The Changing Arctic Landscape of Alaska
Beaver Colonization of the Tundra

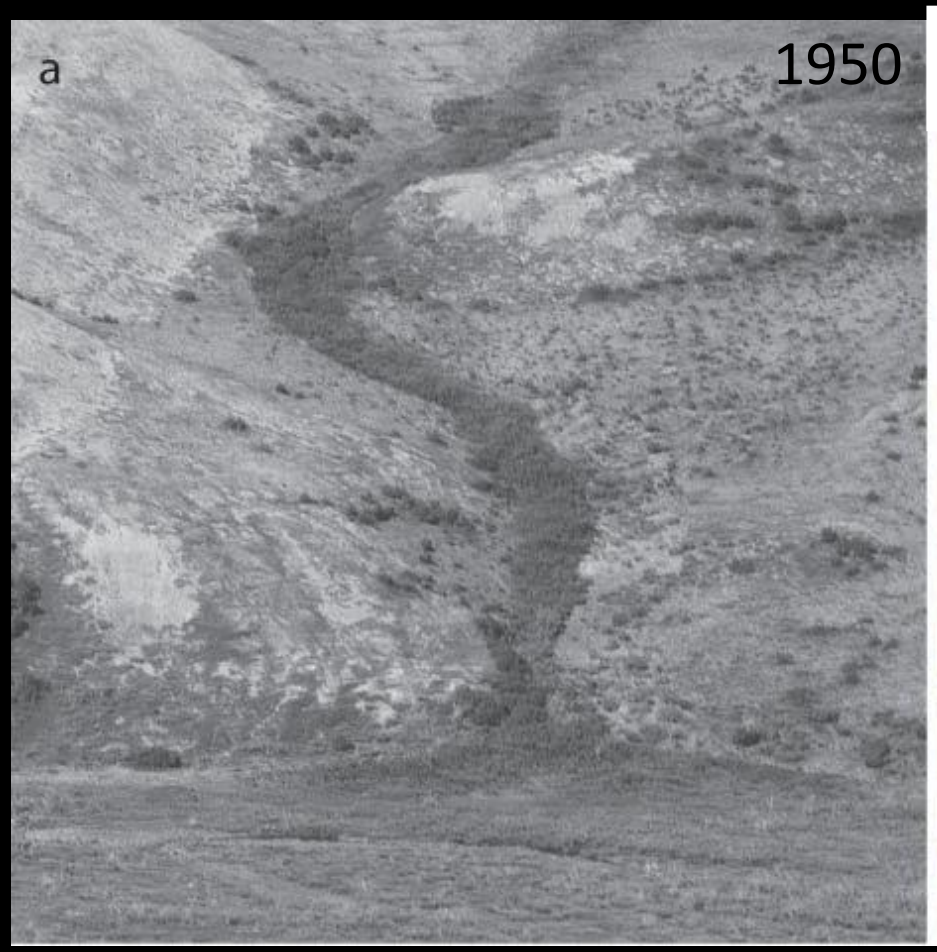


Ken Tape, University of Alaska Fairbanks
Jason Clark, University of Alaska Fairbanks
Ben Jones, University of Alaska Fairbanks

Outline

- Show repeat photography depicting landscape change in the Arctic
  - Glaciers
  - Vegetation
  - Permafrost
- Describe more recent findings related to wildlife

