

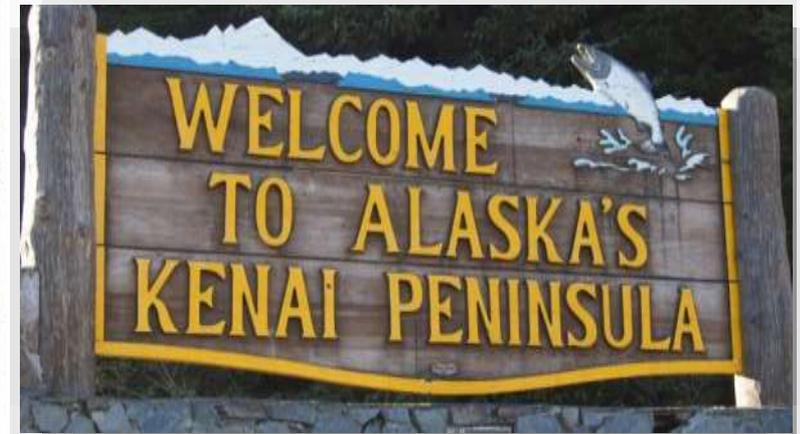
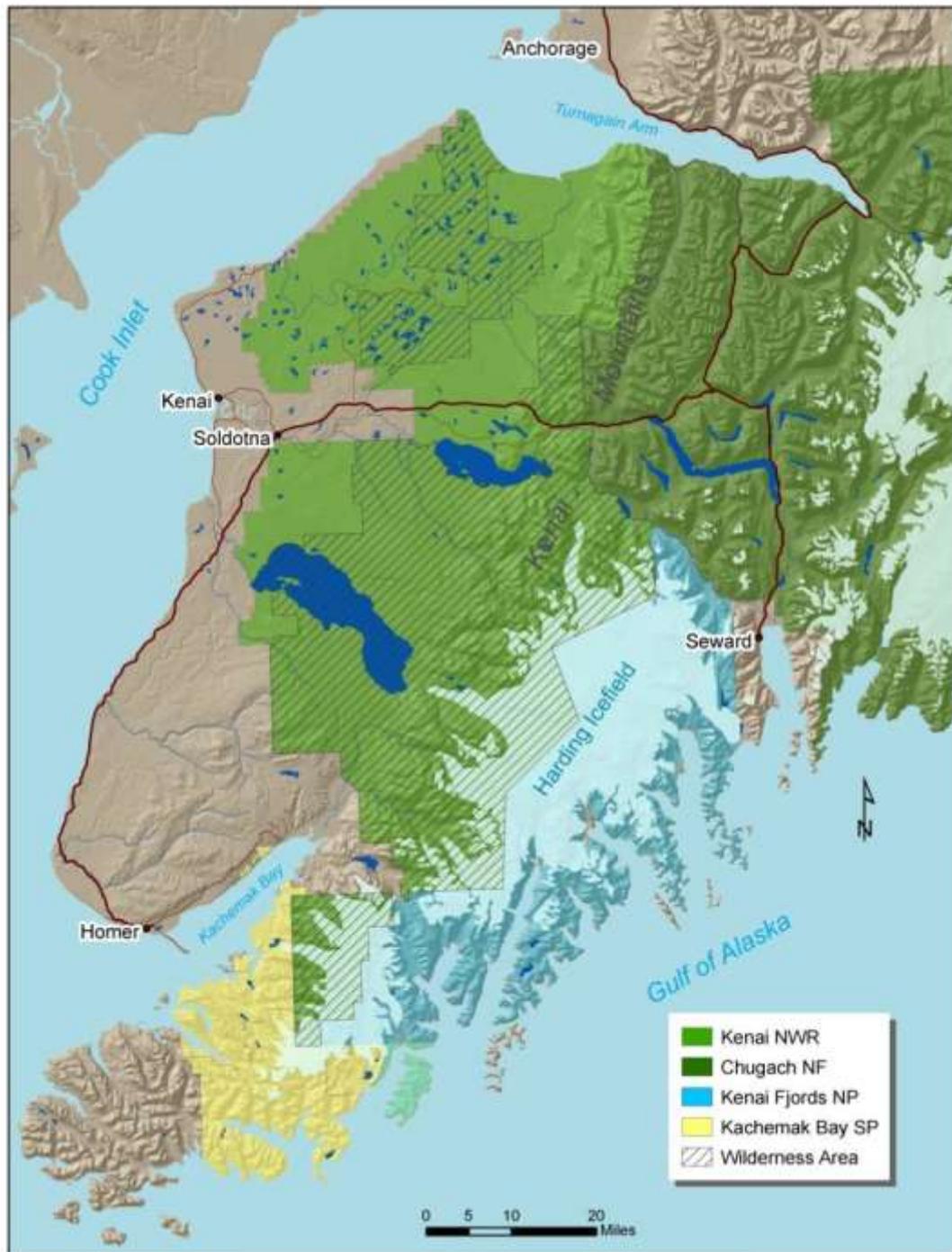
# Kenai Wilderness

**UNIMPAIRED??!**  
**UNTRAMMELED??!**

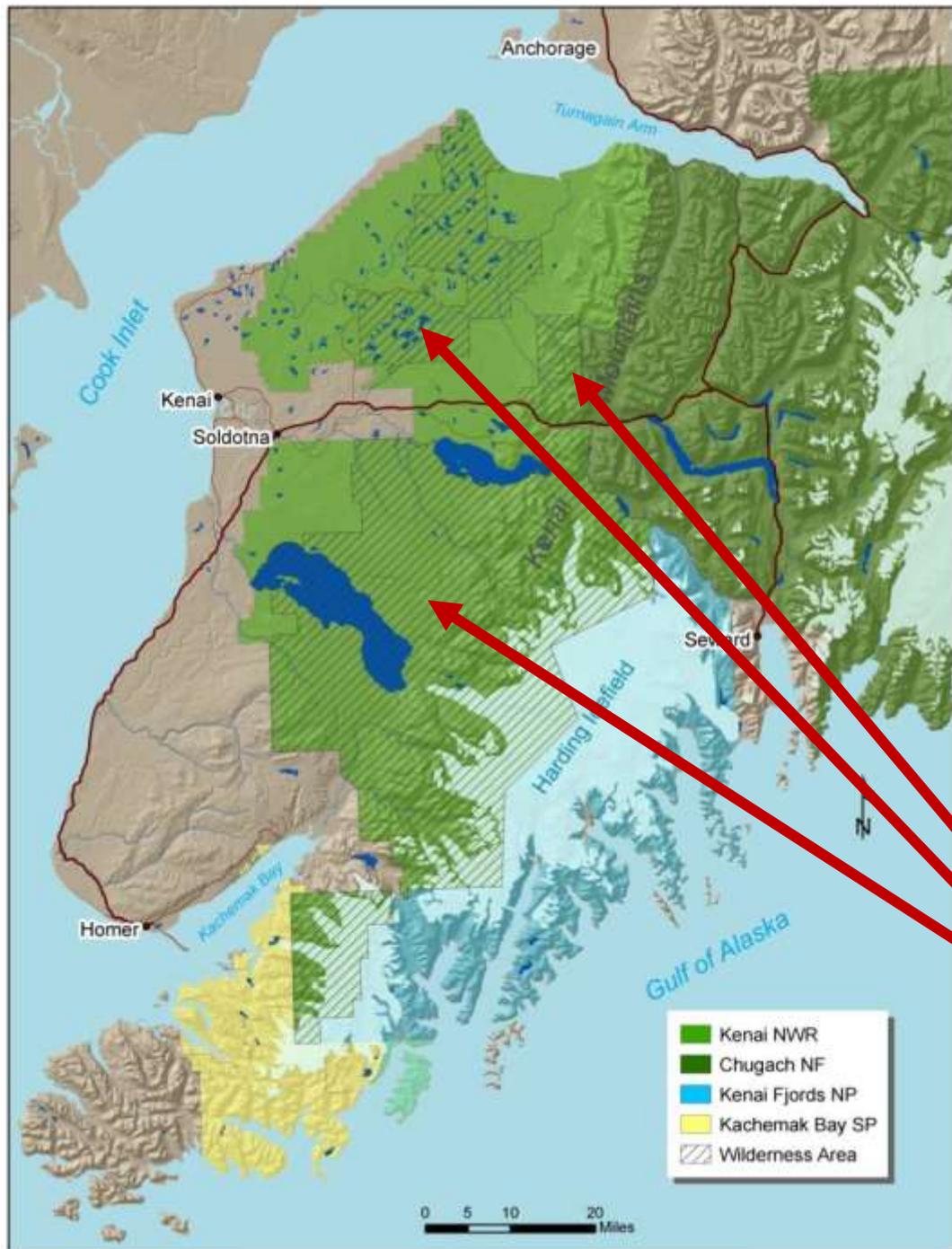
**The case for ecological intervention**

John Morton  
Kenai National Wildlife Refuge





- ✓ Alaska warming 2 – 3 times faster than Lower 48
- ✓ Climate warming effects not masked by other human-caused drivers of change
- ✓ Kenai Peninsula may be best studied locale in AK outside of high Arctic
- ✓ Nexus of two biomes



## Kenai Wilderness

- Mystery Hills unit (46K ac)**
- Dave Spencer unit (187K ac)**
- Andrew Simons unit (1,087K ac)**

# REFUGE PURPOSES

## 1980 ANILCA

- conserve fish & wildlife populations and habitats in their *natural diversity* including but not limited to....
- fulfill international fish & wildlife treaty obligations

**fish and wildlife** = any member of the animal kingdom including without limitation any mammal, fish, bird, amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate...

