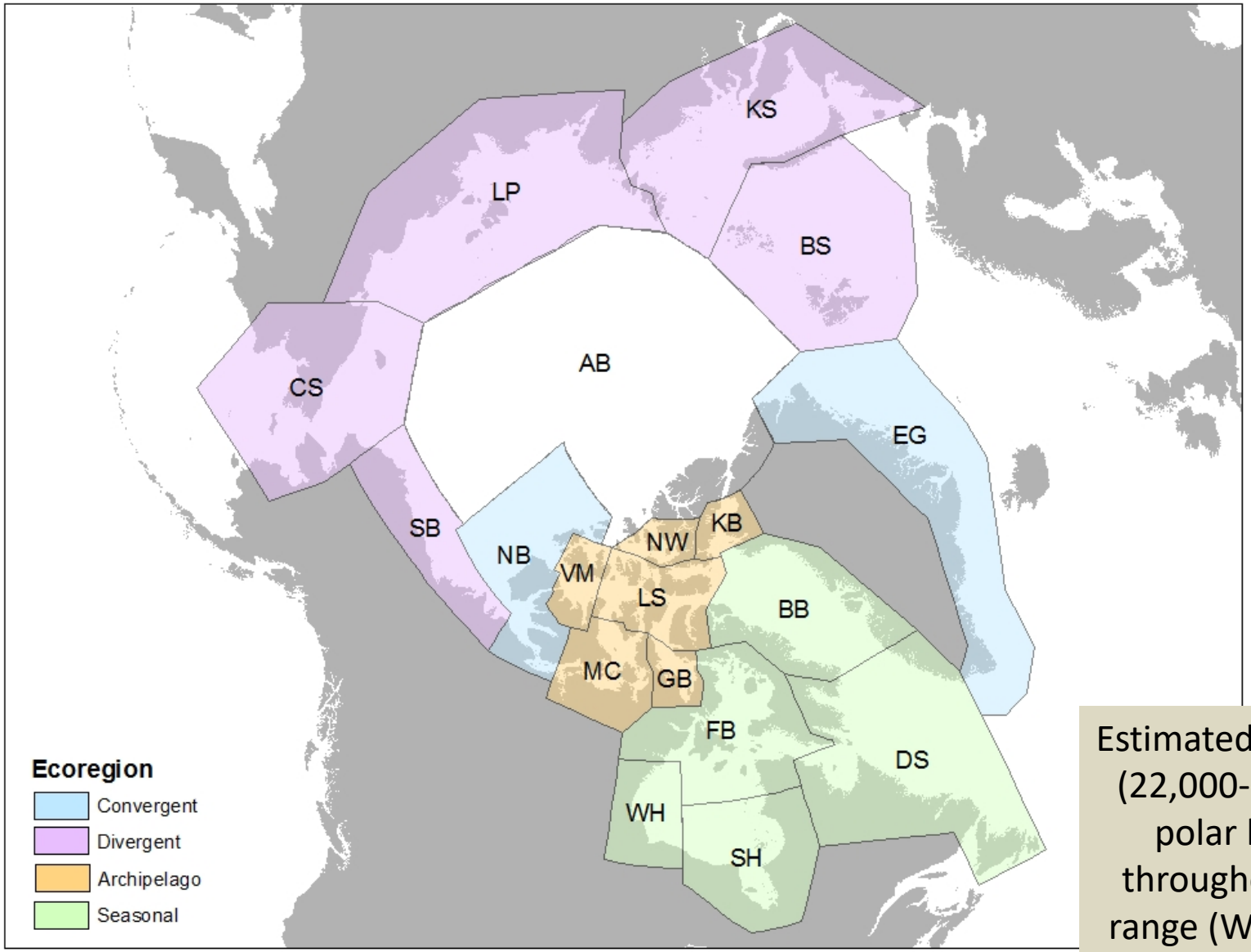
Travel

Hunt

Mate

Some maternity denning

19 subpopulations and 4 ecoregions



Estimated 26,000* (22,000-31,000) polar bears throughout the range (Wiig et al. 2015)

PBSG Status Table, 2014

Variability and uncertainty

There is variability in the current status of polar bear subpopulations based on the best-available scientific information.

There is uncertainty, especially concerning unstudied and less-studied subpopulations.

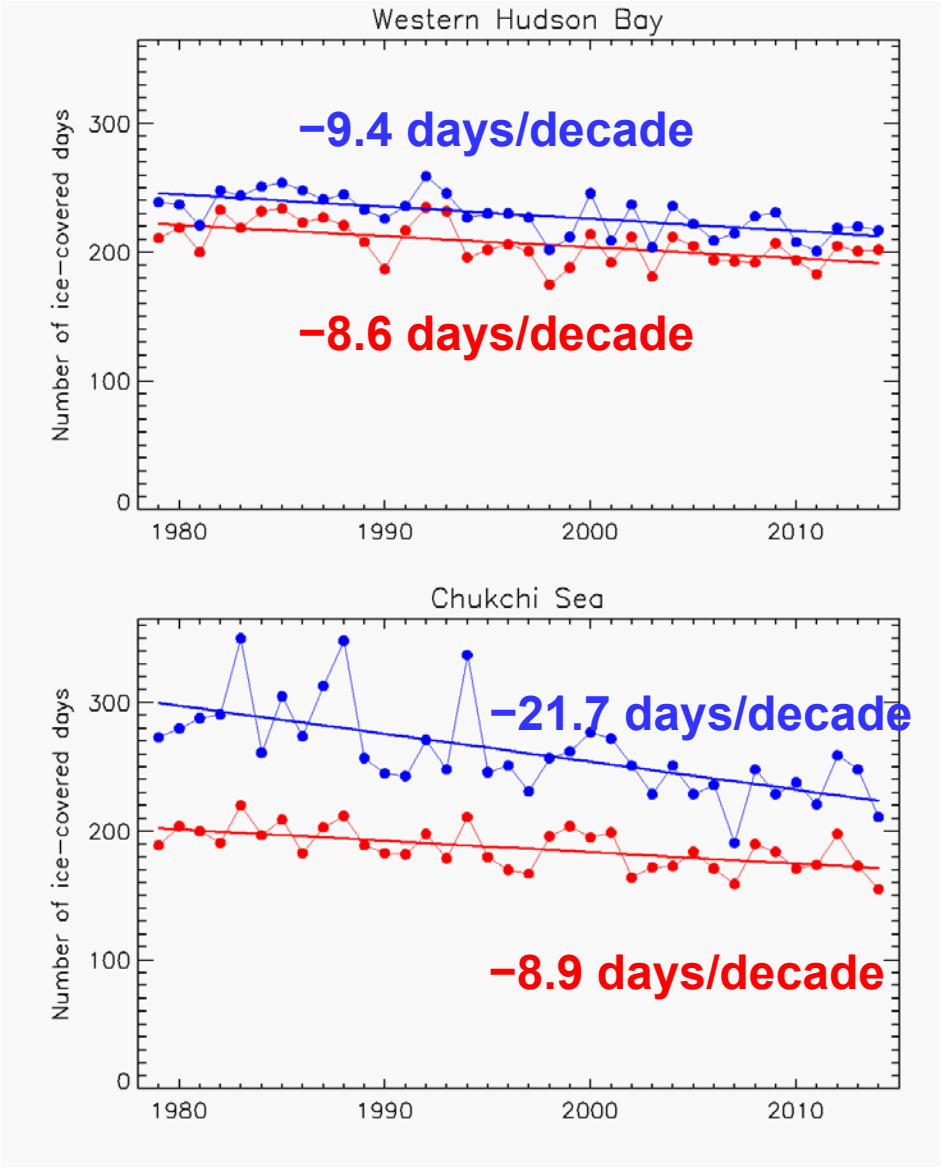
Over the near and mid-term, there is likely to continue to be variability in sea-ice loss impacts on polar bears.

