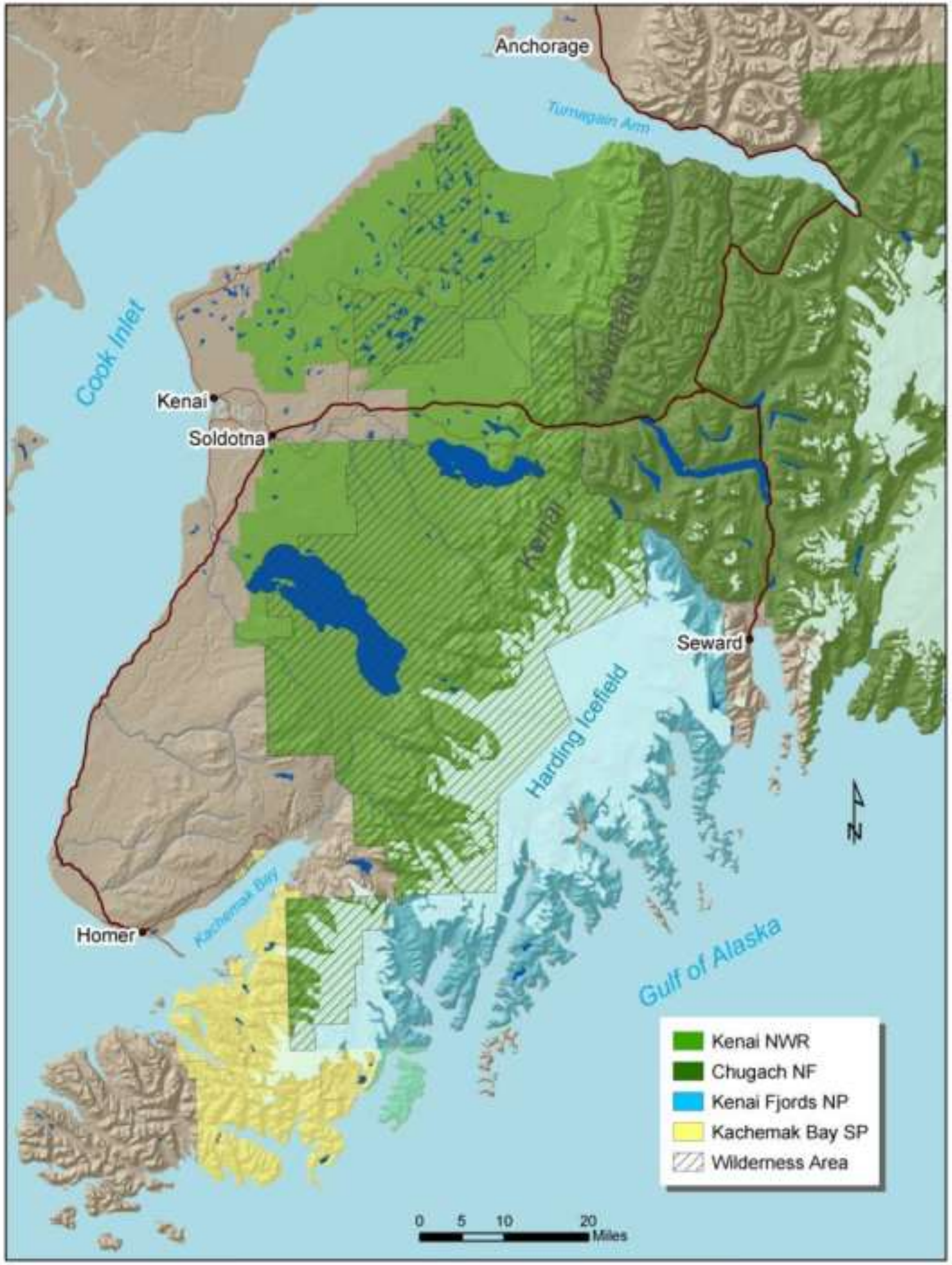
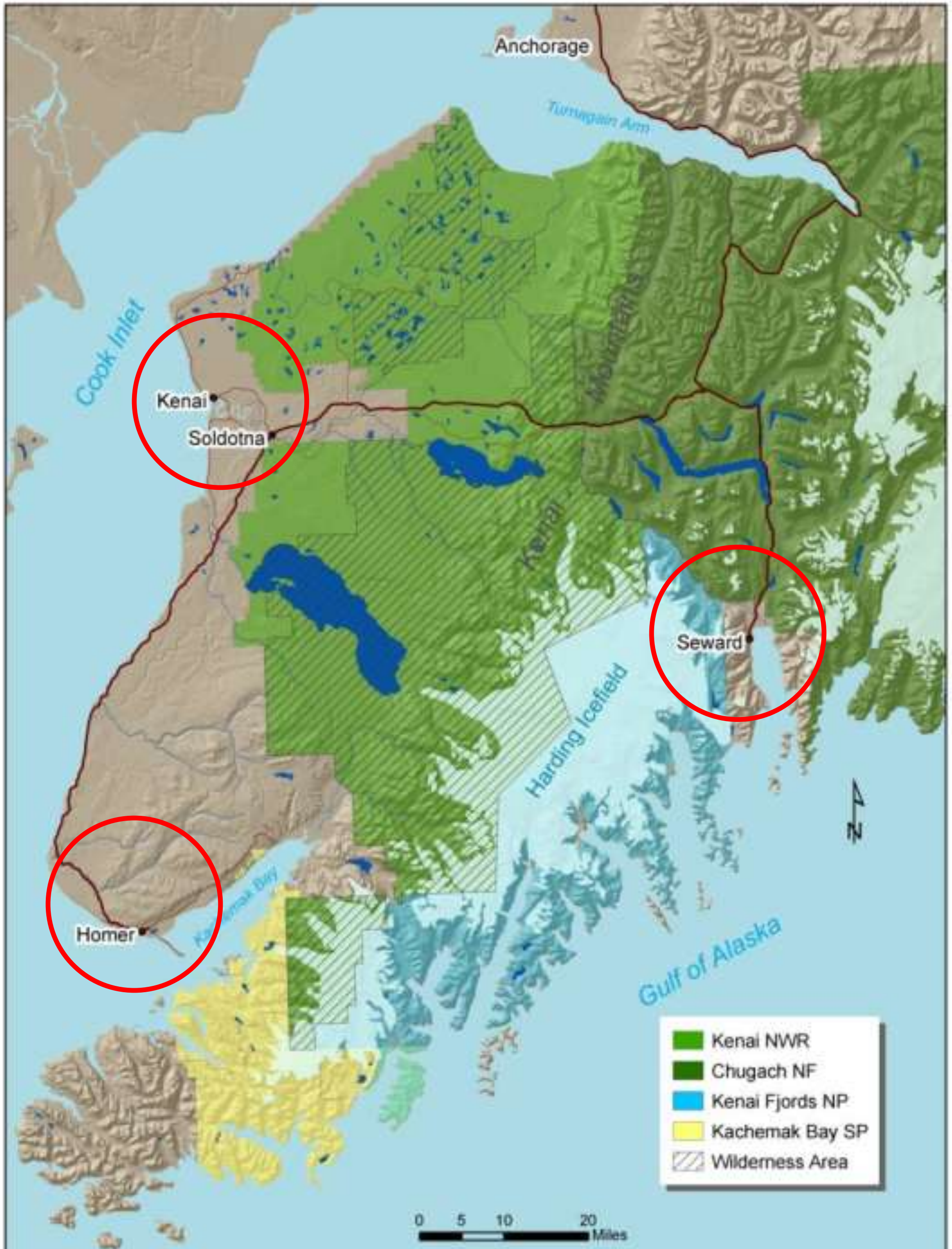
Facilitating ecological transformation on the Kenai Peninsula, Alaska

