Observed changes in terrestrial wildlife linked to 20th century warming

In Arctic Alaska

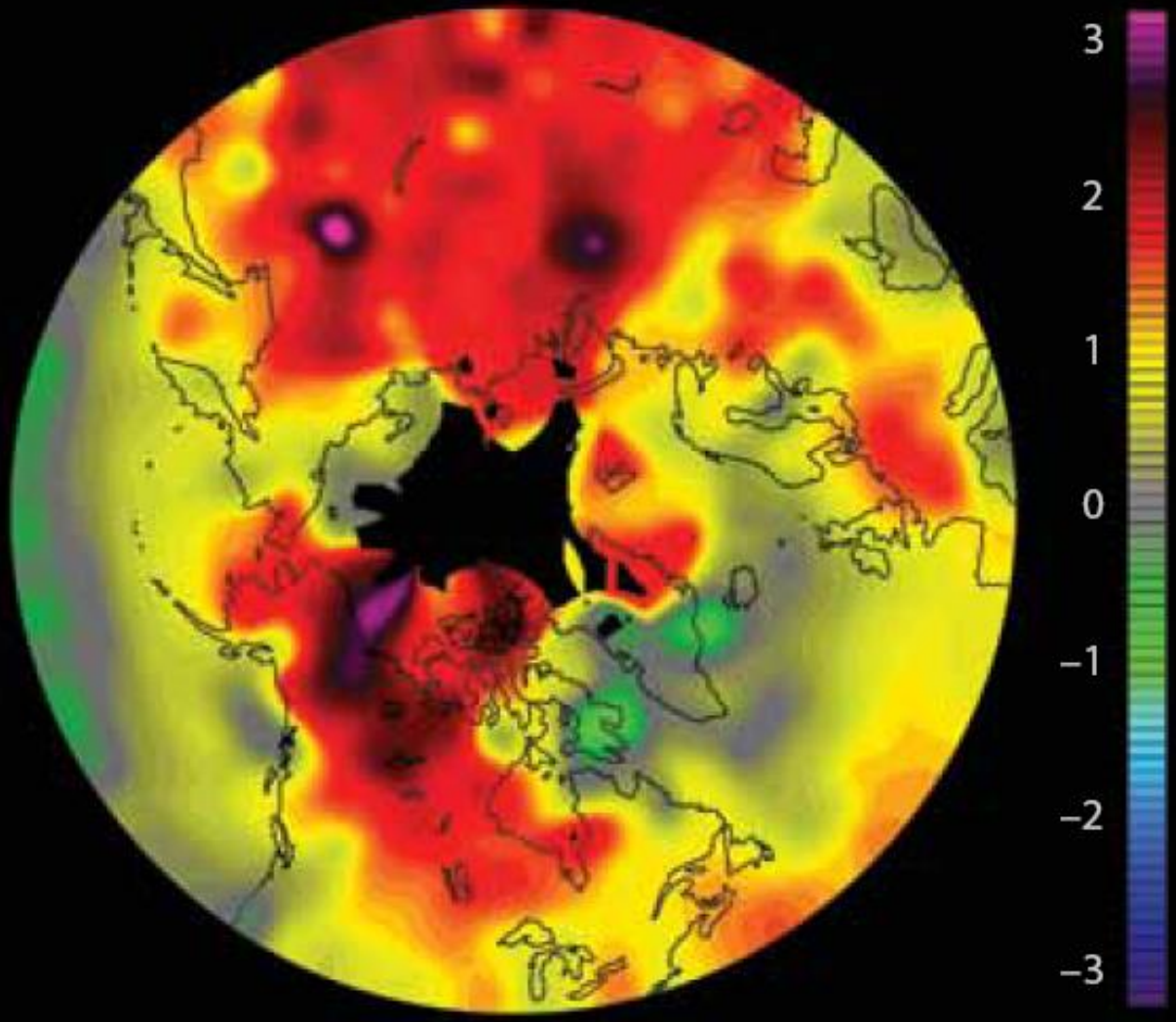
Ken Tape
Water & Environmental Research Center
Institute of Northern Engineering
University of Alaska

Acknowledgements

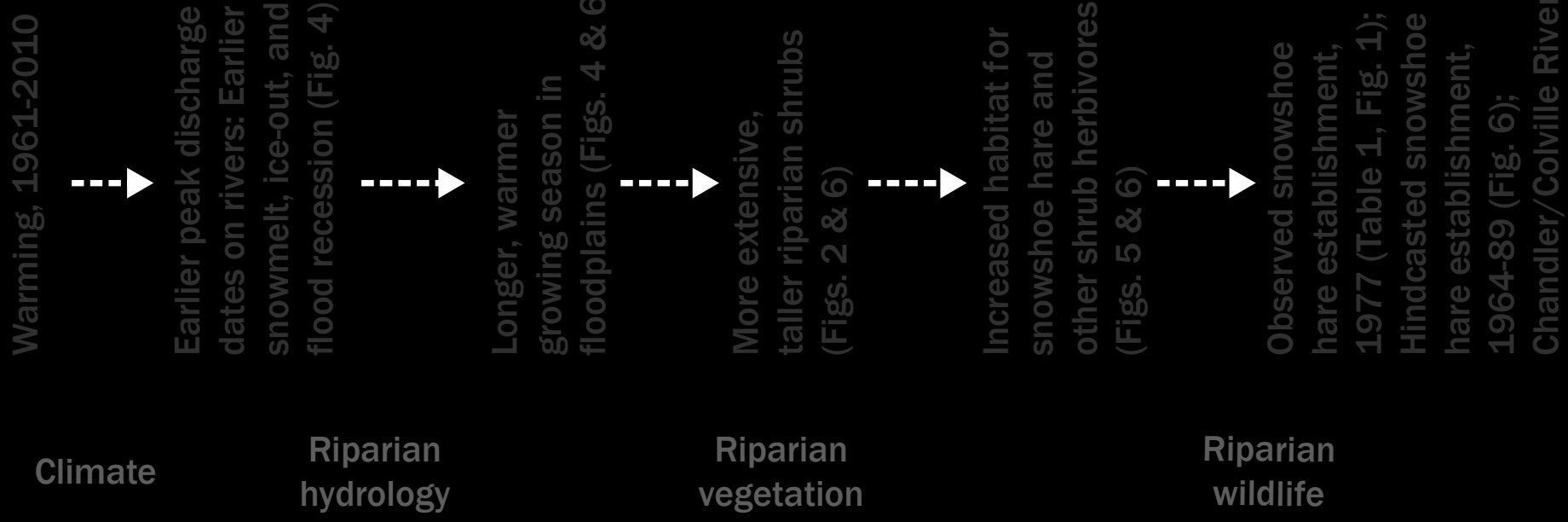
- UAF-INE, USGS, EPSCoR, IAB Coop Unit, NPS
- Dave Gustine (USGS), Roger Ruess (IAB), Jon O'Donnell (NPS), Katie Christie (IAB), David Ward (USGS)

Some effects of warming and earlier snowmelt on

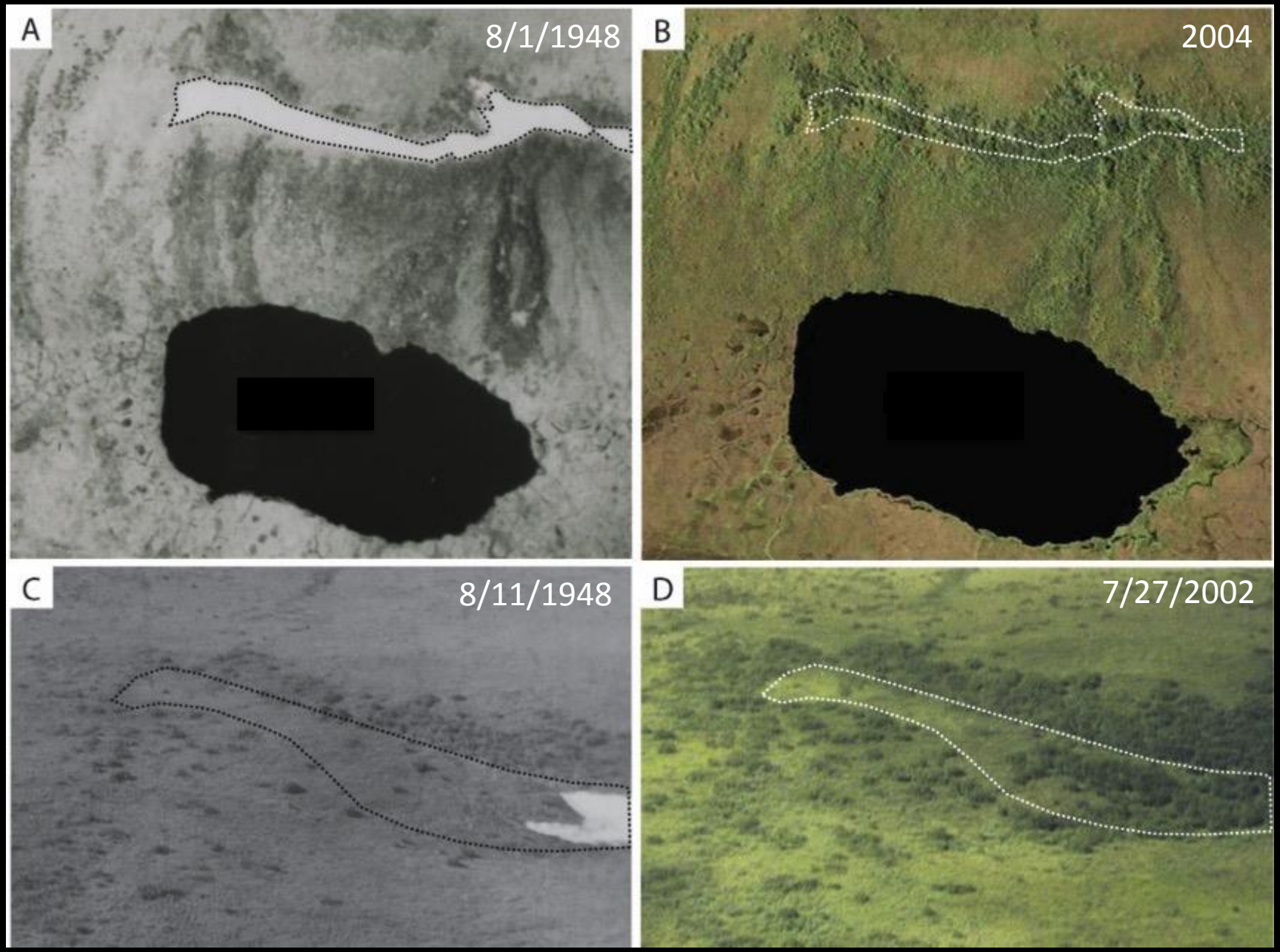
- Herbivore browsers
  - Moose
  - Snowshoe hare
- Migratory birds
  - Arrival timing of multiple species
  - Distribution shifts