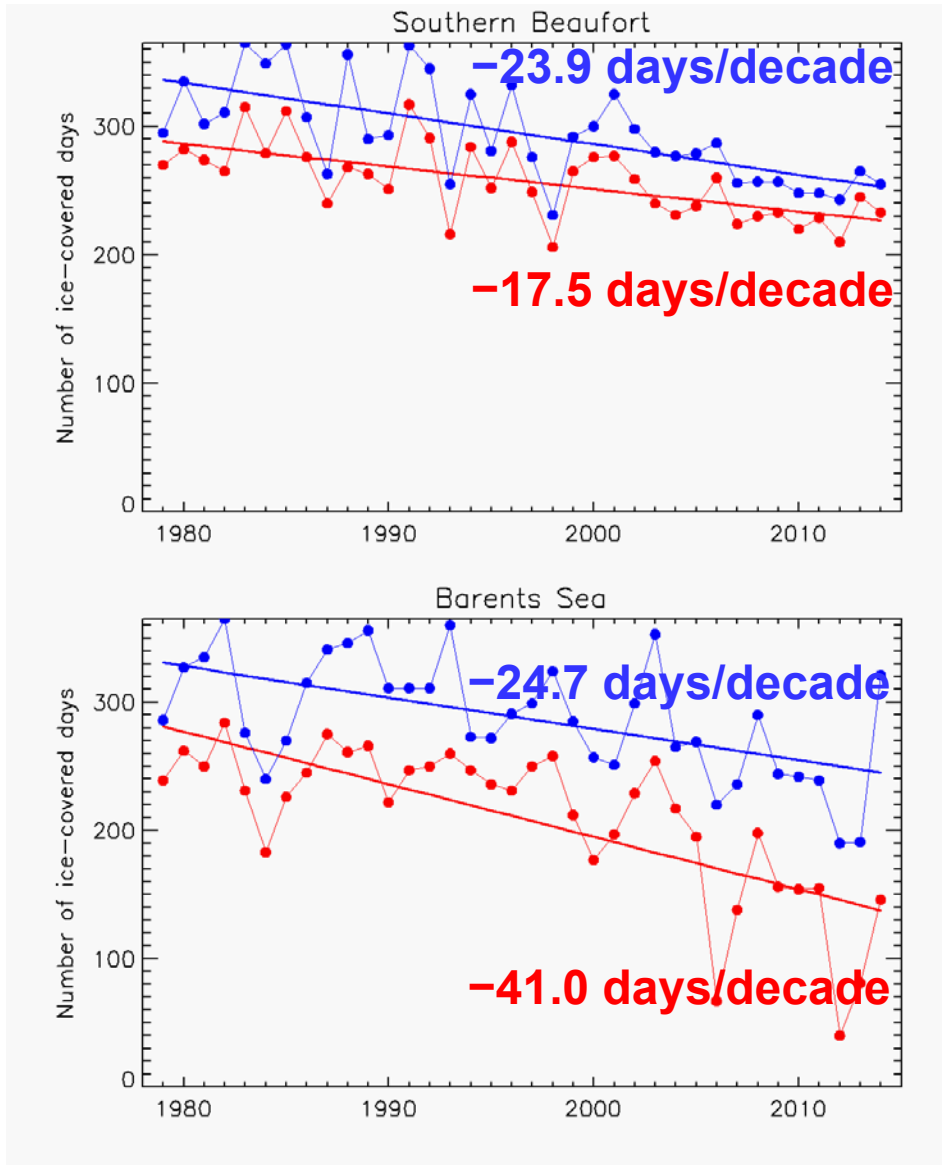
However, **all** subpopulations are expected to be negatively impacted by sea-ice loss over the long-term.

Step 1: Estimate generation Length

- 3,191 ages of adult female polar bears with dependent young from 1967-2013
- Data from all well-studied subpopulations (*n*=11)
- Generation length global mean **11.5 years** (range 9.8 - 13.6)

Step 2: Sea ice metric documented habitat decline in all 19 polar subpopulations

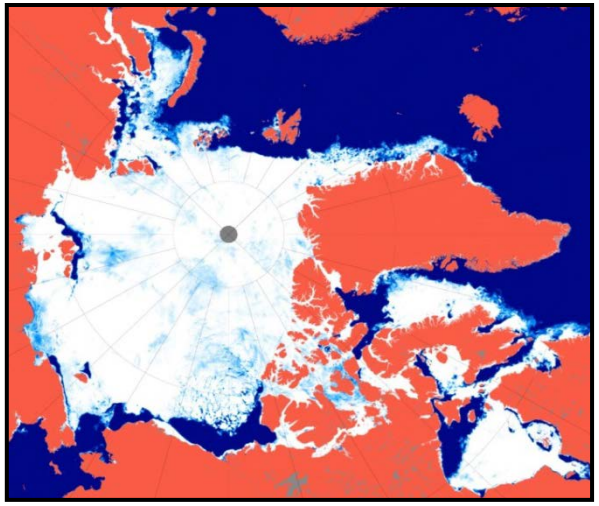




(Stern and Laidre 2016)

Habitat projections

We projected future sea ice conditions forward in time over 3 generations (35-40 years) using the fits from linear models (1979-2014)



Step 3: Population projections

Used three hypothesis-based approaches, given relationships between sea ice and abundance are not completely understood and are currently variable:

Approach 1 assumed a one-to-one proportional relationship between sea ice loss and abundance for each subpopulation

Approaches 2 and 3 estimated linear relationships based on available data to calculate global or ecoregion-specific sea ice/abundance relationships

The first data-based sensitivity analysis evaluating **the potential response of the global population of polar bears to projected sea-ice declines**