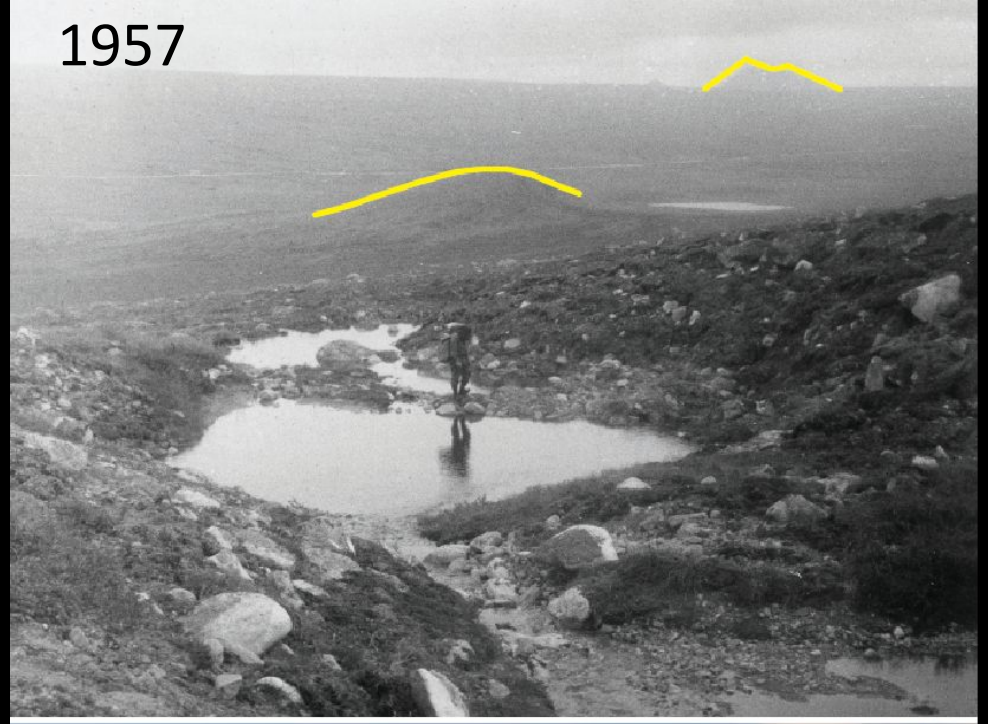
Nimiuktuk River



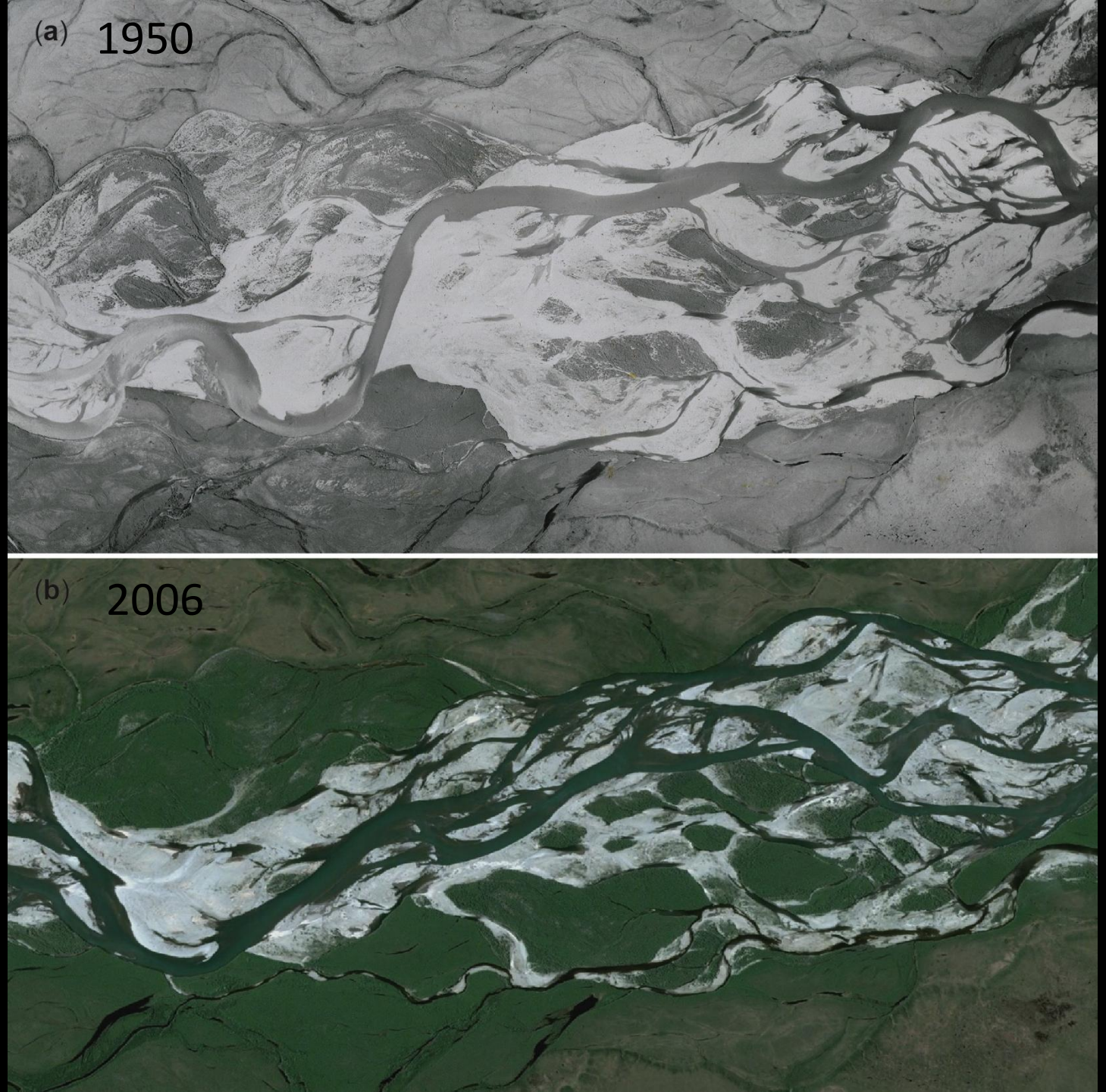


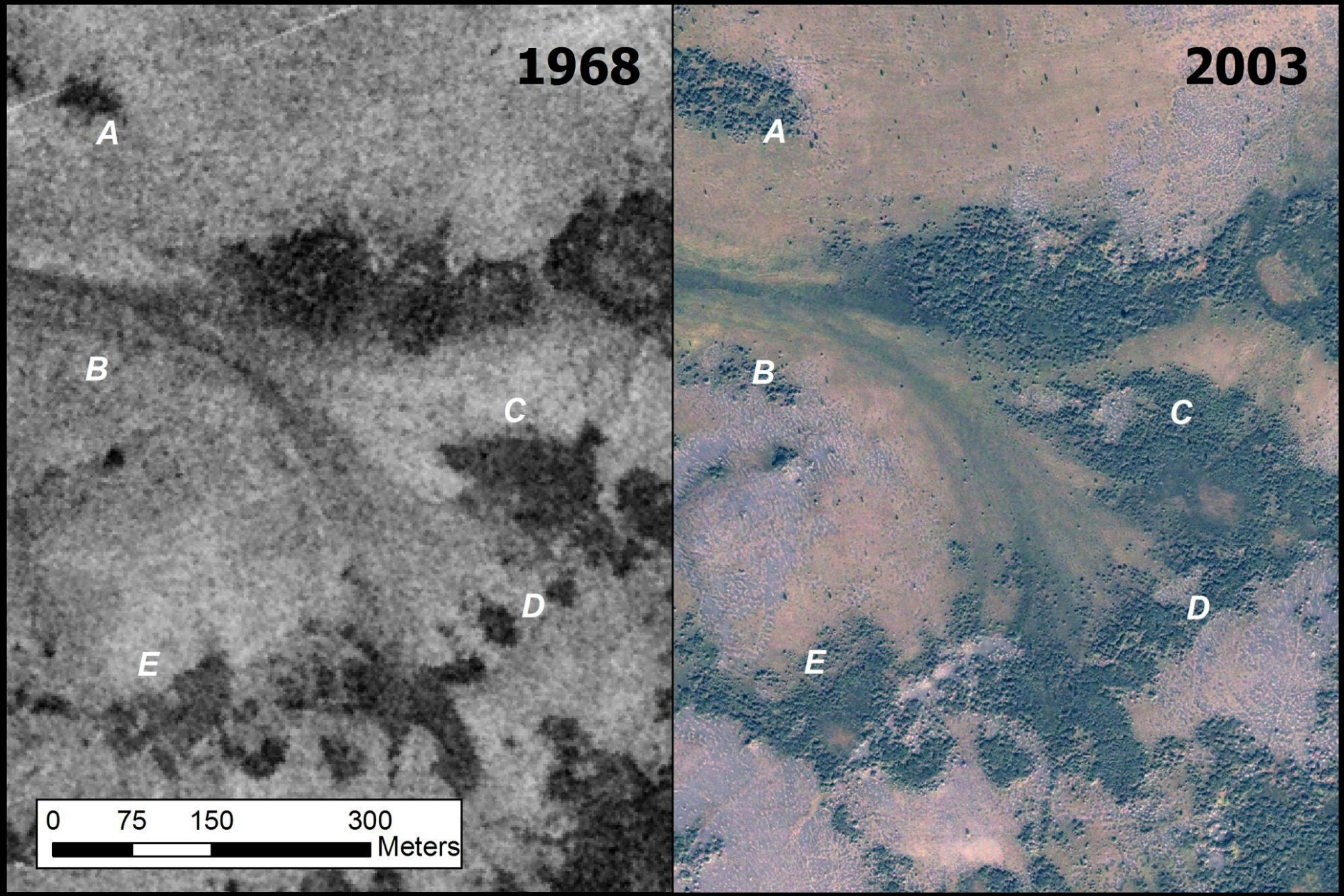

1950
1
2


2002
1
2

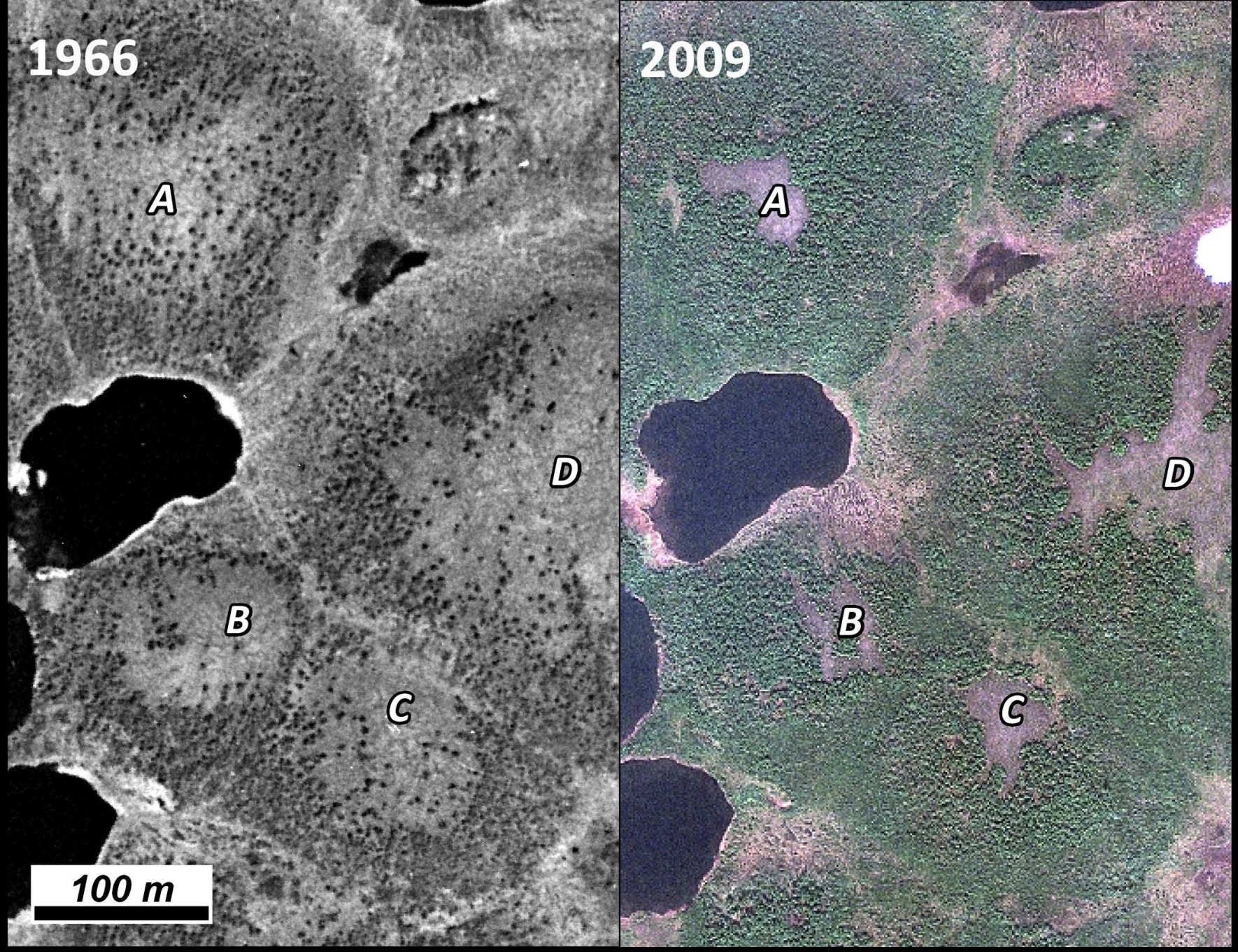

1957


2007


(a) 1950
(b) 2006



J. J. Frost, Alaska Biological Research



J. J. Frost, Alaska Biological Research


1907, Leffingwell


2007, Nolan


1972, Benson


2007, Tape

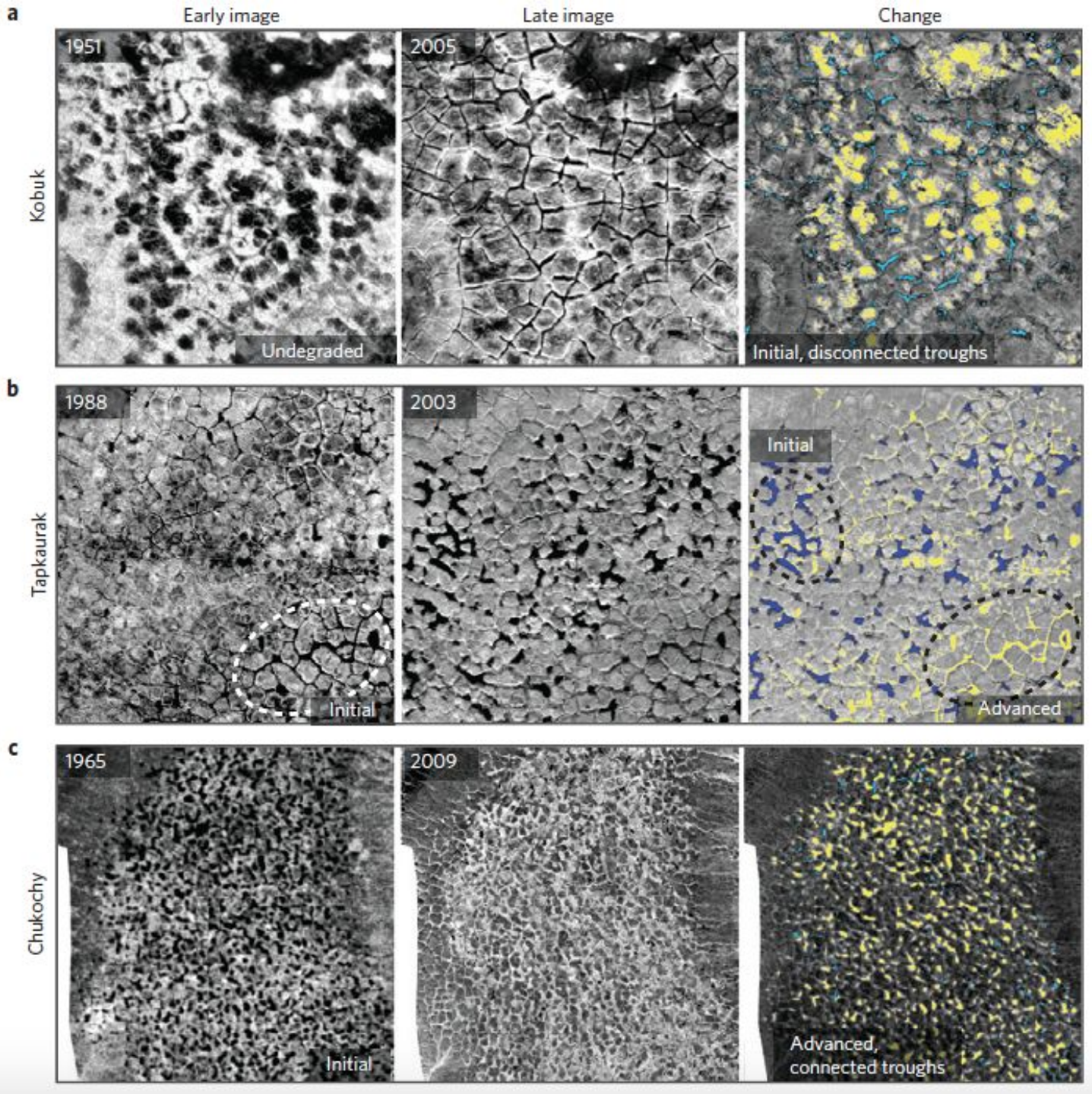
7/24/2005



7/22/2013



V. Romanovsky

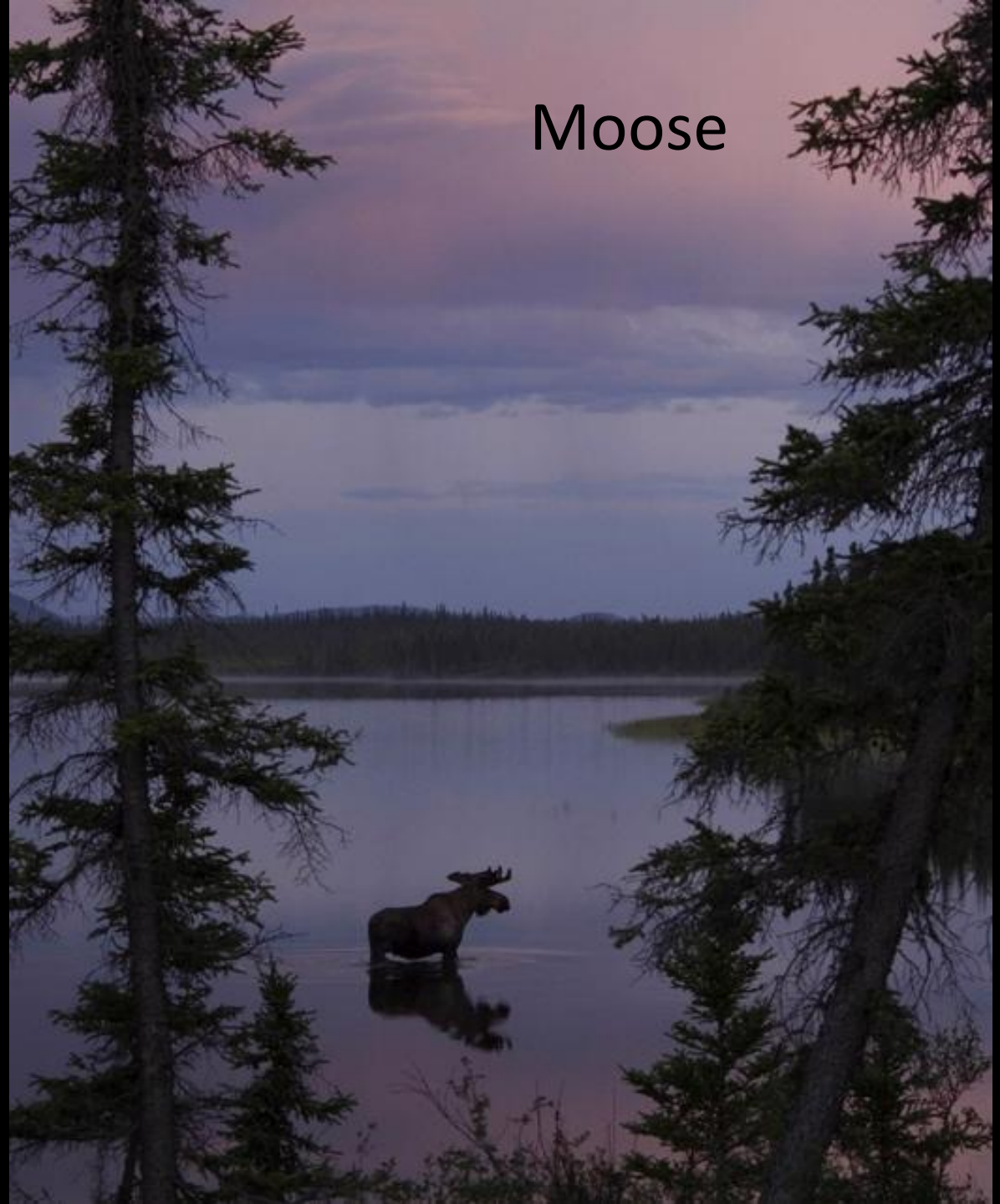

a
Early image
Late image
Change