# OTHER REFUGE PURPOSES

## *1964 Wilderness Act*

- secure an enduring resource of wilderness
- protect and preserve wilderness character
- leave them unimpaired for future use as wilderness

## *1997 Refuge Improvement Act*

- ensure biological integrity, diversity and environmental health



# Dramatic changes in last 50 years in response to warming and drying



- available water declines (60% loss since 1968)
- wetlands dry (6 – 11% per decade)
- glaciers recede (-11% surface area, -21 m elevation, +55% thinning rate)
- + afforestation (trees 1 m/yr, shrubs 2.8 m/yr)
- + unprecedented SBB outbreak (triggered by 2 consecutive warm summers)

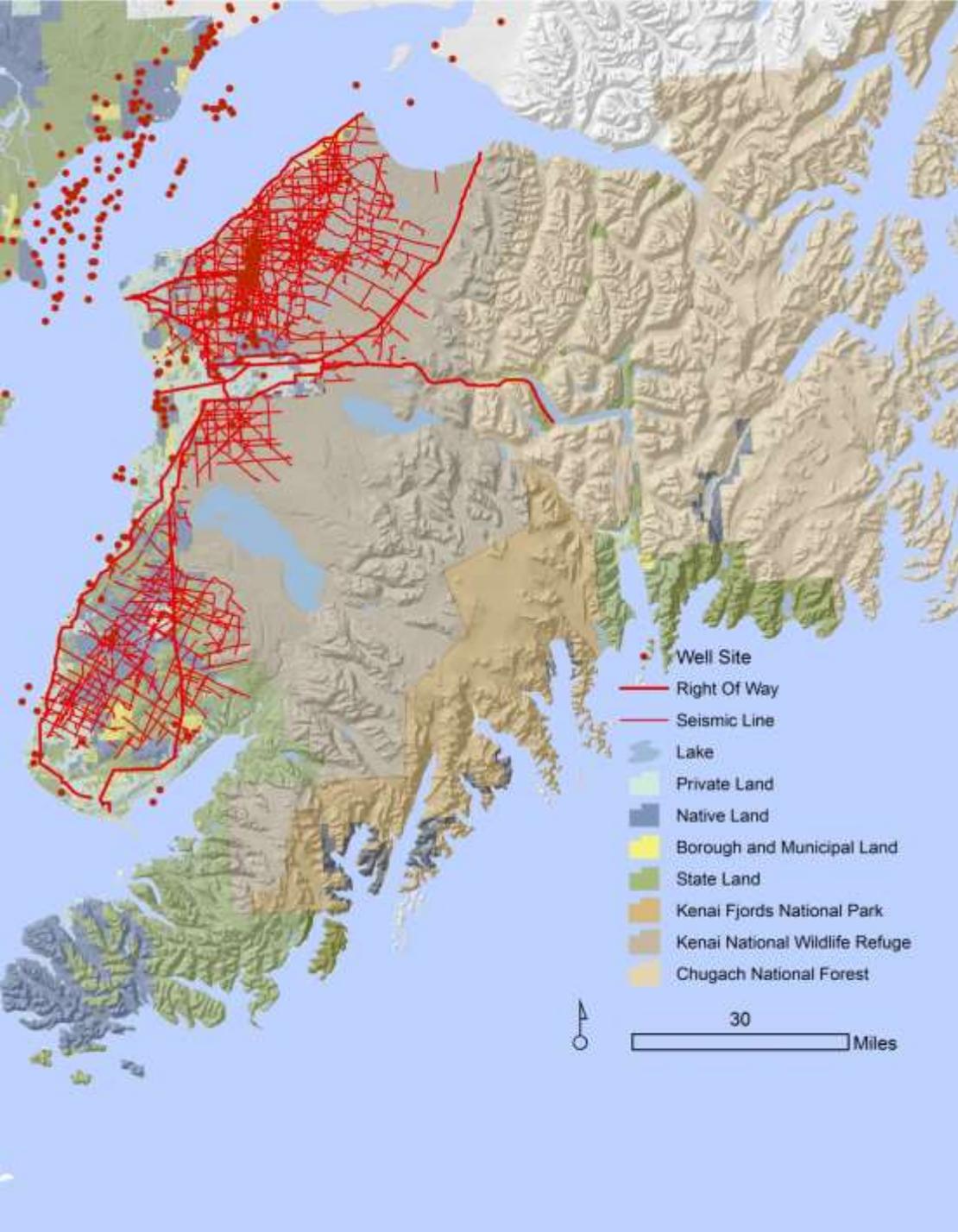


Adageirsdottir et al.1998; Berg et al. 2006,2009; Boucher & Mead 2006; Dial et al. 2007,2016; Klein et al. 2005, Rice 1987, VanLooy et al. 2006



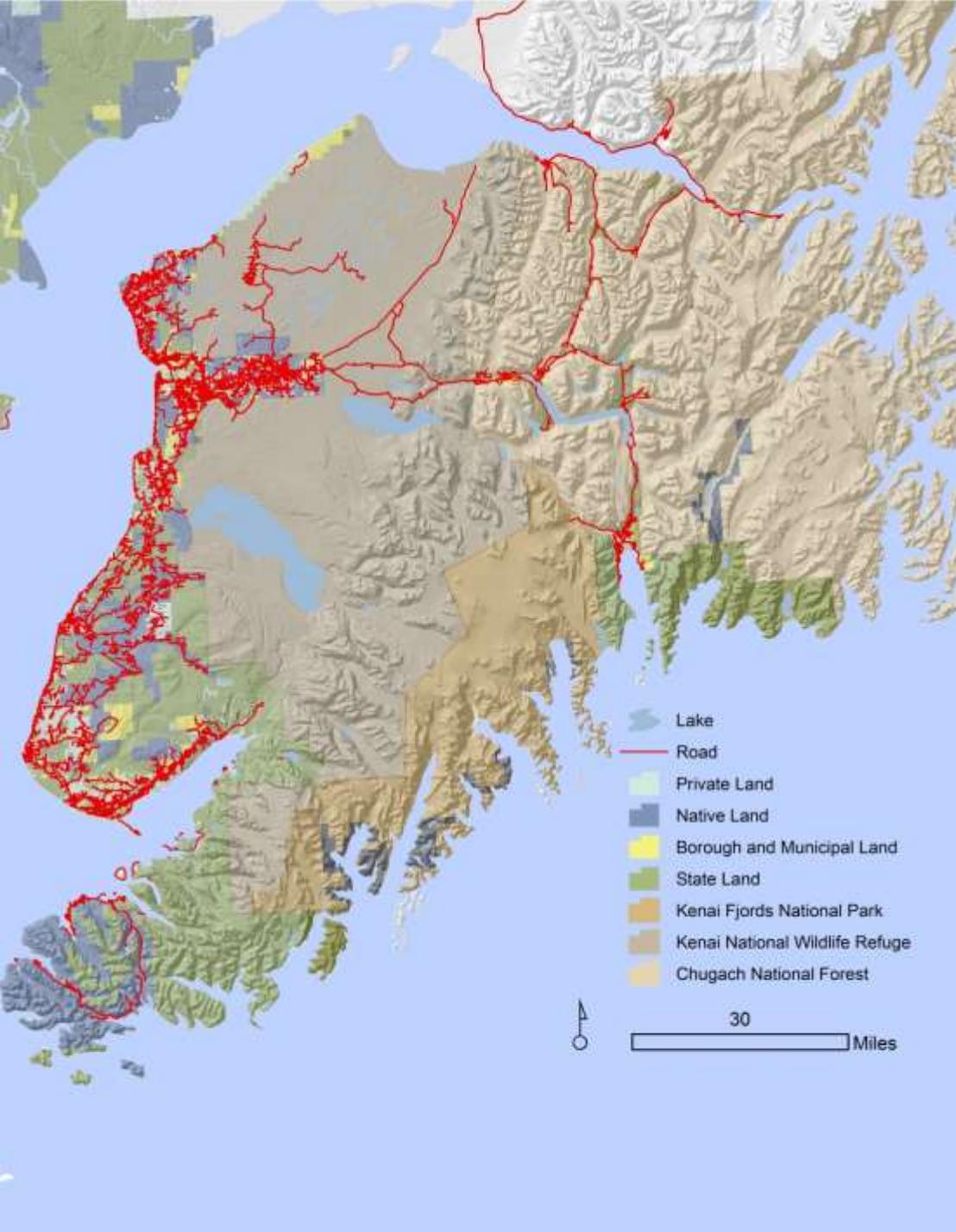
# Commercial oil and gas extraction

- ✓ 13,300 acres of active leases
- ✓ 104 pads, 188 wells
- ✓ >90 buildings
- ✓ 71 miles pipelines, 94 miles roads
- ✓ >1,800 miles of seismic lines



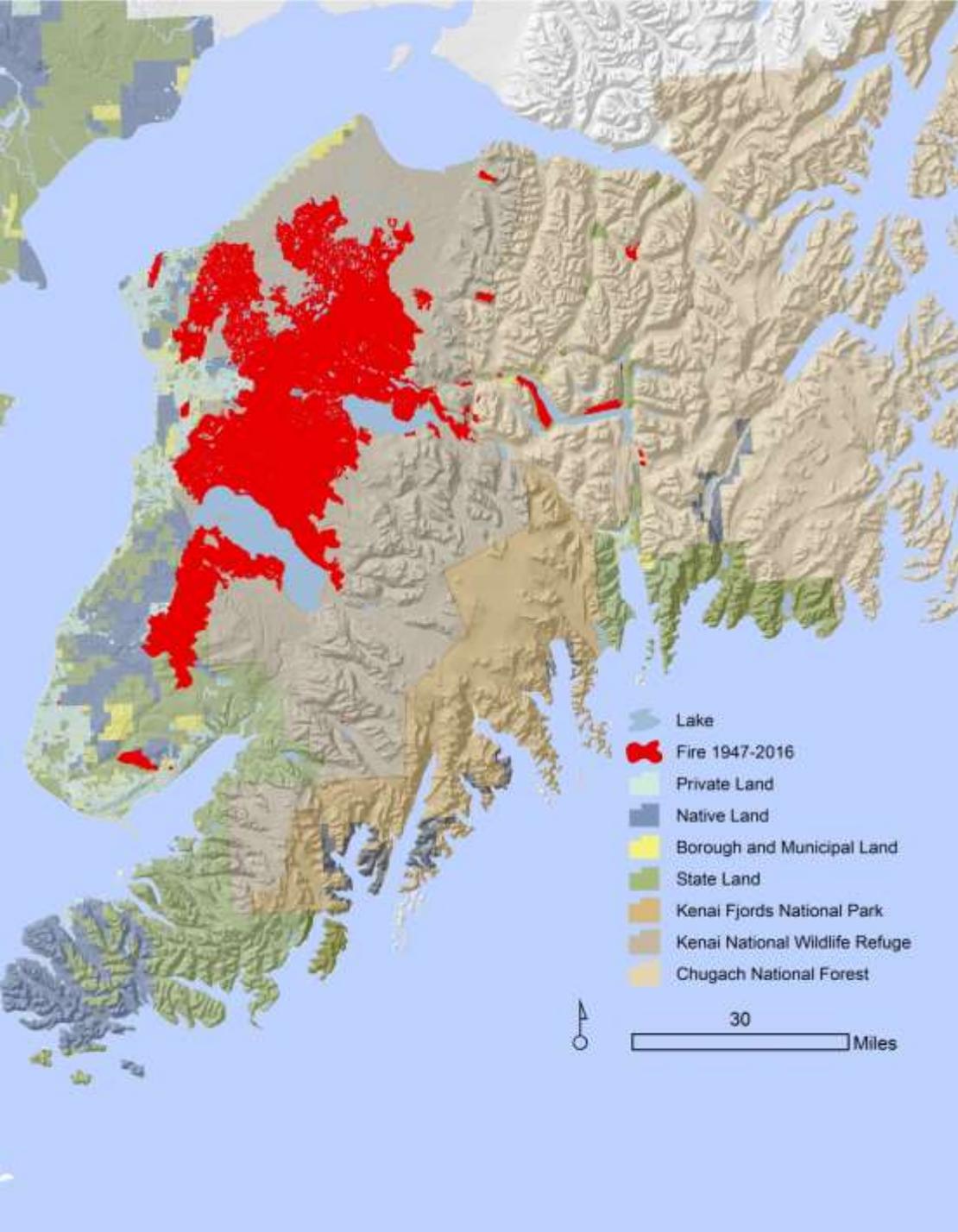
## Roads

- ✓ **3,016 miles of road, crossing anadromous streams at 381 locales**
- ✓ **1.7 million vehicles on 22 miles of highway that bisects KENWR**  
**= 2 vehicles/minute/day**  
**= 250 moose-vehicle collisions/yr**