…the case for doing something versus doing nothing

John Morton
Kenai National Wildlife Refuge

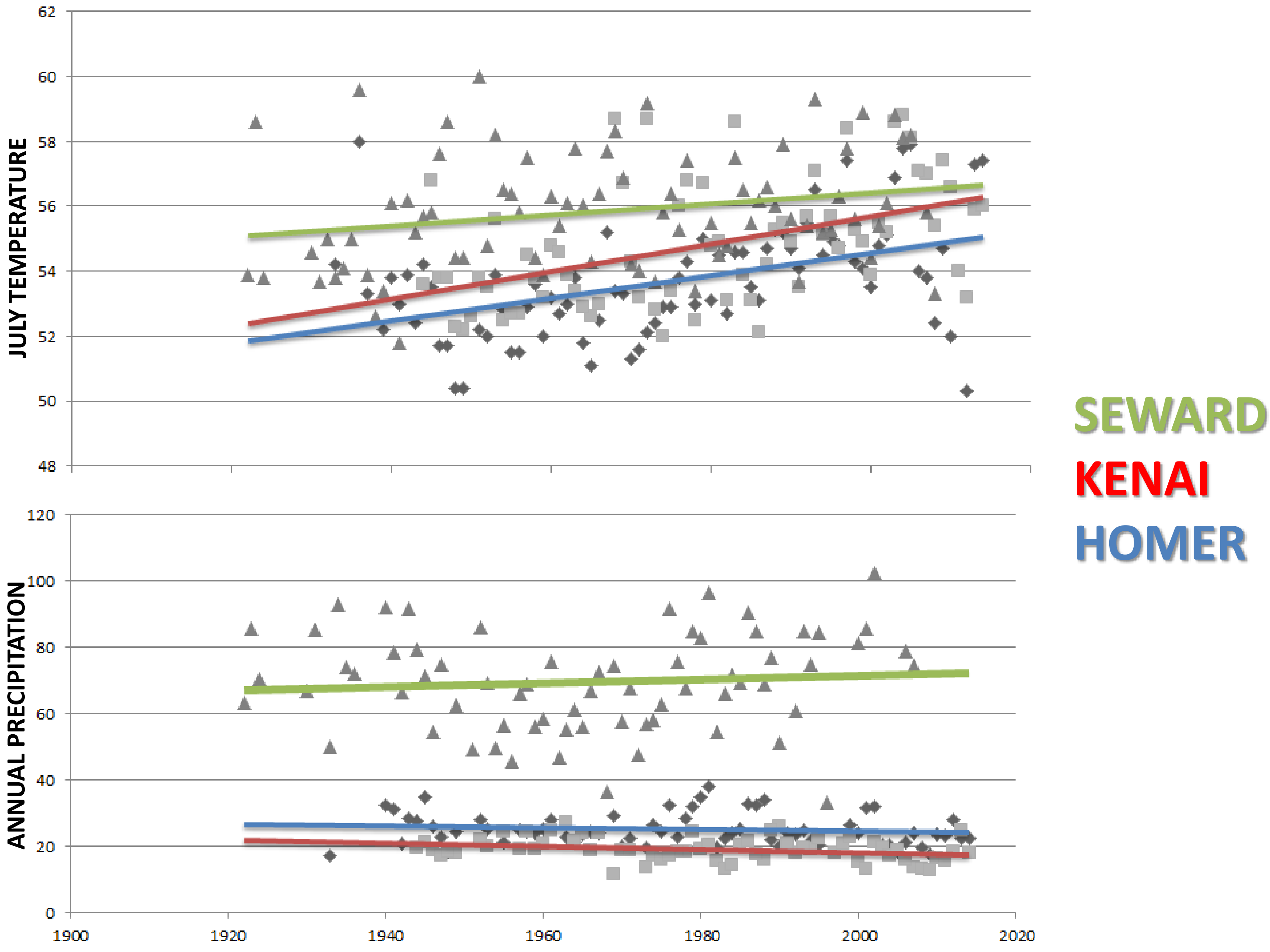


- ✓ Alaska is warming at 2X Lower 48 rate
- ✓ Climate warming effects are not masked by other human-caused drivers of change
- ✓ Kenai Peninsula may be best studied locale in AK outside of high arctic



Conserve fish & wildlife populations and habitats in their *natural diversity* including but not limited to….

