Two sides of the same coin…

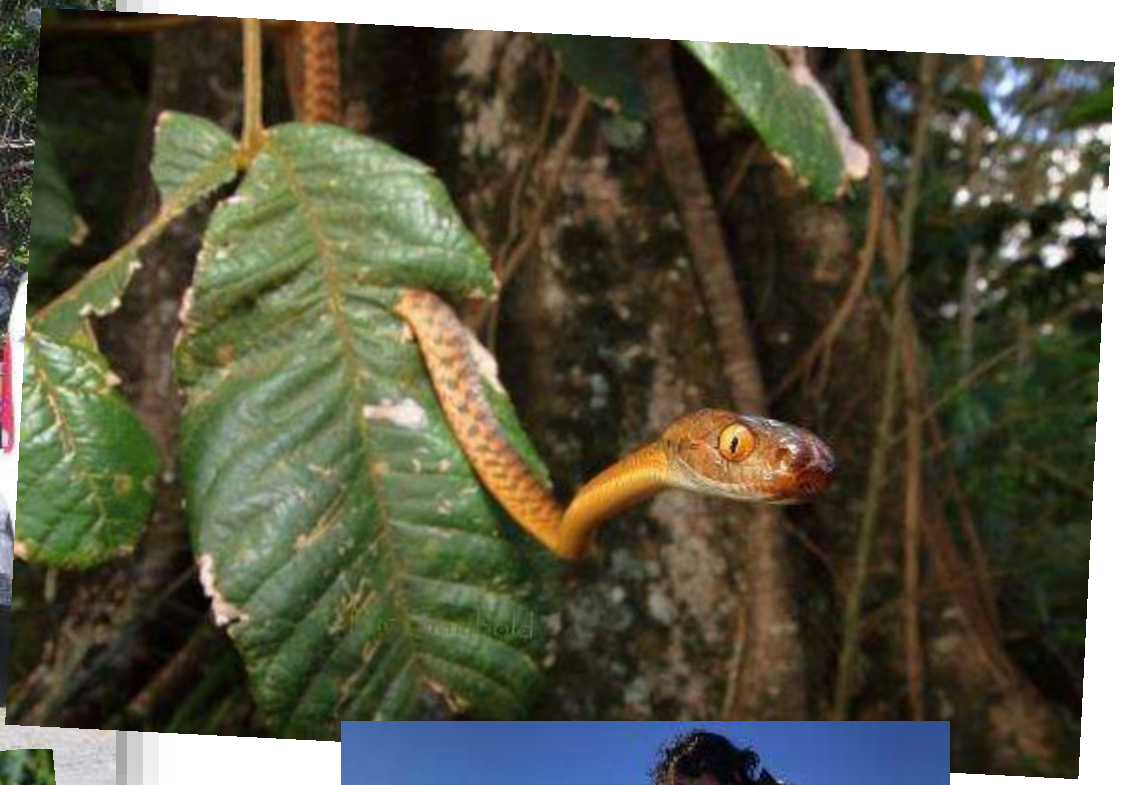
Translocate

Eradicate

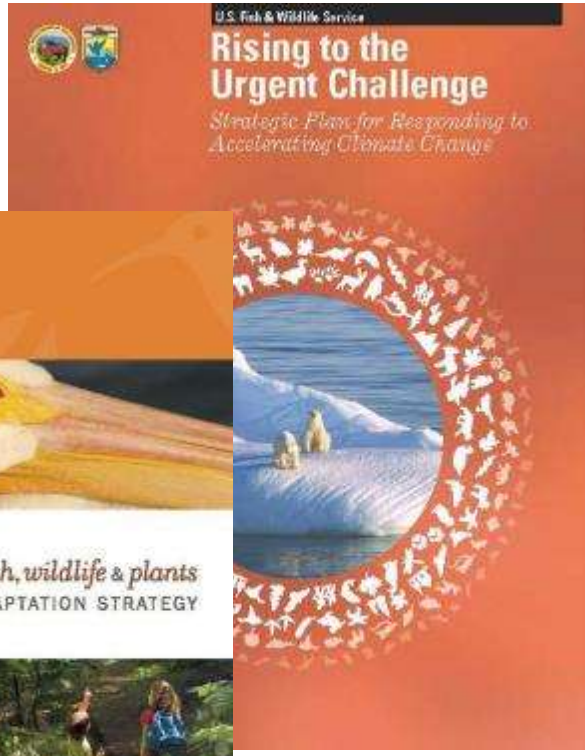
With one hand you giveth, and the other you taketh

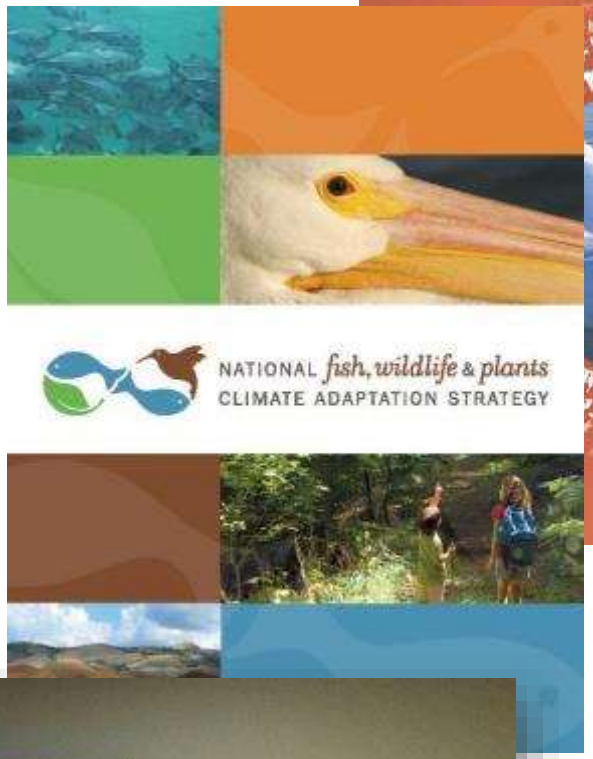
John Morton
Kenai National Wildlife Refuge


R40




Greg Kearnes

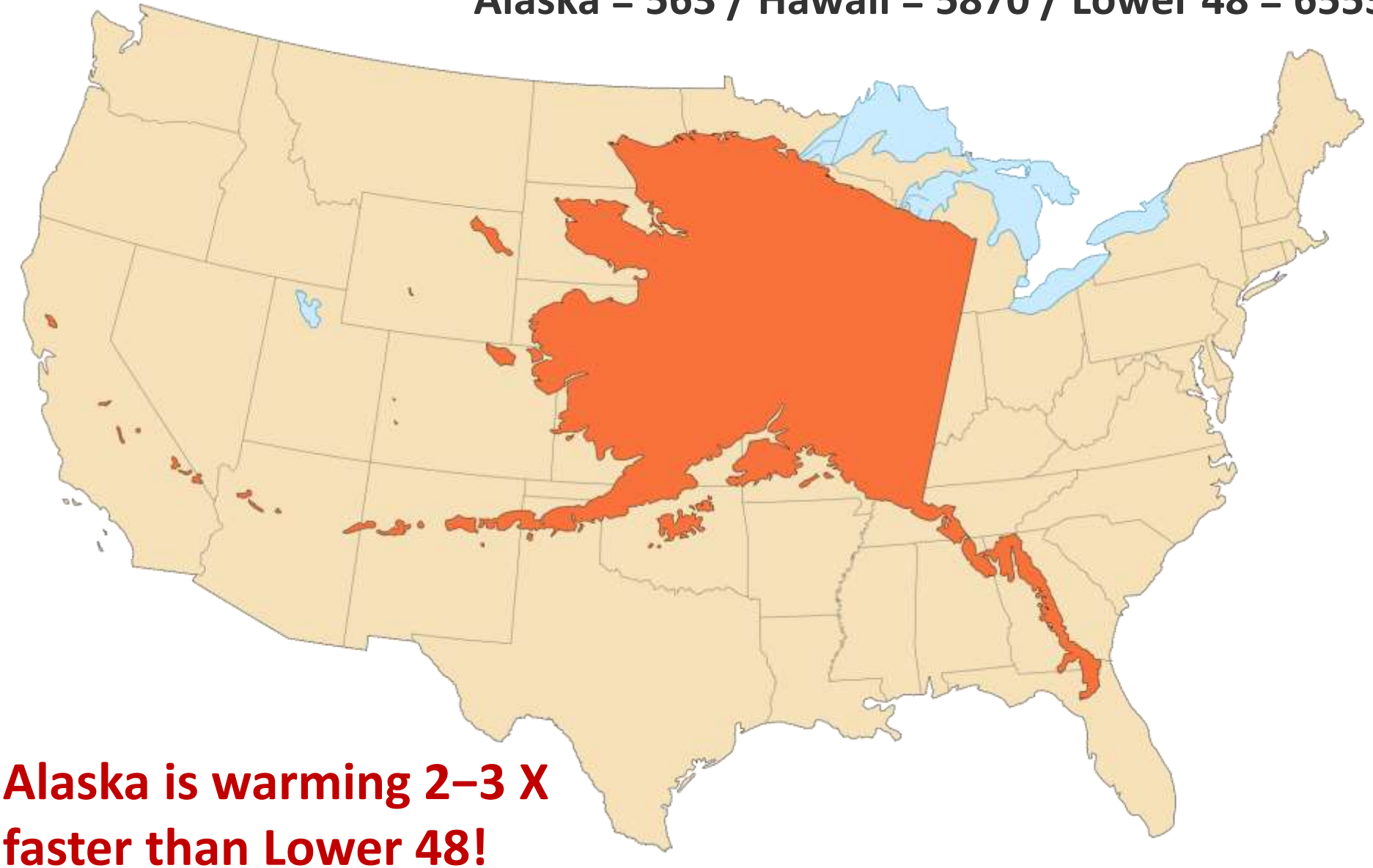

U.S. Fish & Wildlife Service
Rising to the Urgent Challenge
Strategic Plan for Responding to Accelerating Climate Change


NATIONAL fish, wildlife & plants
CLIMATE ADAPTATION STRATEGY


It's not rocket science...
It's harder
Wendy

11,174 non-native species in U.S.

Alaska = 563 / Hawaii = 5870 / Lower 48 = 6553



Alaska is warming 2–3 X faster than Lower 48!

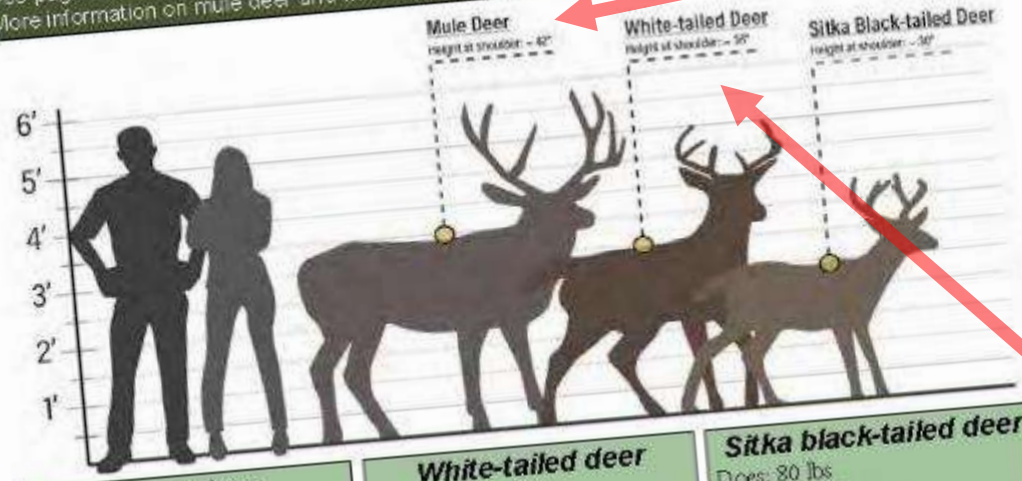
Simpson, A., Eyler, M.C., Sikes, D., Bowser, M., Sellers, E., Guala, G.F., Cannister, M., Libby, R., and Kozlowski, N., 2019, A comprehensive list of non-native species established in three major regions of the United States: Version 2.0, (ver. 2.0, 2019): U.S. Geological Survey data release, https://doi.org/10.5066/P9E5K160.

NEW! Deer in Alaska

In response to concerns over mule and white-tailed deer entering Alaska, the Board of Game made it possible for hunters to harvest those deer in **Units 1, 5, 11-13, 20, and 25** (no closed season, no limit, any mule deer or any white-tailed deer). Hunters must contact the nearest ADF&G office prior to harvesting the deer, and must return the entire carcass, including the hide, to ADF&G. Providing the required specimens helps ADF&G learn more about these animals and conduct disease surveillance.

See page 4 for office contact information, or go online to http://hunt.alaska.gov.

More information on mule deer and white-tailed deer is available at http://alaska.gov/go/CE5V



Mule deer

Does: 110-165 lbs
Bucks: 150-250 lbs
Distinguishing characteristics: bifurcated antlers - each beam forks (bucks), antlers are larger when compared to Sitka black-tailed deer, black tipped tail, and large, mule-like ears. Not common in Alaska.

Photo Credits: Brent Stettler, Utah Division of Wildlife Resources

White-tailed deer

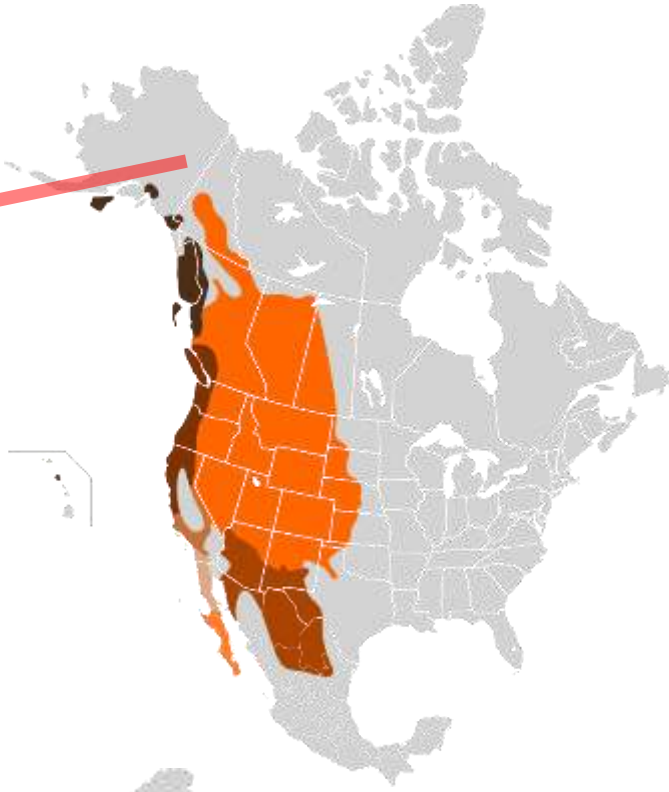
Does: 100-160 lbs
Bucks: 150-225 lbs
Distinguishing characteristics: antlers that have one main beam with individual tines growing off of it (bucks), outside of tail is brown, and underside of tail is bright white and visible when nervous or fleeing. Not common in Alaska.