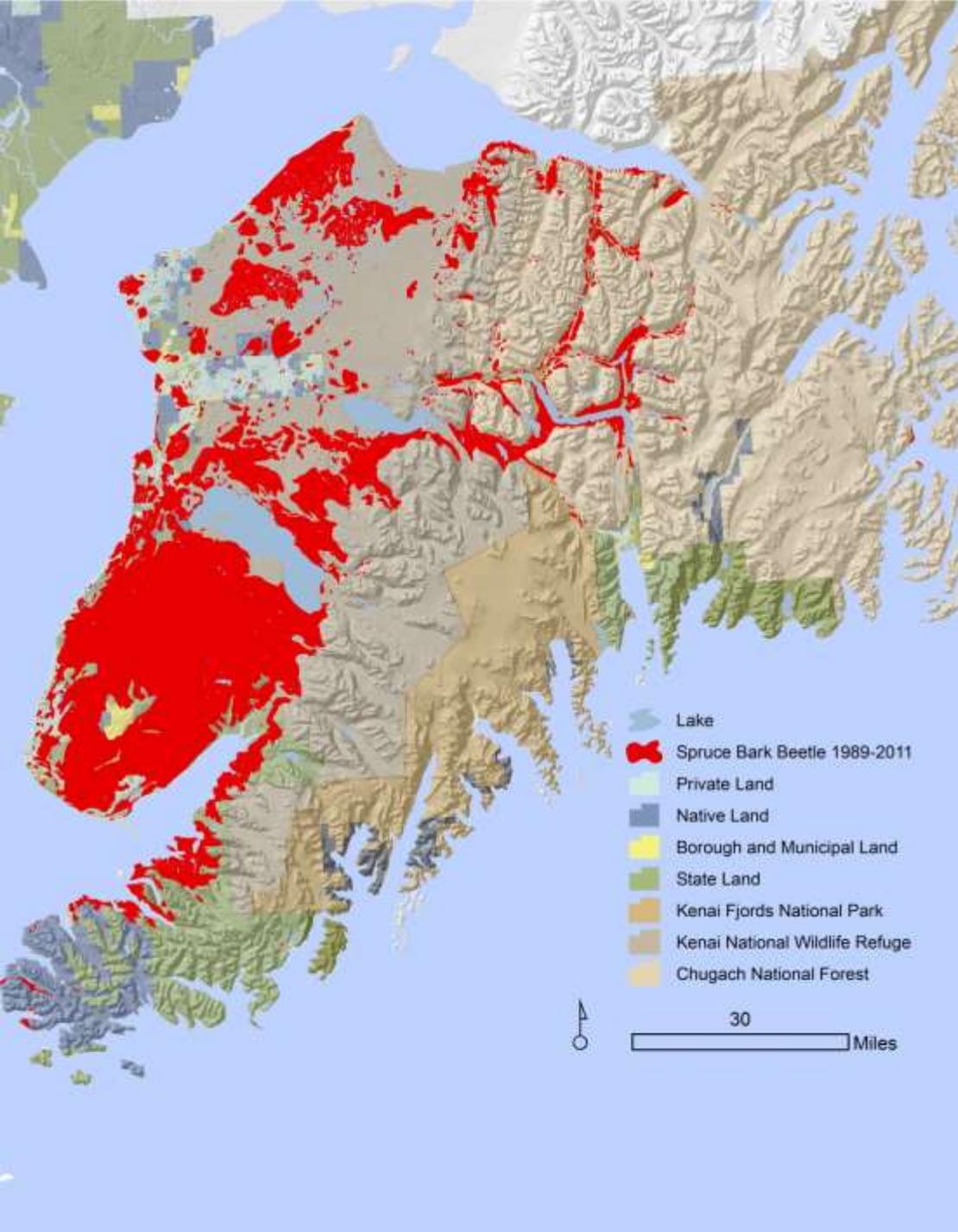
# Wildfire

- ✓ 776K acres since 1947
- ✓ 64 wildfires
- ✓ Alaska fire season start changed from May 1 to April 1 in 2006
- ✓ More lightning-caused fire in last 20 years



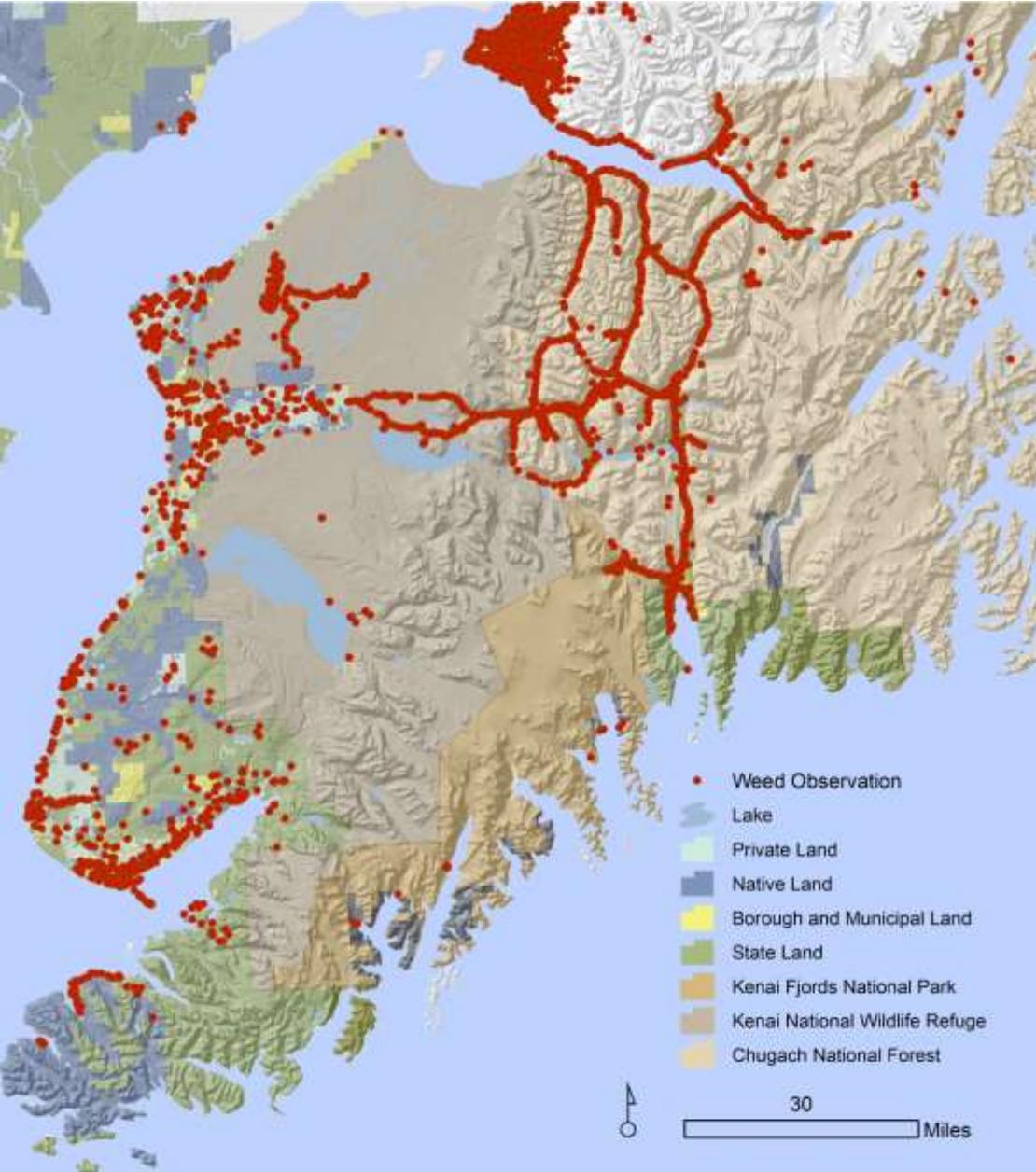
# Spruce Bark Beetle

- ✓ 1.1 million acres 1989-2011
- ✓ 100% tree mortality on southern Kenai
- ✓ Triggered by two consecutive above-average summers