Photo: Kristin Laidre

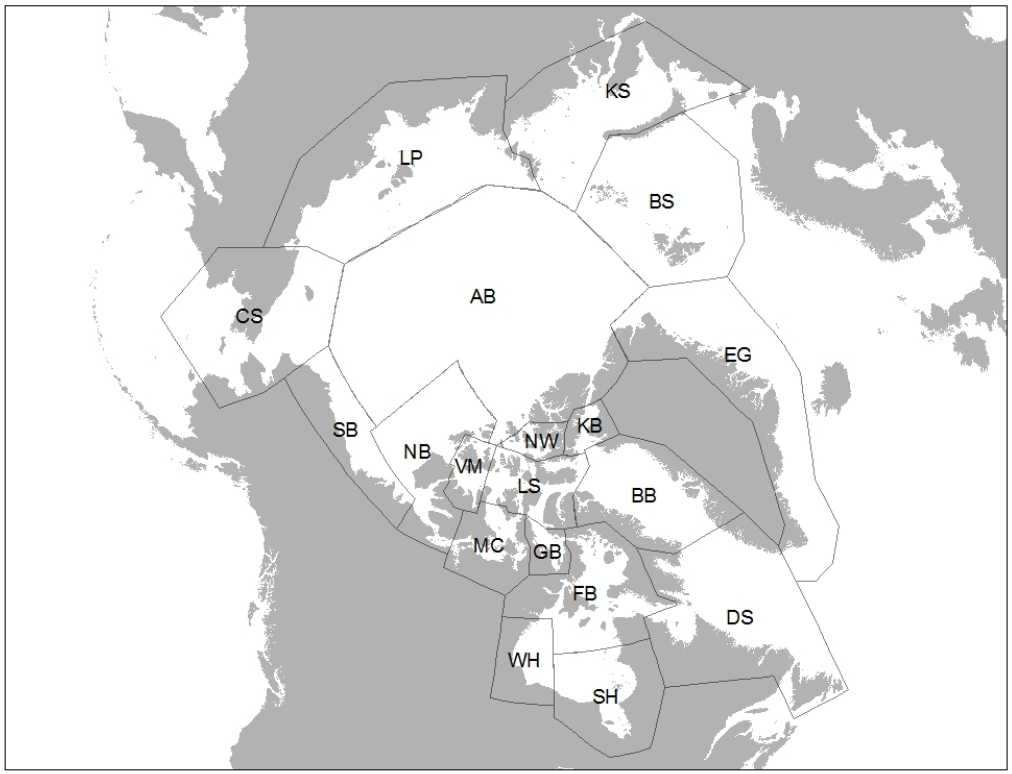
Previous methods to evaluate the effects of sea-ice loss on polar bears:

Global:

- Interviews of experts
- Bayesian Belief Networks incorporating expert opinion to evaluate qualitative effects of changes in sea ice and other stressors

Subpopulation-specific:

- Models projecting a subpopulation forward in time based on survival and reproductive rates



No analysis has directly used estimates of abundance for the 19 polar bear subpopulations to evaluate future status as a function of multiple relationships between abundance and sea ice

Thank you

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Regehr, E.V., Laidre, K. L., Akçakaya, H.R., Amstrup, S., Atwood, T., Lunn, N., Obbard, M., Stern, H., Thiemann, G. & Wiig, Ø. 2016. Conservation status of polar bears (*Ursus maritimus*) in relation to projected sea-ice declines. Biology Letters 12: 20160556. http://dx.doi.org/10.1098/rsbl.2016.0556

Stern, H.L., and K. L. Laidre. 2016. Sea-ice indicators of polar bear habitat. The Cryosphere 10, 2027-2041, doi:10.5194/tc-10-2027-2016.

Using Satellites to Predict Predator-Prey Abundance Across a Climatic Gradient

D. Stoner, J. O. Sexton, J. Nagol, H. Bernales, D. Choate, K. Ironside, K. Longshore, and T. C. Edwards

NASA Funding Opportunity #NNH11AR55I

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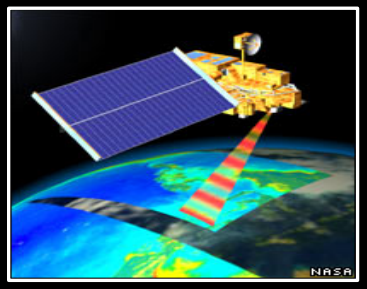
Satellite measures of vegetation predict mule deer and mtn lion abundance across climatic zones

- Climate / land-use forecasts suggest ***population declines***;