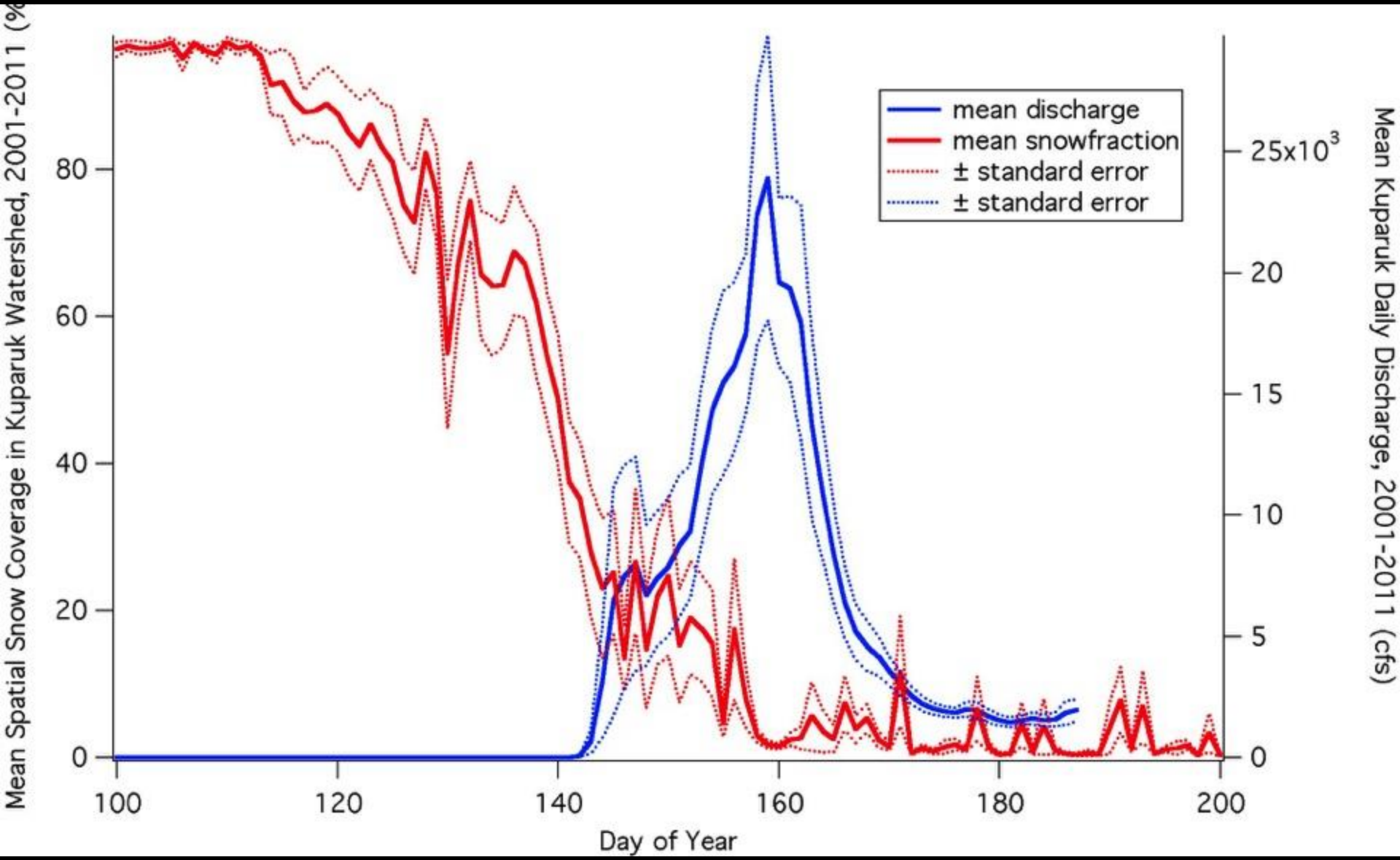
Surface air temperature change (°C) in northern regions during the period 1959 to 2008, relative to the mean. WILLIAM CHAPMAN AND JOHN WALSH

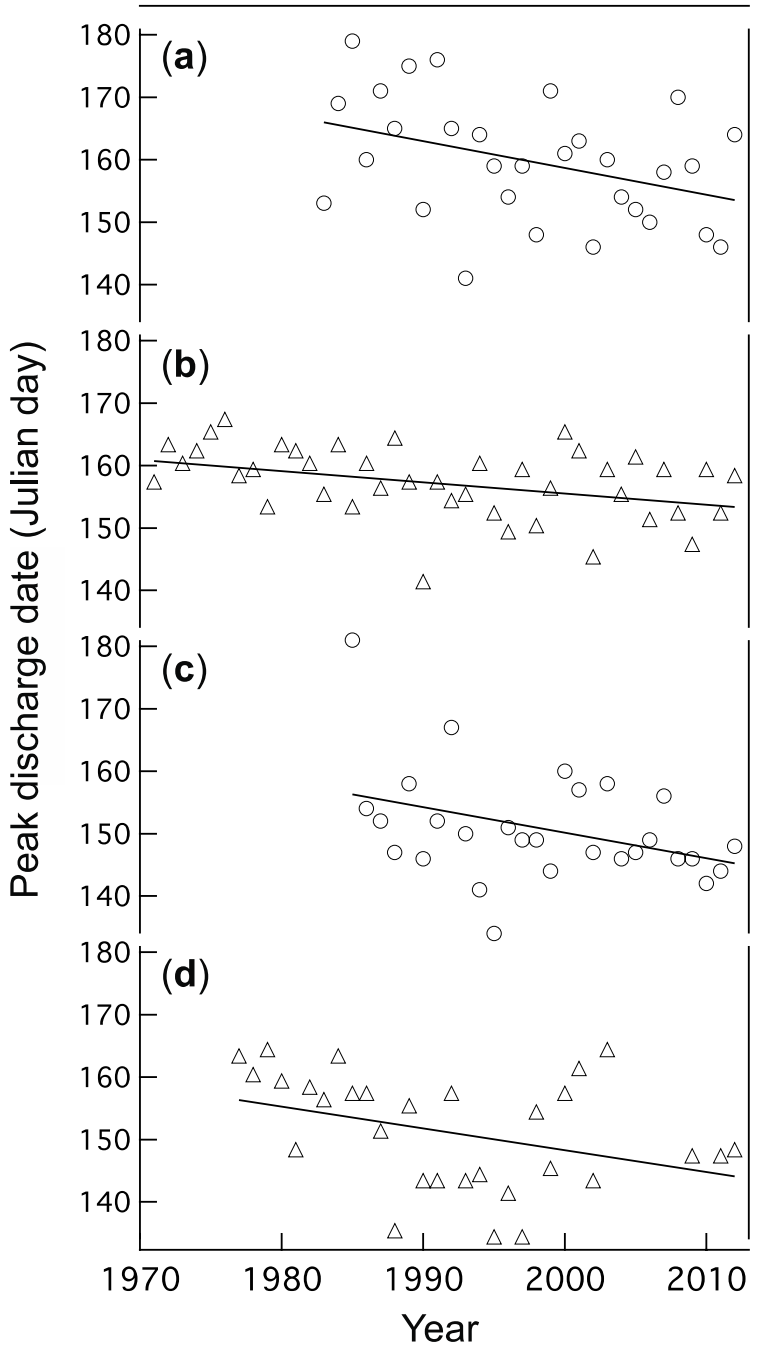


Tape KD, K Christie, G Carroll, JA O'Donnell, 2016. Novel wildlife in the Arctic: the influence of changing riparian ecosystems and shrub habitat expansion on snowshoe hares. *Global Change Biology*