Kobuk
1951
2005
Undegraded
Initial, disconnected troughs
b
Tapkaurak
1988
2003
Initial
Initial
Advanced
c
Chukochy
1965
2009
Initial
Advanced,
connected troughs



Outline

Changes in tundra habitat and distribution of beavers and other herbivore browsers

- Herbivore browsers
  - Moose
  - Snowshoe hares
  - Beavers

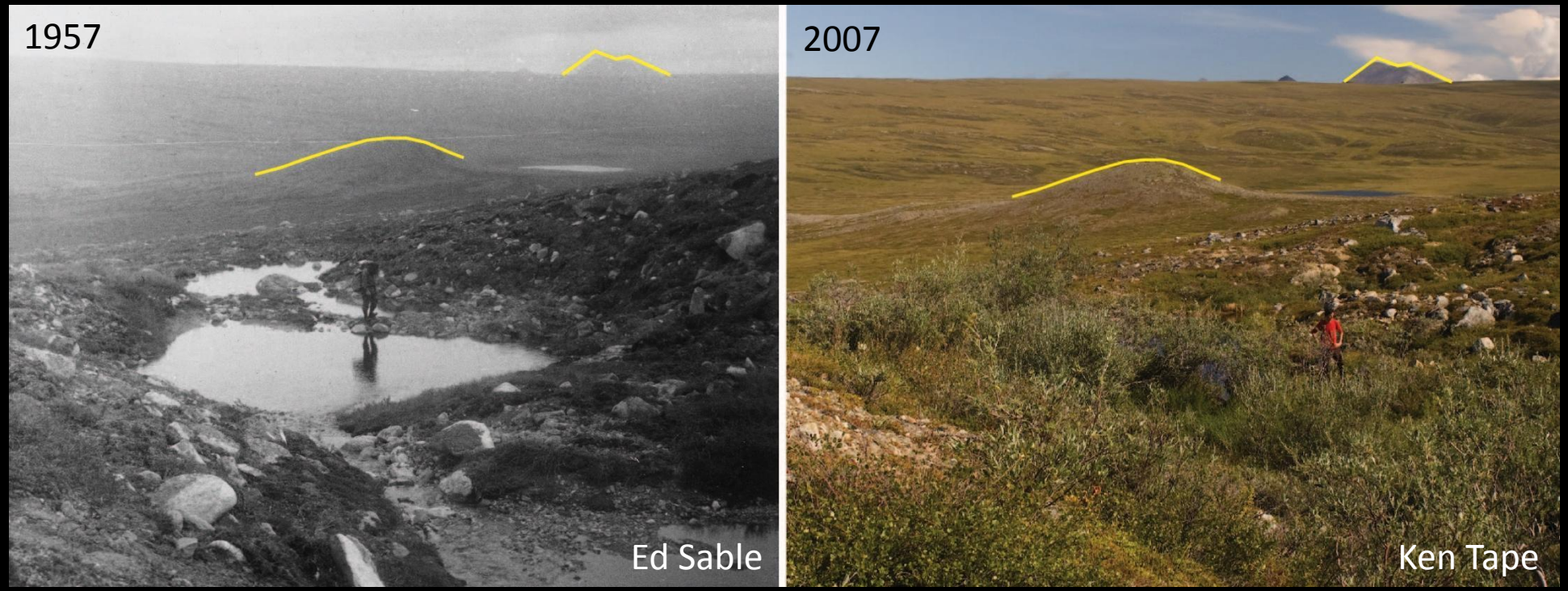

Moose

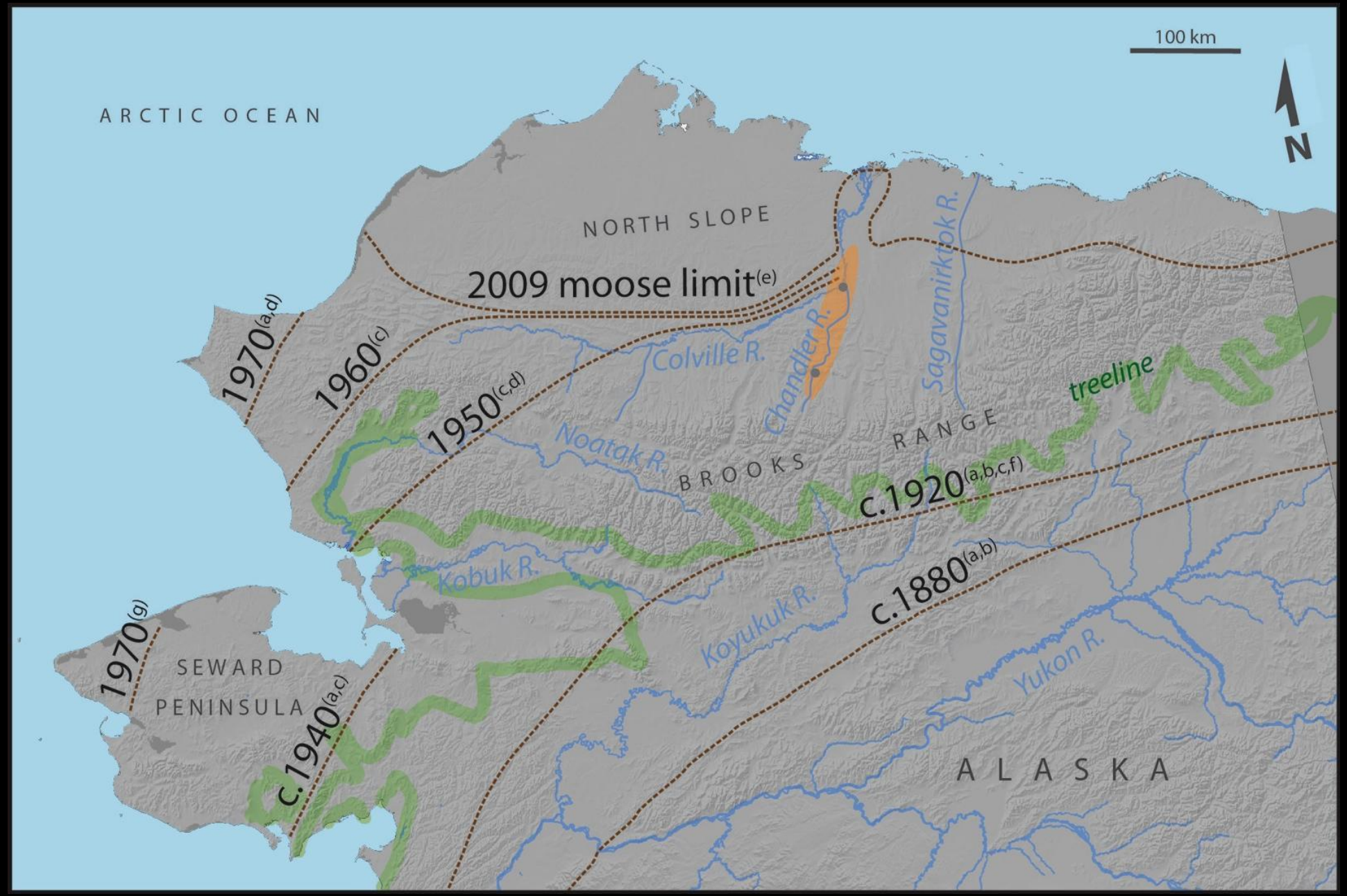



Wild and Free


APR.27,12 10:45 PM

Jago River, eastern North Slope





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.