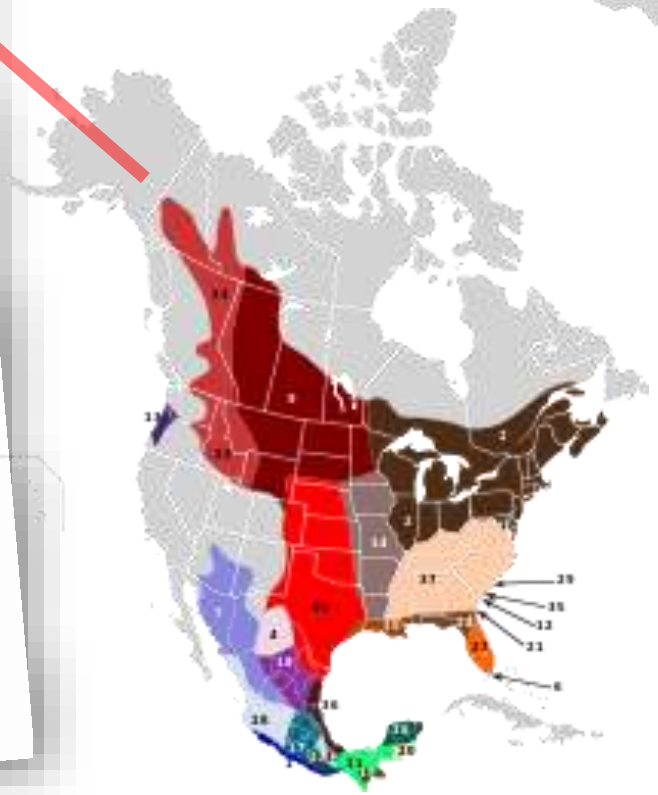
Photo Credit: National Park Service

Sitka black-tailed deer

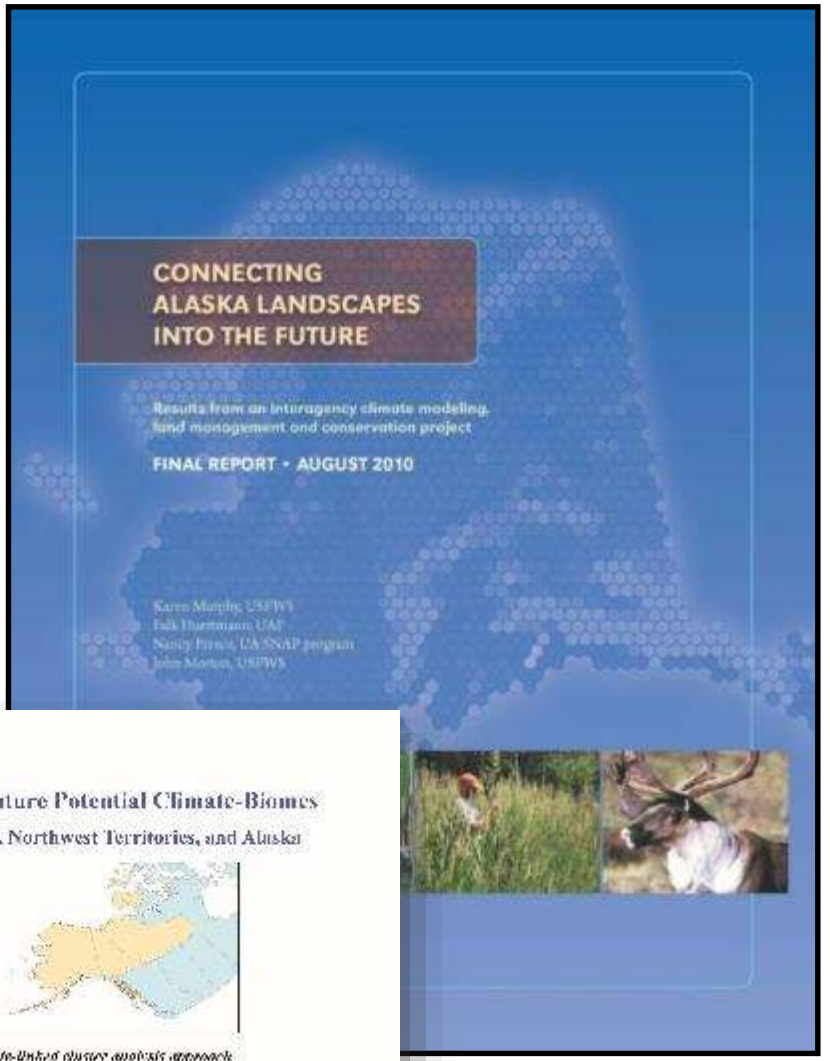
Does: 80 lbs
Bucks: 120-200 lbs
Distinguishing characteristics: bifurcated antlers - each beam forks (bucks), antlers are smaller when compared to mule deer, outside of tail is entirely black or dark brown, and the face is dark.
Common in Southeast Alaska, Prince William Sound, and Kodiak.

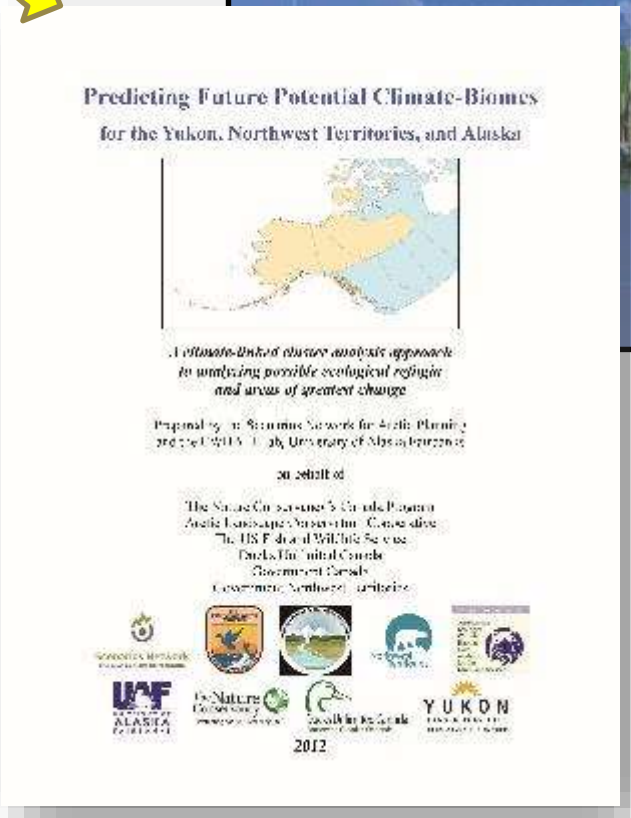
effective July 1, 2019 through June 30, 2020





Interagency effort to pioneer assessment of climate change effects on biome and species distributions using climate envelope models





Current climate (2000)

How invasive species practitioners tend to think

U.S. FISH & WILDLIFE SERVICE

Figure 3
Areas of Critical Change
Current Climate
MaxEnt

Number of Overlapping Species
"Excellent" Ranked Habitat

1
2
3
4
5
6
7
8
9
10

HDR

https://www.fws.gov/alaska/fisheries/invasive/reports.htm

2020

U.S. FISH & WILDLIFE SERVICE

Figure 4
Areas of Critical Change
2020
B2 Scenario
MaxEnt

Number of Overlapping Species "Excellent" Ranked Habitat

1
2
3
4
5
6
7
8
9
10

HDR

https://www.fws.gov/alaska/fisheries/invasive/reports.htm

2050

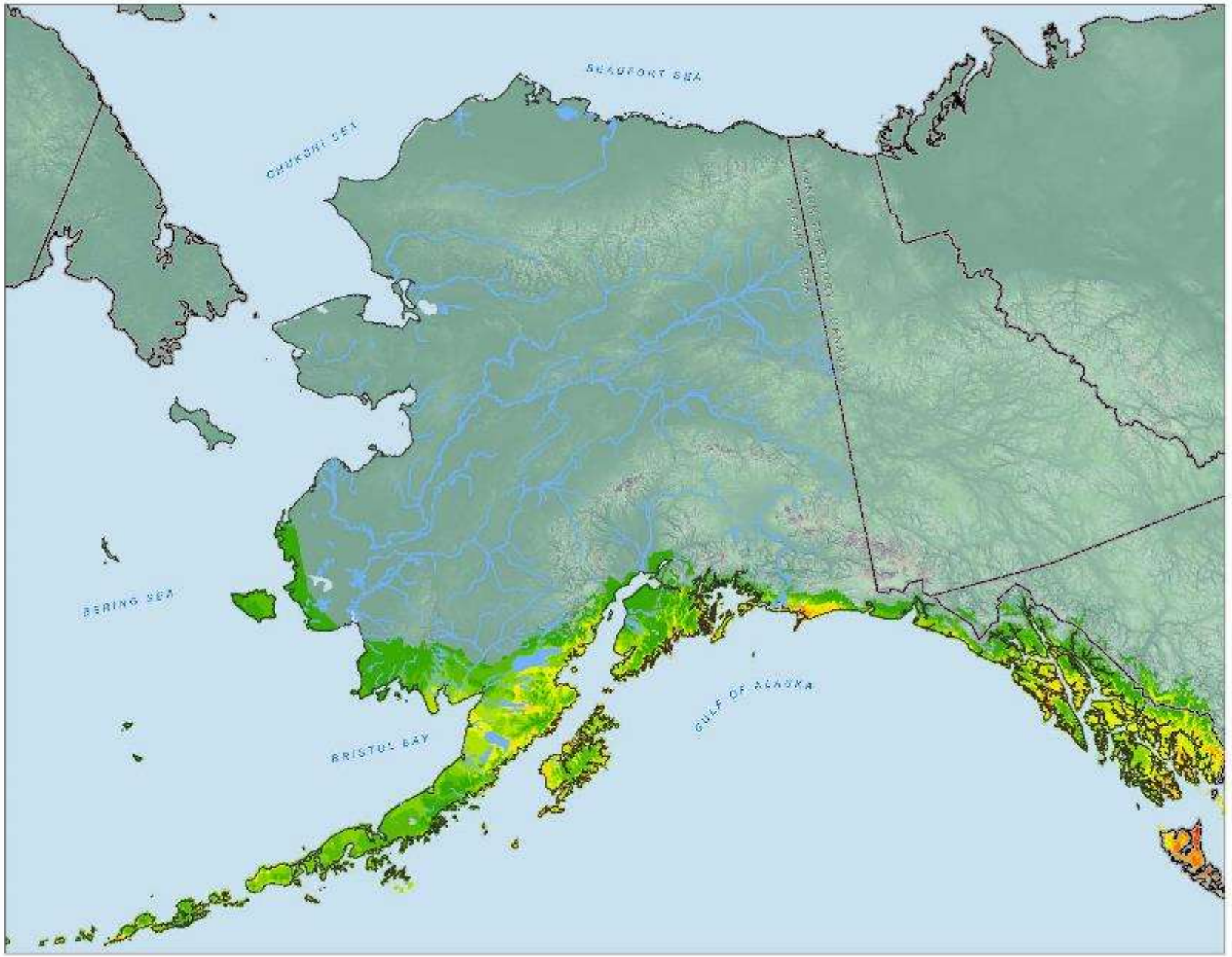


Figure 5
Areas of Critical Change
2050
B2 Scenario
MaxEnt

Number of Overlapping Species
"Excellent" Ranked Habitat

1
2
3
4
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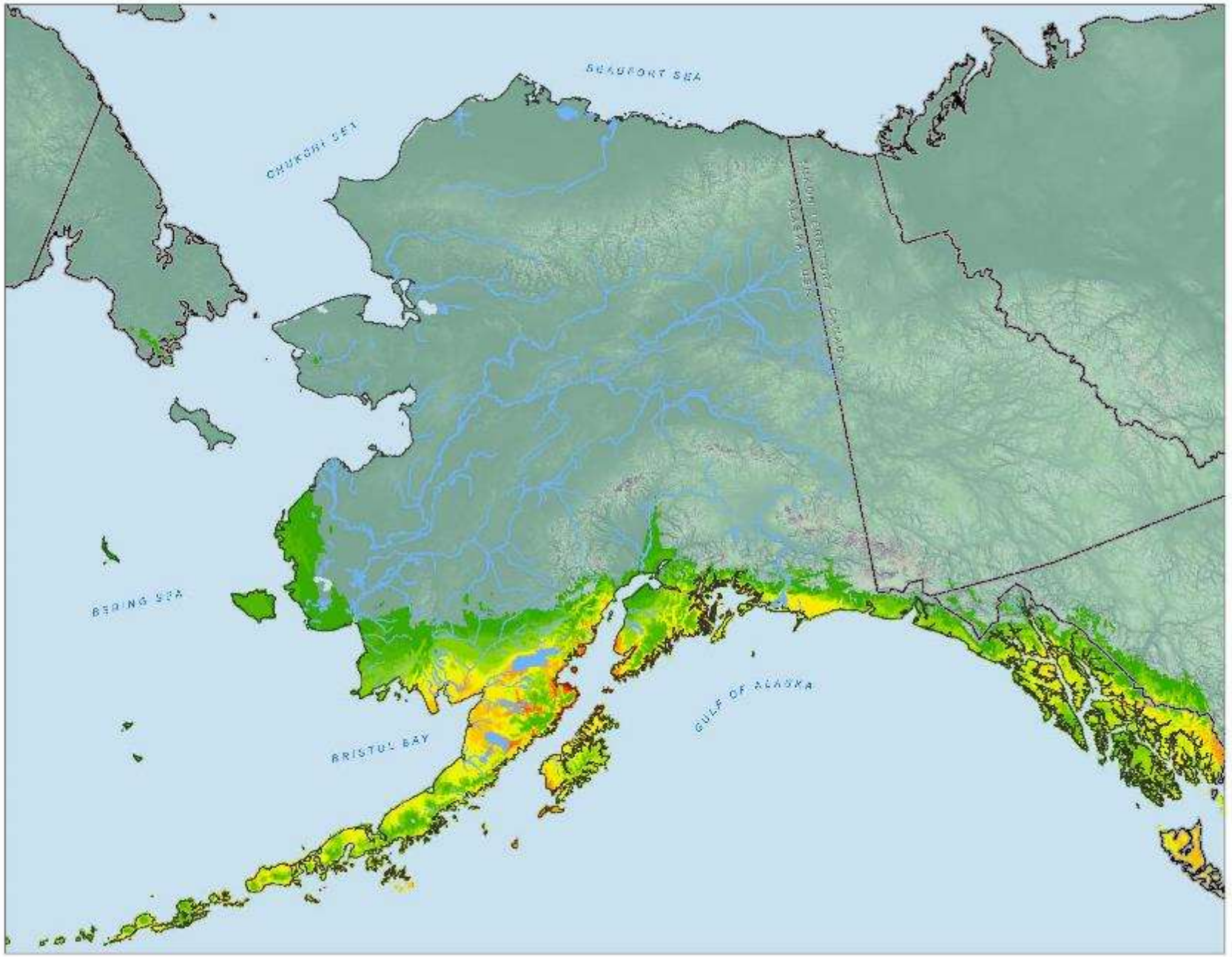
6
7
8
9
10