A
8/1/1948
B
2004
C
8/11/1948
D
7/27/2002

Discharge reflects the decreasing snow fraction on the landscape





Sag River
4.2 days per decade
R2 = 0.15, **P** = 0.03

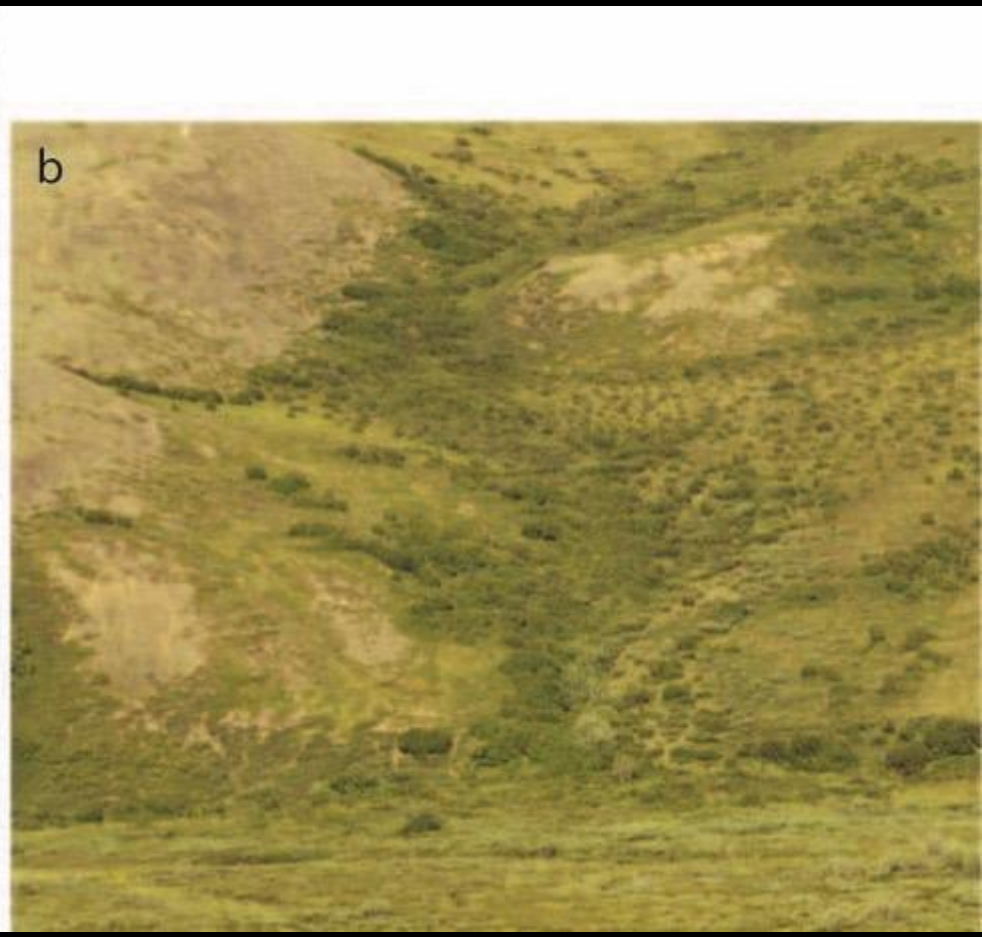
Kuparuk River
1.8 days per decade
R2 = 0.15, **P** = 0.01

Wulik River
4.1 days per decade
R2 = 0.14, **P** = 0.047

Kobuk River
3.5 days per decade
R2 = 0.14, **P** = 0.04

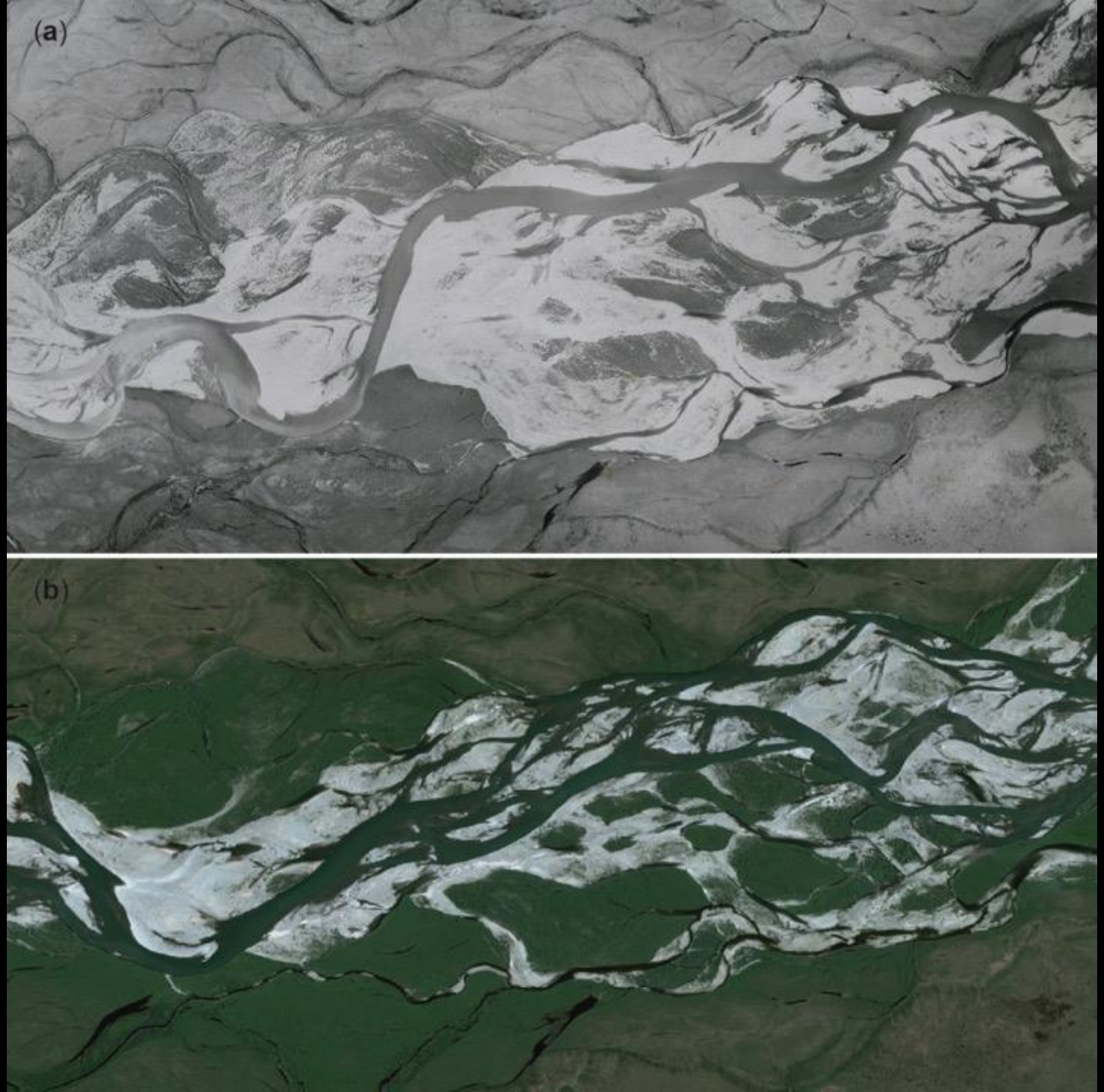
Tape KD, K Christie, G Carroll, JA O'Donnell, 2016. Novel wildlife in the Arctic: the influence of changing riparian ecosystems and shrub habitat expansion on snowshoe hares. *Global Change Biology*

Shrub expansion via waterways

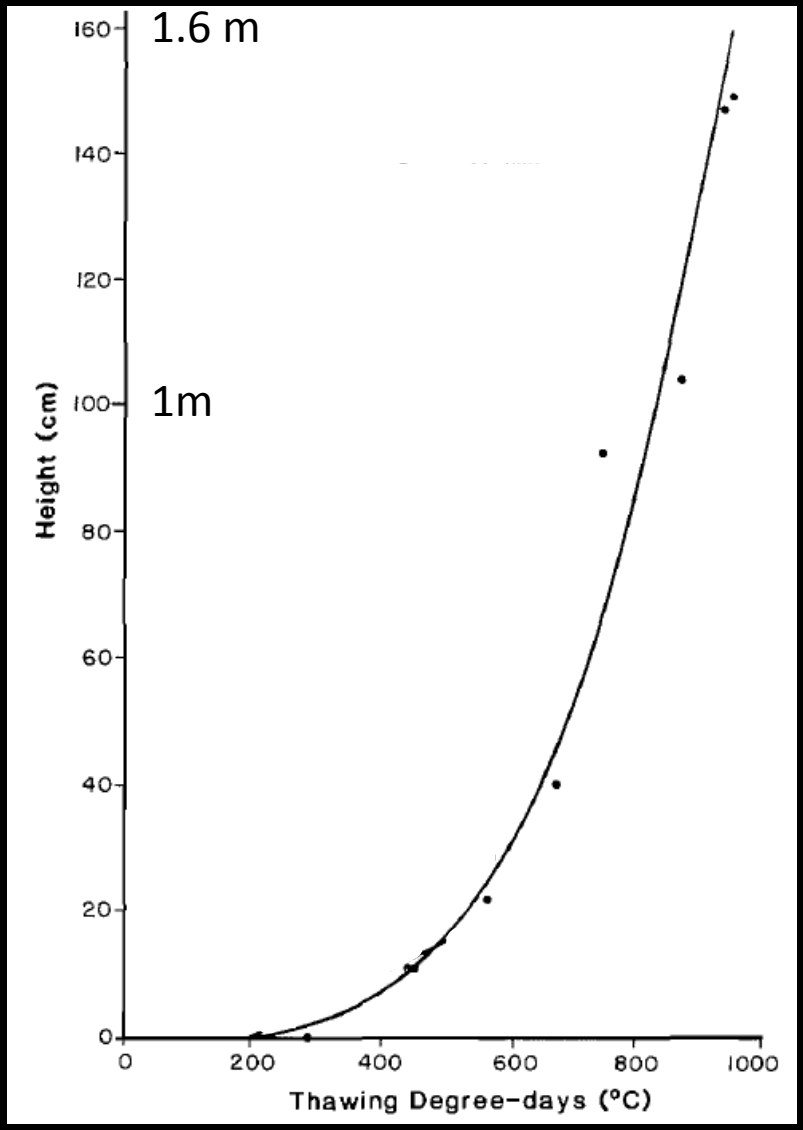



1957


2007


(a)
(b)