Identifying moose and hare tundra habitat

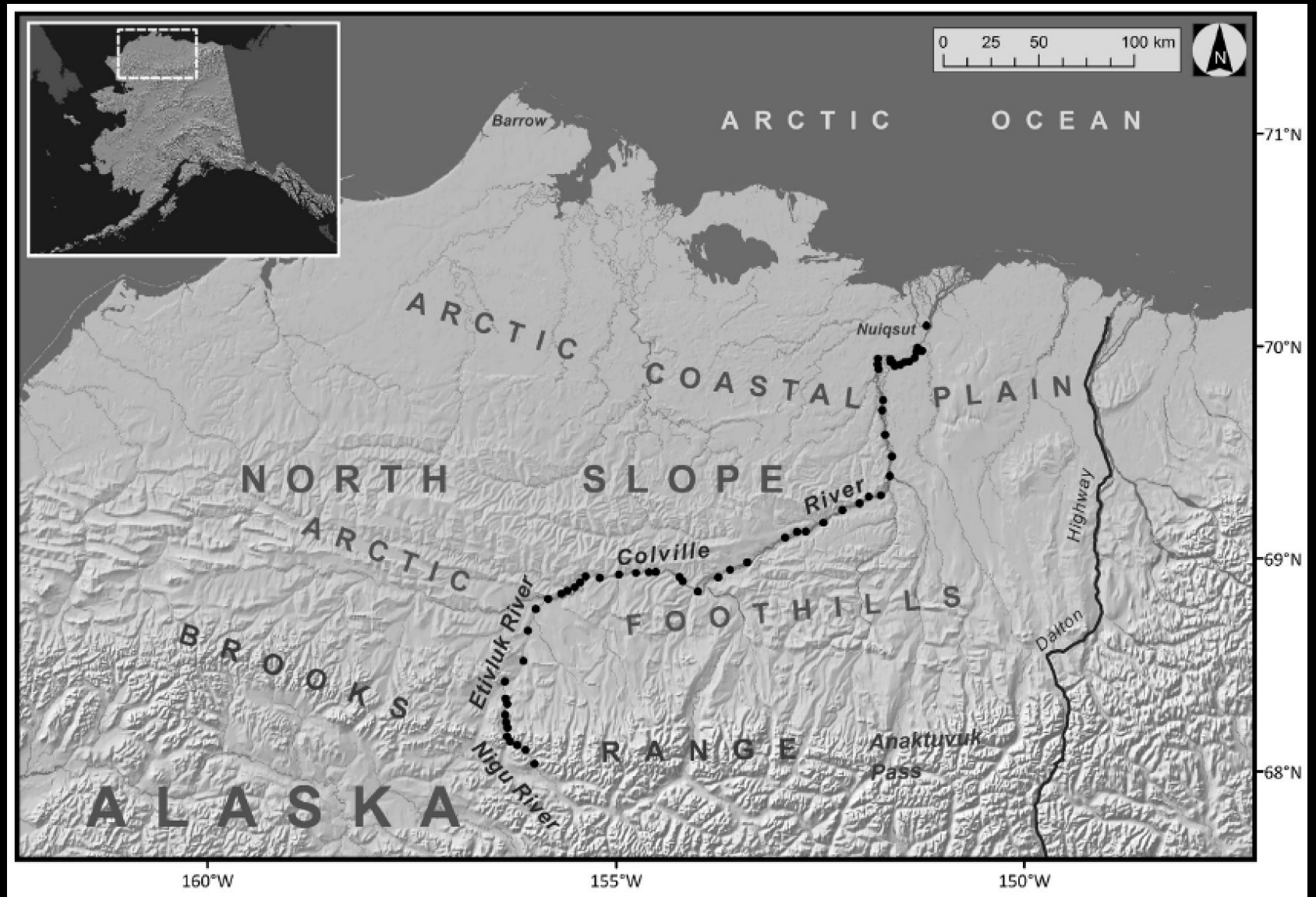
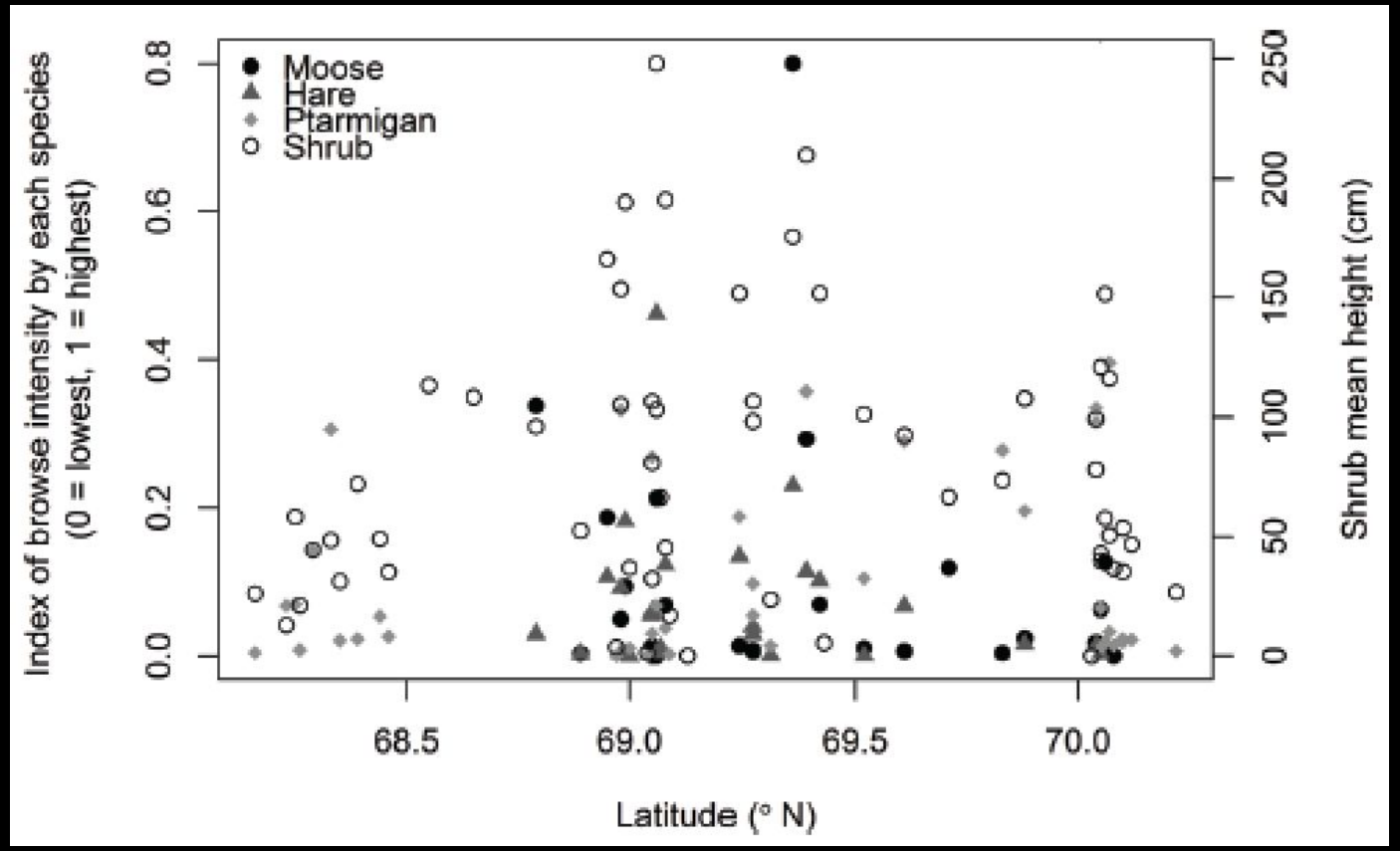


FIGURE 1. Shrub sampling sites (black dots) along floodplains of three rivers on the North Slope of Alaska.

Moose and hare browse appears only in the presence of tall shrubs

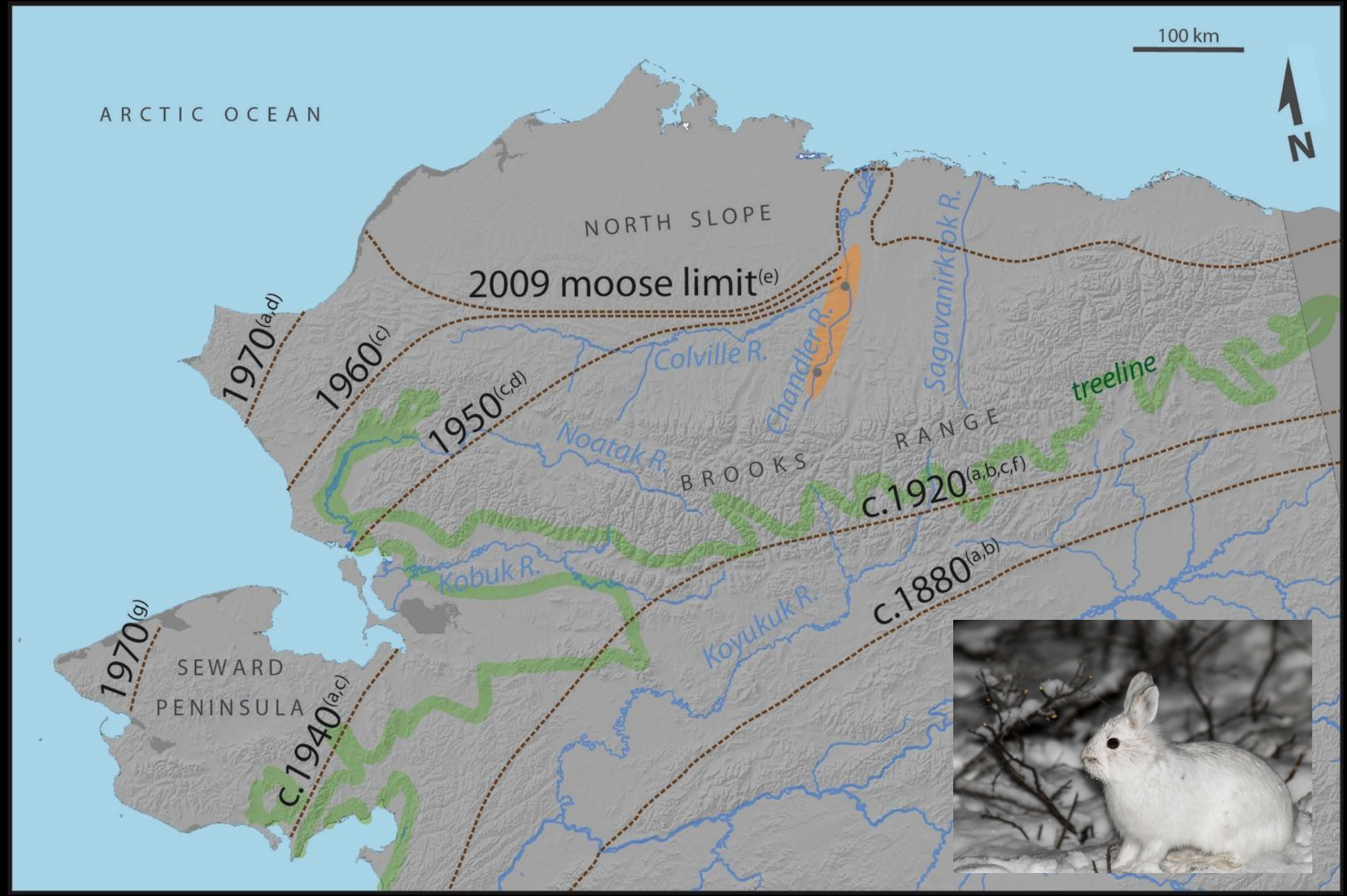


Arctic, Antarctic, and Alpine Research, Vol. 49, No. 2, 2017, pp. 291–304
DOI: http://dx.doi.org/10.1657/AAAR0016-058
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AAAR

The role of vegetation structure in controlling distributions of vertebrate herbivores in Arctic Alaska

Jiake Zhou[1,2,3,*], Laura Prugh[4], Ken D. Tape[5], Gary Kofinas[2,3,6], and Knut Kielland[1,2]


100 km
N
ARCTIC OCEAN
NORTH SLOPE
2009 moose limit(e)
1970(a,d)
1960(c)
1950(c,d)
Colville R.
Chandler R.
Sagavanirktok R.
treeline
Noatak R.
BROOKS RANGE
c.1920(a,b,c,f)
Kobuk R.
Koyukuk R.
c.1880(a,b)
1970(g)
SEWARD PENINSULA
c.1940(a,c)