https://www.fws.gov/alaska/fisheries/invasive/reports.htm

2080



U.S. FISH & WILDLIFE SERVICE

Figure 6
Areas of Critical Change
2080
B2 Scenario
MaxEnt

Number of Overlapping Species
"Excellent" Ranked Habitat

1
2
3
4
5
6
7
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9
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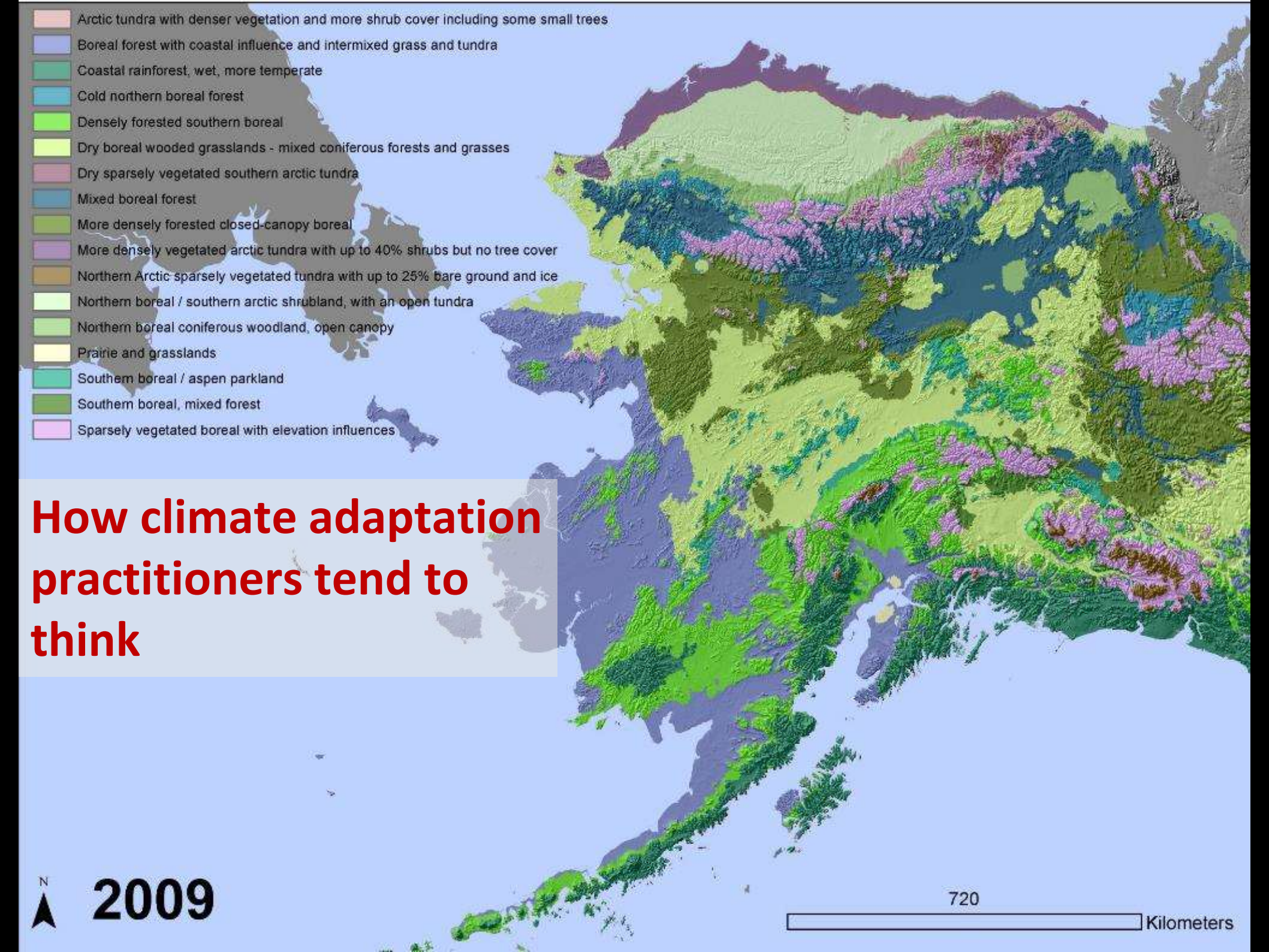
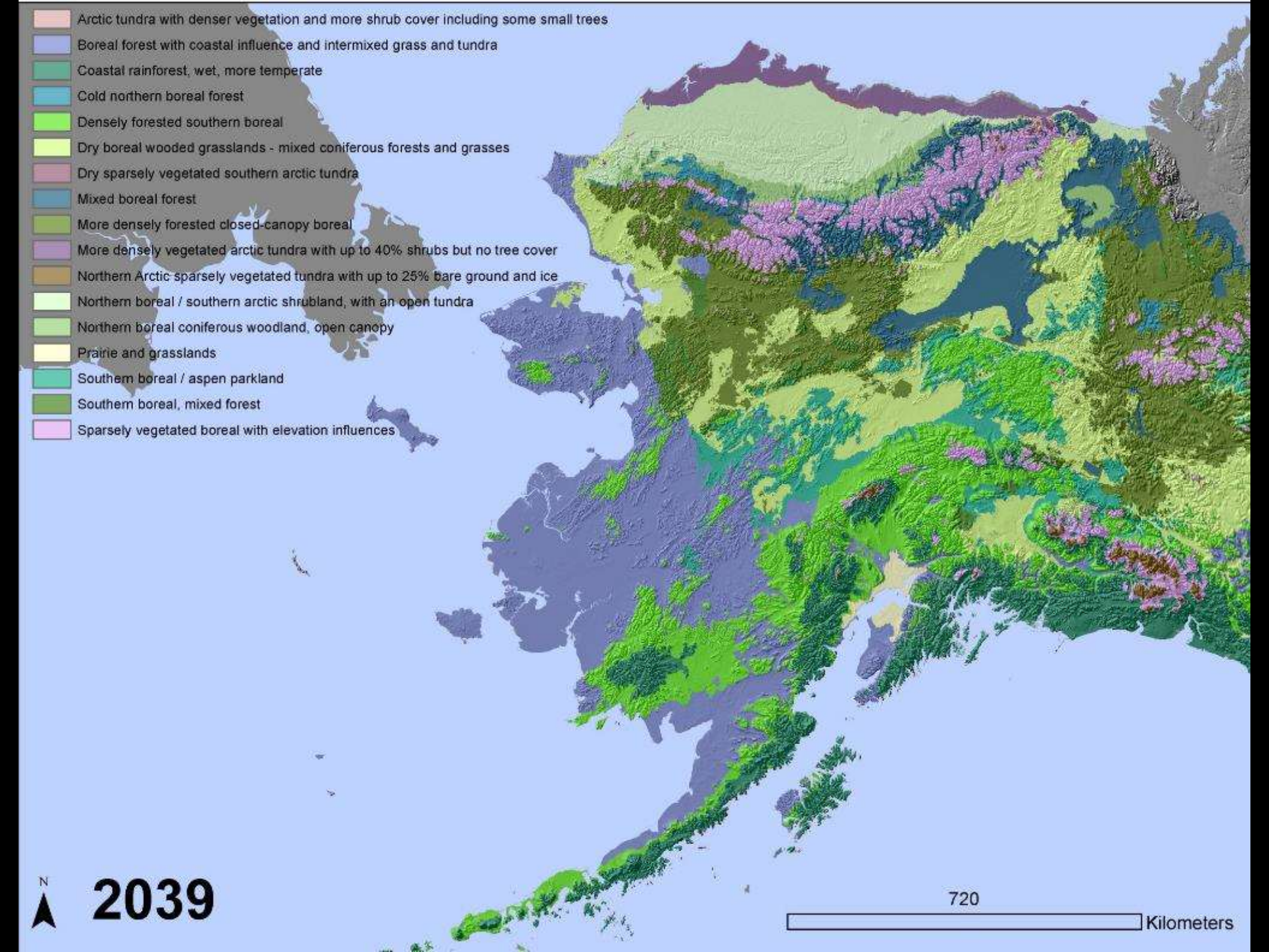
11
12
13
14
15

HDR

https://www.fws.gov/alaska/fisheries/invasive/reports.htm


Arctic tundra with denser vegetation and more shrub cover including some small trees
Boreal forest with coastal influence and intermixed grass and tundra
Coastal rainforest, wet, more temperate
Cold northern boreal forest
Densely forested southern boreal
Dry boreal wooded grasslands - mixed coniferous forests and grasses
Dry sparsely vegetated southern arctic tundra
Mixed boreal forest
More densely forested closed-canopy boreal
More densely vegetated arctic tundra with up to 40% shrubs but no tree cover
Northern Arctic sparsely vegetated tundra with up to 25% bare ground and ice
Northern boreal / southern arctic shrubland, with an open tundra
Northern boreal coniferous woodland, open canopy
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
How climate adaptation practitioners tend to think
N
2009
720
Kilometers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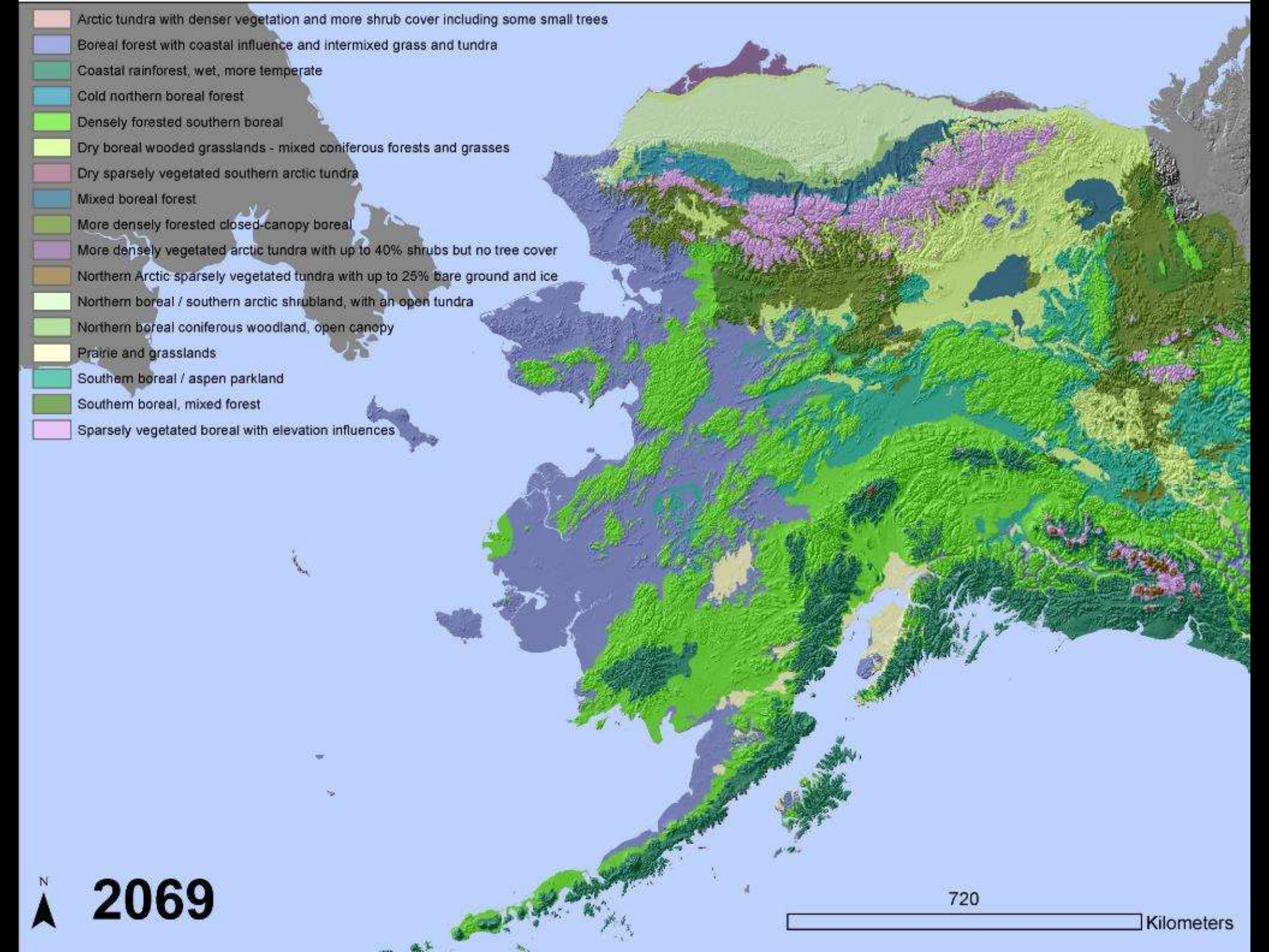
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
N
2039
720
Kilometers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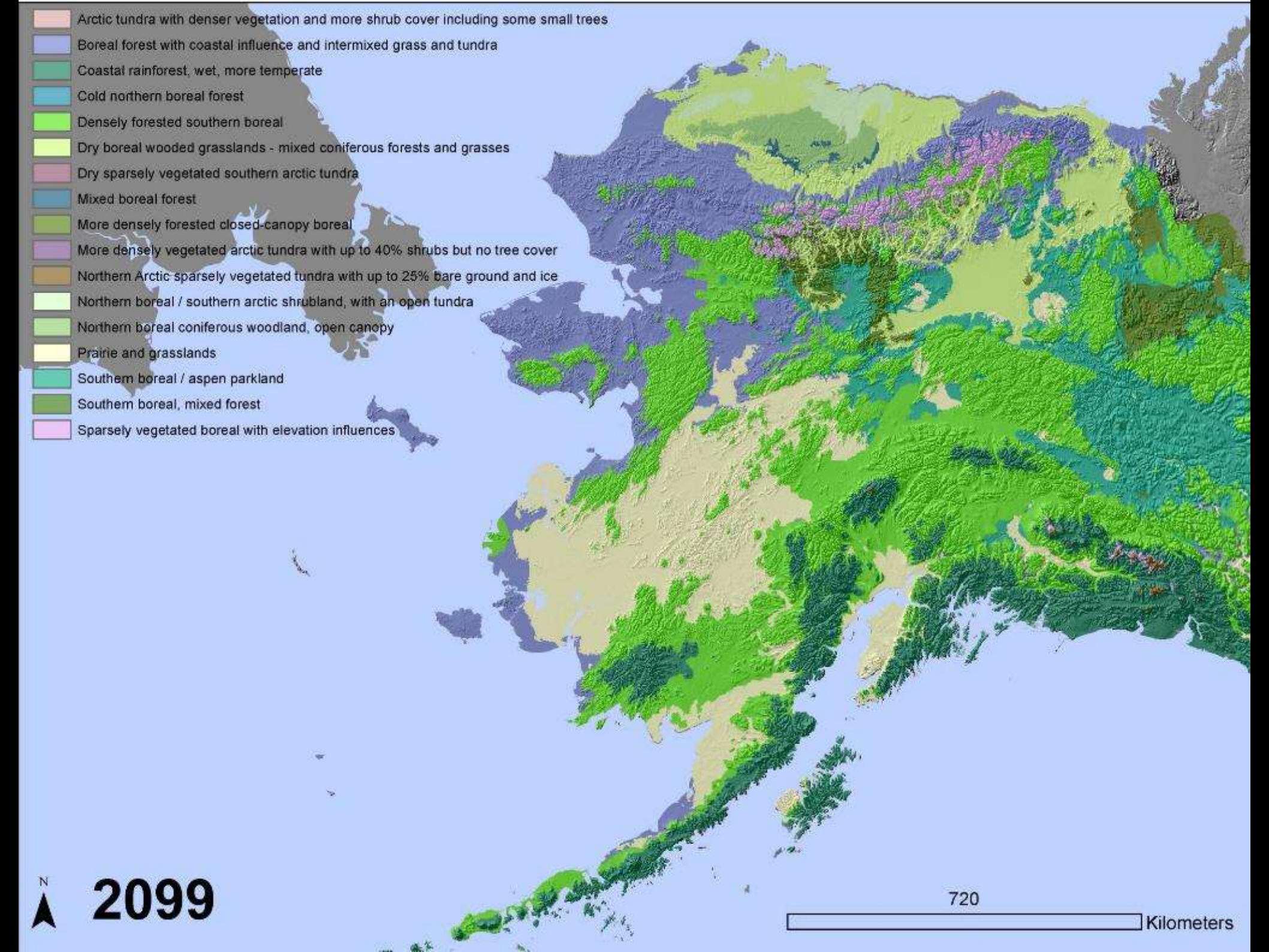
Northern boreal coniferous woodland, open canopy
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
N
2069
720
Kilometers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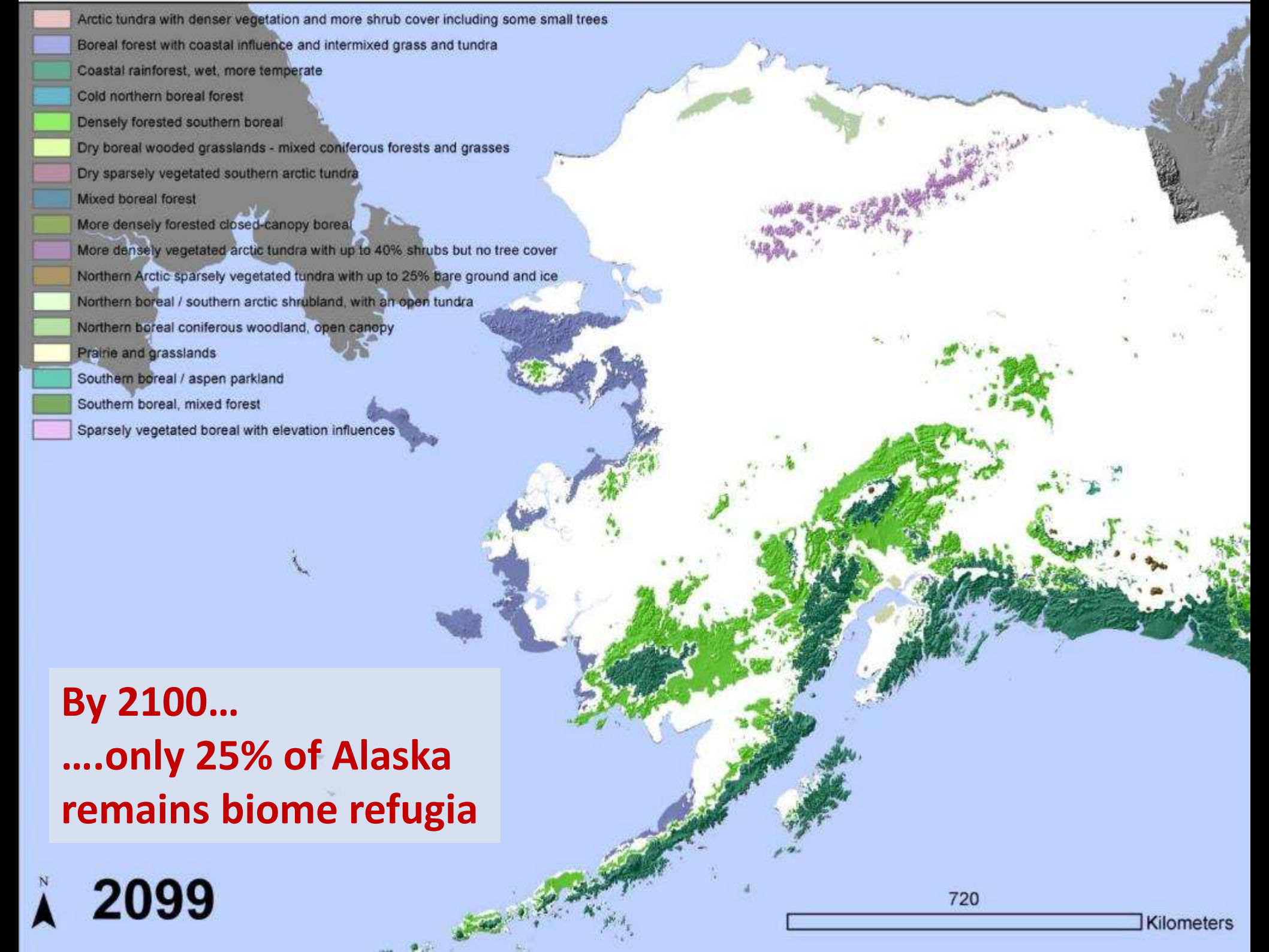
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
N
2099
720
Kilometers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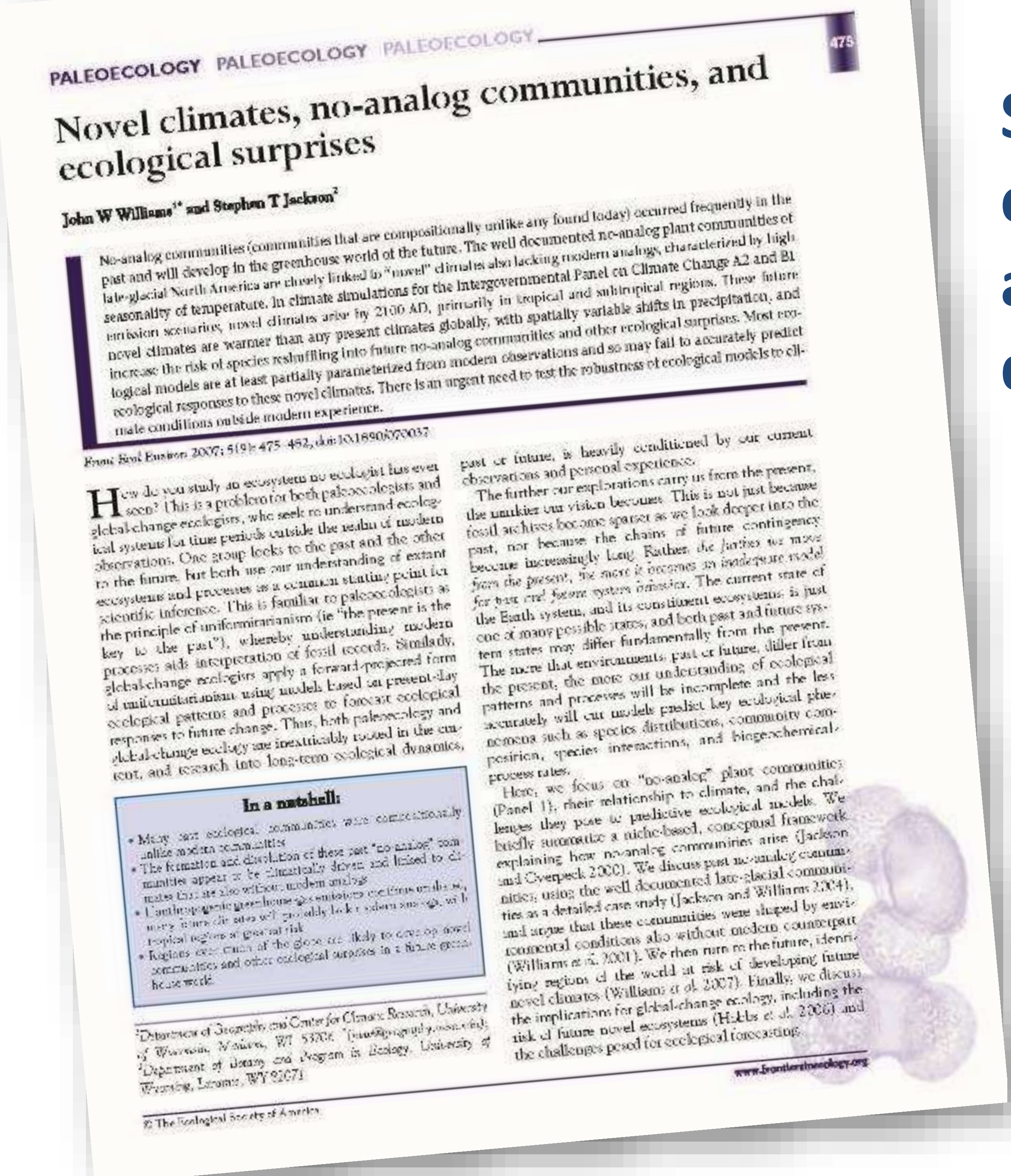
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
By 2100…
….only 25% of Alaska
remains biome refugia
N
2099
720
Kilometers