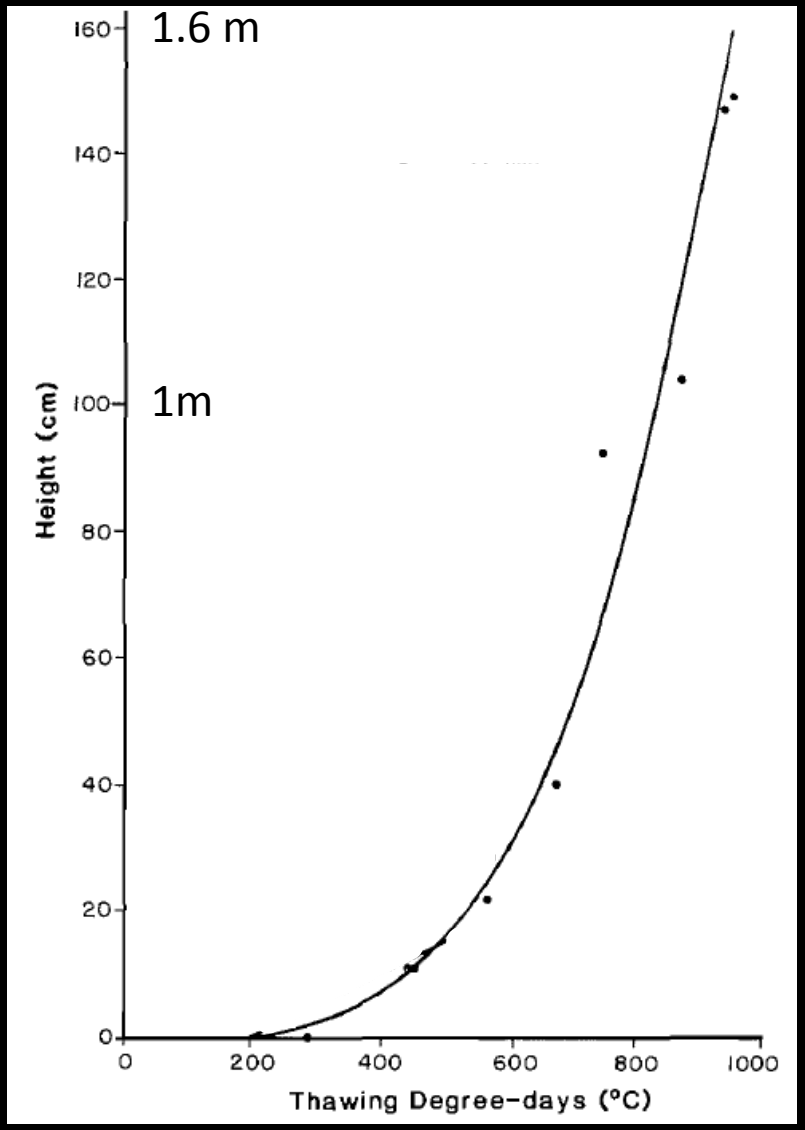
ARCTIC COAST INLAND



Walker, D. A. Height and growth rings of *Salix lanata* ssp *richardsonii* along the coastal temperature gradient of northern Alaska. *Canadian Journal of Botany-Revue Canadienne De Botanique* **65**, 988-993 (1987).

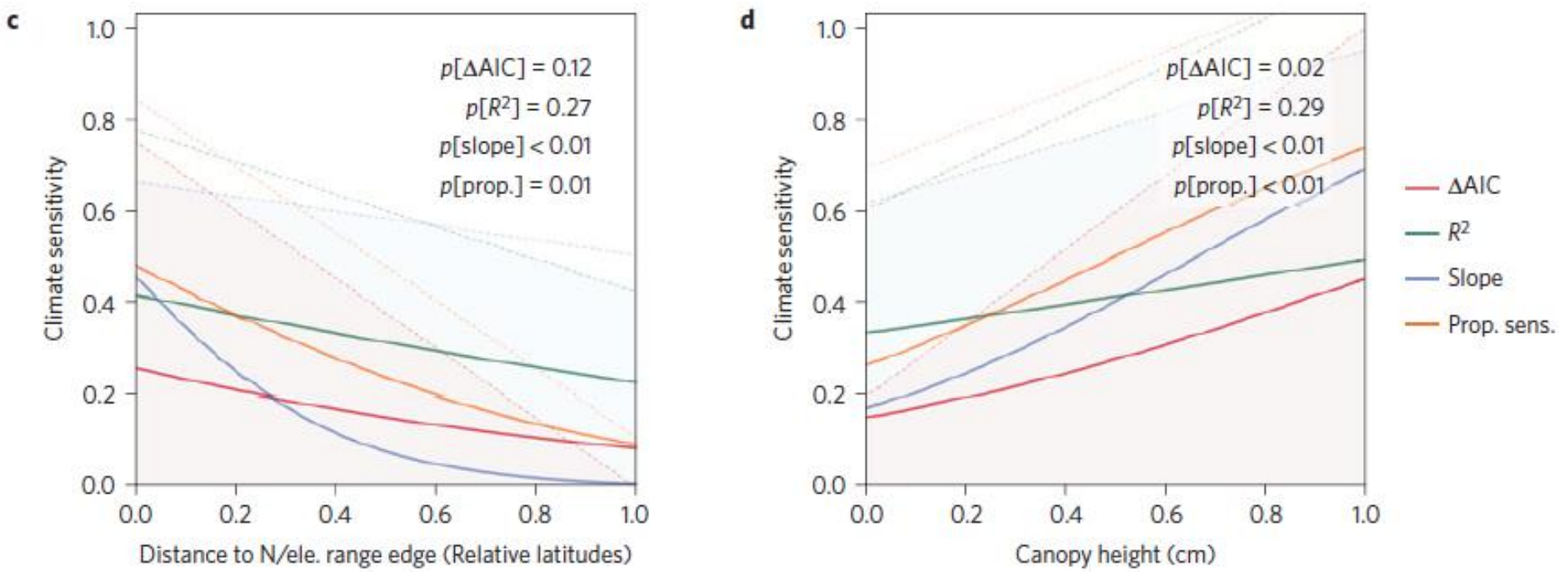
The 25% increase in Thaw-Degree-Days since 1860 correlates with a doubling of shrub height