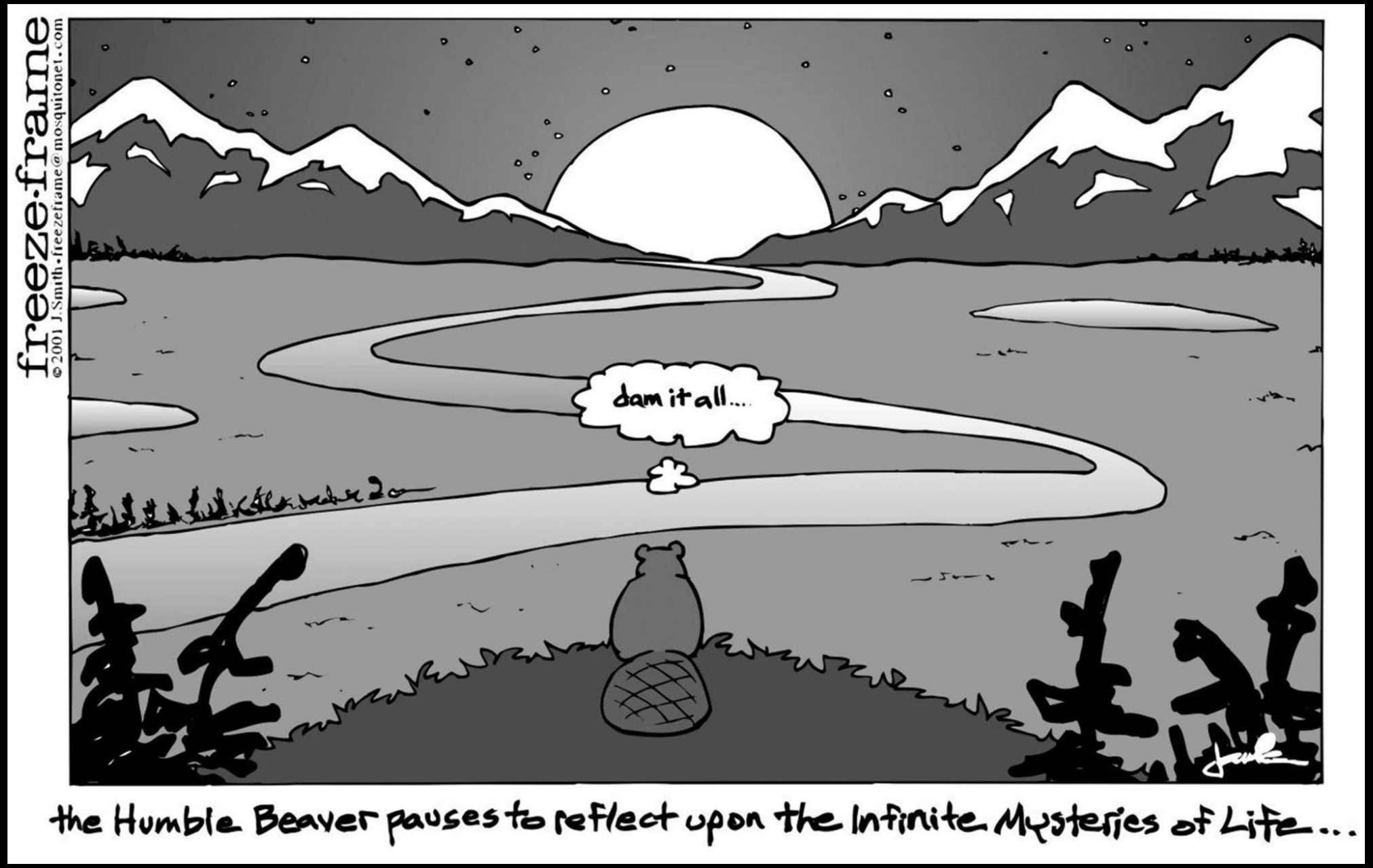
Outline

Changes in tundra habitat and distribution of beavers and other herbivore browsers

- Herbivore browsers
  - Moose
  - Snowshoe hares
  - Beavers



National Geographic Magazine, Sep 2019



the Humble Beaver pauses to reflect upon the Infinite Mysteries of Life...