- Loss of wildlife will have ***economic implications***…






Vegetation: drought conditions 2002

Great Basin

Mojave Desert

Colorado Plateau

NV

UT

CA

AZ

CO

NM

MX

Vegetation

HIGH

MED

LOW

120° W

116° W

112° W

108° W

40° N

38° N

36° N

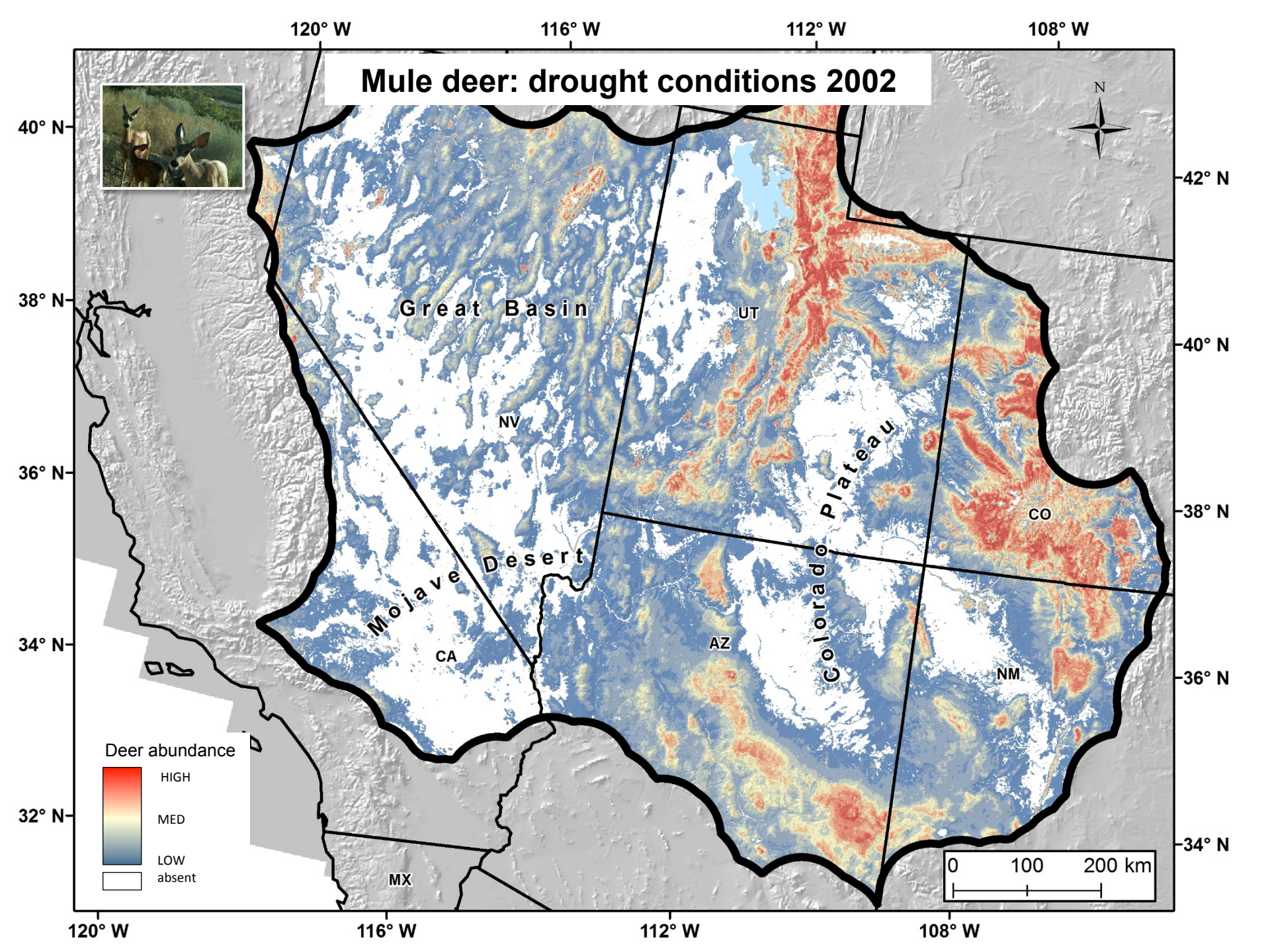
34° N

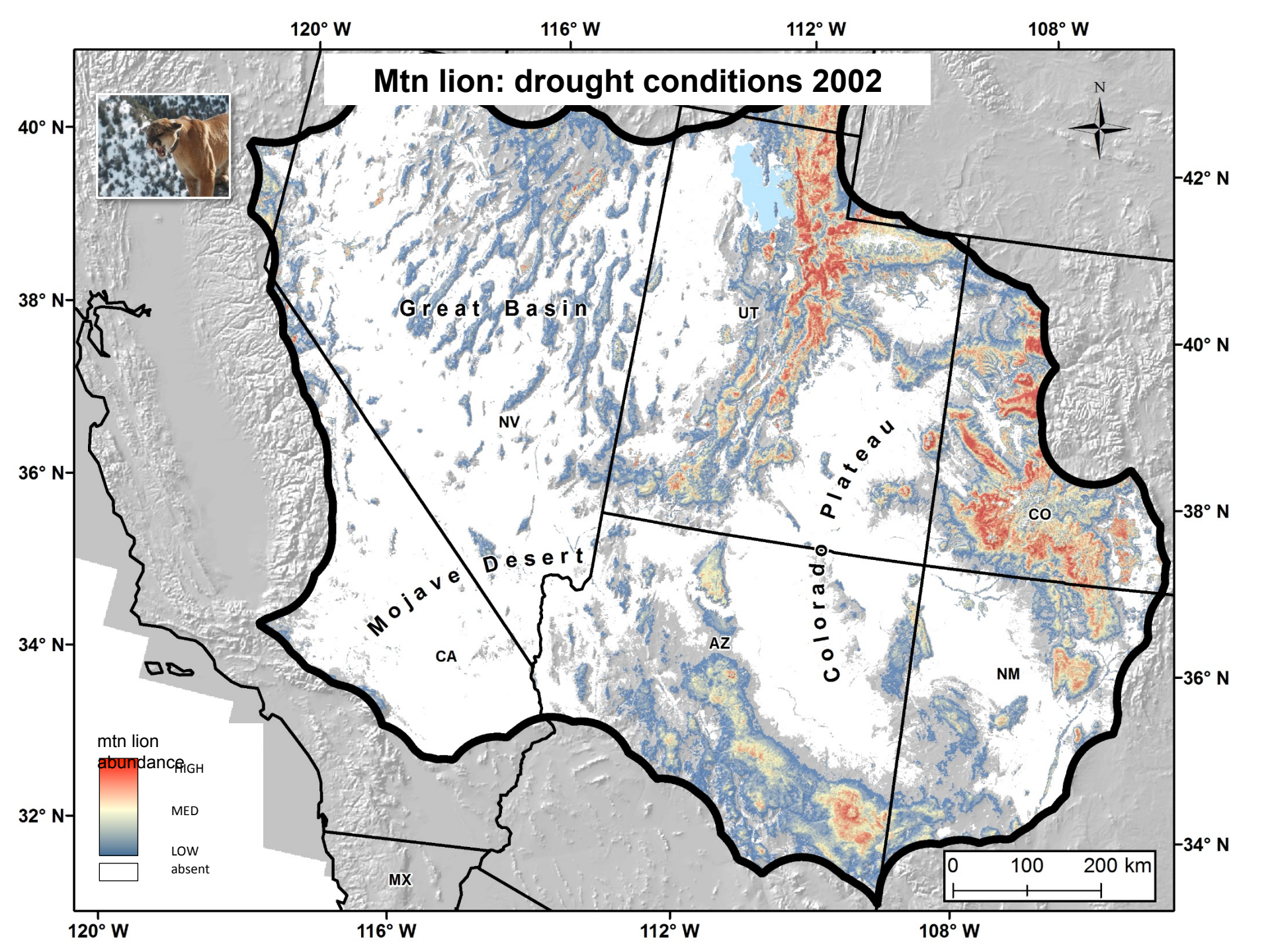
32° N

42° N

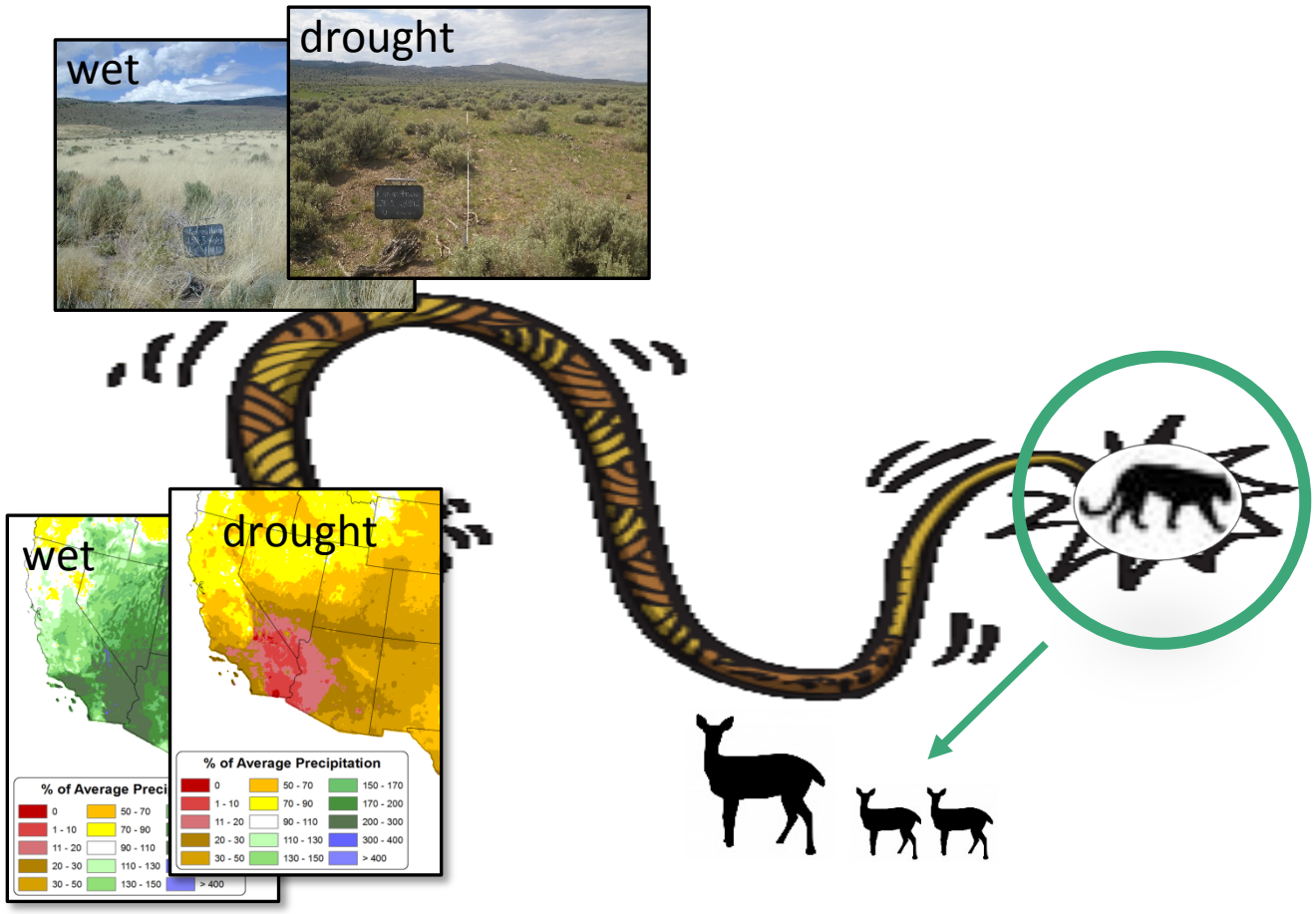
0 100 200 km

N


Mule deer: drought conditions 2002
120° W
116° W
112° W
108° W
40° N
38° N
36° N
34° N
32° N
42° N
N
Great Basin
NV
UT
Colorado Plateau
CO
Mojave Desert
CA
AZ
NM
MX
Deer abundance
HIGH
MED
LOW
absent
0
100
200 km


Mtn lion: drought conditions 2002
120° W
116° W
112° W
108° W
40° N
38° N
36° N
34° N
32° N
42° N
40° N
38° N
36° N
34° N
N
Great Basin
Mojave Desert
Colorado Plateau
NV
UT
CO
CA
AZ
NM
MX