ARCTIC COAST INLAND

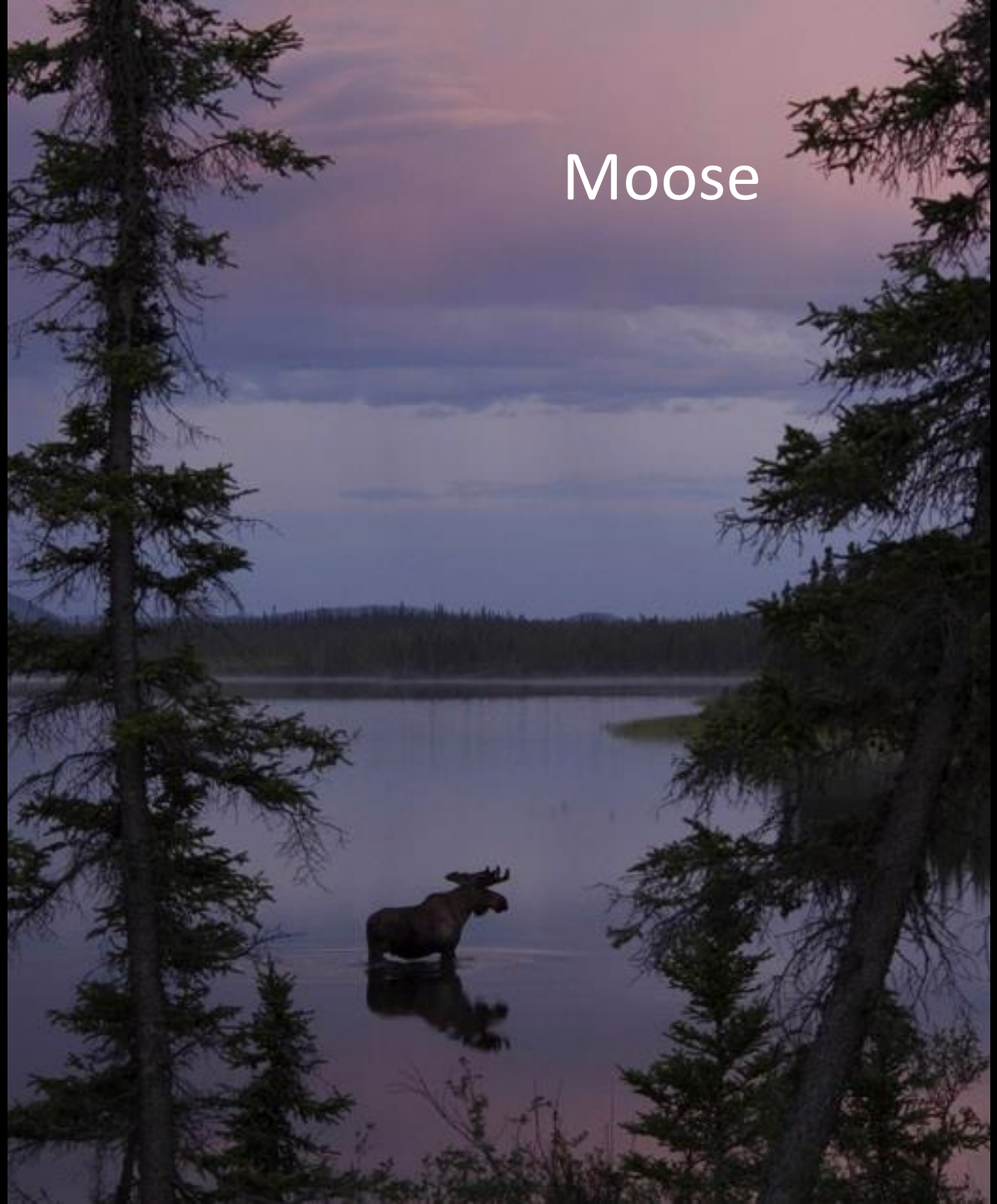


Walker, D. A. Height and growth rings of *Salix lanata* ssp *richardsonii* along the coastal temperature gradient of northern Alaska. *Canadian Journal of Botany-Revue Canadienne De Botanique* **65**, 988-993 (1987).

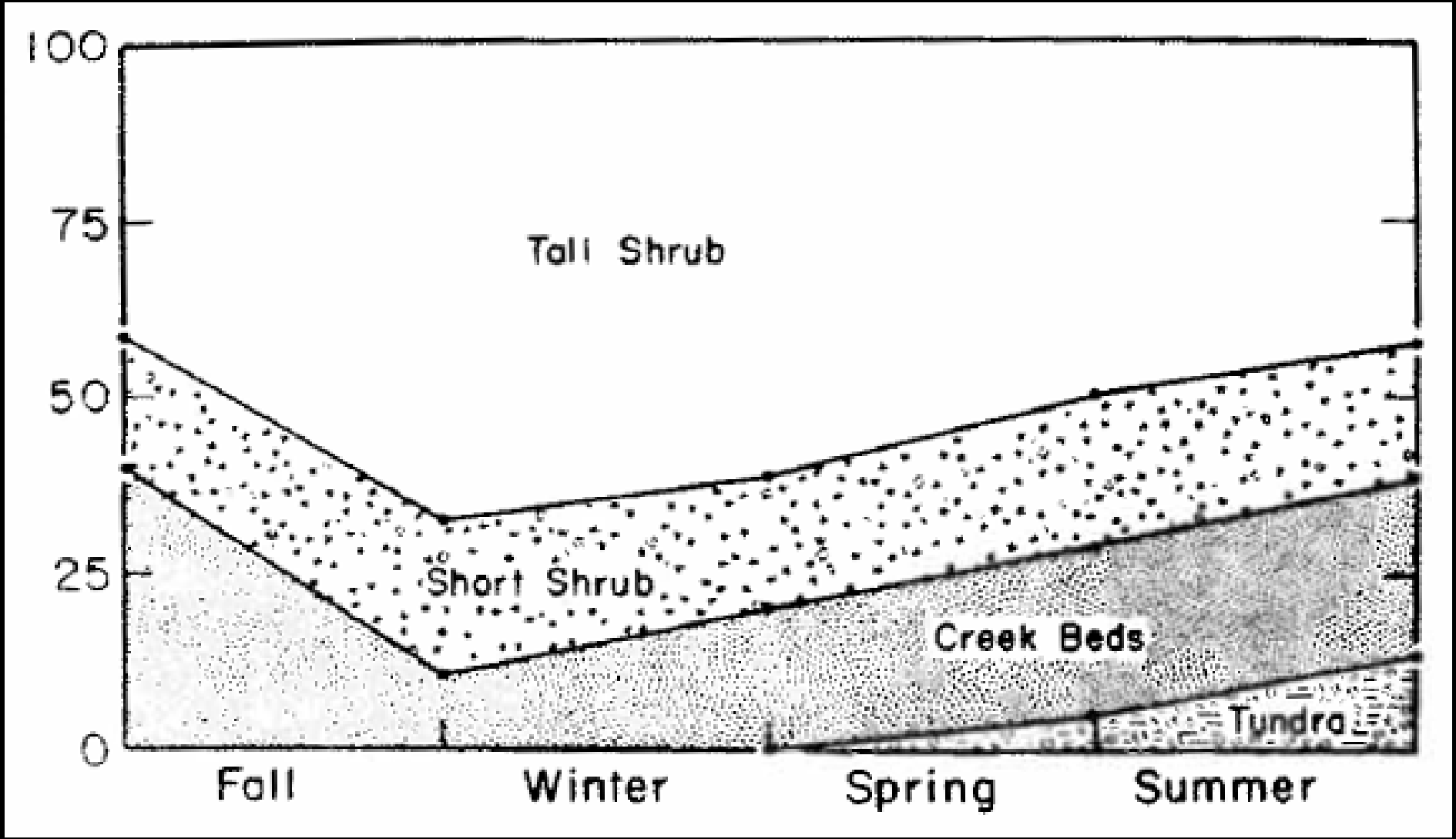
Tall shrubs near northern range limit are most sensitive to climate



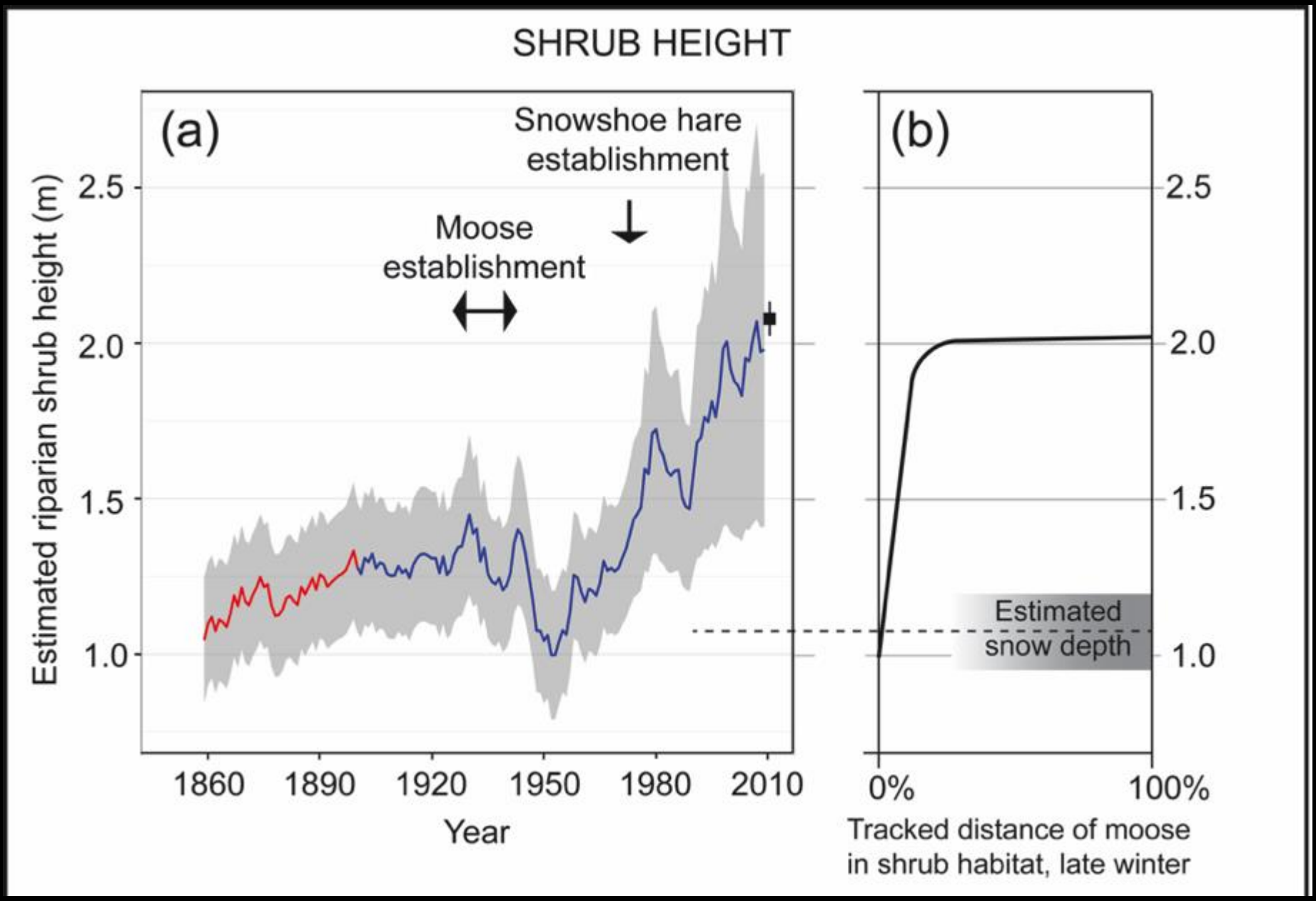
Myers-Smith, I.H., Elmendorf, S.C., Beck, P.S., Wilmking, M., Hallinger, M., Blok, D., Tape, K.D., Rayback, S.A., Macias-Fauria, M., Forbes, B.C. and Speed, J.D., 2015. Climate sensitivity of shrub growth across the tundra biome. *Nature Climate Change*, *5*(9), pp.887-891.