PALEOECOLOGY PALEOECOLOGY PALEOECOLOGY 475

Novel climates, no-analog communities, and ecological surprises

John W Williams[1*] and Stephen T Jackson[2]

No-analog communities (communities that are compositionally unlike any found today) occurred frequently in the past and will develop in the greenhouse world of the future. The well documented no-analog plant communities of late-glacial North America are closely linked to "novel" climates also lacking modern analogs, characterized by high seasonality of temperature. In climate simulations for the Intergovernmental Panel on Climate Change A2 and B1 emission scenarios, novel climates arise by 2100 AD, primarily in tropical and subtropical regions. These future novel climates are warmer than any present climates globally, with spatially variable shifts in precipitation, and increase the risk of species reshuffling into future no-analog communities and other ecological surprises. Most ecological models are at least partially parameterized from modern observations and so may fail to accurately predict ecological responses to these novel climates. There is an urgent need to test the robustness of ecological models to climate conditions outside modern experience.

Front Ecol Environ 2007; 5(9): 475–482, doi:10.1890/070037

How do you study an ecosystem no ecologist has ever seen? This is a problem for both paleoecologists and global-change ecologists, who seek to understand ecological systems for time periods outside the realm of modern observations. One group looks to the past and the other to the future, but both use our understanding of extant ecosystems and processes as a common starting point for scientific inference. This is familiar to paleoecologists as the principle of uniformitarianism (ie "the present is the key to the past"), whereby understanding modern processes aids interpretation of fossil records. Similarly, global-change ecologists apply a forward-projected form of uniformitarianism, using models based on present-day ecological patterns and processes to forecast ecological responses to future change. Thus, both paleoecology and global-change ecology are inextricably rooted in the current, and research into long-term ecological dynamics, past or future, is heavily conditioned by our current observations and personal experience.

The further our explorations carry us from the present, the murkier our vision becomes. This is not just because fossil archives become sparser as we look deeper into the past, nor because the chains of future contingency become increasingly long. Rather, the further we move from the present, the more it becomes an inadequate model for past and future system behavior. The current state of the Earth system, and its constituent ecosystems, is just one of many possible states, and both past and future system states may differ fundamentally from the present. The more that environments, past or future, differ from the present, the more our understanding of ecological patterns and processes will be incomplete and the less accurately will our models predict key ecological phenomena such as species distributions, community composition, species interactions, and biogeochemical process rates.

Here, we focus on "no-analog" plant communities (Panel 1), their relationship to climate, and the challenges they pose to predictive ecological models. We briefly summarize a niche-based, conceptual framework explaining how no-analog communities arise (Jackson and Overpeck 2000). We discuss past no-analog communities, using the well documented late-glacial communities as a detailed case study (Jackson and Williams 2004), and argue that these communities were shaped by environmental conditions also without modern counterparts (Williams et al. 2001). We then turn to the future, identifying regions of the world at risk of developing future novel climates (Williams et al. 2007). Finally, we discuss the implications for global-change ecology, including the risk of future novel ecosystems (Hobbs et al. 2006) and the challenges posed for ecological forecasting.

In a nutshell:

- Many past ecological communities were compositionally unlike modern communities
- The formation and dissolution of these past "no-analog" communities appear to be climatically driven and linked to climates that are also without modern analogs
- Under anthropogenic greenhouse gas emissions, climates will probably lack modern analogs ... tropical regions at greatest risk
- Regions ... of the globe are likely to develop novel communities and other ecological surprises in a future greenhouse world

[1]Department of Geography and Center for Climatic Research, University of Wisconsin, Madison, WI 53706; [2]Department of Botany and Program in Ecology, University of Wyoming, Laramie, WY 82071

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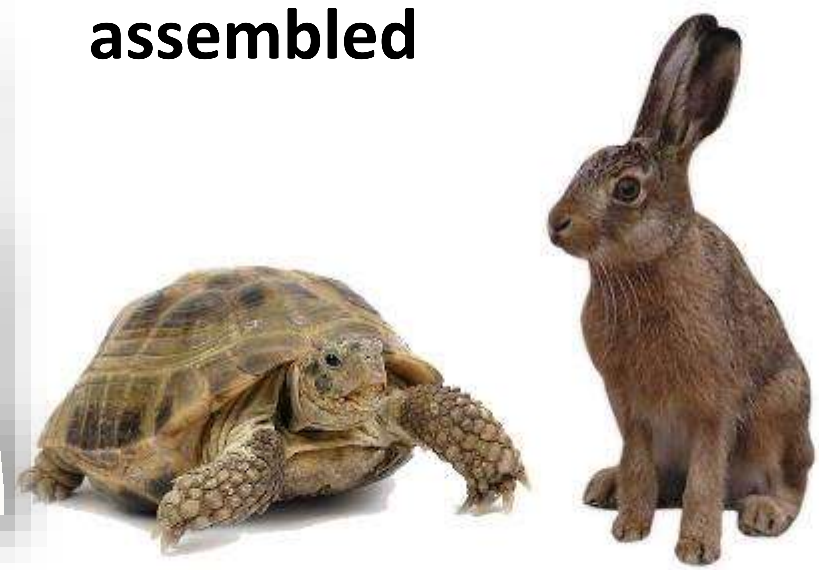
www.frontiersinecology.org

So which species will compose novel assemblages in the dynamic systems?

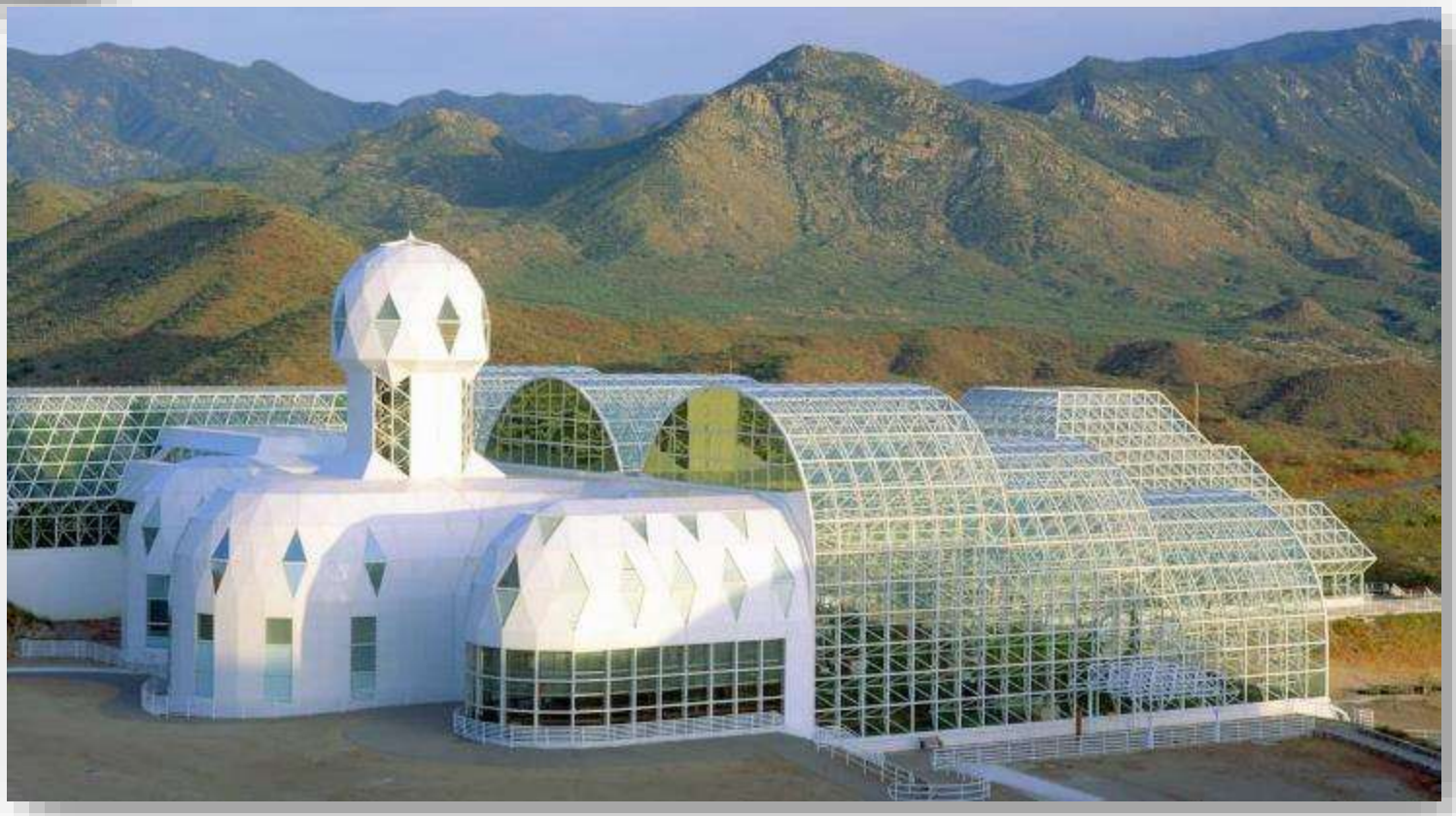
The ones that are there when its being assembled

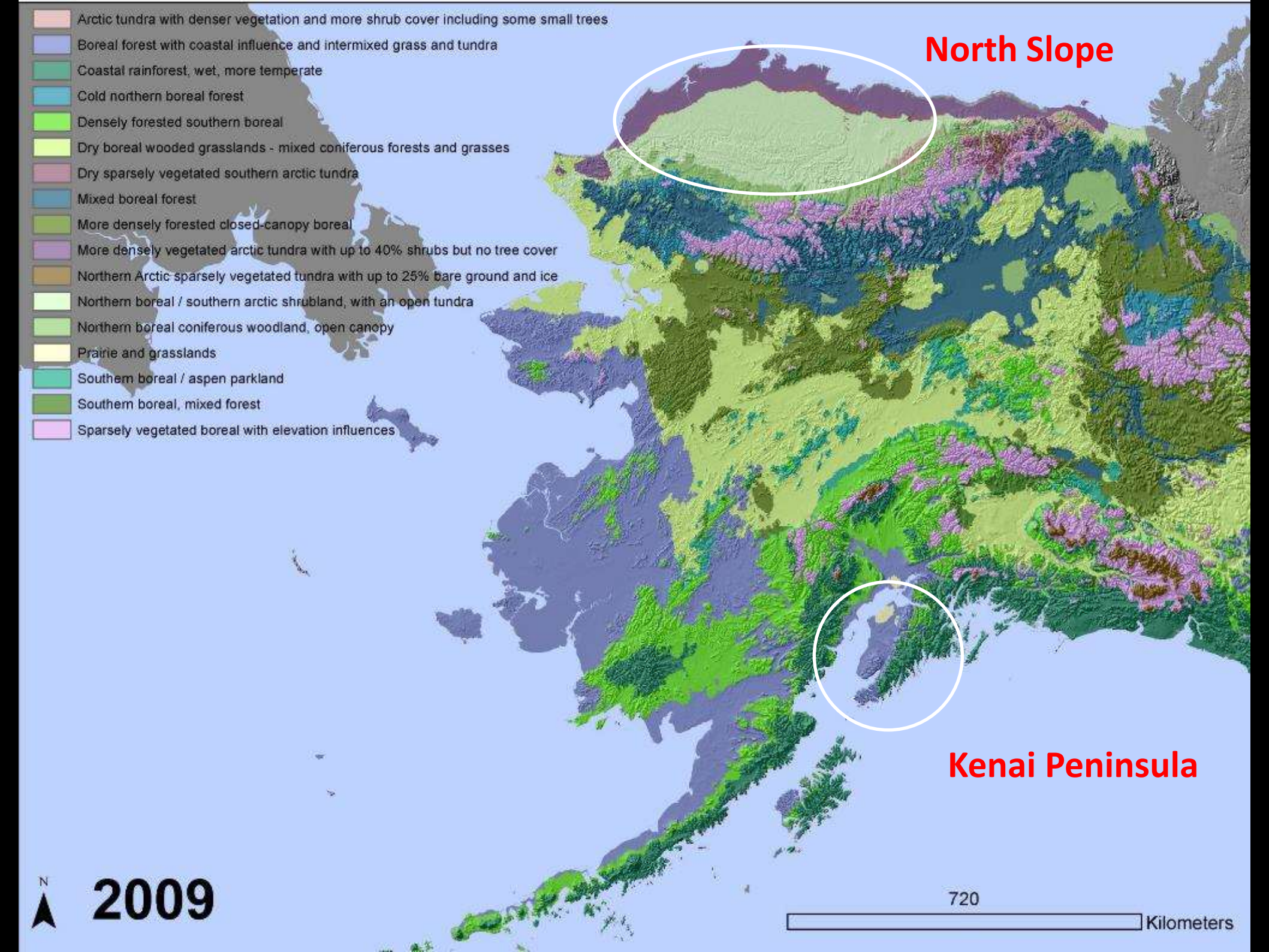


Tony Burgess

As systems ecologist Howard Odum advised the Biosphere 2 staff…

"shovel the species in, and let extinction sort it out"