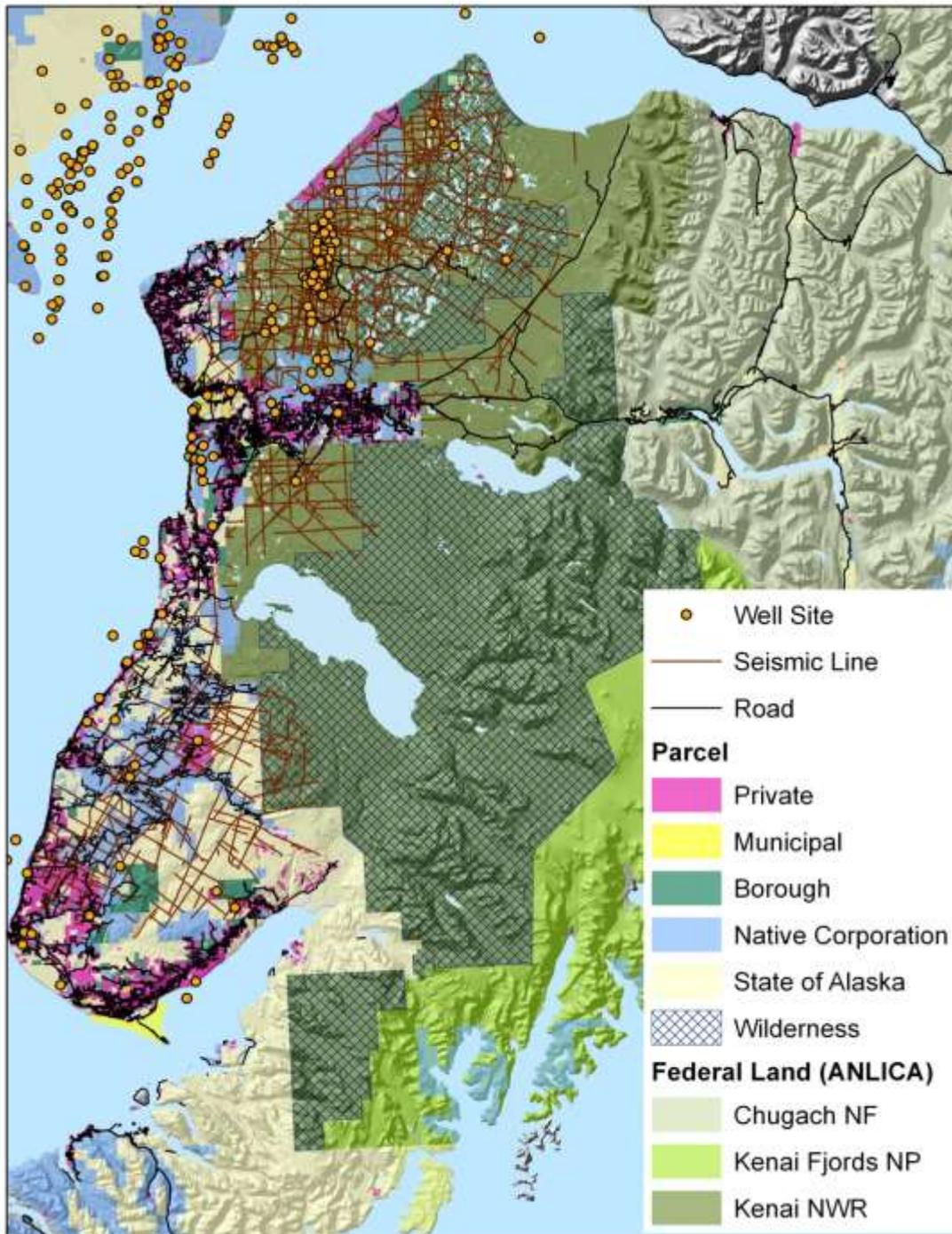
# Invasive plants

- ✓ 115 exotic plant species
- ✓ 27,772 records since 2002
- ✓ >50 species poised to invade from Anchorage



## Rapid parcelization of non-Federal lands

- ✓ ~56,000 people in Kenai Peninsula Borough
- ✓ 238,800 acres on 55,000 private parcels
- ✓ 2.2% human population growth  
= 1,000 new residents/year  
= 1.5 housing units/day
- ✓ 37 miles of Wilderness along  
175 miles wildland-urban interface



# As part of Alaska's "urban refuge", stricter management within Kenai Wilderness

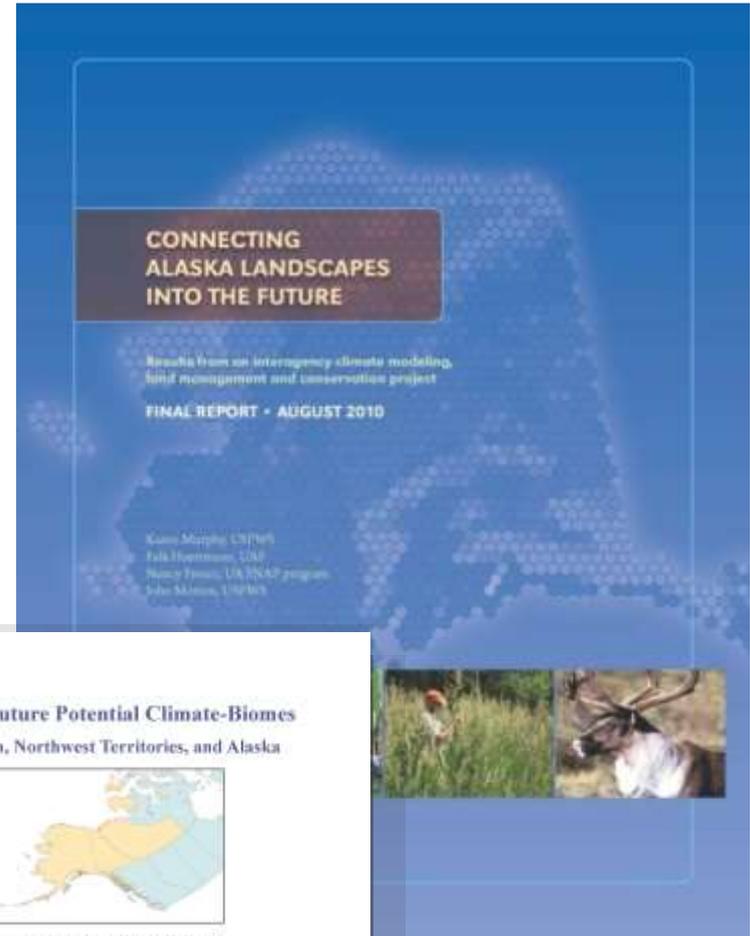
- ✓ **Snowmachines:** closed in alpine tundra and closed elsewhere when snow cover is adequate
- ✓ **Aircraft:** closed on >137 float-plane accessible lakes in Wilderness
- ✓ **Motorboats:** closed in Wilderness canoe systems
- ✓ **Prescribed fire:** to protect life/property or to restore, protect or maintain wilderness values
- ✓ **Hand tools:** used to maintain horse-packing and hiking trails



# Aggressive restoration outside Wilderness to maintain naturalness



# Interagency effort to assess climate change effects on biome distributions



## Predicting Future Potential Climate-Biomes for the Yukon, Northwest Territories, and Alaska



*A climate-linked cluster analysis approach  
to analyzing possible ecological refugia  
and areas of greatest change*

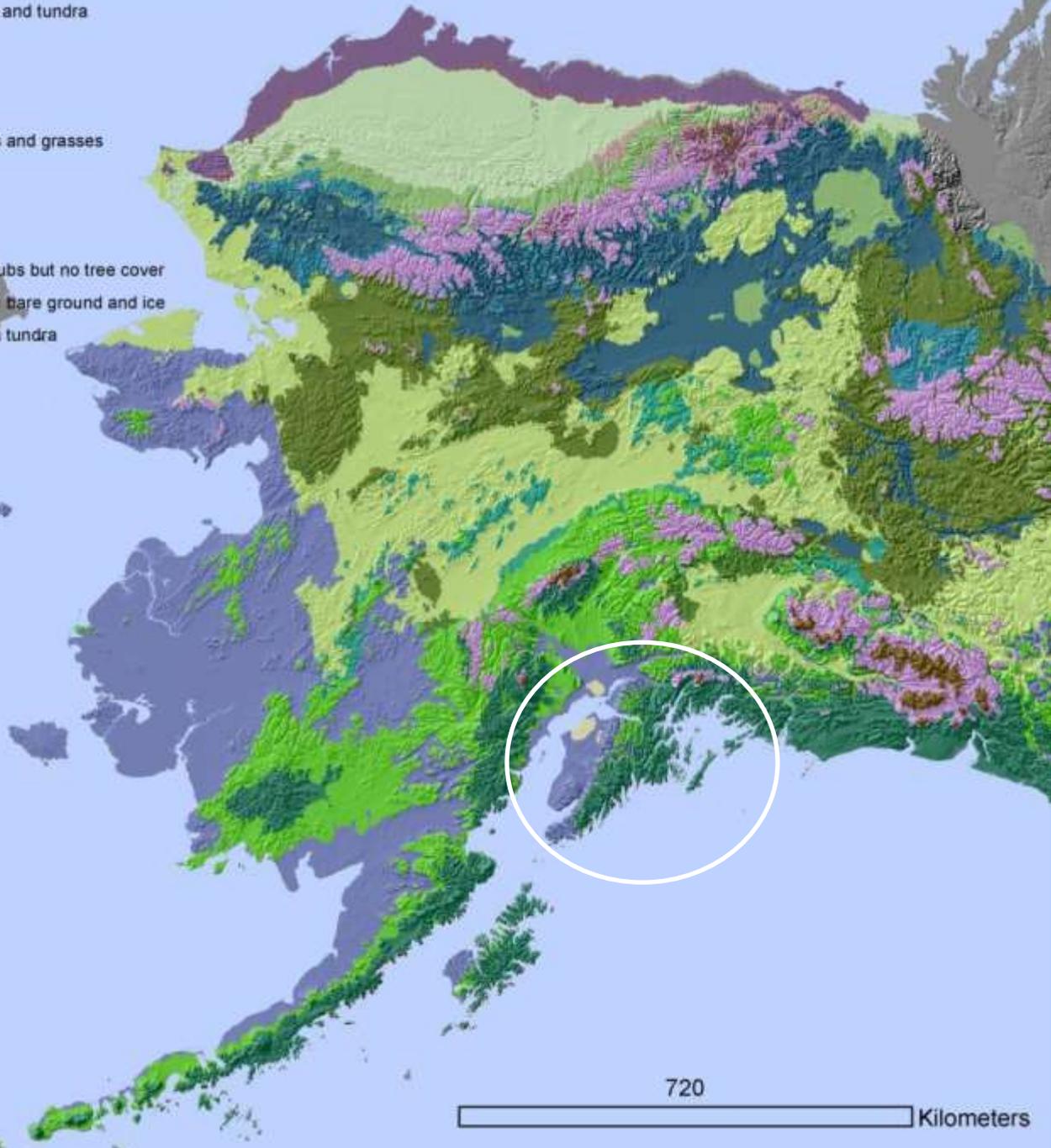
Prepared by the Scenario Network for Arctic Planning  
and the ESWHALE lab, University of Alaska Fairbanks

on behalf of

The Nature Conservancy's Canada Program  
Arctic Landscape Conservation Cooperative  
The US Fish and Wildlife Service  
Ducks Unlimited Canada  
Government Canada  
Government Northwest Territories