Moose

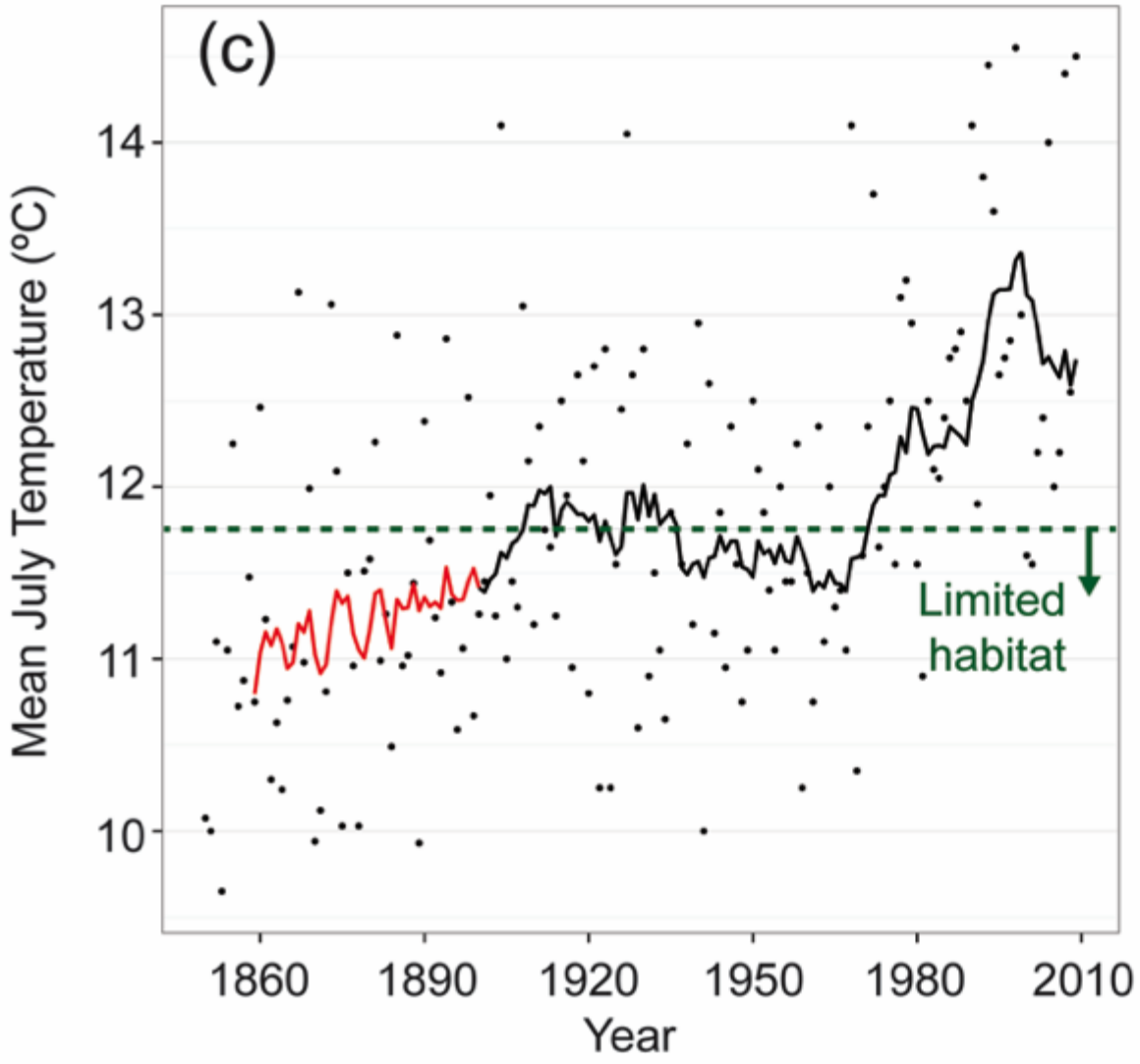
Moose on Alaska's North Slope spend 80-90% of the winter in habitats with shrubs taller than 1 m (very similar requirement to snowshoe hares)

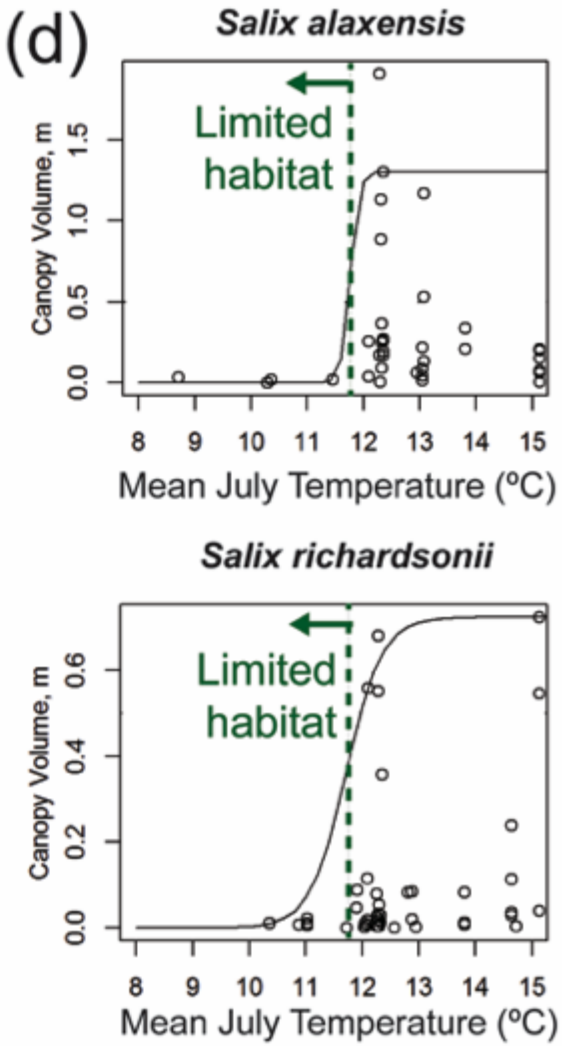


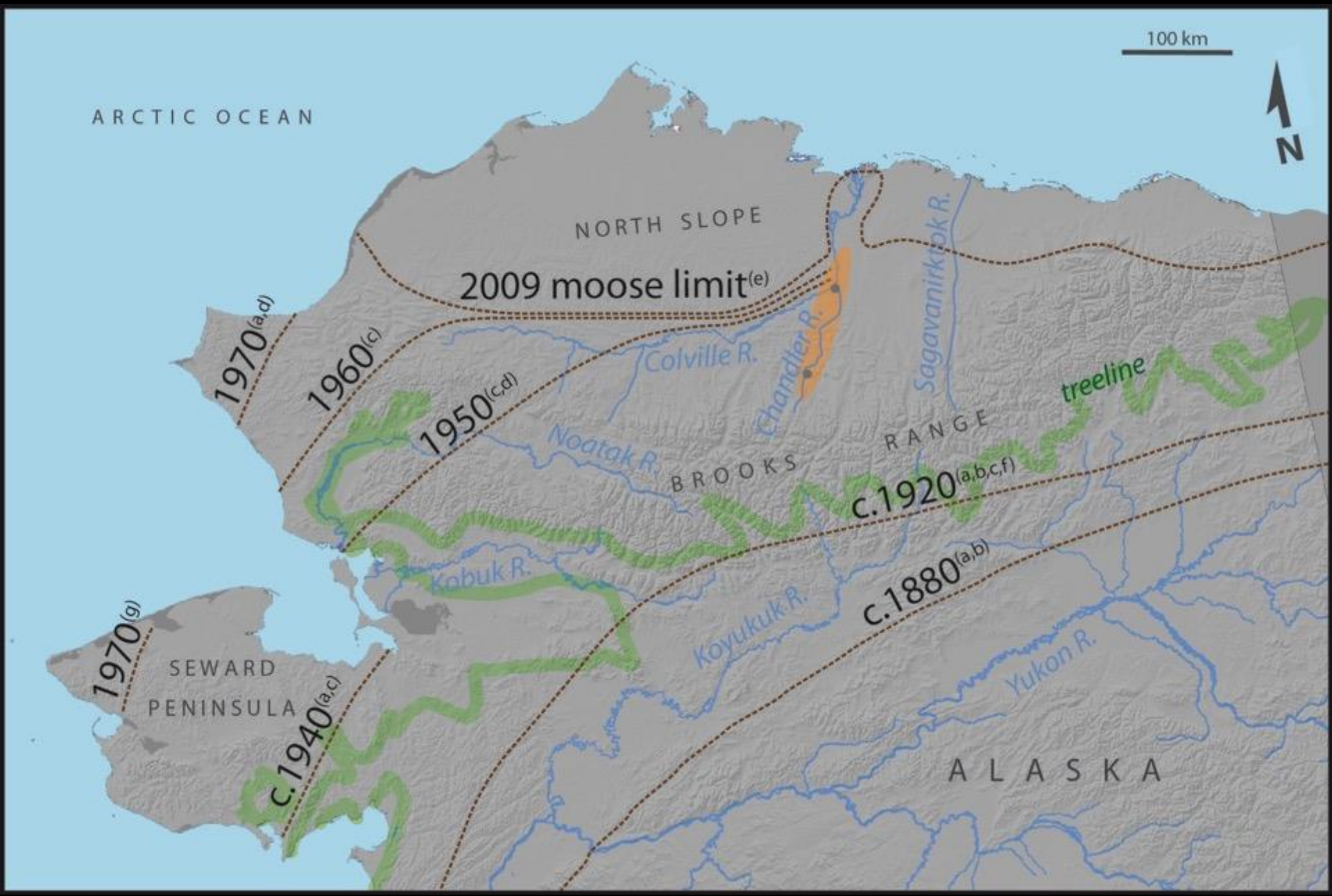
Mould, E. Habitat Relationships of Moose in Northern Alaska. *Alces* **13**, 144-156 (1977)