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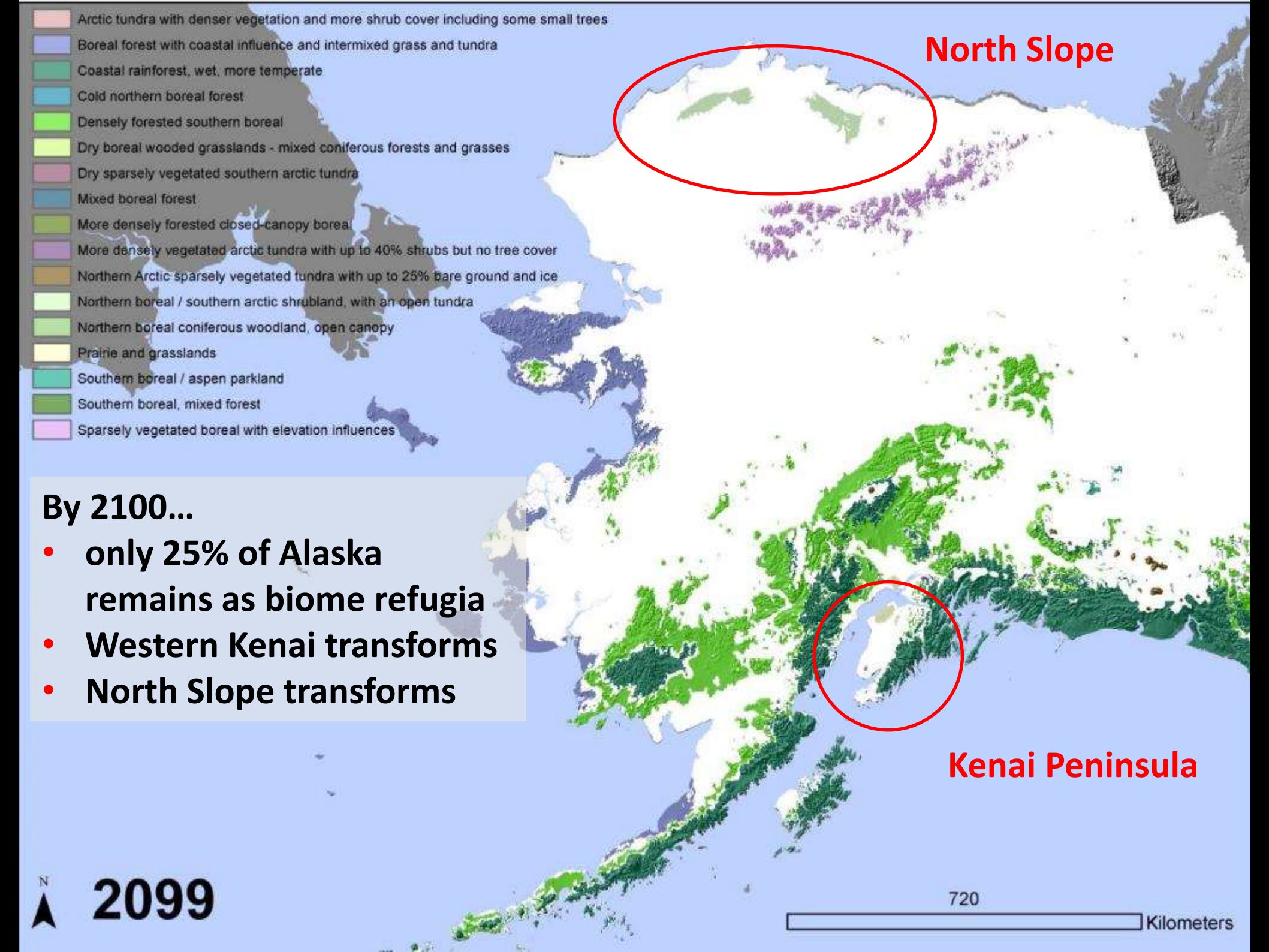
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
North Slope
Kenai Peninsula
N
2009
720
Kilometers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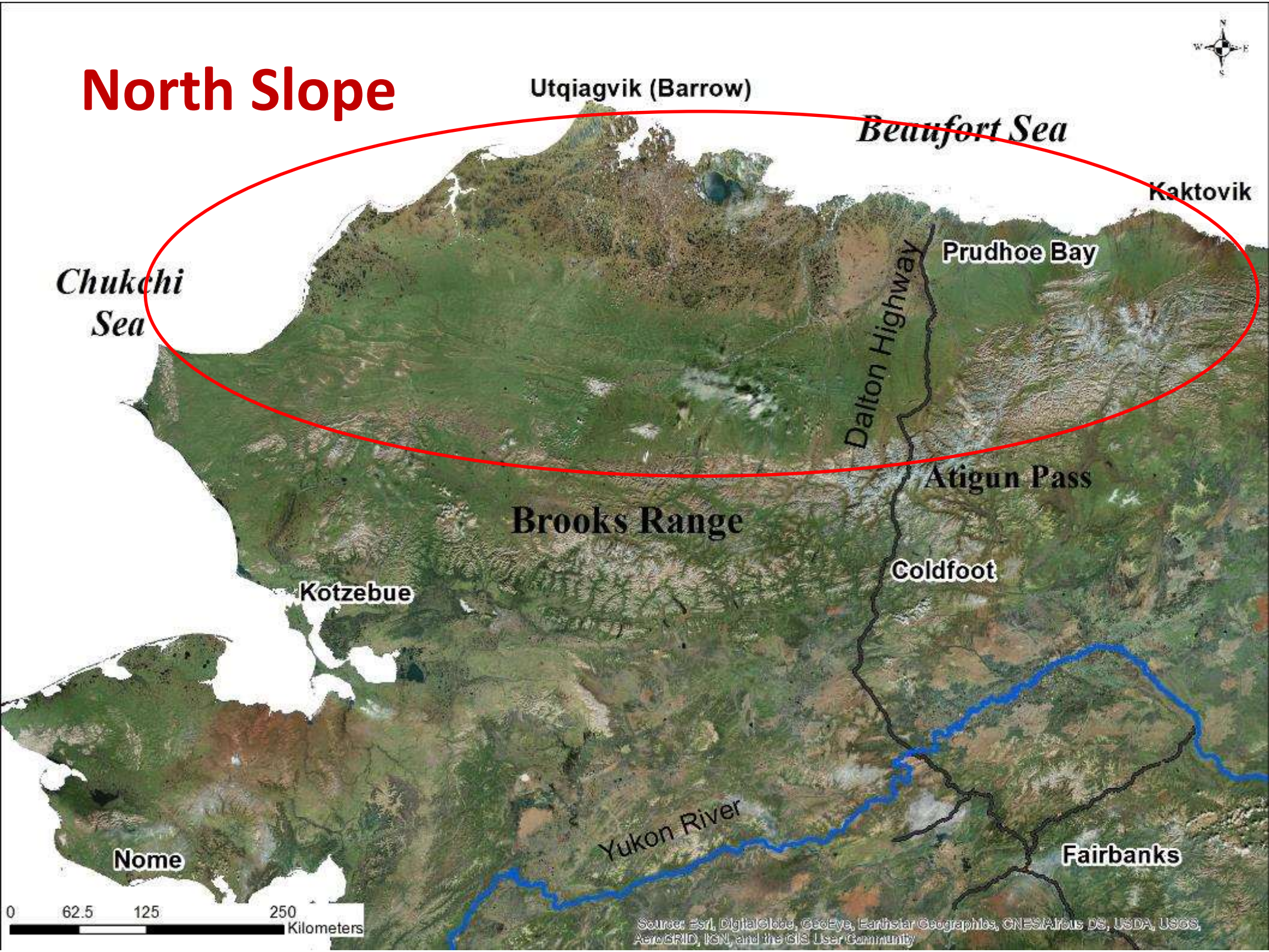
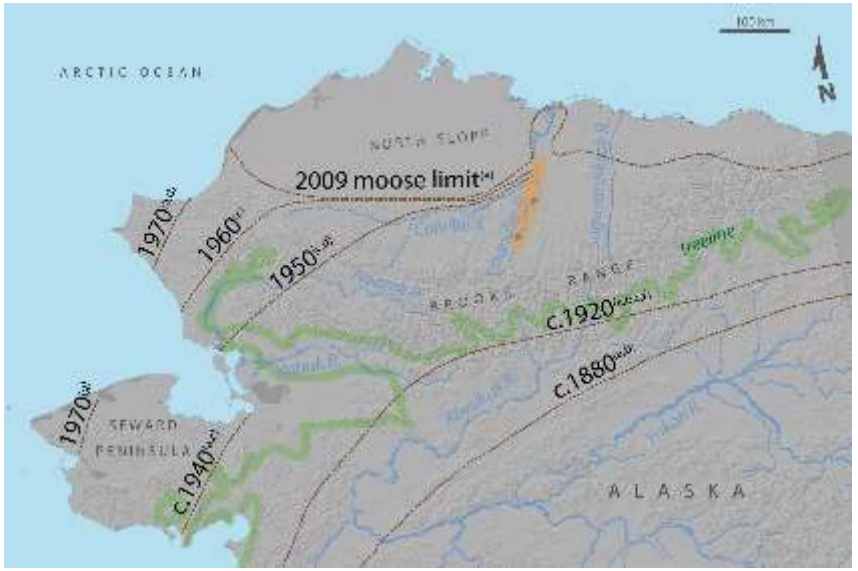
Prairie and grasslands
Southern boreal / aspen parkland
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
North Slope
By 2100…
• only 25% of Alaska remains as biome refugia
• Western Kenai transforms
• North Slope transforms
Kenai Peninsula
N
2099
720
Kilometers


North Slope
Utqiagvik (Barrow)
Beaufort Sea
Kaktovik
Prudhoe Bay
Chukchi Sea
Dalton Highway
Atigun Pass
Brooks Range
Coldfoot
Kotzebue
Yukon River
Nome
Fairbanks
0 62.5 125 250 Kilometers
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

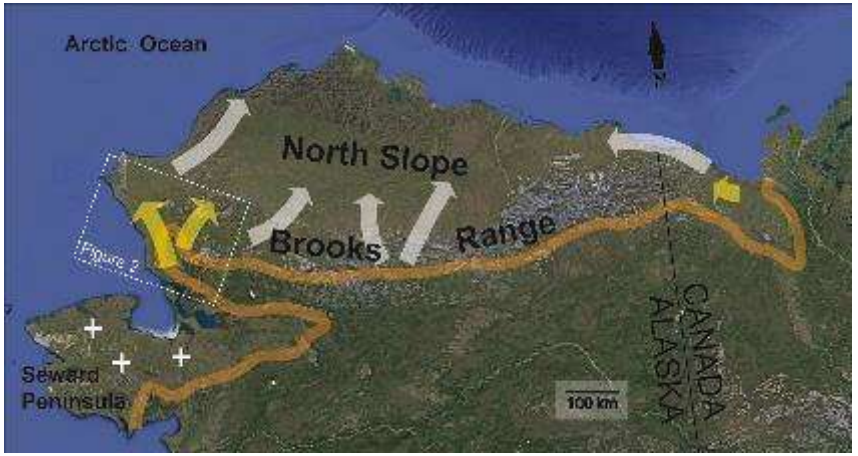
Extant species

Departing Alaskan species



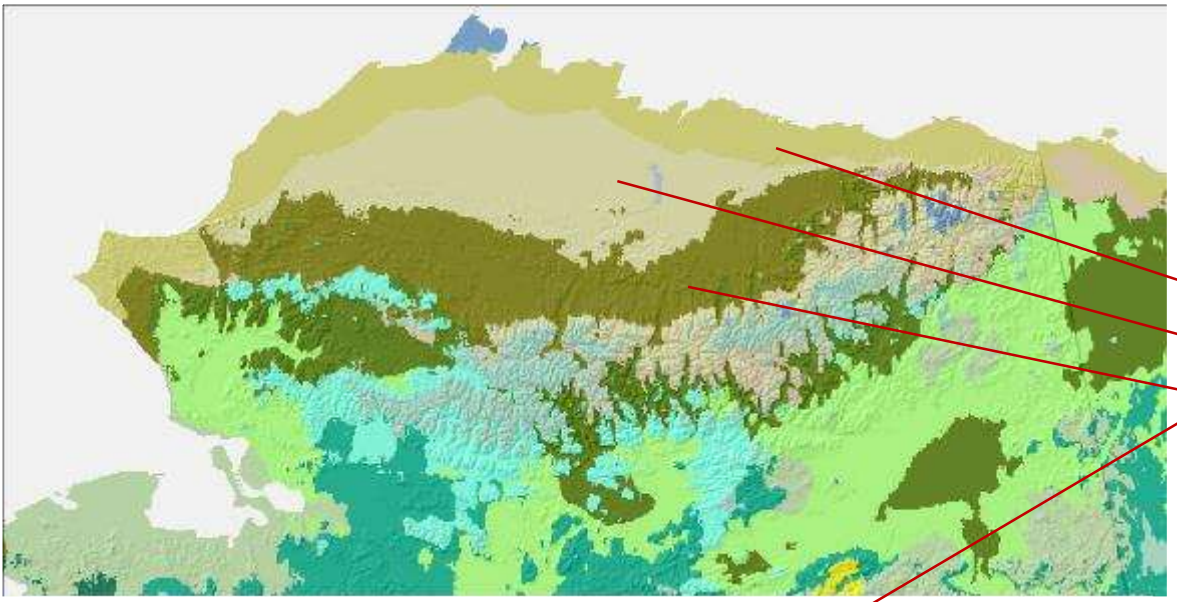
Arriving Alaskan species

Tape et al. 2016. Range expansion of **MOOSE** in arctic Alaska linked to warming and increased shrub habitat.
PLoS ONE 11(4):e0152636



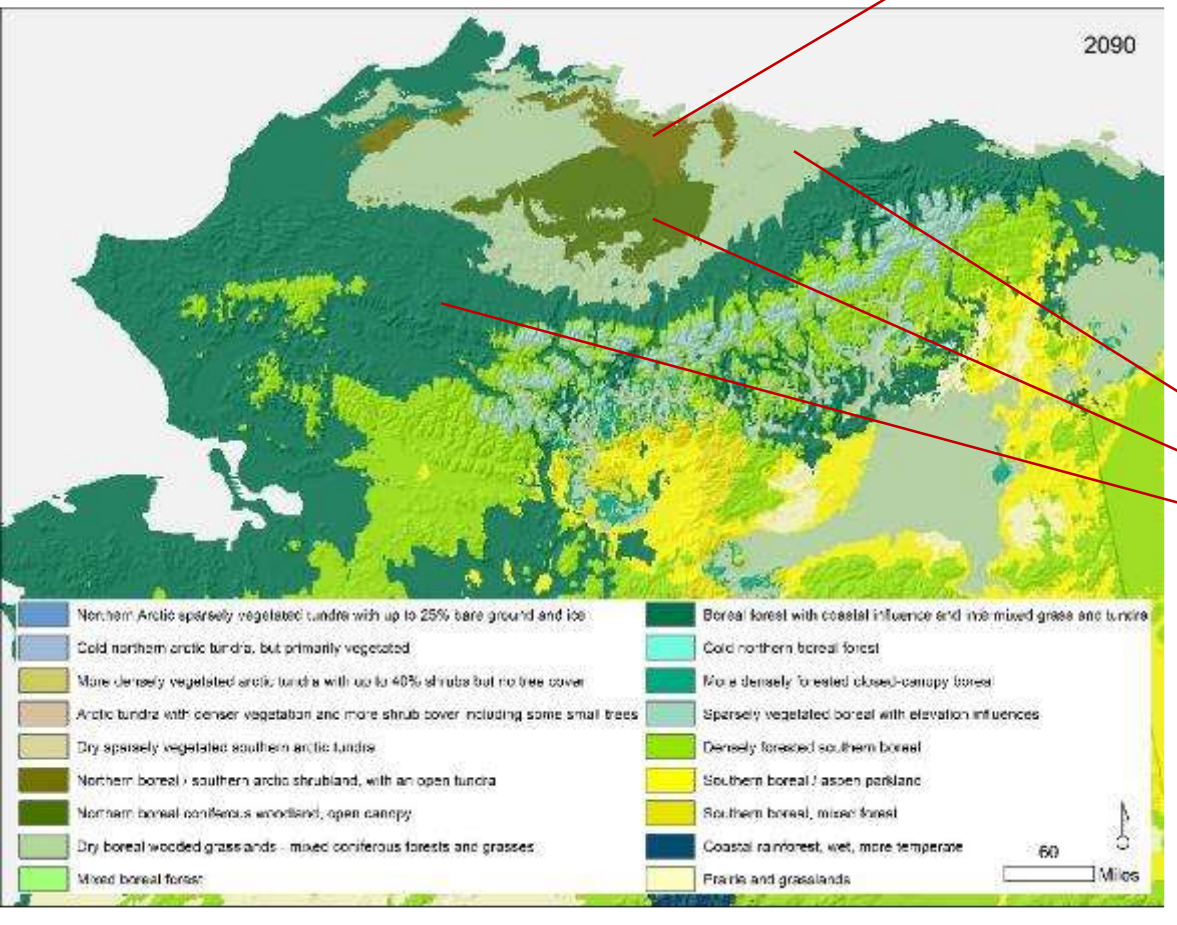
Tape et al. 2018. Tundra be dammed: **BEAVER** colonization of the Arctic.
Global Change Biology 24:4478-4488.

Breen. 2014. **BALSAM POPLAR** (*Populus basamifera* L.) on the Arctic Slope of Alaska.
Phytocoenologia 44:1-17.