- 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



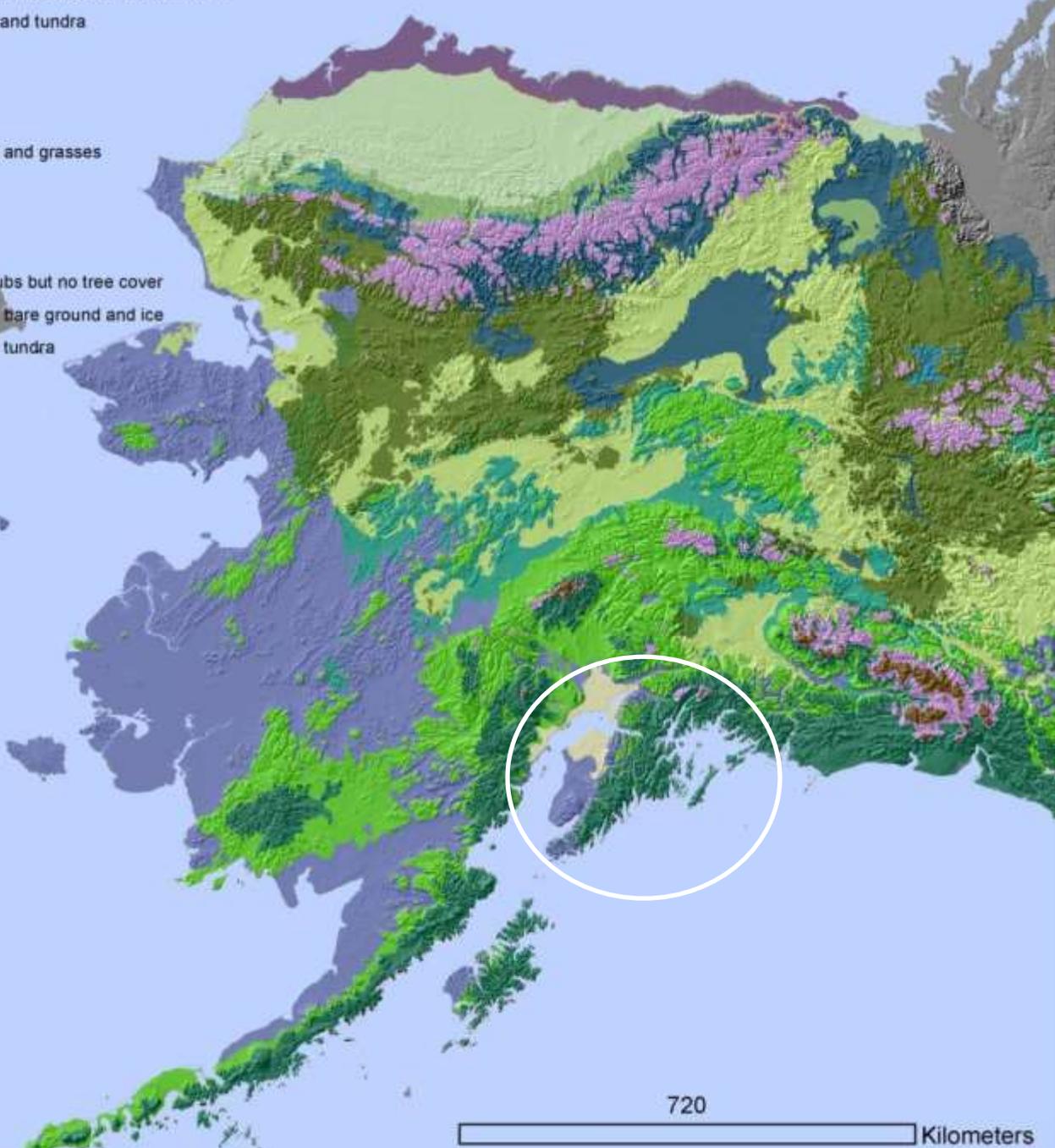
**2009**

720 Kilometers

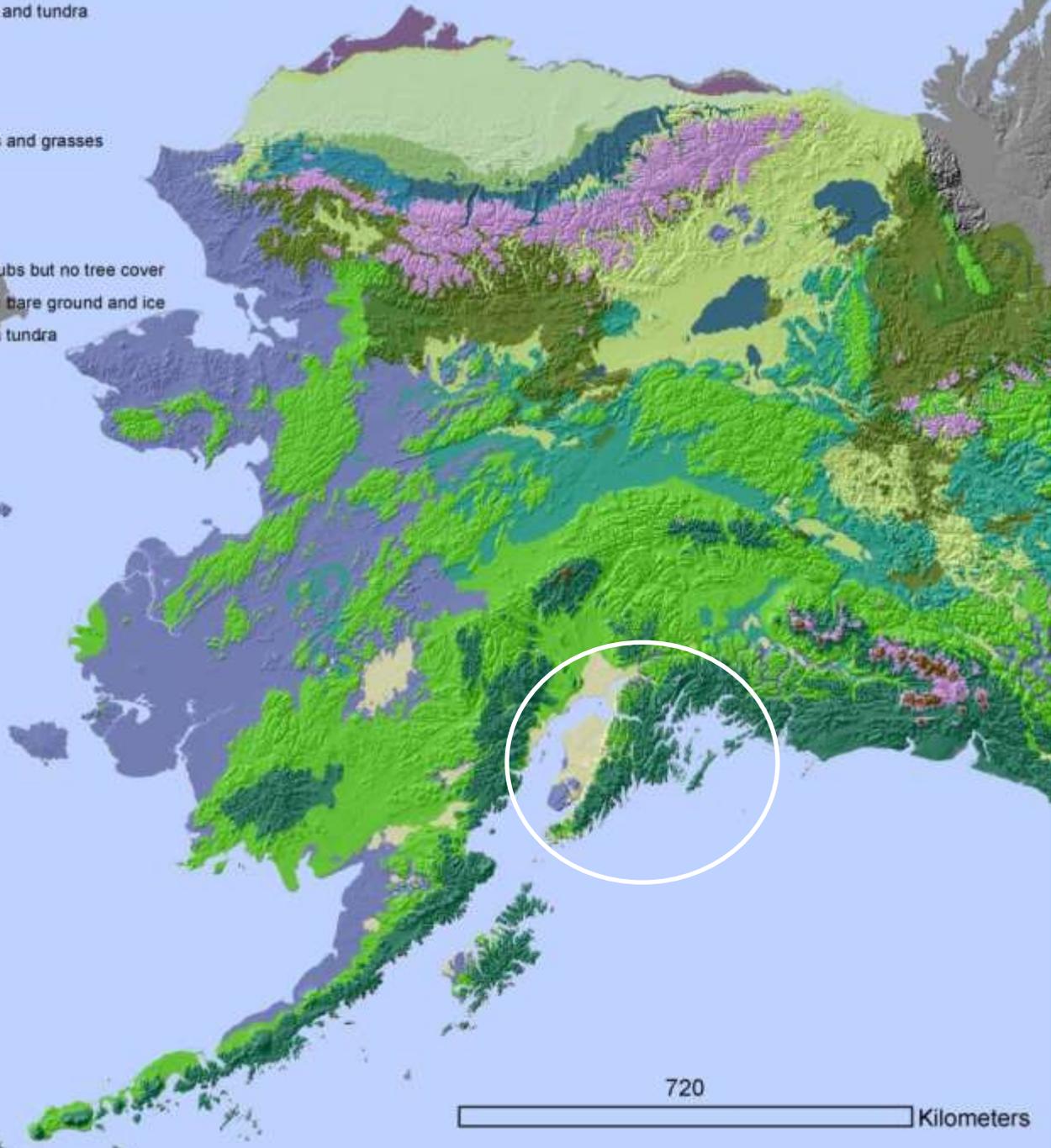
- Arctic tundra with denser vegetation and more shrub cover including some small trees
- Boreal forest with coastal influence and intermixed grass and tundra
- Coastal rainforest, wet, more temperate
- Cold northern boreal forest
- Densely forested southern boreal
- Dry boreal wooded grasslands - mixed 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

**2039**

720 Kilometers



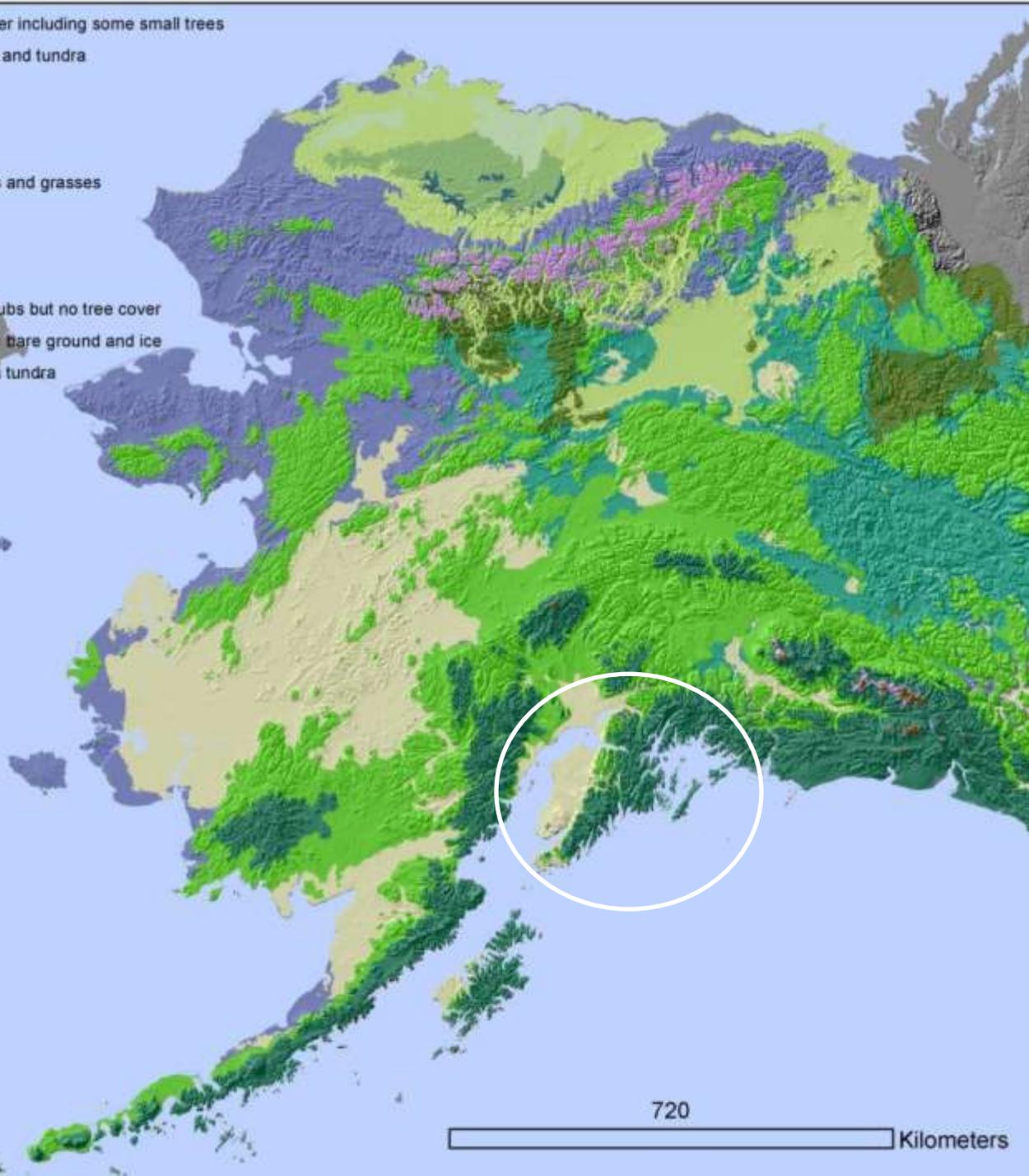
- Arctic tundra with denser vegetation and more shrub cover including some small trees
- Boreal forest with coastal influence and intermixed grass and tundra
- Coastal rainforest, wet, more temperate
- Cold northern boreal forest
- Densely forested southern boreal
- Dry boreal wooded grasslands - mixed 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