Jason Clark

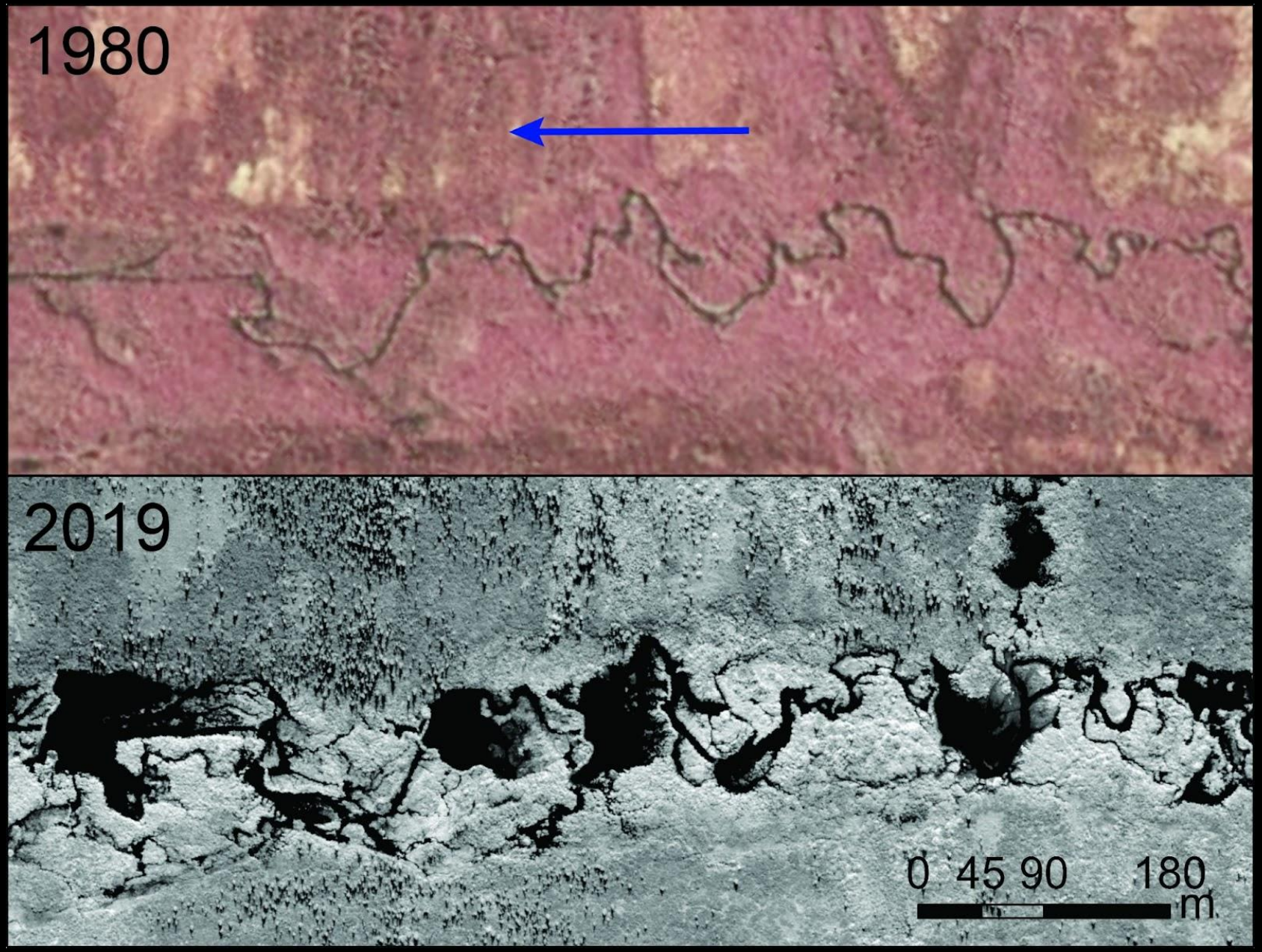


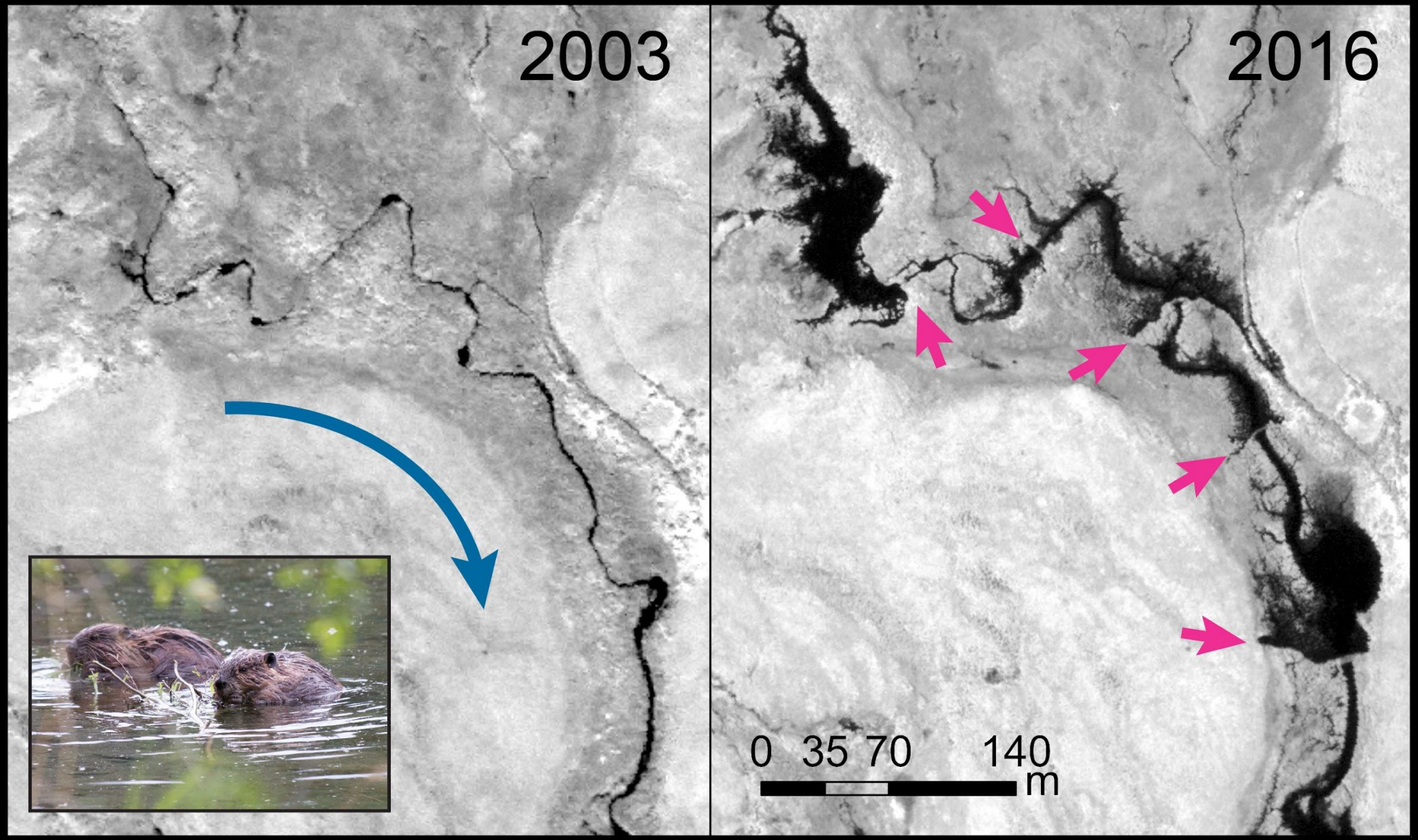




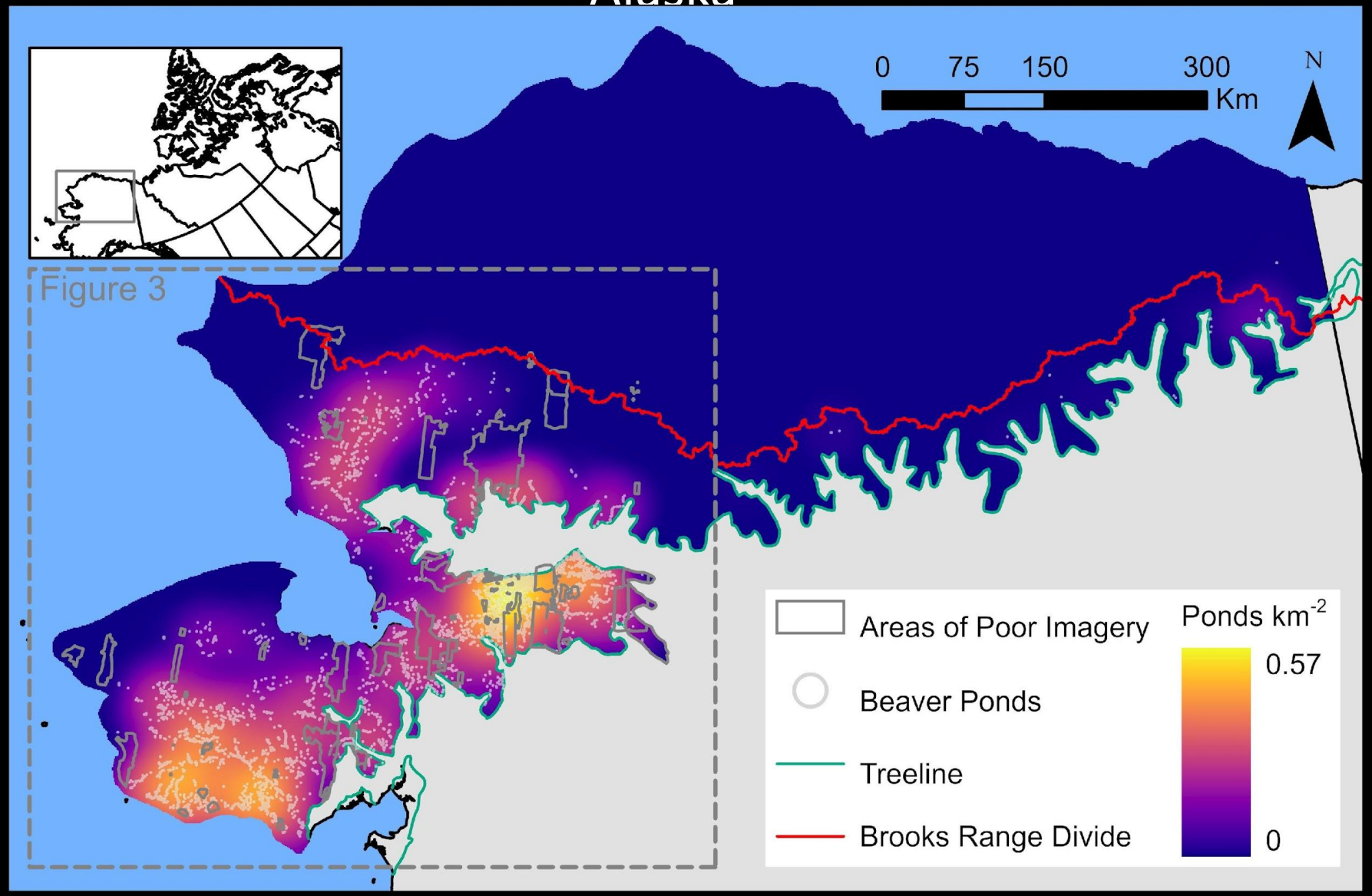





1980
2019
0 45 90 180
m

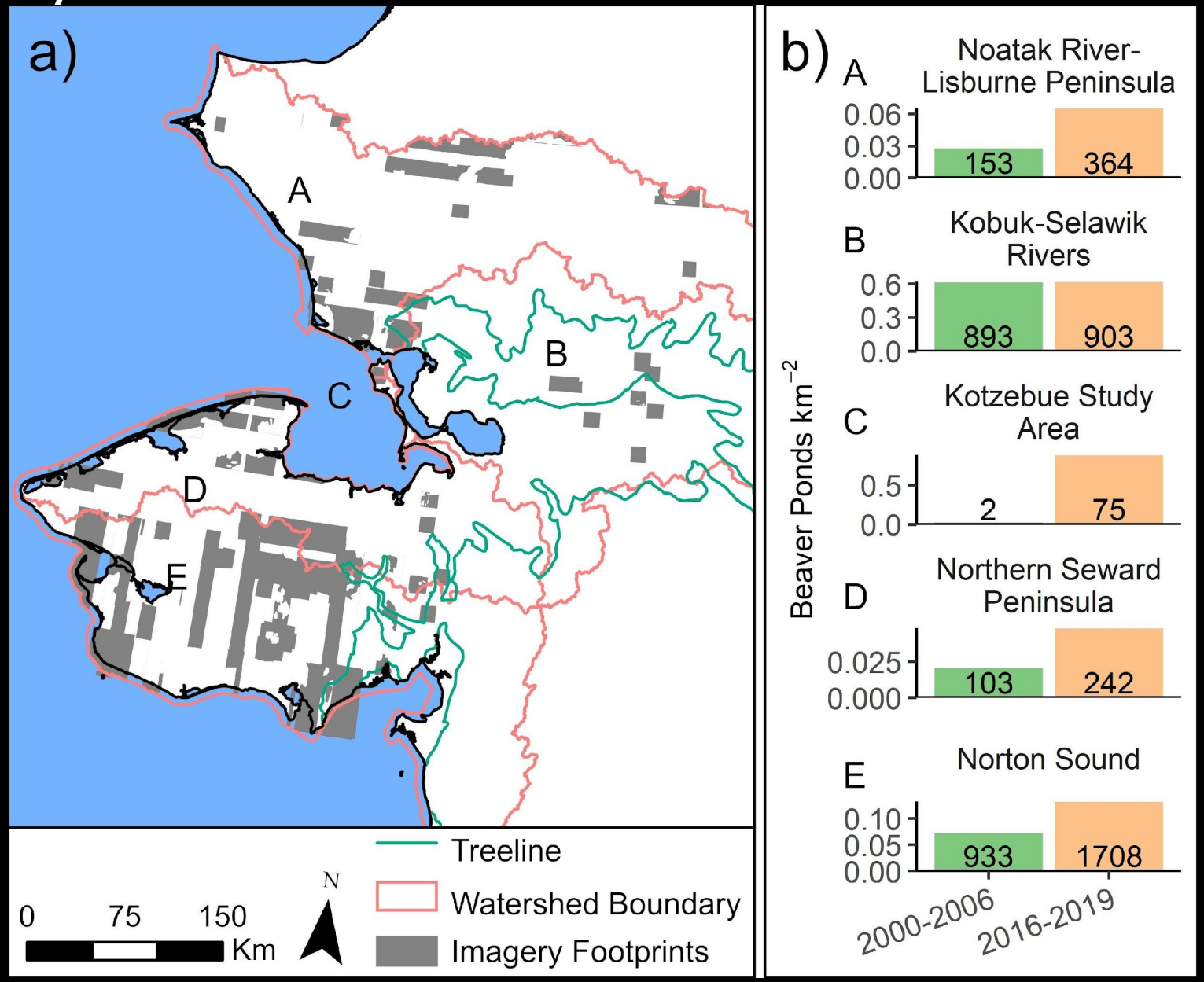

2003
2016
0 35 70 140
m

12,000 beaver ponds mapped in Arctic Alaska

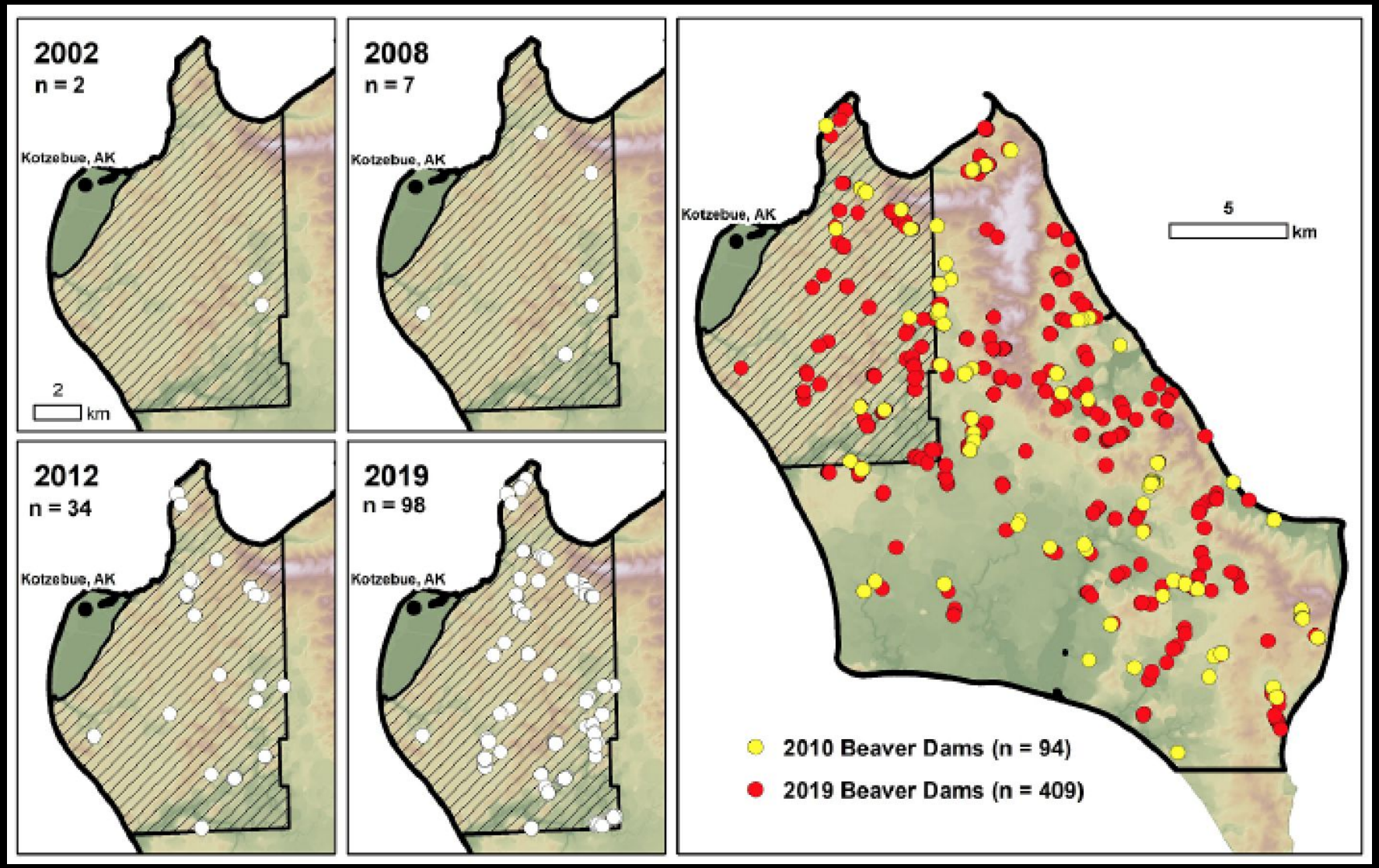


2022. Expanding beaver pond distribution in Arctic Alaska, 1949-2019. *Scientific Reports*

Doubling of beaver ponds in last 20 years

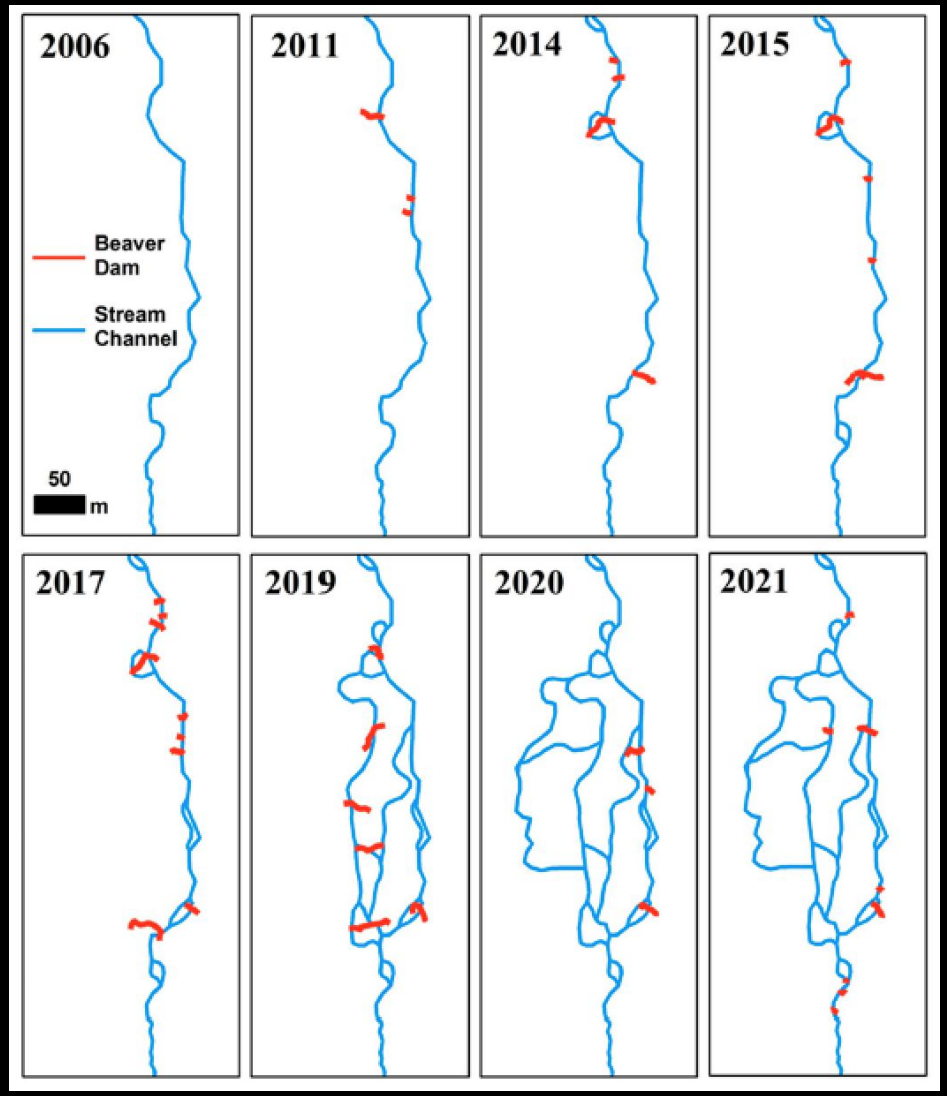


Increase in beaver ponds near Kotzebue, 2002-2019



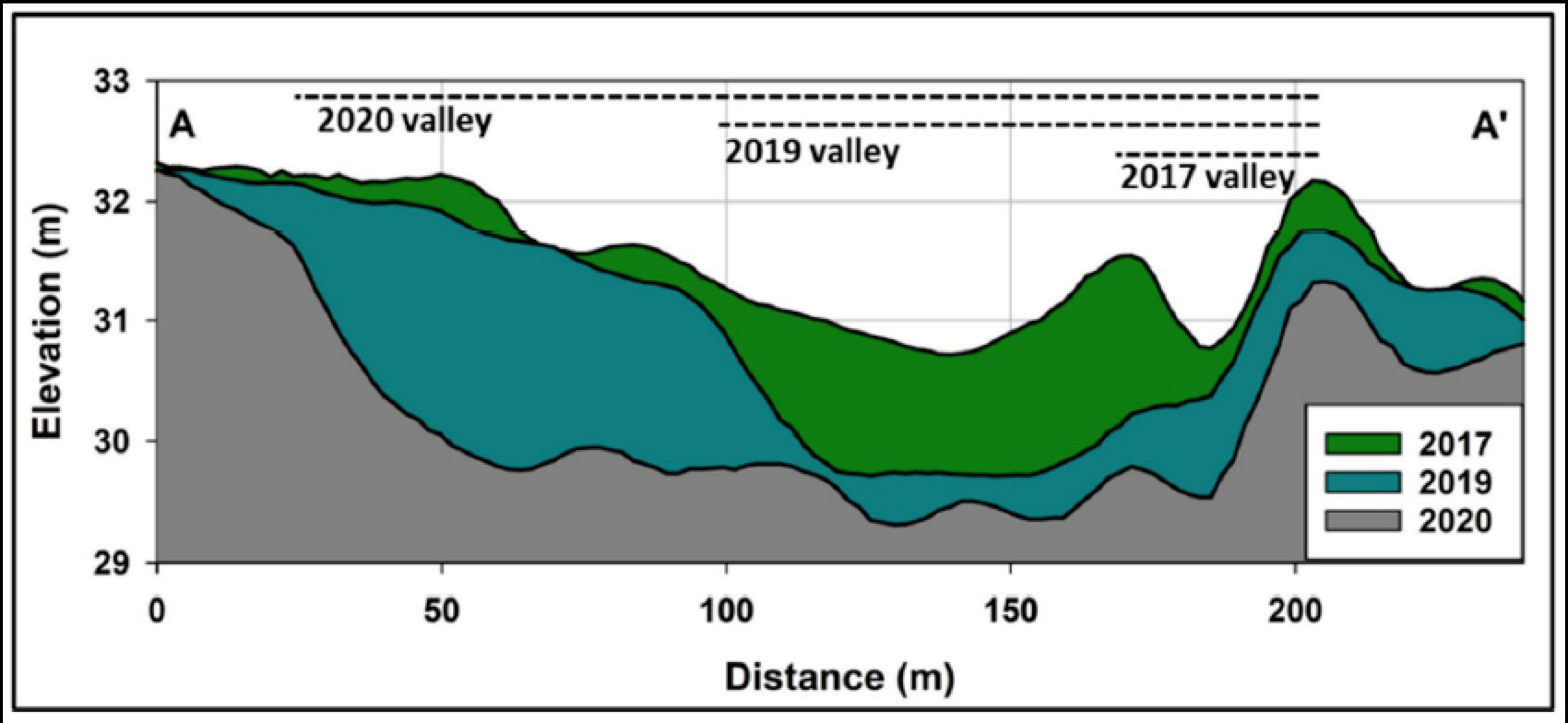
Jones, BM, KD Tape, I Nitze, JA Clark, J Disbrow, G Grosse, 2020. Increase in beaver dams controls surface water and thermokarst dynamics in an arctic tundra region, Baldwin Peninsula, NW Alaska. *Environmental Research Letters*.

Channel development following beaver arrival

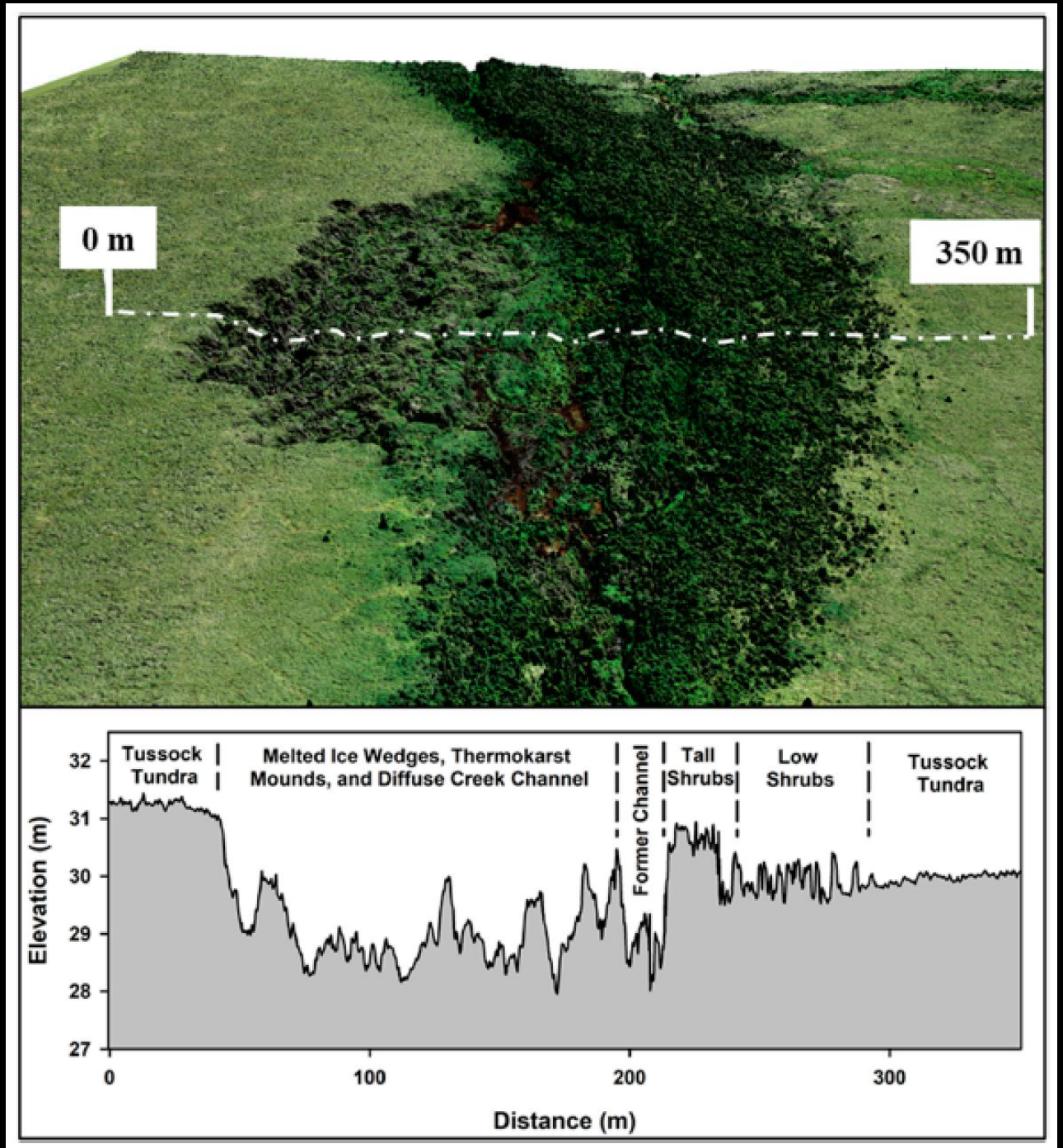


Jones, B.M., Tape, K.D., Clark, J.A., Bondurant, A.C., Ward Jones, M.K., Gaglioti, B.V., Elder, C.D., Witharana, C. and Miller, C.E., 2021. Multi-Dimensional Remote Sensing Analysis Documents Beaver-Induced Permafrost Degradation, Seward Peninsula, Alaska. *Remote Sensing*, *13*(23), p.4863.

Beaver-induced stream diversion and thermokarst, subsidence

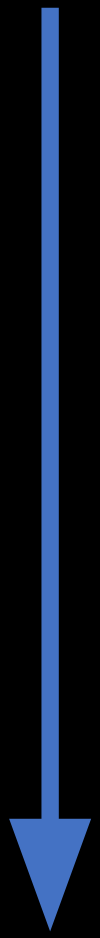