In 2000, 100% is TUNDRA

- tundra < 40% shrubs and no trees (23%)
- tundra but sparsely vegetated (35%)
- shrubland with open tundra (30%)



By 2100, >55% is CONIFER

- dry boreal wooded grasslands (28%)
- northern boreal coniferous woodlands (9%)
- mixed boreal forest (46%)

Predicting Future Potential Climate-Biomes for the Yukon, Northwest Territories, and Alaska. 2012. Scenarios Network for Arctic Planning and EWHALE lab, UAF

“Topographically mediated climate poses a strong environmental barrier (i.e., the Brooks Range) to species migration, causing a pronounced time lag [1,000 years] in forest expansion…Migration corridors (low mountain passes and river valleys) or human introduction of trees will be critical for successful northward movement of [spruce] forest through the Brooks Range”

— Rupp, Chapin & Starfield 2001

Modeling the influence of topographic barriers on treeline advance at the forest-tundra ecotone in northwestern Alaska. Climatic Change 48: 399–416

White Spruce Seedling (*Picea glauca*) Discovered North of the Brooks Range along Alaska's Dalton Highway

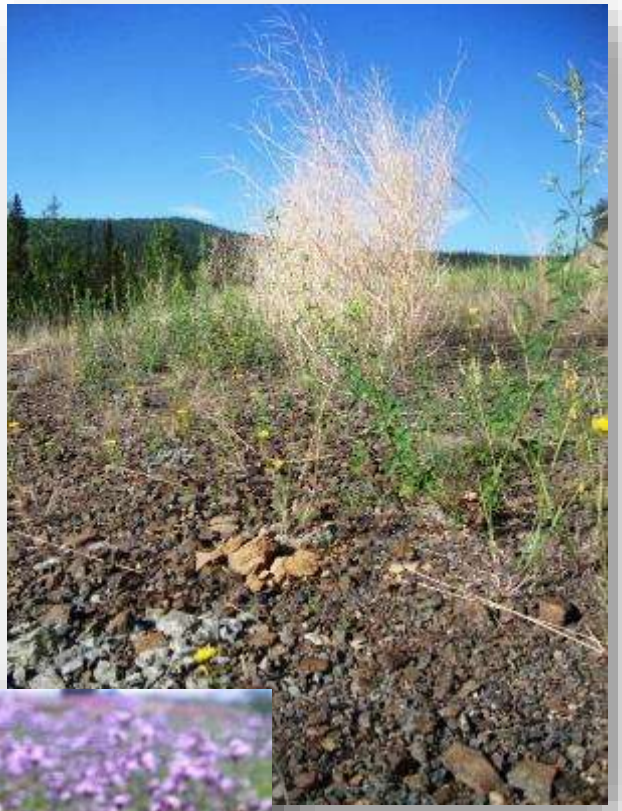
"The authors welcome comments on whether to protect or pull this likely human-introduced seedling or leave its future to chance"

Arriving Eurasian species

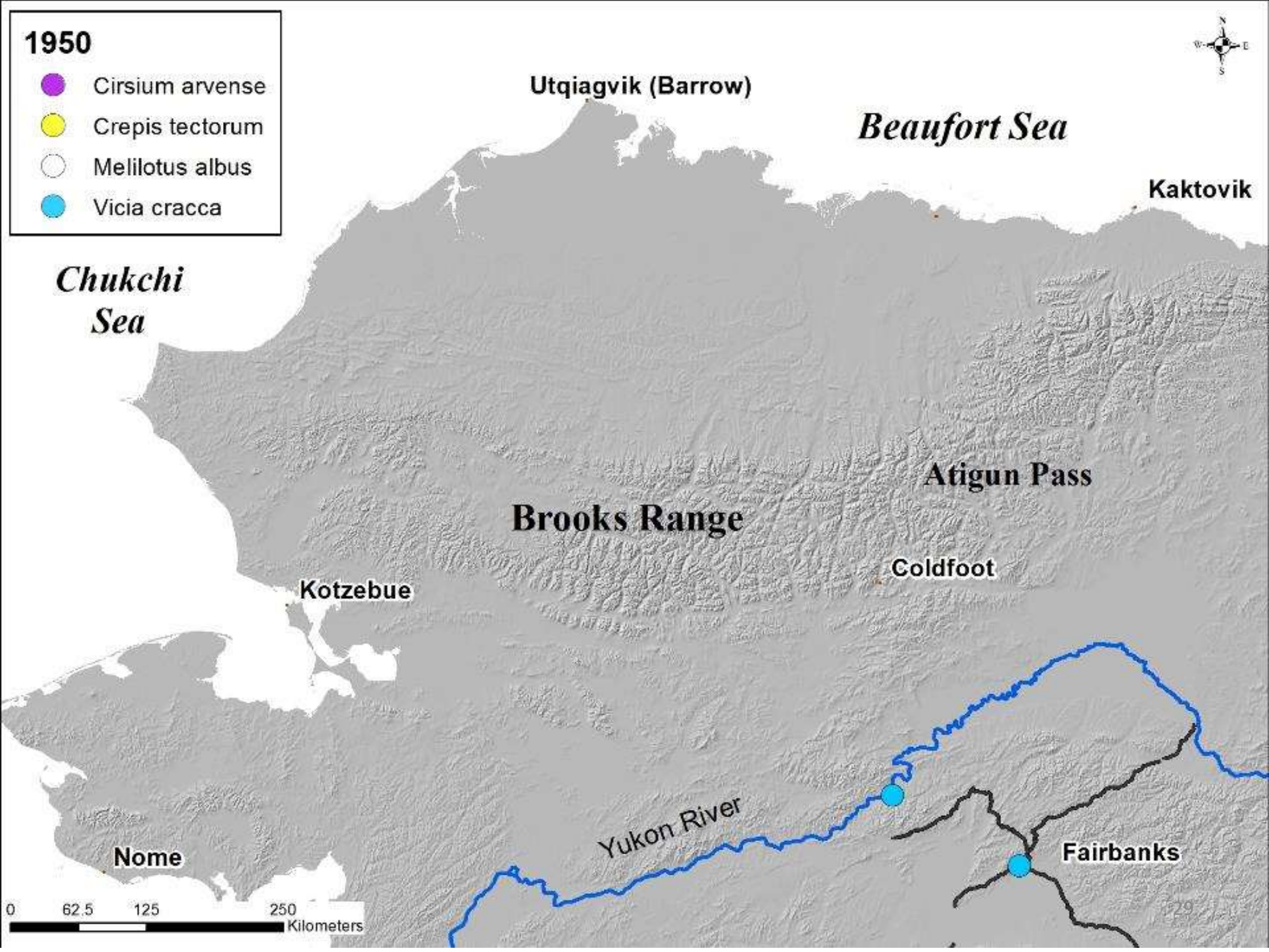
Bird vetch

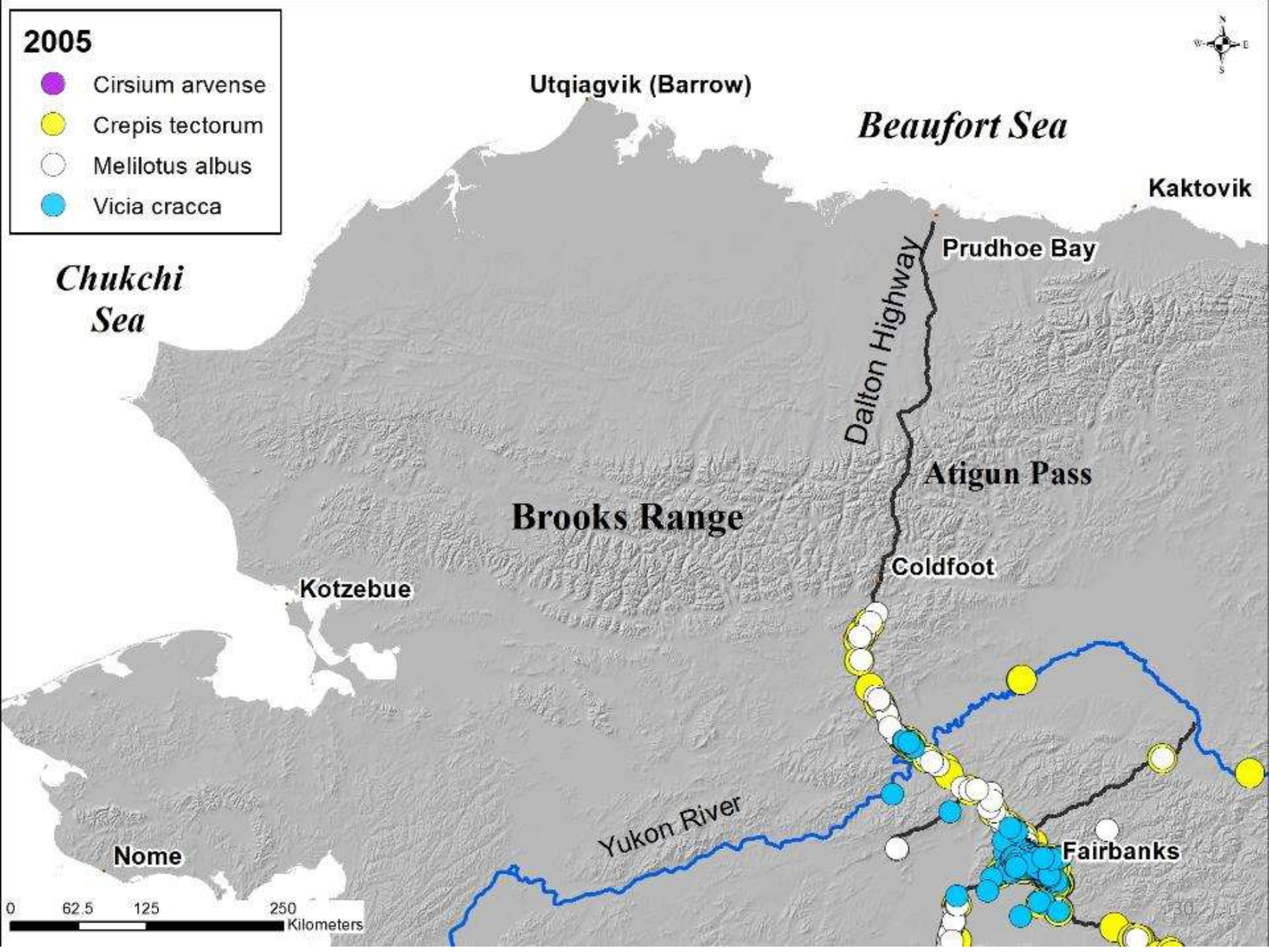
White sweetclover

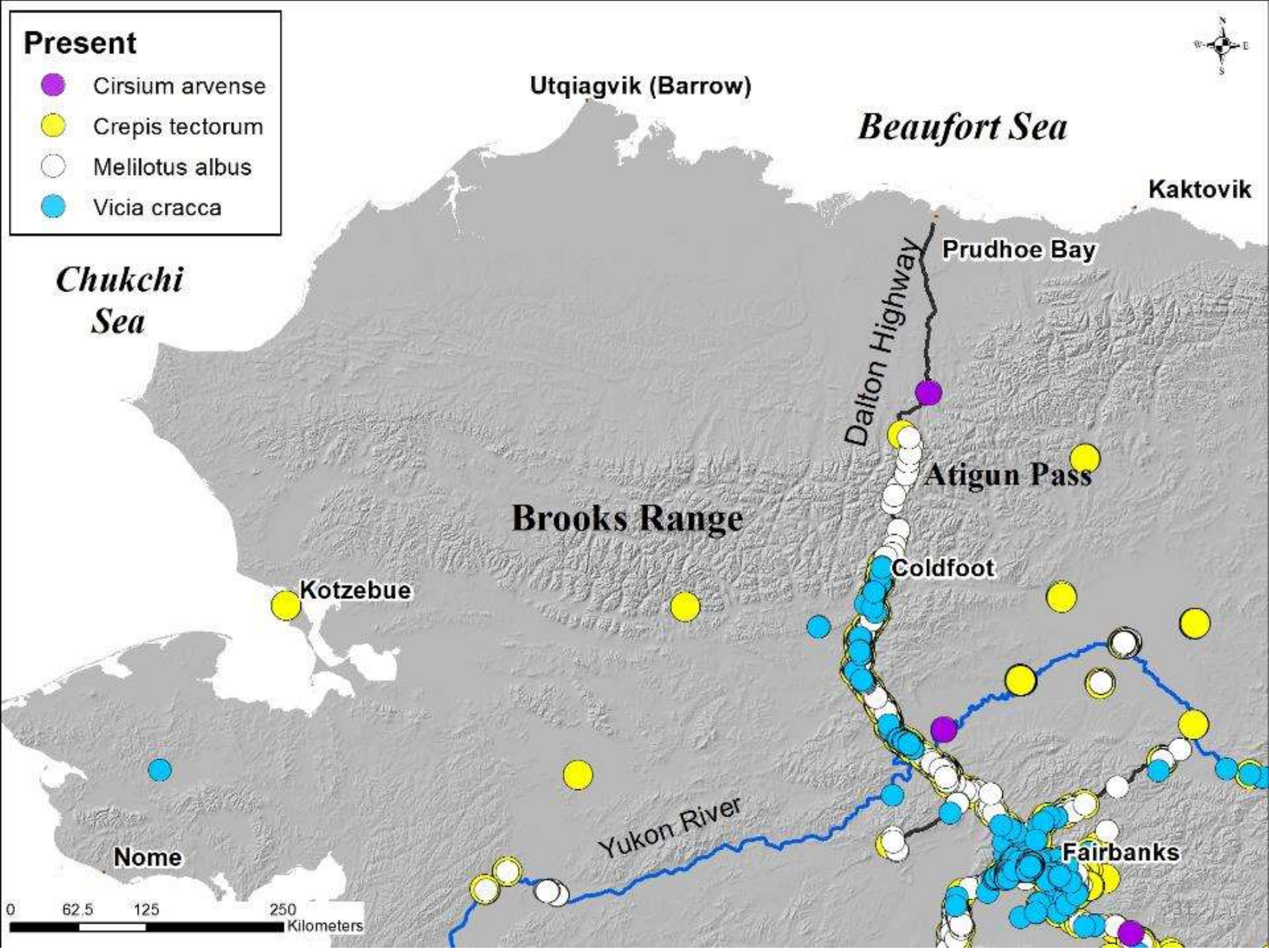
Creeping thistle



Narrowleaf hawksbeard


1950
Cirsium arvense
Crepis tectorum
Melilotus albus
Vicia cracca
Utqiagvik (Barrow)
Beaufort Sea
Kaktovik
Chukchi Sea
Atigun Pass
Brooks Range
Coldfoot
Kotzebue
Yukon River
Fairbanks
Nome
0 62.5 125 250
Kilometers


2005
Cirsium arvense
Crepis tectorum
Melilotus albus
Vicia cracca
Utqiagvik (Barrow)
Beaufort Sea
Kaktovik
Prudhoe Bay
Dalton Highway
Chukchi Sea
Atigun Pass
Brooks Range
Coldfoot
Kotzebue
Yukon River
Nome
Fairbanks
0 62.5 125 250
Kilometers

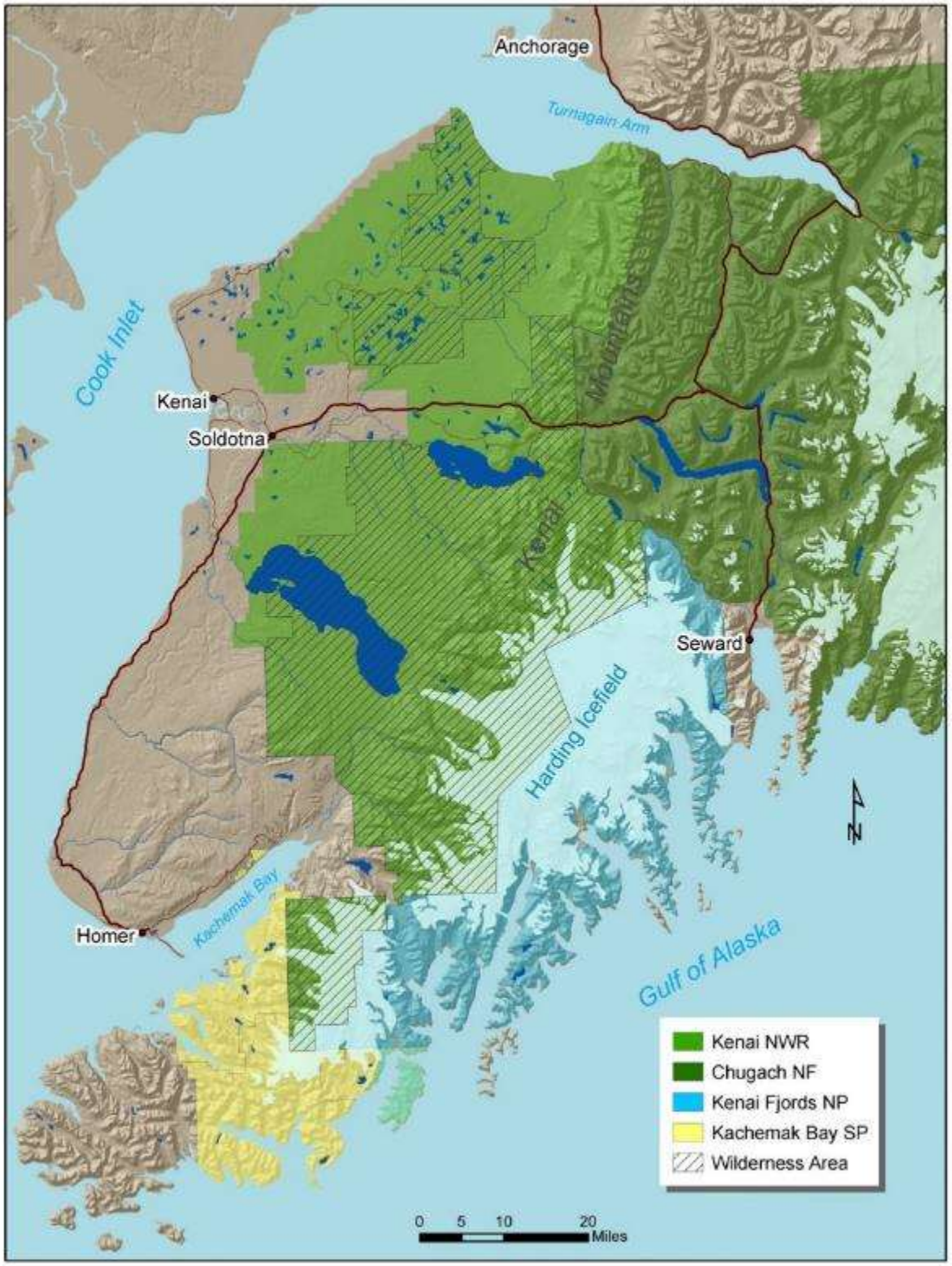

Present
Cirsium arvense
Crepis tectorum
Melilotus albus
Vicia cracca
Utqiagvik (Barrow)
Beaufort Sea
Kaktovik
Prudhoe Bay
Dalton Highway
Chukchi Sea
Atigun Pass
Brooks Range
Coldfoot
Kotzebue
Yukon River
Nome
Fairbanks
0 62.5 125 250
Kilometers