mtn lion abundance
HIGH
MED
LOW
absent
0
100
200 km

Climate drives the system…



Take Home Points

<u>Satellite imagery in wildlife management</u>:

Lower costs | higher precision | broad-scale

<u>BENEFITS</u>:

Wildlife recreation

$150 billion / yr

<u>COSTS</u>:

Agriculture | Vehicle collisions | Human safety

$5 billion / yr

US Fish & Wildlife Service. 2012. National survey of fishing, hunting, and wildlife-associated recreation.

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Monitoring Wild Reindeer Migration in Changing Environments in Taimyr, Russia

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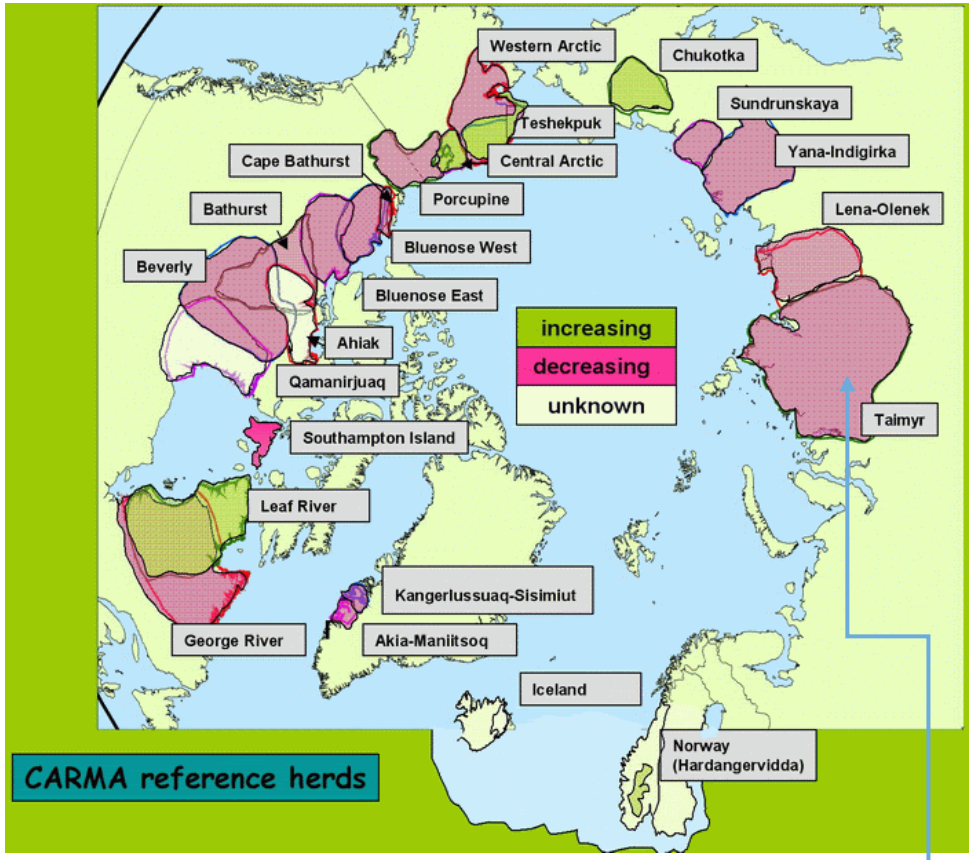
*ARCTICenter, University of Northern Iowa, **Colorado College, ***US Fish and Wildlife, ****Joint Directorate of Taimyr Nature Preserves, ****SPIIRAN, ***** UCSB