Jones, B.M., Tape, K.D., Clark, J.A., Bondurant, A.C., Ward Jones, M.K., Gaglioti, B.V., Elder, C.D., Witharana, C. and Miller, C.E., 2021. Multi-Dimensional Remote Sensing Analysis Documents Beaver-Induced Permafrost Degradation, Seward Peninsula, Alaska. *Remote Sensing*, *13*(23), p.4863.


0 m
350 m
Tussock Tundra
Melted Ice Wedges, Thermokarst Mounds, and Diffuse Creek Channel
Former Channel
Tall Shrubs
Low Shrubs
Tussock Tundra
Elevation (m)
32
31
30
29
28
27
0
100
200
300
Distance (m)



START



NOW

- 2018. Tundra be dammed: Beaver colonization of the Arctic.
- 2020. Increase in beaver dams controls surface water and thermokarst dynamics in an Arctic tundra region, Baldwin Peninsula, northwestern Alaska.
- 2021. Beaver Engineering: Tracking a new disturbance regime in the Arctic.
- 2022. Expanding beaver pond distribution in Arctic Alaska, 1949-2019.
- Multi-Dimensional Remote Sensing Analysis Documents Beaver-Induced Permafrost Degradation, Seward Peninsula, Alaska.
- *In Review.* Thermal modeling of three lakes within the continuous permafrost zone in Alaska using LAKE 2.0 model.
- *In Prep.* Beaver disturbance & Arctic methane emissions from airborne remote sensing.
- *In Prep.* Predicting beaver habitat suitability in Arctic Alaska using species distribution modeling and future climate.