Creeping thistle 50 miles north of Atigun Pass

Straw erosion wattles likely vector

Lessons learned from the leading edge of continental species distributions

- A warming climate, invasive species and humans share two common traits – they know no boundaries and they have similar trajectories
- Extant species are disappearing, new species (native and nonnative) are appearing – but not all
- If we do nothing, we will have novel communities… but not of “native” species and not necessarily diverse


Anchorage
Turnagain Arm
Cook Inlet
Kenai
Soldotna
Kenai Mountains
Seward
Harding Icefield
Homer
Kachemak Bay
Gulf of Alaska
Kenai NWR
Chugach NF
Kenai Fjords NP
Kachemak Bay SP
Wilderness Area
0 5 10 20
Miles


ALASKA


Headquarters
Kenai
National
Wildlife
Refuge
U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Dramatic changes in last 5 decades in response to warming and drying

– available water declines (62% loss since 1968)

– wetlands dry (6 – 11% per decade), peatlands afforest

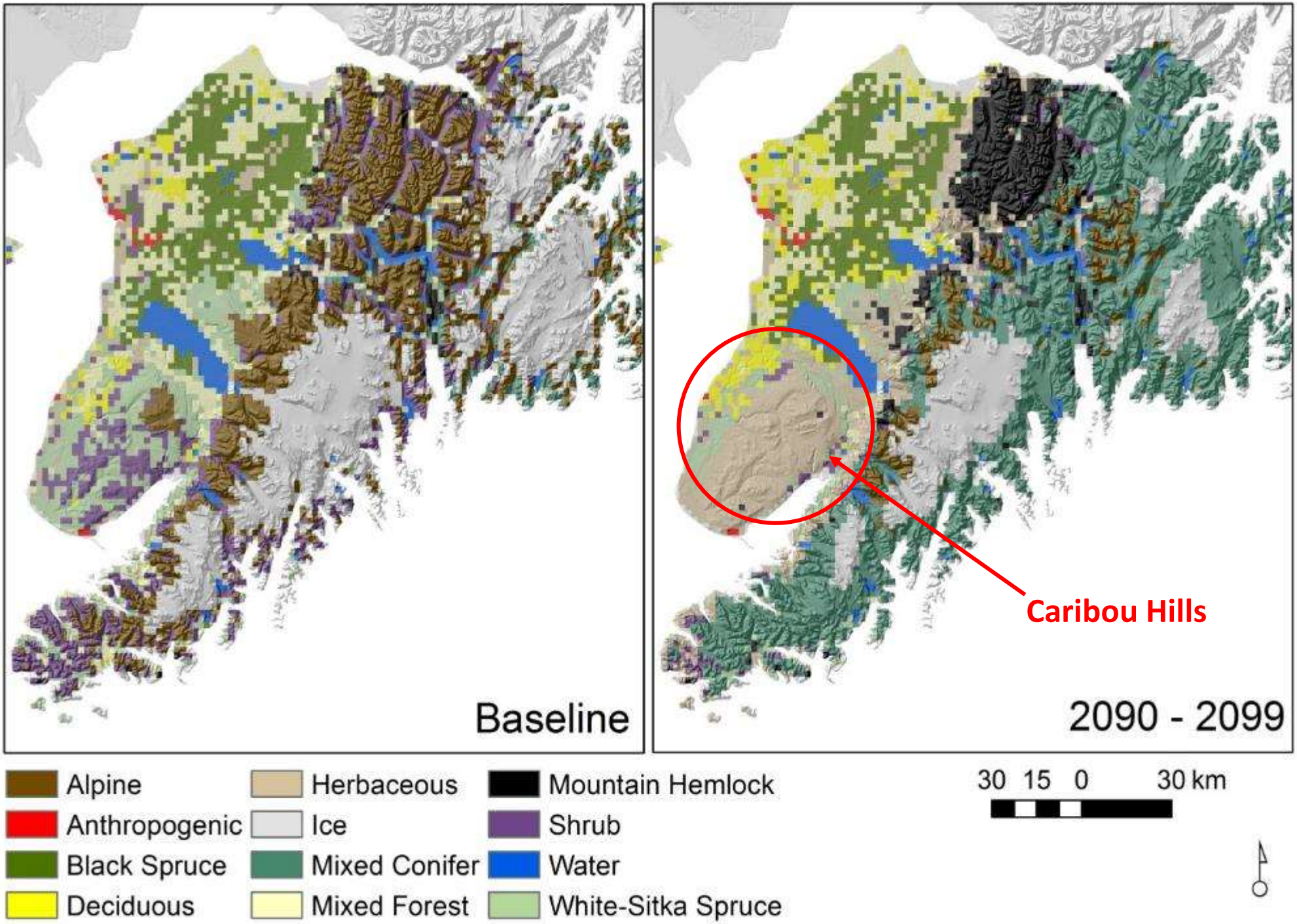
– glaciers recede (11% surface area, 21 m elevation)

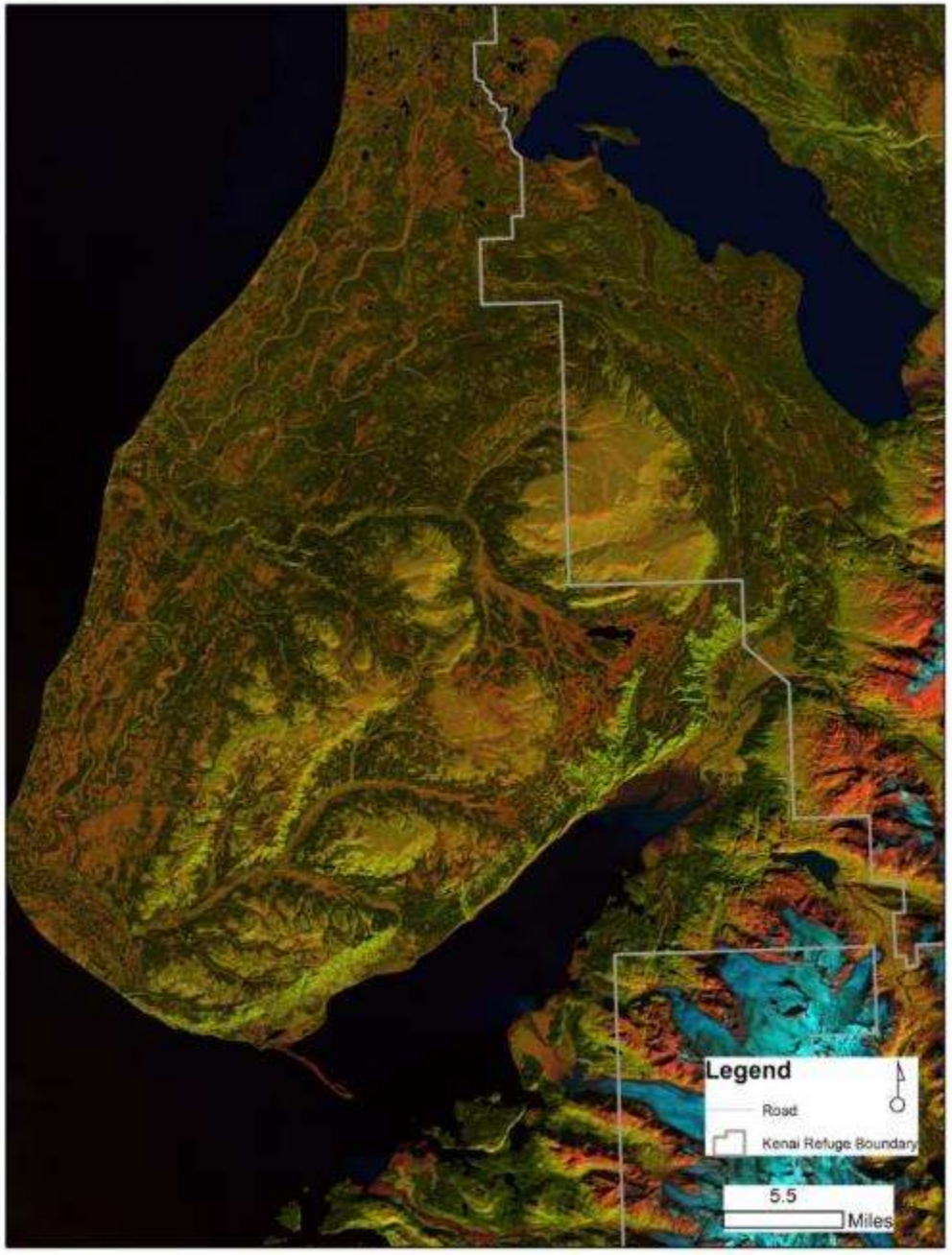
+ nonglacial salmon streams warm (17 of 48 sublethal in July)

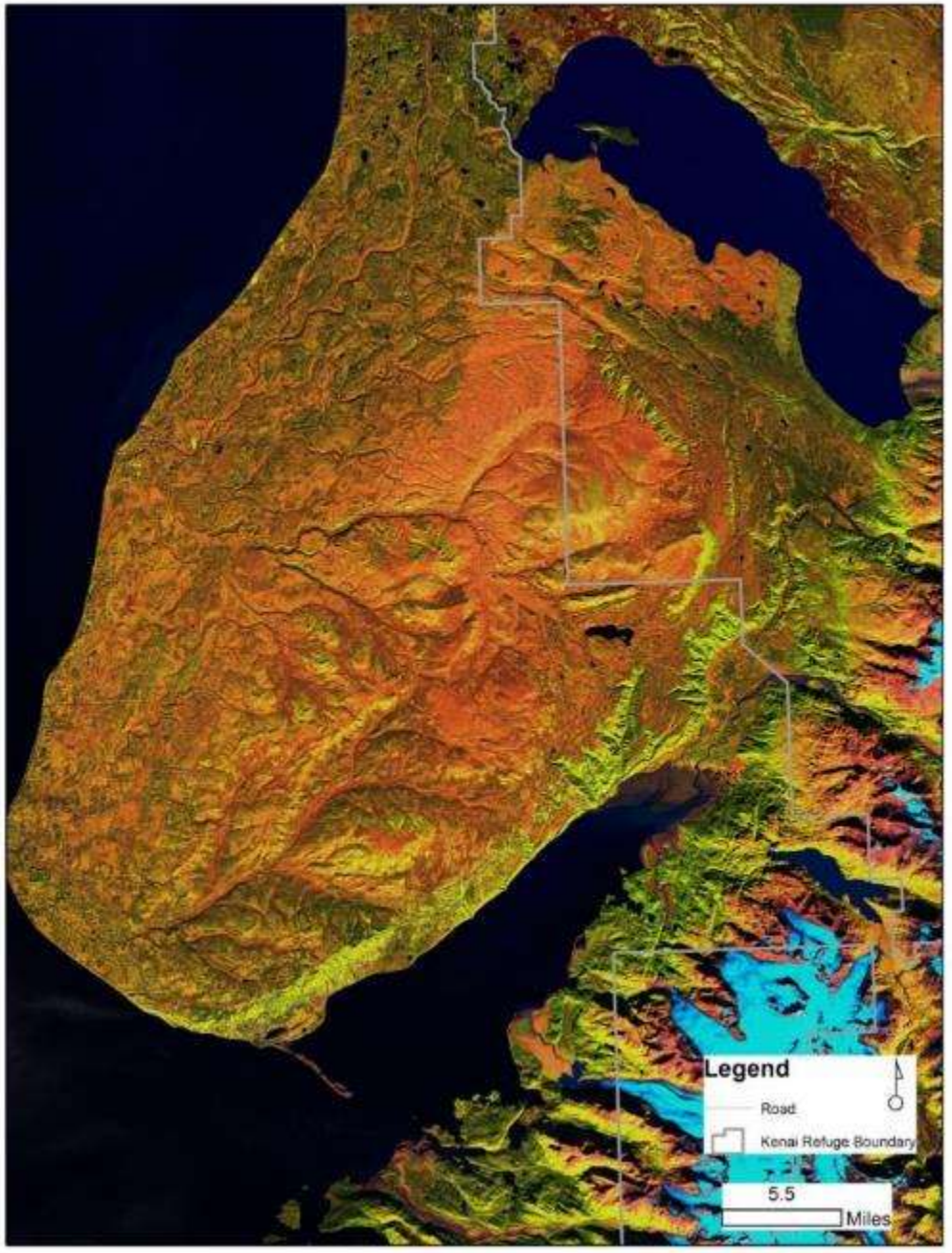
+ afforestation (trees 1 m/yr, shrubs 2.8 m/yr)

+ spruce bark beetle outbreaks (triggered by 2 consecutive warm summers)

Δ fire regime (lightning, grass, spring, shorter MFRI)


Baseline
2090 - 2099
Caribou Hills
Alpine
Anthropogenic
Black Spruce
Deciduous
Herbaceous
Ice
Mixed Conifer
Mixed Forest
Mountain Hemlock
Shrub
Water
White-Sitka Spruce
30 15 0 30 km