**2069**

720 Kilometers

- 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



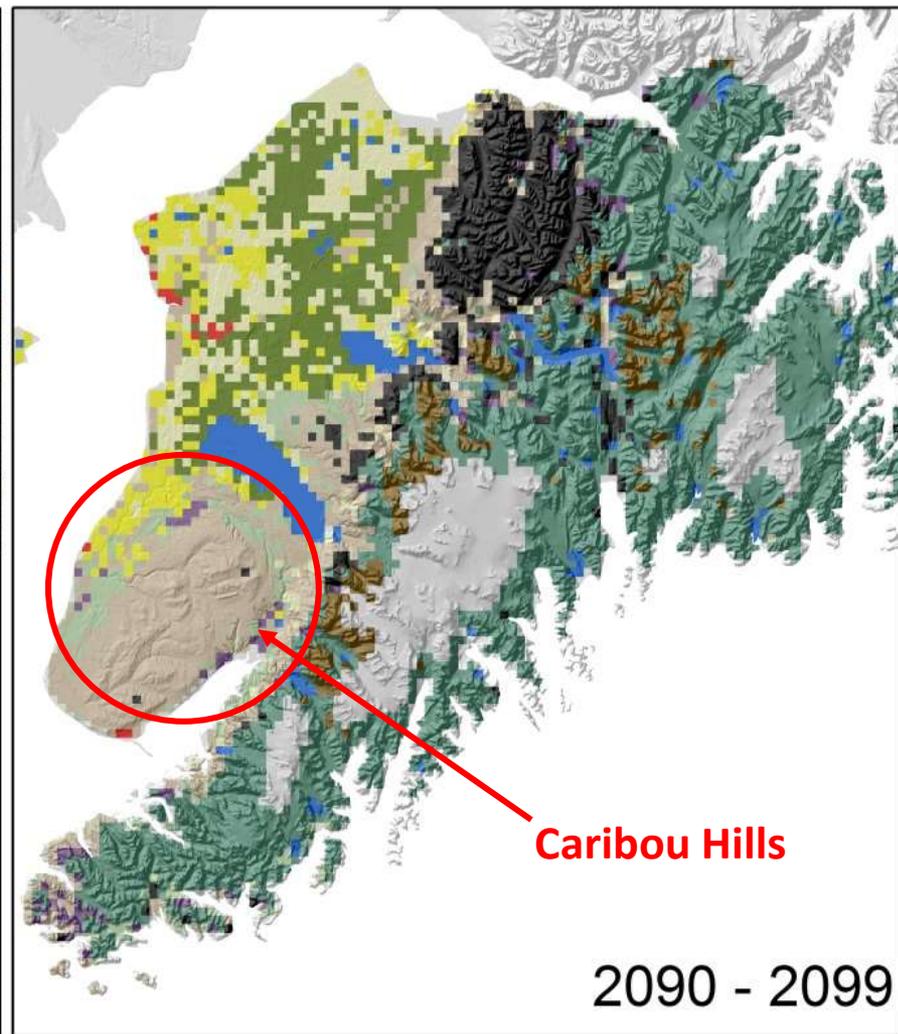
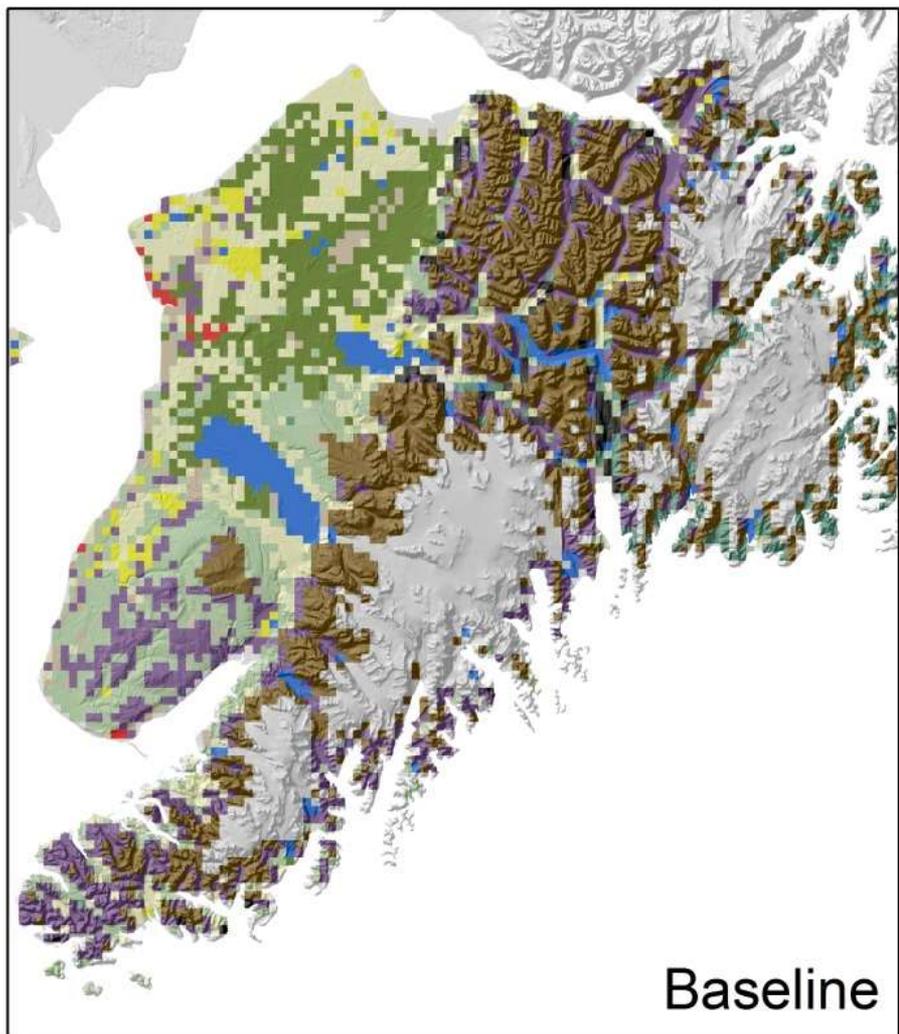
**2099**

720 Kilometers

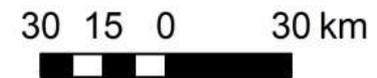
# Forecasting the Kenai Peninsula's landscape through 2100

- ✓ Climate envelope modeling using Random Forests™
- ✓ A1B scenario decadal averages for temperature, precipitation (SNAP)
- ✓ landcover type with greatest % cover in 2km pixels
- ✓ if previous landcover type for each timestep (2039, 2069, 2099)  $P > 0.5$  then stay; if  $P < 0.5$  then landcover type with highest probability



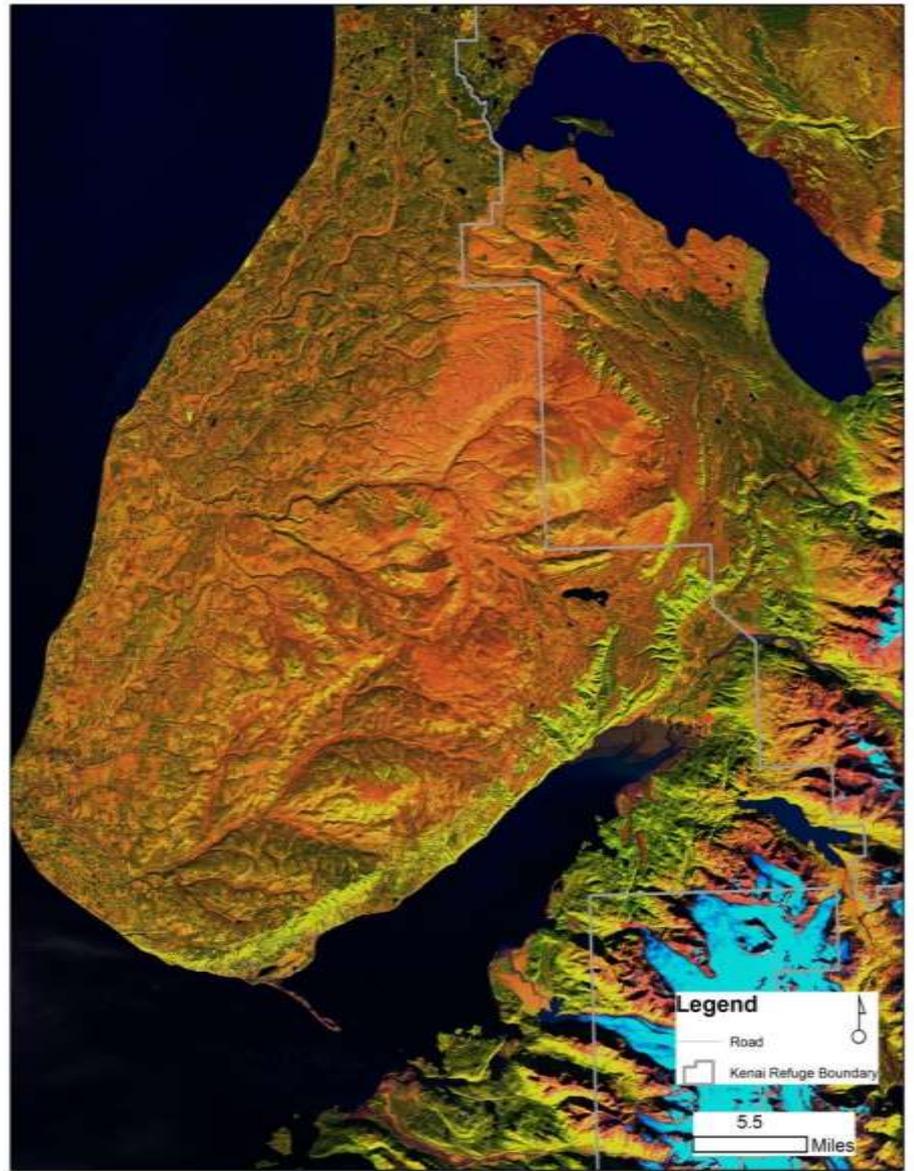


- |               |               |                    |
|---------------|---------------|--------------------|
| Alpine        | Herbaceous    | Mountain Hemlock   |
| Anthropogenic | Ice           | Shrub              |
| Black Spruce  | Mixed Conifer | Water              |
| Deciduous     | Mixed Forest  | White-Sitka Spruce |