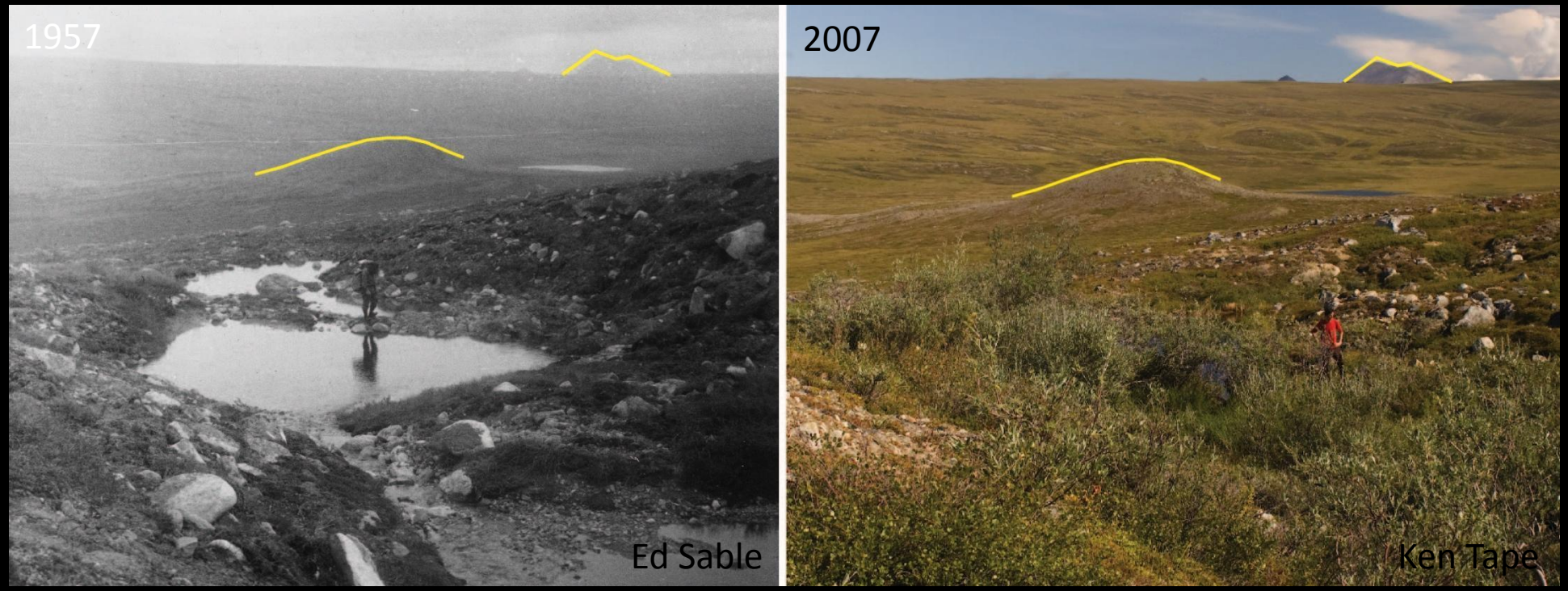


Beyond permafrost…

- Carbon cycling & methane
- Water quality
- Fish
- Biodiversity
- Invertebrates, food webs
- Boat access
- Hypotheses: Oases

Beaver colonization of the Arctic: Possible Causes

- Warming air temps increase shrubs and river discharge in winter, creating more tundra beaver habitat, shorter winters
- Recovery from over-trapping in Alaska during 19th and early 20th centuries



Winter fieldwork, March/April 2022









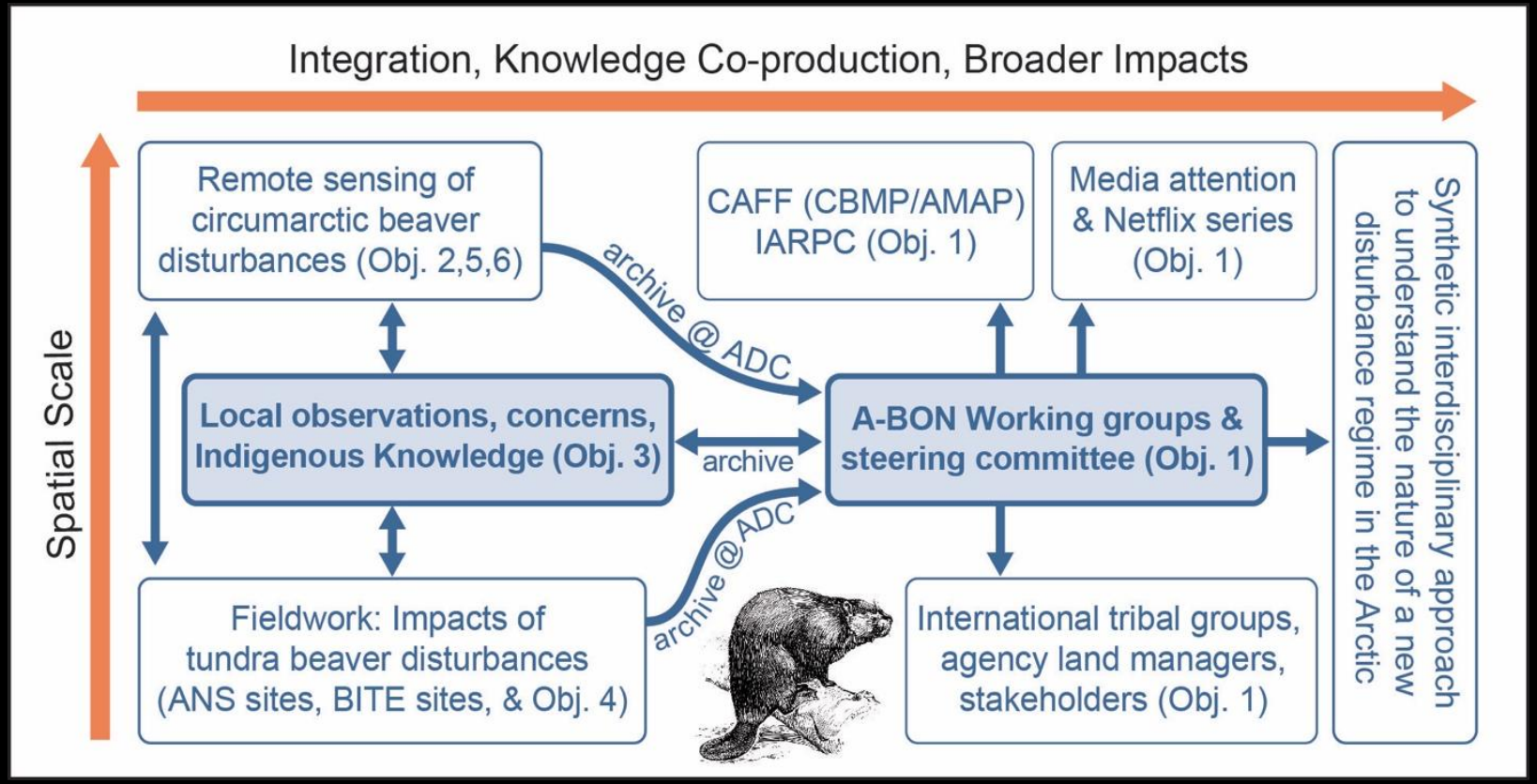




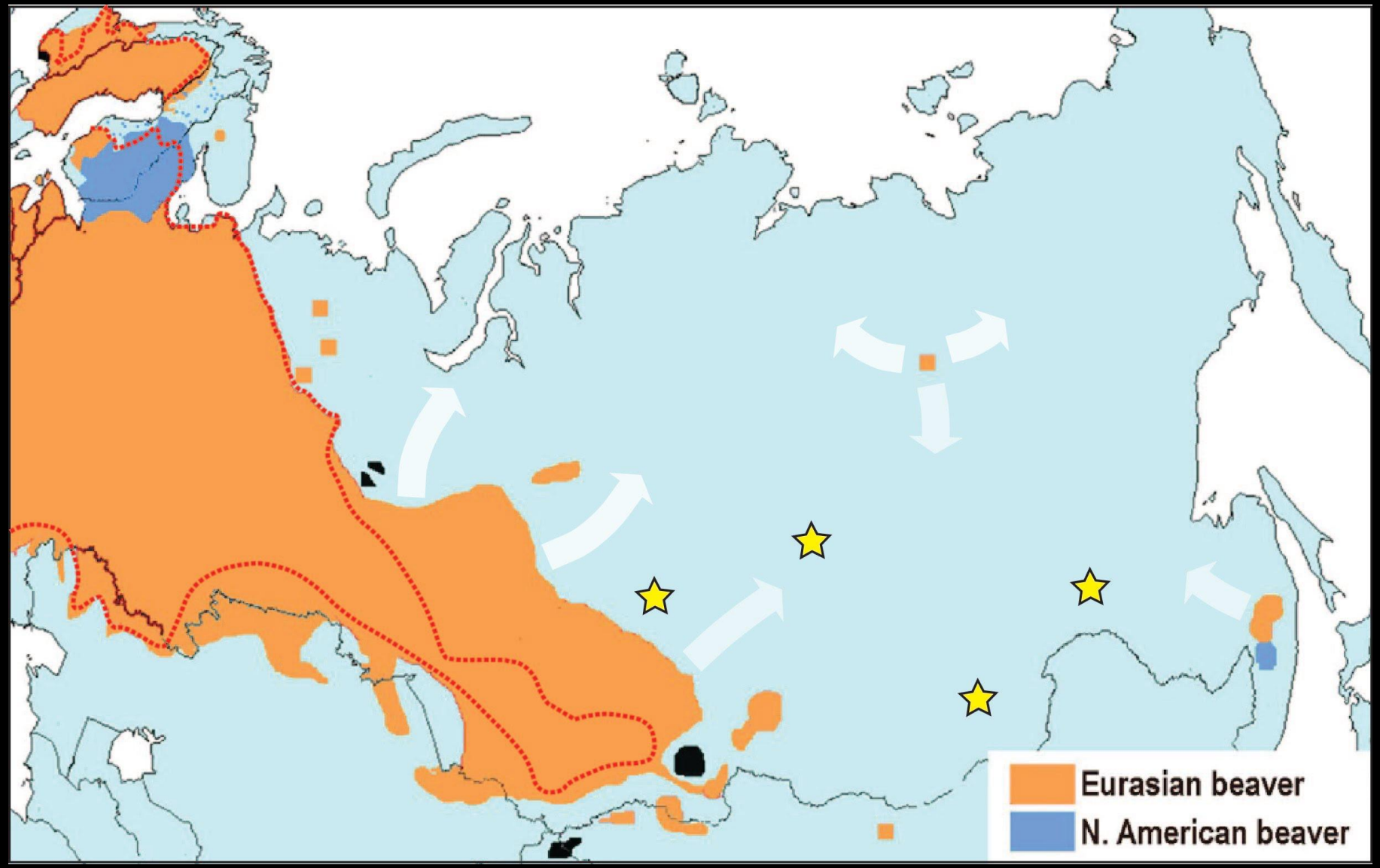


Arctic Beaver Observation Network

- NSF Arctic Observatory Network: 2021-2026
- Virtual meeting: March 2022
- Synthesis paper with key questions
- Working groups
- Adding members
- Circumarctic mapping




Thank you


Eurasian beaver
N. American beaver