Take home messages

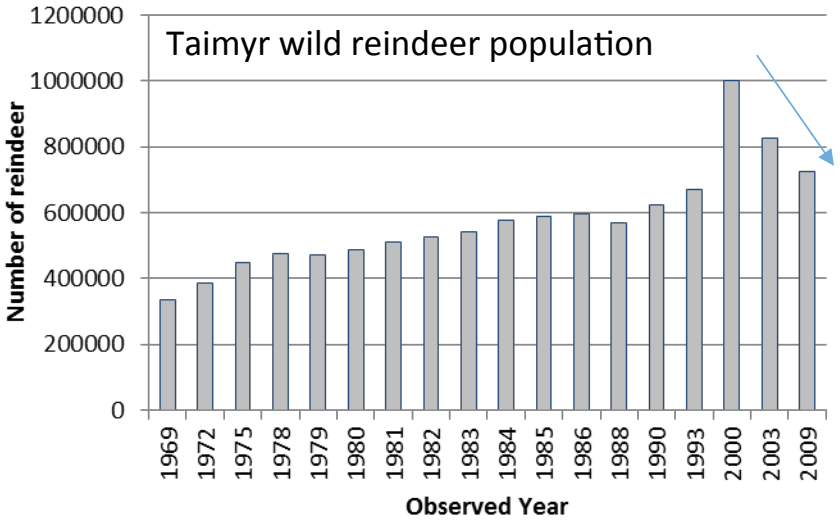
- Wild reindeer and caribou population are declining
- Strong evidence of long-term **spatial fidelity:** *reindeer return to the same locations year after year*
- Recent **migration shift**
- Changes in range likely driven by climate change (warmer temperatures, increased mosquito harassment, rivers open early) and human activity
- Satellite imagery shows that the arrival of reindeer to new grounds doesn't seem to lead to overgrazing

Declining Reindeer/Caribou Populations!

2,500,000 reindeer and caribou



Source: CircumArctic Reindeer Monitoring and Assessment (2014)

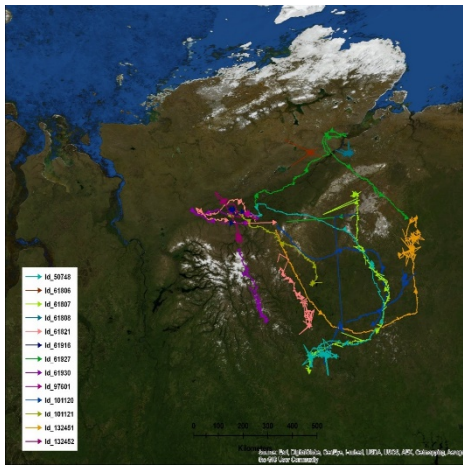


Taimyr wild reindeer herd: 600,000
24% of world population

Observing Shifts in Wild Reindeer Migration:

airborne and satellite data

Real-time tracking using satellite collars



Landsat land cover data

Impacts on wild reindeer migration

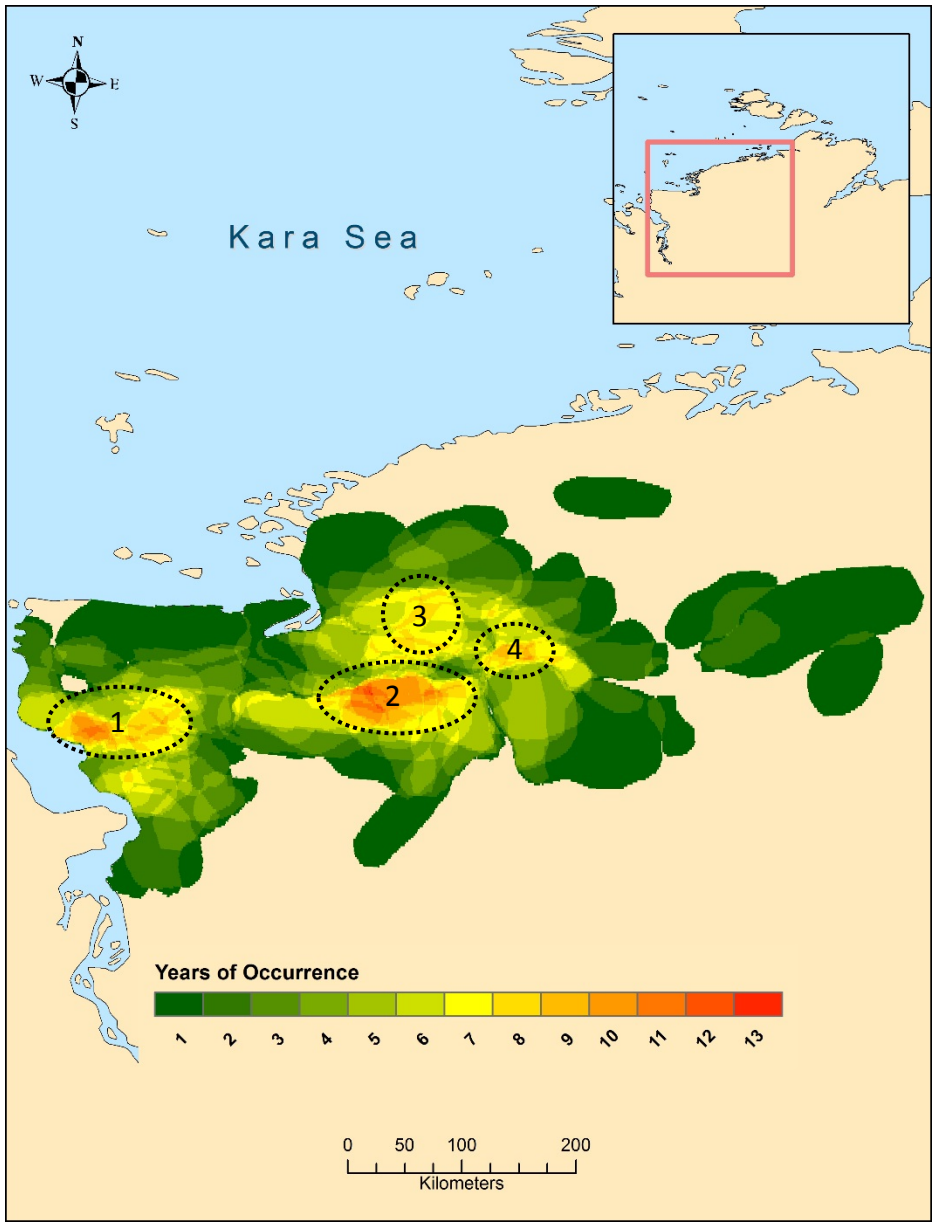
Climate change

- Warming (+1.5C)
- Unstable winters (icing)
- Rivers open earlier
- Summer grounds move north (longer distance to cover)
- Increased mosquito harassment
- “Greening” of tundra
- Wildfires

Human activity

- Migration obstacles: infrastructure
- Hunting pressure, poaching
- Disturbance and pollution of pastures
- Competition with domestic reindeer
- Predator control (or lack of such)
- Pollution (Norilsk)