**SEPT 1985**

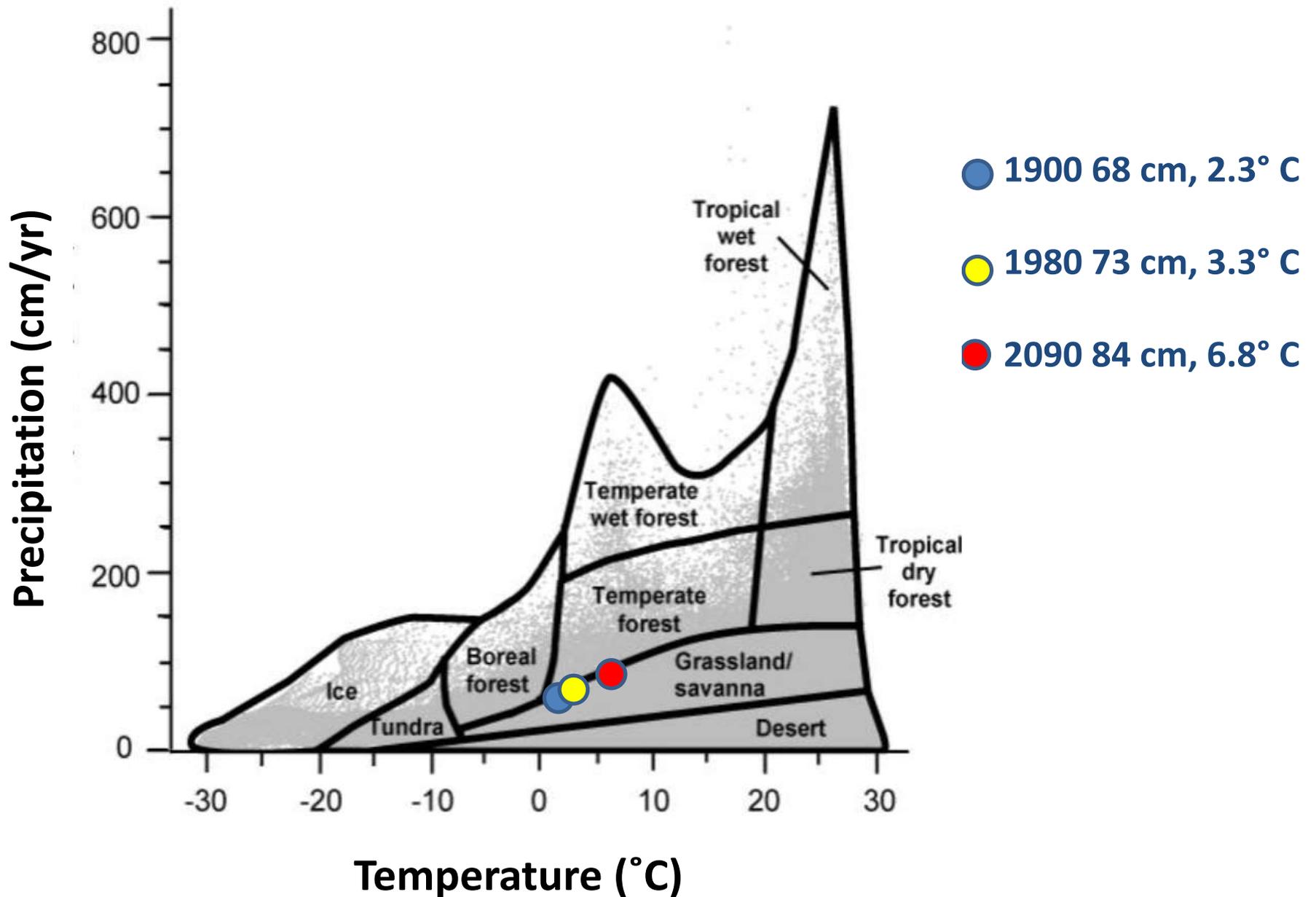


**SEPT 2014**



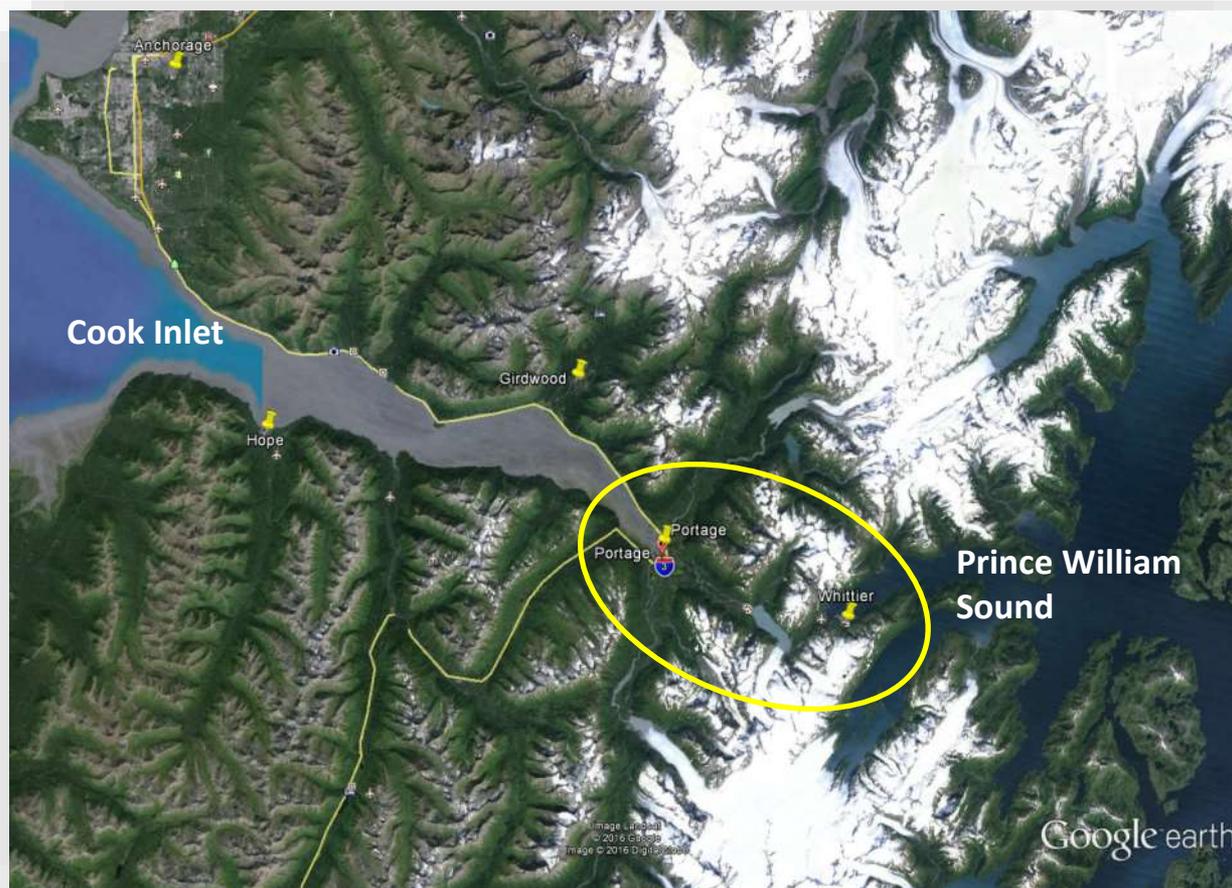
2015/07/19





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

# 10-mile wide isthmus is a migration barrier



Wilson et al. 2015



Tomasik and Cook 2005



Jackson et al. 2008



**> 138 exotic species of flora (108) and fauna (30) on Kenai Peninsula are poised to fill novel assemblages...**



# Some fauna deliberately introduced

Sitka black-tailed deer	1916	Cordova Chamber of Commerce
Ruffed grouse	1952	ADF&G
Grayling, rainbow	1952	USFWS
Northern pike	1970s	citizen
Lodgepole pine	1970s	AK State Forestry
Blackfish	1990s	citizen
<i>Lathrolestes thomsonii</i>	2004	US Forest Service



# >60 tree species deliberately introduced



- Ash (green)
  - Birch (Rocky Mountain white, weeping)
  - Elm (Siberian)
  - Linden (big leaf, little leaf)
  - **Maple (Amur, Norway, red, silver, Tatarian)**
  - Mountain ash (European/S. aucuparia)
  - Oak (Burr, Red)
  - Russian olive
  - Poplar (Norway)
  - Willows (11 species)
  - Many fruit tree varieties (e.g., Bird's cherry)
- 
- Cedar (Western red, white)
  - **Dawn redwood (Metasequoia)**
  - Fir (balsam, Douglas, grand, Korean, Sakhalin, Shasta red, silver, subalpine, white)
  - Hemlock (Eastern)
  - Juniper
  - Larch (Alaska, Dahurian, Siberian, Western)
  - Pine (Austrian, bristlecone, Eastern white, lodgepole, limber, Manchurian, Mugo, Ponderosa, Scotch, Siberian, Western white)
  - Spruce (Black Hills, blue, dwarf Alberta, Englemann, Norway)



# 2 questions we need to ask ourselves....

A photograph of a beach at sunset. The sky is a mix of blue, purple, and orange. The ocean is calm, reflecting the sky. In the foreground, there is a dark, sandy beach. In the middle ground, several polar bears are wading in the shallow water. They are surrounded by many seagulls. The scene is peaceful but carries a message of environmental concern.

*What's the risk of doing nothing?*

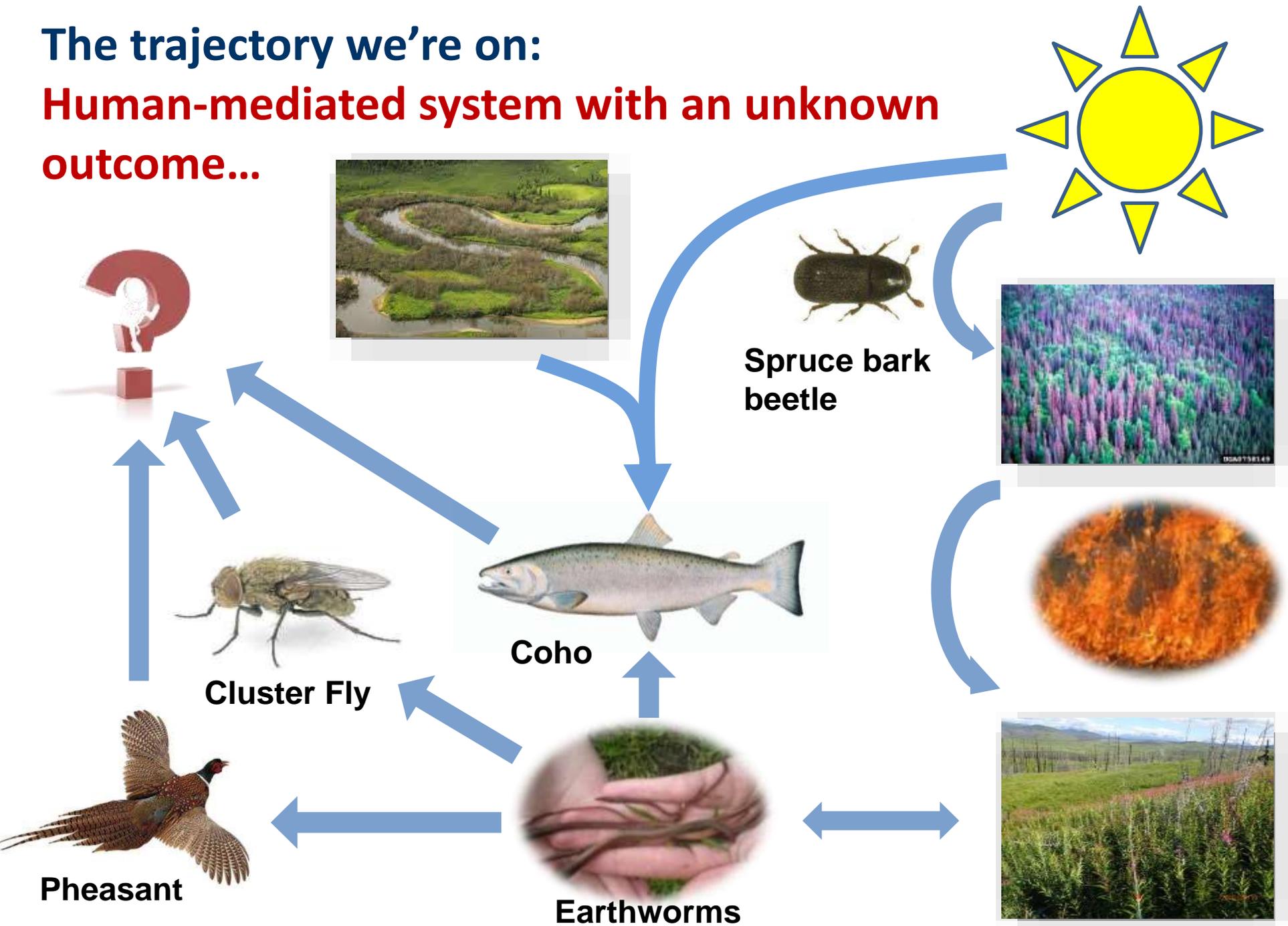
*What's the risk of doing something wrong?*