SHRUB HEIGHT
(a)
Snowshoe hare establishment
Moose establishment
Estimated riparian shrub height (m)
2.5
2.0
1.5
1.0
1860
1890
1920
1950
1980
2010
Year
(b)
2.5
2.0
1.5
1.0
Estimated snow depth
0%
100%
Tracked distance of moose in shrub habitat, late winter

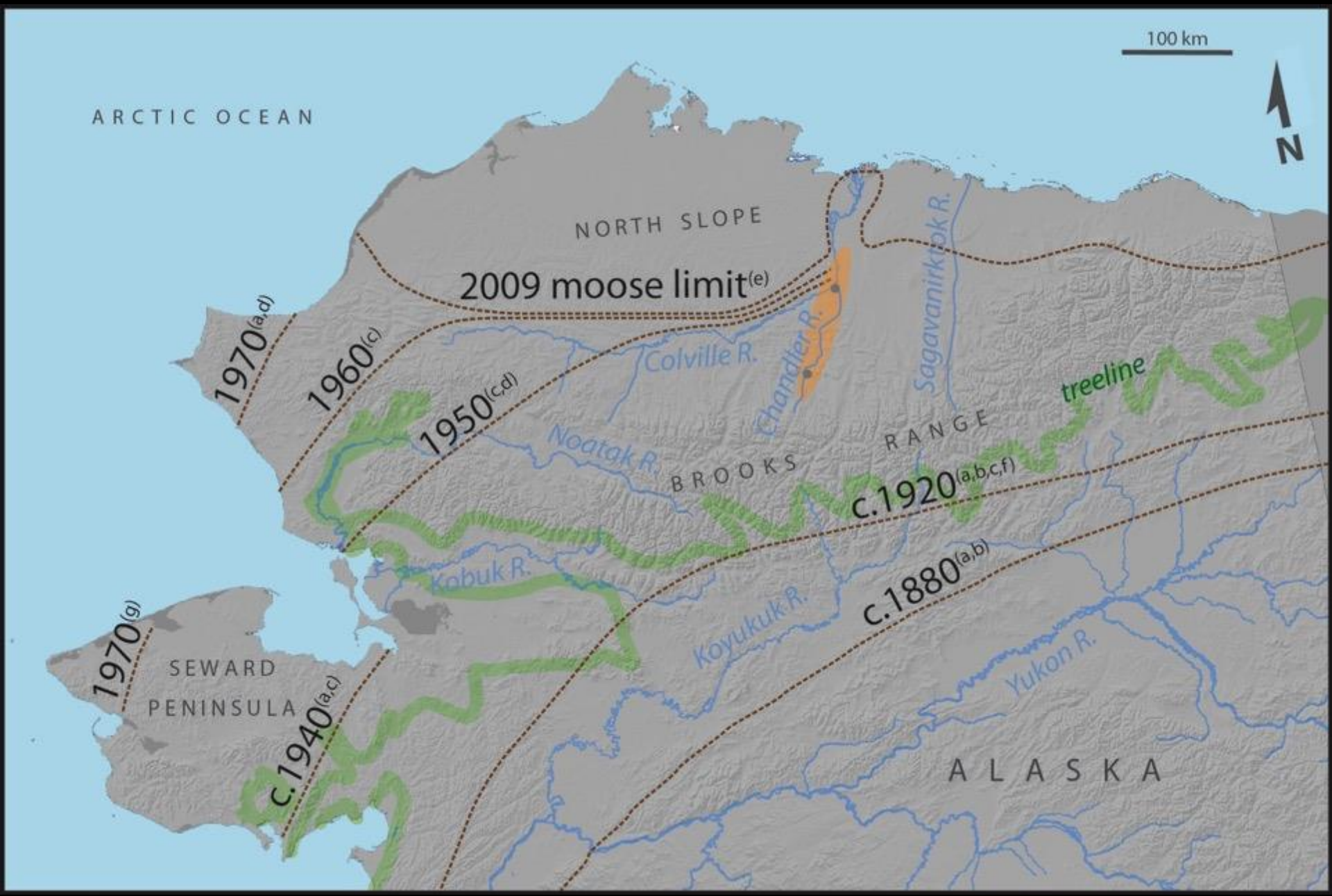
SHRUB CANOPY VOLUME







Tape, K.D., Gustine, D.D., Ruess, R.W., Adams, L.G. and Clark, J.A., 2016. Range Expansion of Moose in Arctic Alaska Linked to Warming and Increased Shrub Habitat. *PloS one*, *11*(4), p.e0152636.



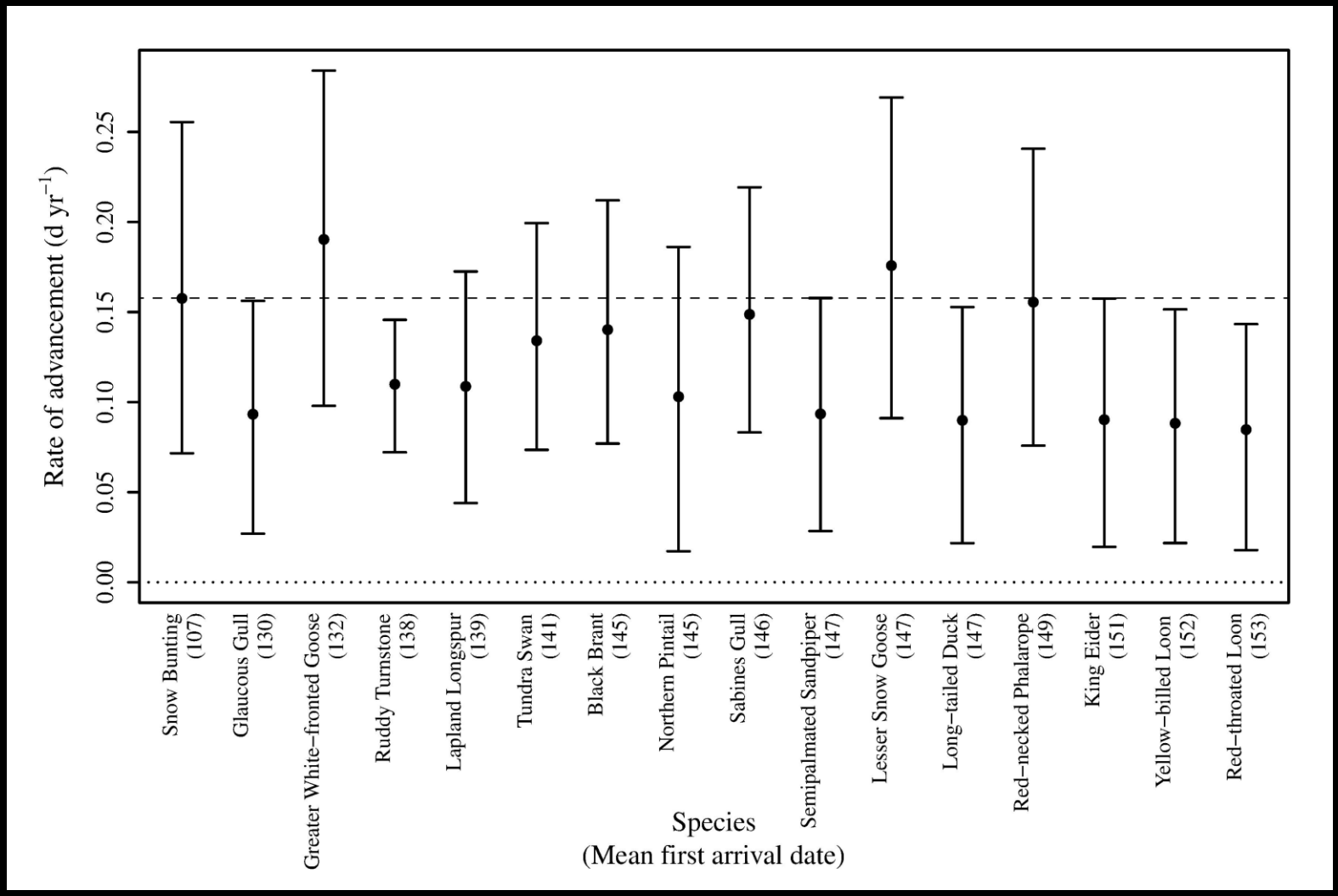
Increased habitat vs. Hunting cessation?