Results: Spatial Fidelity and Shift Confirmed



Temporal variation
STRONG SPATIAL FIDELITY

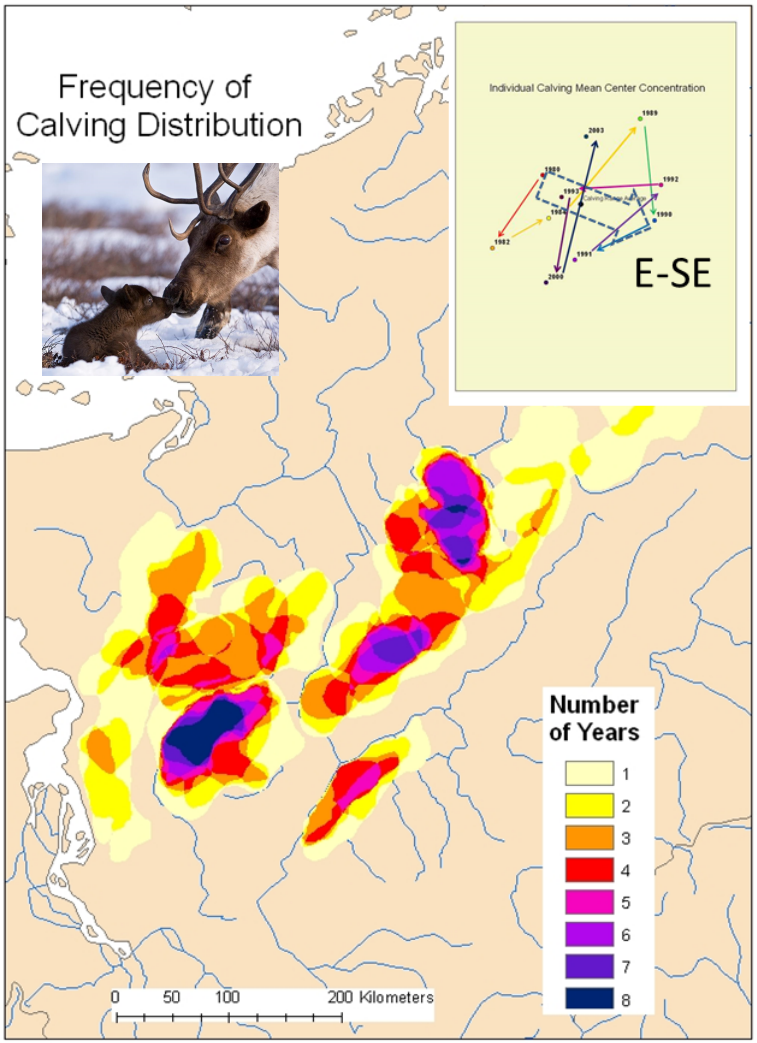
SUMMER Fidelity:

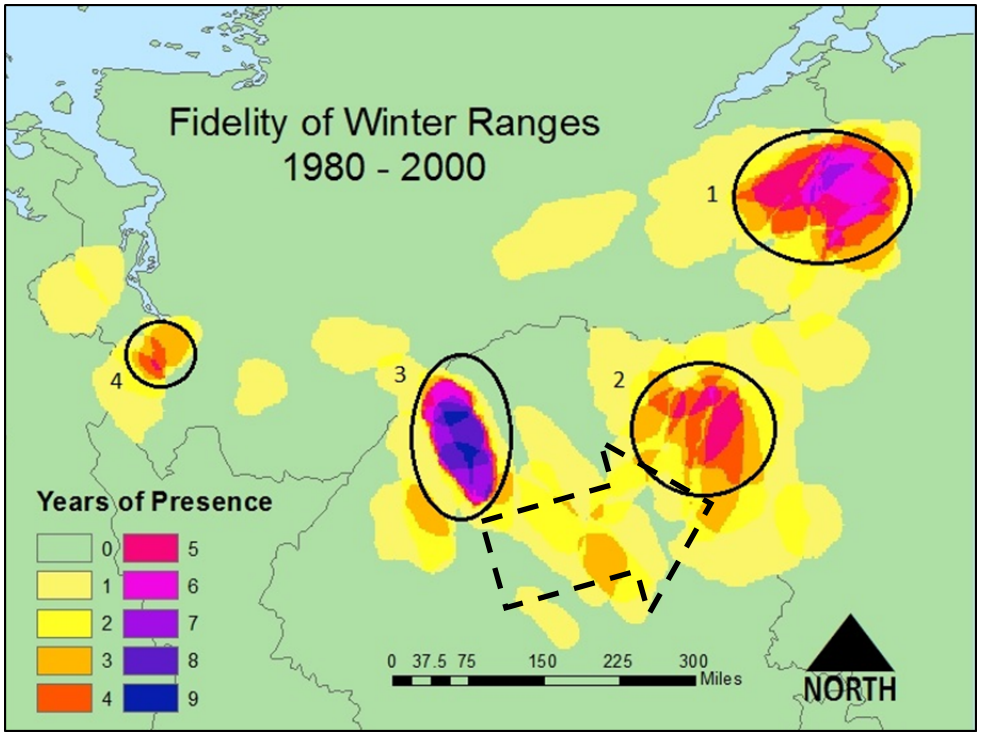
- Compact distribution of annual summer grounds
- 4 areas identified as frequently used (> 50%)

Change (since 2000):

- Deviate **further away** from historical locations
- Summer concentrations are shifting to the **east and north**
- Re-utilizing smaller percentages of range
- Summer grounds **rising in elevation**
- Populations **declining in western habitat**

Calving and winter shifts: East





- **Longer distances** to travel between calving and summer ranges
- **Increasing calf mortality**
- Forced to cross open rivers

Results: How does reindeer presence affect vegetation?

Caribou population fluctuations may result of natural shift from year to year in response to forage availability (Gunn et al., 2009)

Is overgrazing an issue for Taimyr reindeer population?