----Rosa Meehan

10 Feb 2010

The trajectory we're on:

**Human-mediated system with an unknown outcome...**



DECREASING UNCERTAINTY BUT REDUCED OPPORTUNITY TO STEWARD THE OUTCOME

FOREST

LOGEPOLE PINE



BLACK-TAILED DEER



CURRENT TRAJECTORY (Wilderness???)

INTRODUCED GRAZERS

GRASS

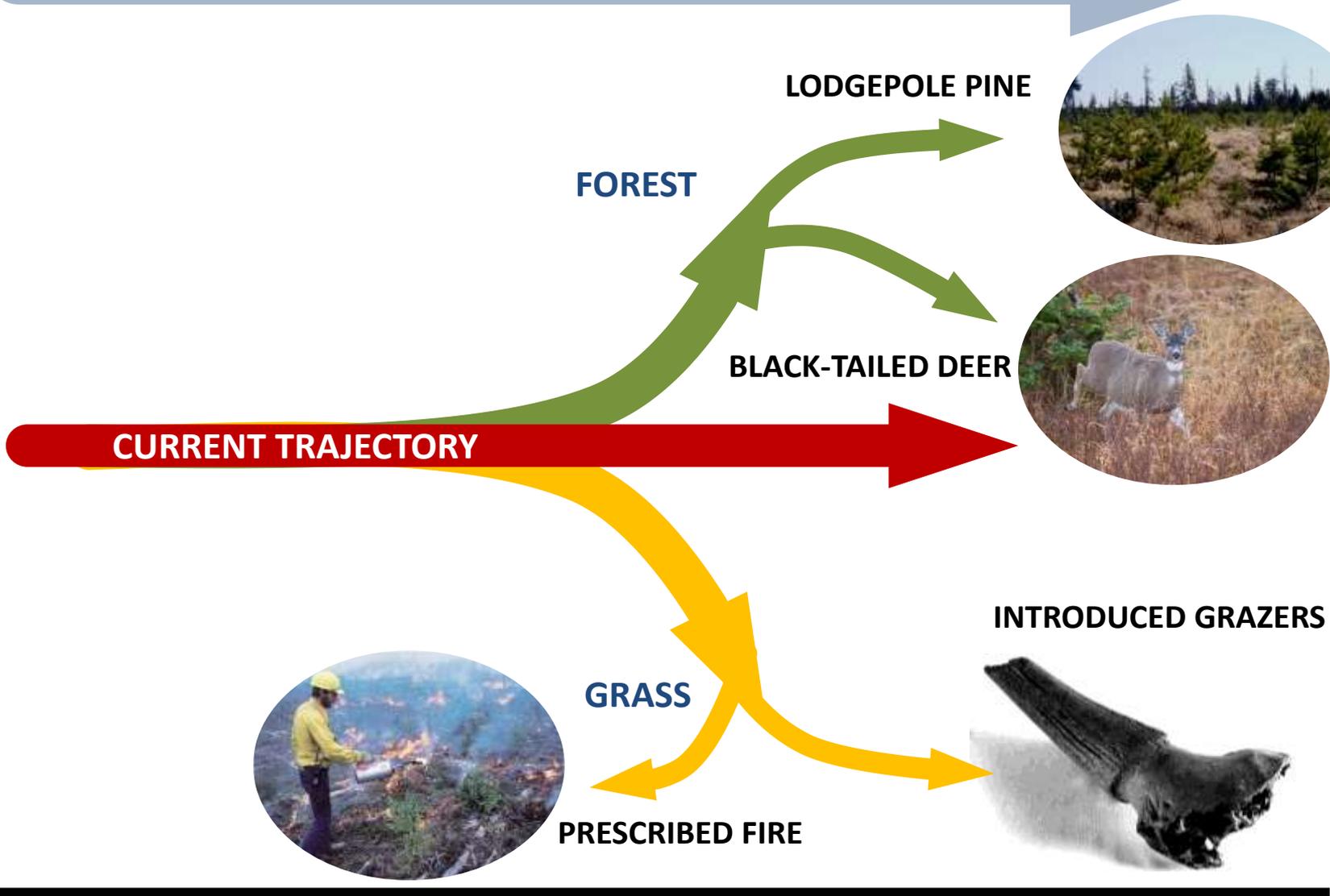


PRESCRIBED FIRE



TIME

DECREASING UNCERTAINTY BUT REDUCED OPPORTUNITY TO STEWARD THE OUTCOME



**TIME**

Klein and Reger 2015

# 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 isthmus and rainshadow of Kenai Mountains
- ✓ Novel assemblages ≠ simple re-shuffling of native flora and fauna
- ✓ Many exotic species already introduced and more *en route*
- ✓ And we squander our early opportunities to steward outcomes!

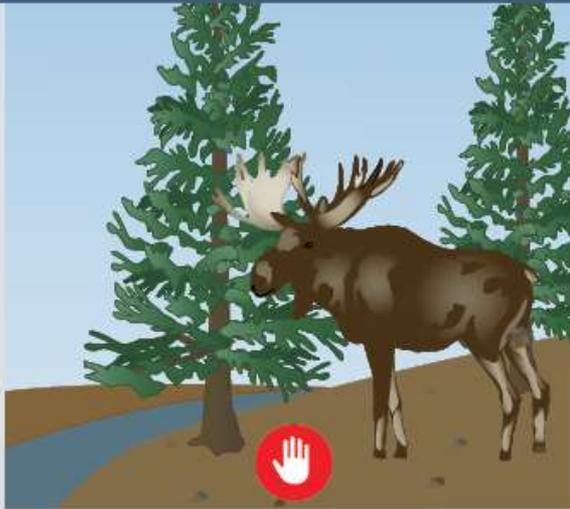
# The RAD Decision Framework

## RESIST

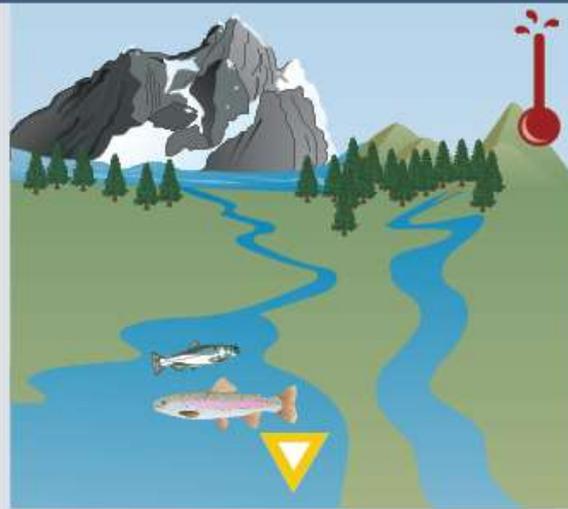
## ACCEPT

## DIRECT

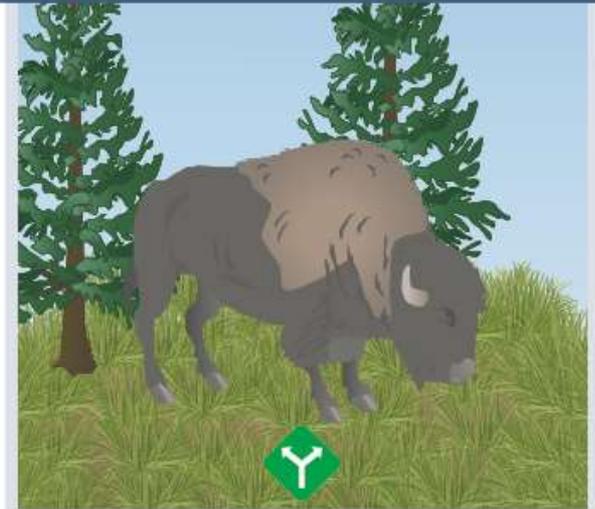
### Kenai Peninsula, Alaska: A Case Study



Stream banks are restored, some invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Many invasives are not managed either due to infeasibility or lack of perceived threat.



Glaciers are melting, non-glacial streams are warming, tree line is rising, and wetlands are drying. Yet, the effects have not been severe enough to prompt a management response. Society has accepted the changes in fish and wildlife communities, even with higher costs to ecosystem services.



A spruce bark beetle epidemic and human-caused fire have shifted white spruce forests into a novel grassland ecosystem. Non-native trees are being planted, and the introduction of large grazers is being considered to stabilize the new grasslands and related communities.

THE BALANCING ACT: ECOLOGICAL INTERVENTIONS AND DECISION TRADEOFFS  
TO PRESERVE WILDERNESS CHARACTER

By

LUCILLE ANNA LIEBERMAN

B.A. Philosophy, University of Vermont, Burlington, VT, 2011

Thesis

presented in partial fulfillment of the requirements  
for the degree of

Master of Science  
Environmental Studies

The University of Montana  
Missoula, MT

May 2017

Approved by:

Scott Whittenburg, Dean of The Graduate School  
Graduate School

Dan Spencer, Committee Chair  
Environmental Studies

Len Broberg, Committee Member  
Environmental Studies

Elizabeth Metcalf, Committee Member  
Society and Conservation

**“Ecological interventions occurred in 37% of the wilderness units sampled (n ~ 500), with the greatest proportion of interventions by agency from the National Park Service.”**

# Questions?