Establishing habitat requirements for moose, snowshoe hare, ptarmigan

Some effects of warming and earlier snowmelt on

- Herbivore browsers
  - Moose
  - Snowshoe hare
- Migratory birds
  - Arrival timing of multiple species
  - Distribution shifts

First migratory birds arrived 3-10 days earlier, 1964 to 2013

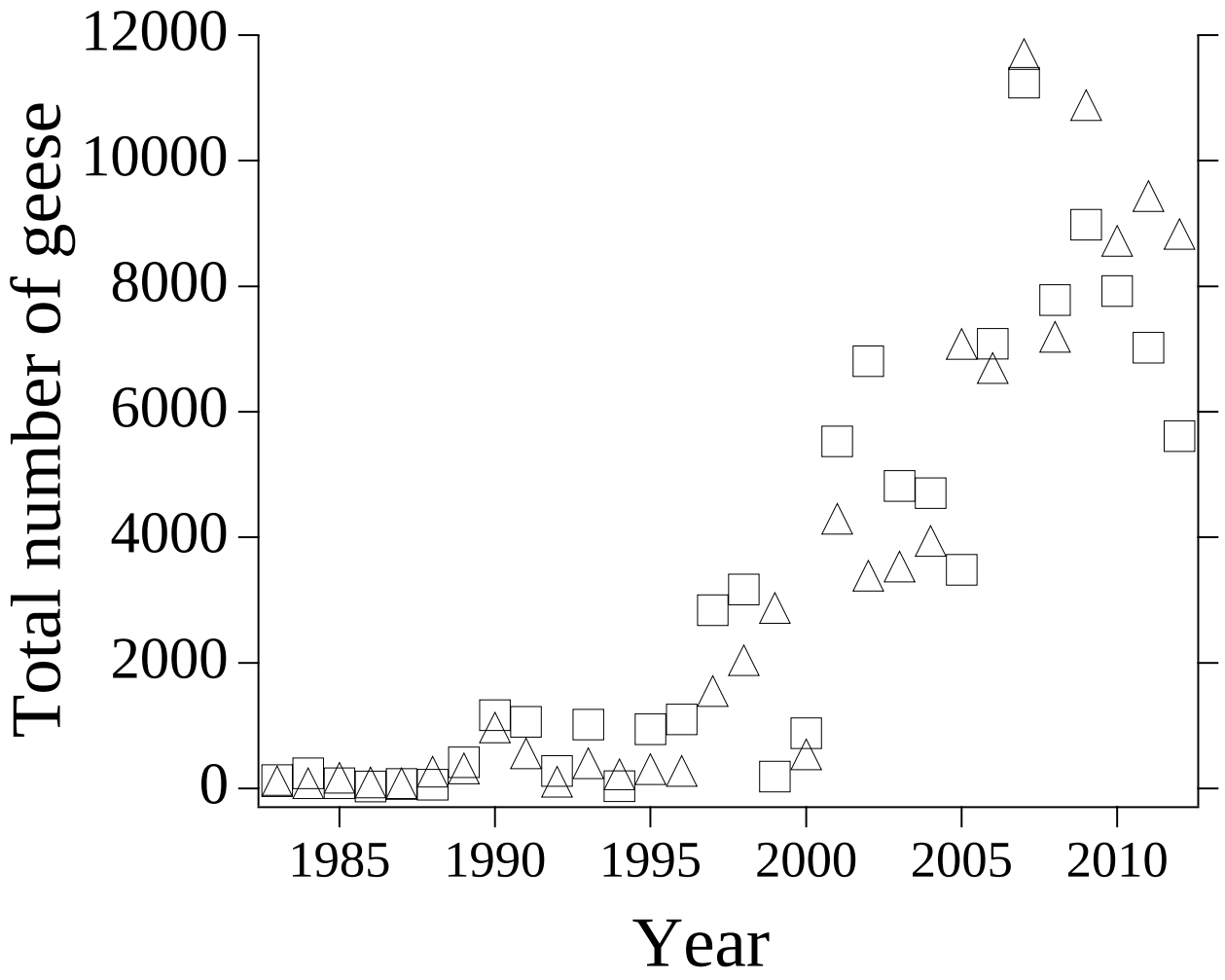


Ward, D.H., Helmericks, J., Hupp, J.W., McManus, L., Budde, M., Douglas, D.C. and Tape, K.D., 2015. Multi-decadal trends in spring arrival of avian migrants to the central Arctic coast of Alaska: effects of environmental and ecological factors. *Journal of Avian Biology*.

Study Area

Tape, K.D., Flint, P.L., Meixell, B.W. and Gaglioti, B.V., 2013. Inundation, sedimentation, and subsidence creates goose habitat along the Arctic coast of Alaska. Environmental Research Letters, 8(4), p.045031.

Emigration of geese from inland habitat to coastal habitat (Smith River & Garry Creek)



Soil/sediment pits dug exclusively in grazing lawns to determine habitat history

Results

Smith River estuary

Garry Creek estuary

Sedimentation and Salt-Tolerant grazing Lawn formation

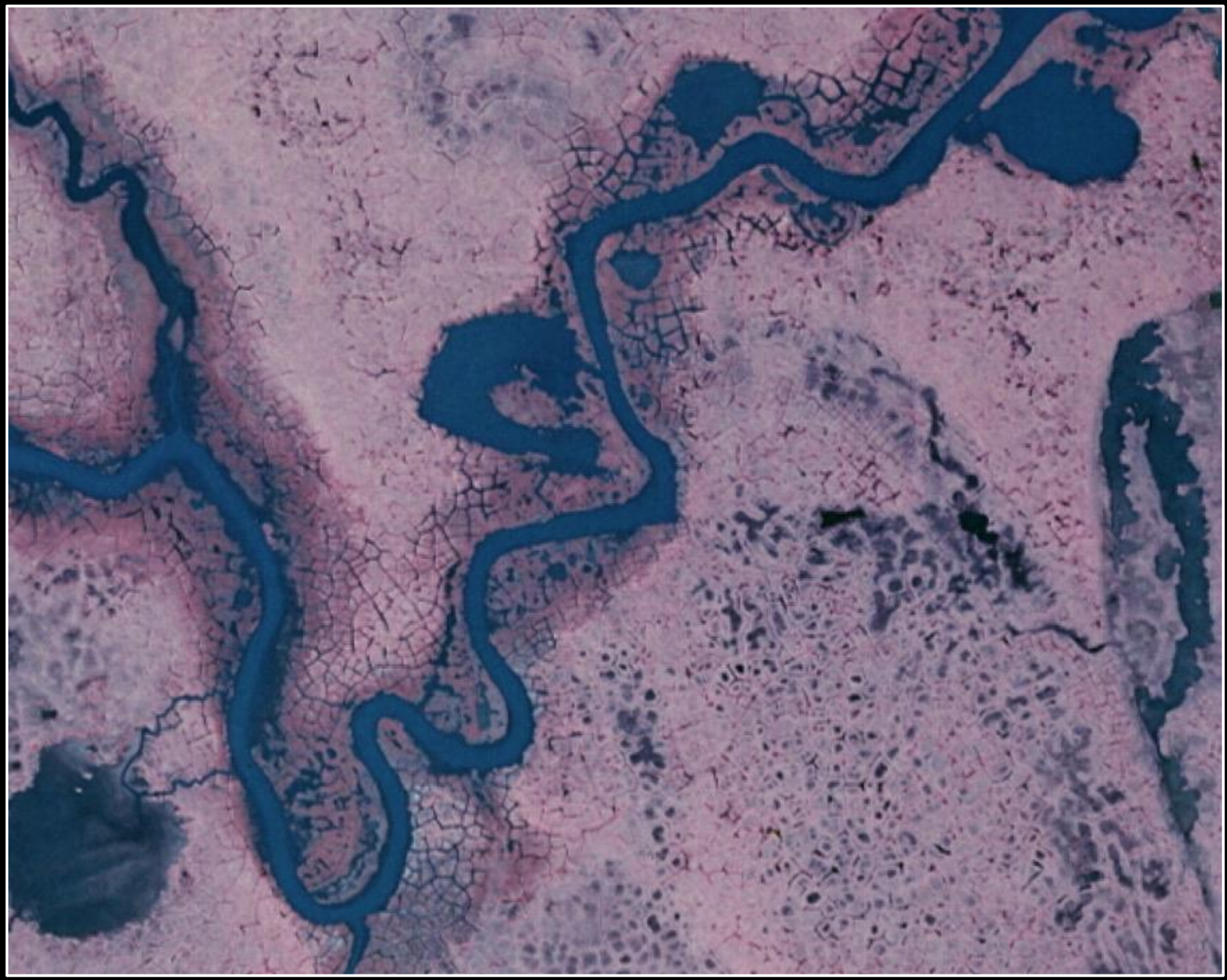
Peat accumulation

Results

Smith River estuary

Sedimentation and Salt-Tolerant grazing Lawn formation

Peat accumulation



Some effects of warming and earlier snowmelt on

- Herbivore browsers
  - Moose
  - Snowshoe hare
- Migratory birds
  - Arrival timing of multiple species
  - Distribution shifts for geese

How do we generalize and move beyond a collection of case studies?

(How do we predict?)


Thank You