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



JULY TEMPERATURE
62
60
58
56
54
52
50
48
ANNUAL PRECIPITATION
120
100
80
60
40
20
0
1900
1920
1940
1960
1980
2000
2020
SEWARD
KENAI
HOMER

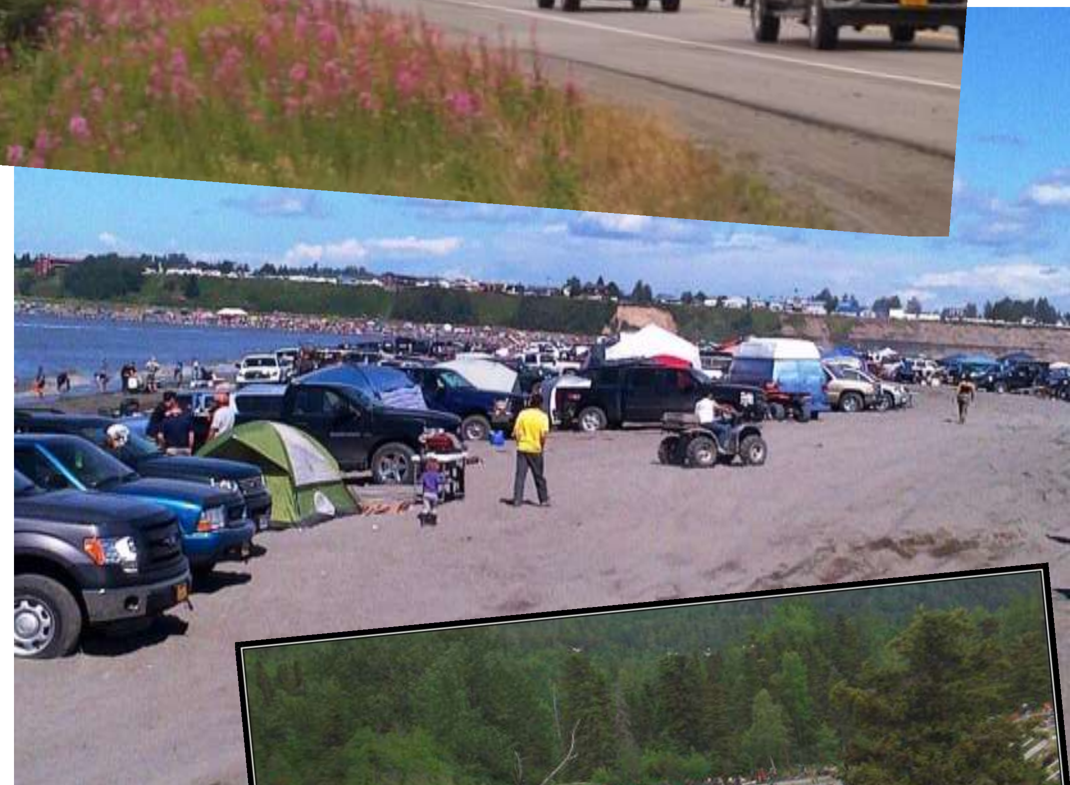

Biomes - 2009
Aleutian Islands
Arctic
Boreal
Boreal Transition
North Pacific Maritime
Western Tundra
N
W
E
S
Arctic Ocean
Chukchi Sea
Beaufort Sea
Kotzebue Sound
Anadyr Gulf
Norton Sound
Bering Sea
Kuskokwim Bay
Bristol Bay
Gulf of Alaska
Pacific Ocean
Arctic
Boreal
Boreal Transition
Western Tundra
North Pacific Maritime
Aleutians
0
125
250
500 Miles












Kenai's landscape has changed dramatically in last 50 years in response to warming and drying