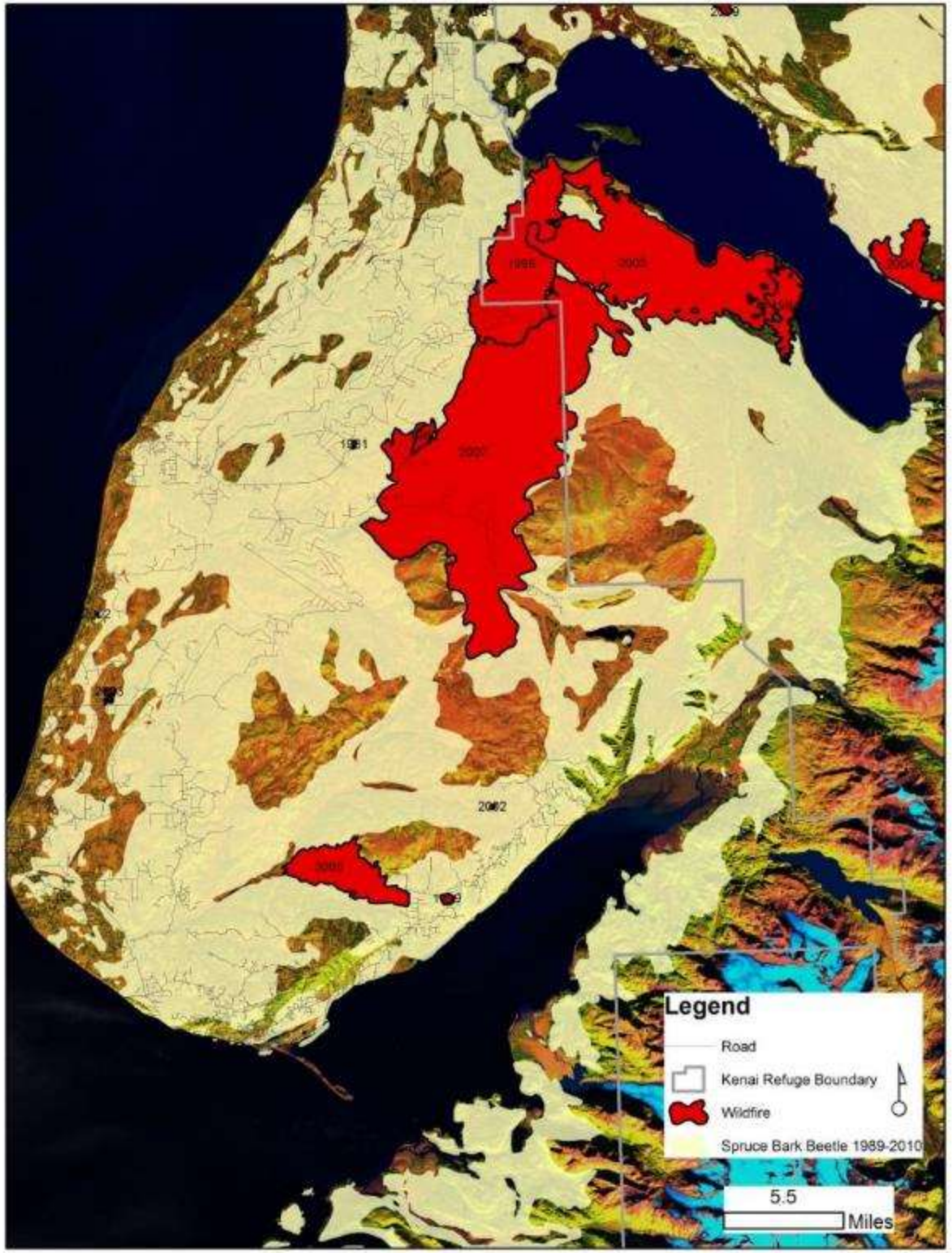




SEPT 1985

SEPT 2014

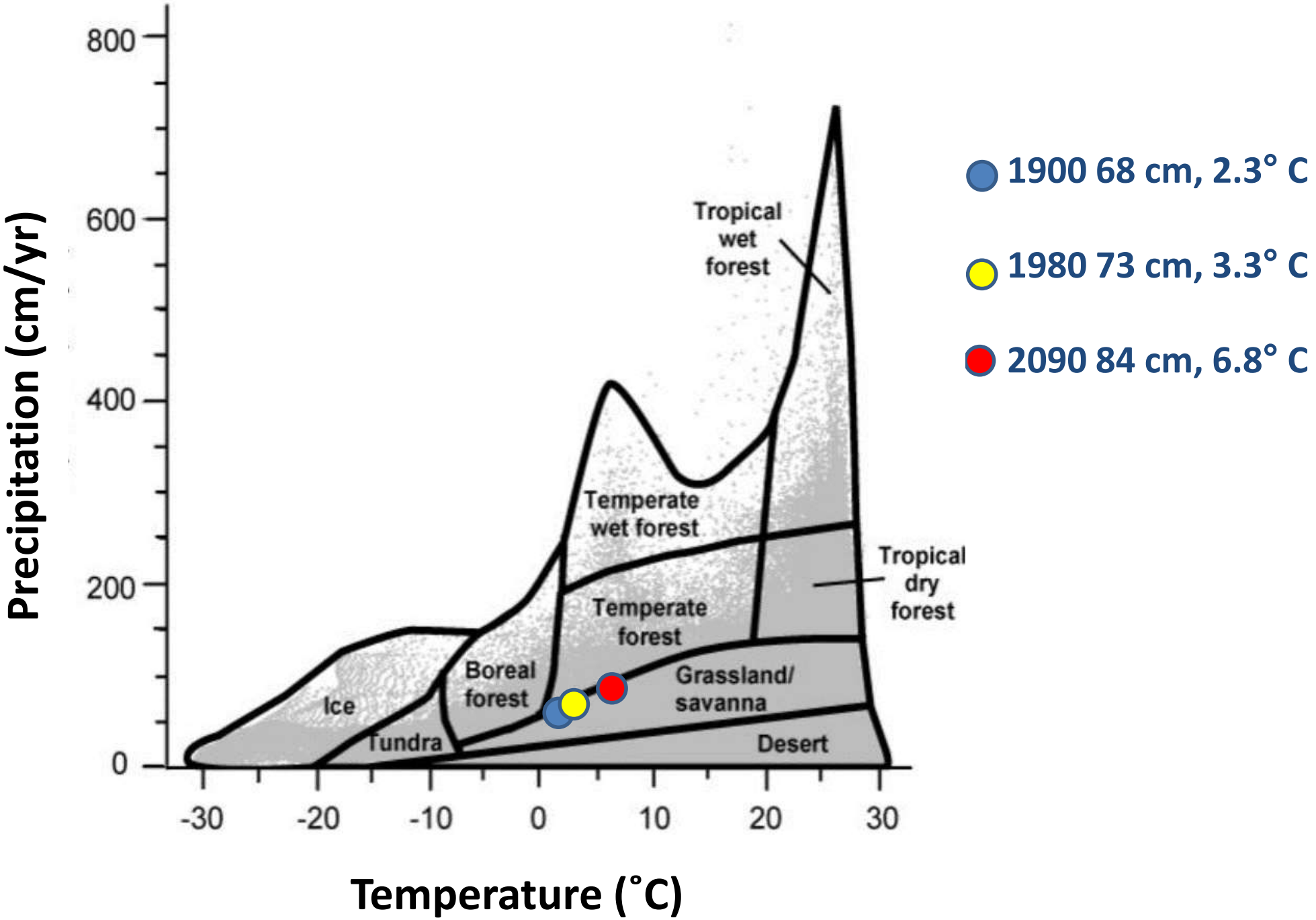
Spruce Bark Beetle Mortality (1989-2010)



Wildfires (1994–2007)

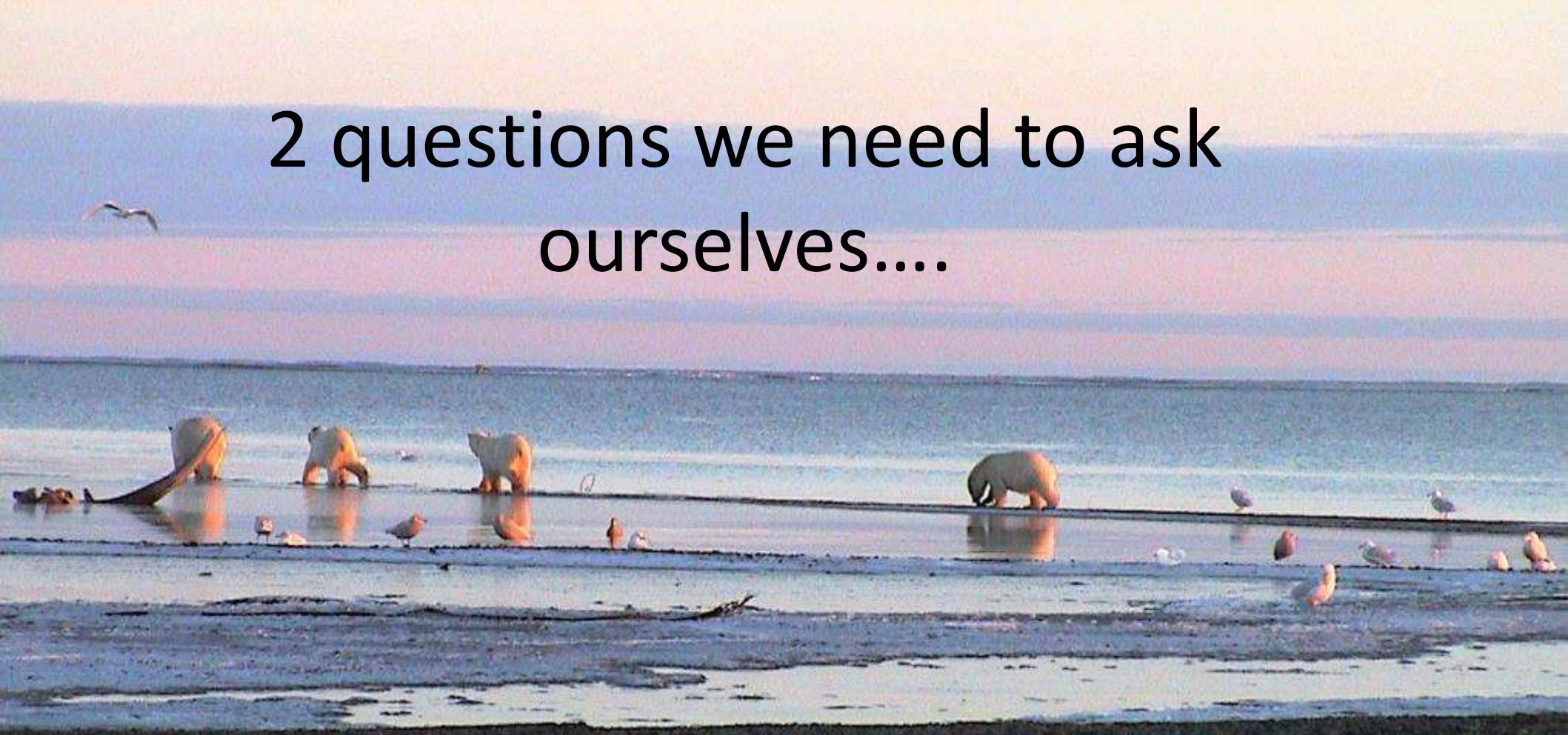
1994 Windy Point
1996 Crooked Creek
2005 Glacier Creek
2005 Fox Creek
2005 Tracy Avenue
2007 Caribou Hills


2015/07/19



Staudinger et al. 2012. Impacts of Climate Change on Biodiversity, Ecosystems, and Ecosystem Services: Technical Input to the 2013 National Climate Assessment.

2 questions we need to ask ourselves….



What's the risk of doing nothing?

What's the risk of doing something wrong?

----Rosa Meehan
10 Feb 2010

> 138 nonnative species of flora (108) and fauna (30) occur on the Kenai Peninsula, poised to fill novel assemblages

The trajectory we're on:

Human-mediated system with an unknown outcome…

Spruce bark beetle

Coho

Cluster Fly

Pheasant

Earthworms

Doing nothing is really doing something…
just incoherently and haphazardly

- **Kenai Peninsula is already responding to a changing climate and forecasted to continue doing so**
- **Latitudinal migration is constrained by the isthmus and Kenai Mountains' rainshadow**
- **Novel assemblages ≠ simple re-shuffling of native flora and fauna**
- **Many exotic species already introduced and more enroute**
- **And we squander our early opportunities to steward outcomes!**

Could this novel system be stewarded towards one that is more diverse?

CURRENT TRAJECTORY (ACCEPT)

Could this novel system be stewarded towards one that is more diverse?

LODGEPOLE PINE

BLACK-TAILED DEER

FOREST

CURRENT TRAJECTORY (ACCEPT)

Could this novel system be stewarded towards one that is more diverse?

LODGEPOLE PINE

BLACK-TAILED DEER

FOREST

CURRENT TRAJECTORY (ACCEPT)

GRASS

PRESCRIBED FIRE

INTRODUCED GRAZERS

Could this novel system be stewarded towards one that is more diverse?

LODGEPOLE PINE

BLACK-TAILED DEER

FOREST

CURRENT TRAJECTORY (ACCEPT)

GRASS

PRESCRIBED FIRE

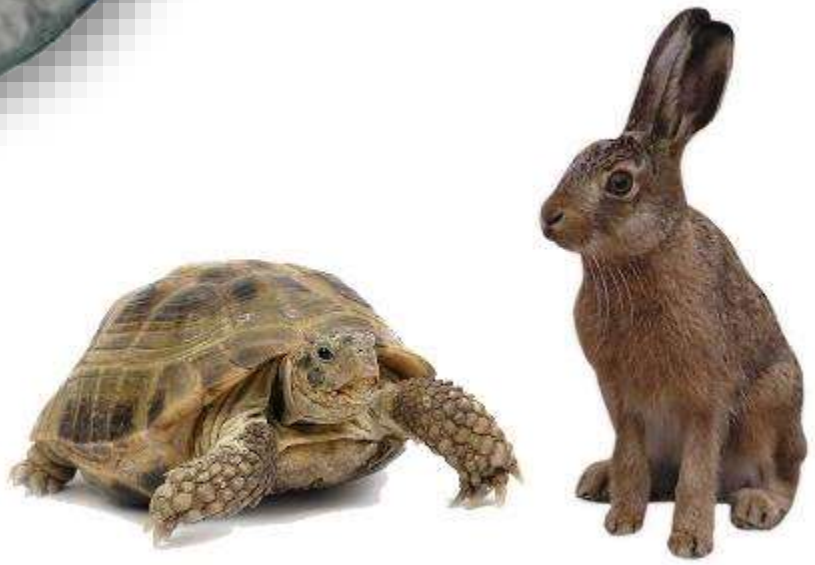
INTRODUCED GRAZERS

Two sides of the same coin

Translocate

Eradicate

- **In a no-analog human-driven future, there are no optimal choices – just bad decisions**
- **The Land does not understand human will or intent or our values – it only responds to outcome**

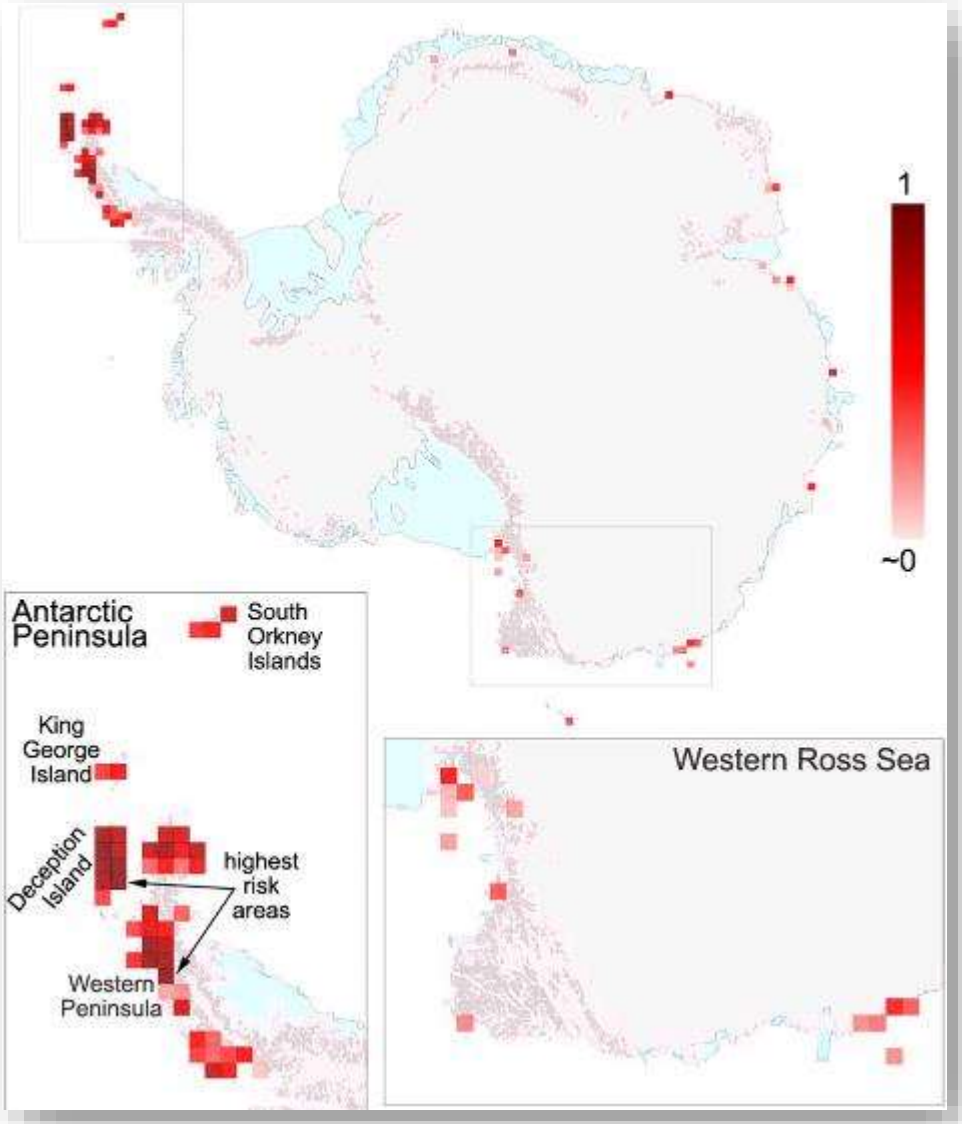


We need a reality check on which species are "packing" our changing systems..

11,174 non-native species in U.S.

Simpson, A., Eyler, M.C., Sikes, D., Bowser, M., Sellers, E., Guala, G.F., Cannister, M., Libby, R., and Kozlowski, N., 2019, A comprehensive list of non-native species established in three major regions of the United States: Version 2.0, (ver. 2.0, 2019): U.S. Geological Survey data release, https://doi.org/10.5066/P9E5K160.

We need to question our collective ability to manage nonnative species at a landscape scale…



Risk of alien vascular plants establishing in Antarctica

~70,000 seeds (40 families) carried to Antarctica by 40,000 tourists and scientists during one summer

***Poa annua* (1 of 3 vascular plants)**

Steven L. Chown et al. PNAS 2012;109:13:4938-4943

We need a sophisticated interdisciplinary perspective on managing exotic species…

- The Land is already responding to a warming climate and forecasted to continue doing so – what is native?
- Expect novel assemblages, but appreciate we can influence their composition
- Focus on <u>eradicating</u> novel species (spatial scale)
- Be circumspect about invasive species rankings (temporal scale)
- When in doubt, kill it! We can always introduce it