- Large herd observed in July 2000
- ***Landsat*** satellite was overhead

NDVI – index that shows plant "greenness" (proxy of biomass, abundance)

Mean NDVI values on 7/26/2000

Within: .369 ⟵ depression

Outside: .391

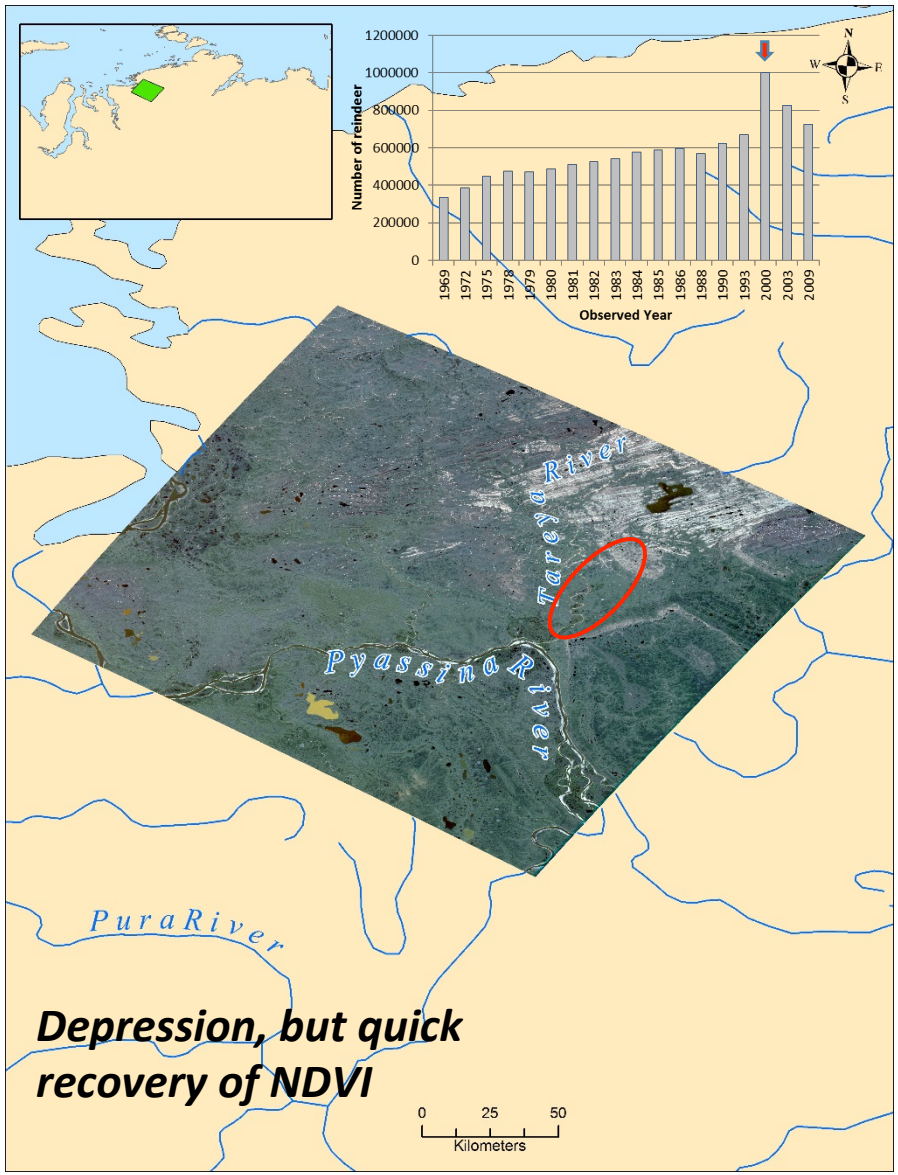
Difference: 0.228

Mean NDVI values on 8/11/2000

Within : .451 ⟵ rapid recovery

Outside: .469

Difference: 0.184



Take home messages recap

- Wild reindeer and caribou population is declining
- Strong evidence of long-term **spatial fidelity:** *reindeer return to the same locations year after year*
- Recent **migration shift** in summer habitats (N-NE): colder and higher elevations
- Recent shift in calving areas has increased distance between reindeers' calving and winter grounds, increasing calf mortality
- Changes in range likely driven by climate change (warmer temperatures, increased mosquito harassment, rivers open early) and human activity
- Satellite imagery shows that the arrival of reindeer to new grounds doesn't seem to lead to overgrazing

Questions?

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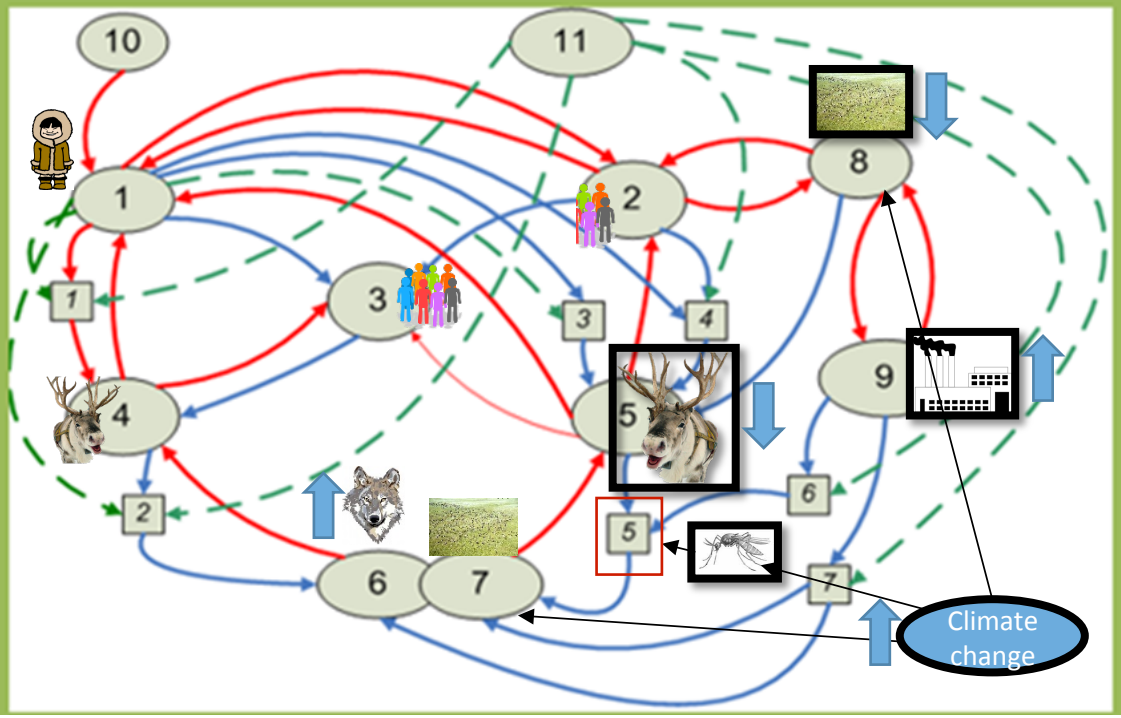
Take home messages

- Wild reindeer and caribou population are declining
- Strong evidence of long-term **spatial fidelity:** *reindeer return to the same locations year after year*
- Recent **migration shift** (east, north)
- Changes in range likely driven by climate change (warmer temperatures, increased mosquito harassment, rivers open early) and human activity
- Satellite imagery shows that the arrival of reindeer to new grounds doesn't seem to lead to overgrazing

REINDEER-ENVIRONMENT-HUMAN SYSTEMS ARE CHANGING:



KEY CHANGES:

- Increasing temperatures
- Ice-on-snow events, winter precipitation
- Industrial pressure (mining, pipelines)
- Increasing predator and mosquito harassment
- Unregulated hunting, poaching
- Overgrazing?

positive impacts
negative impacts
information flows