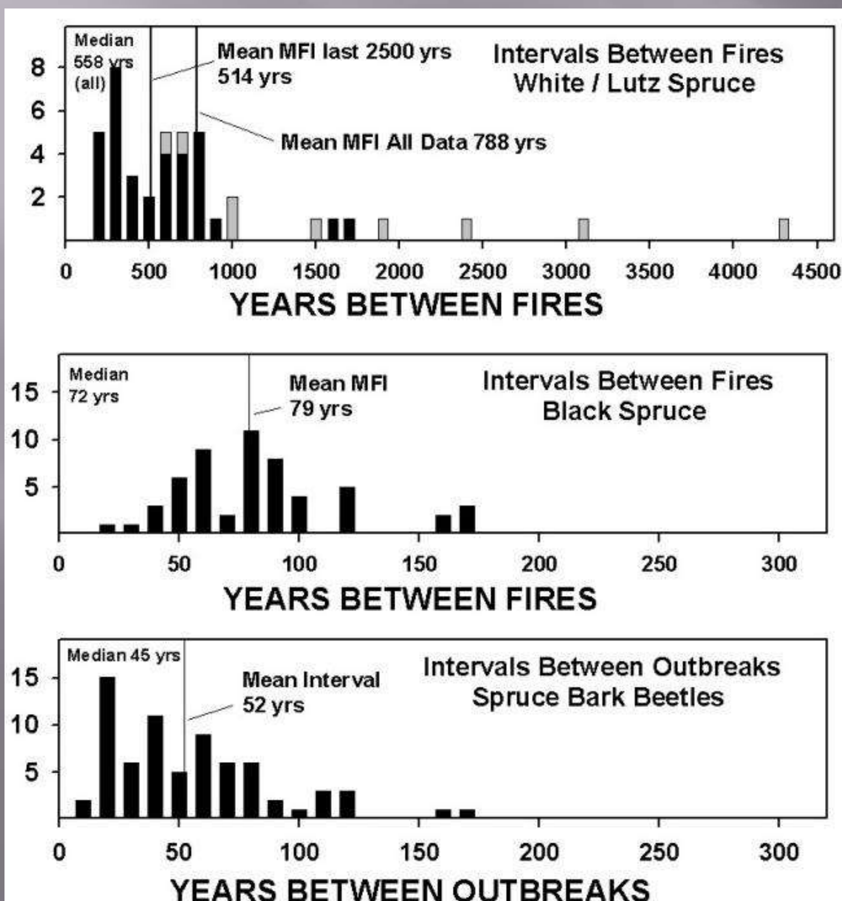
- – available water (60% loss since 1968)
- – wetlands (6 – 11% per decade)
- – glaciers (11% surface area, 30m elevation)
- + treeline (1m per yr, 2.8m per yr)
- + SB beetle outbreaks (triggered by 2 consecutive warm summers)

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

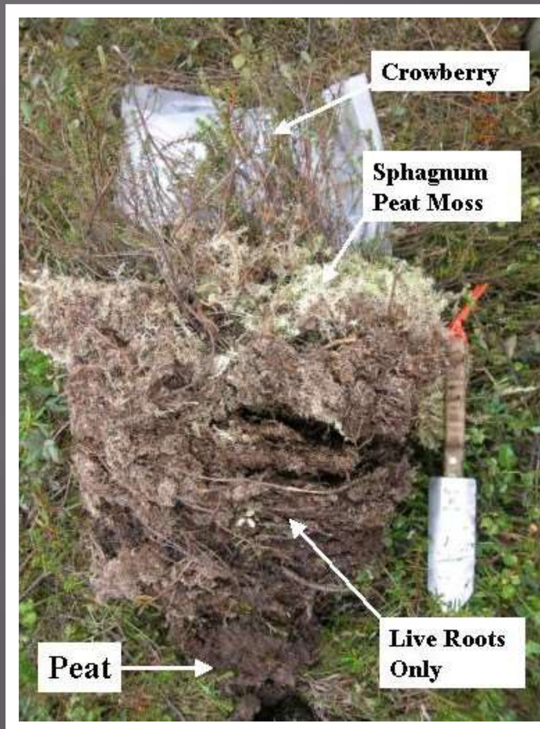
Conversion of white/Lutz spruce forests to Calamagrostis savannah

Boucher and Mead 2006, Bowser et al. 2017

Official fire season is now April 1 instead of May 1

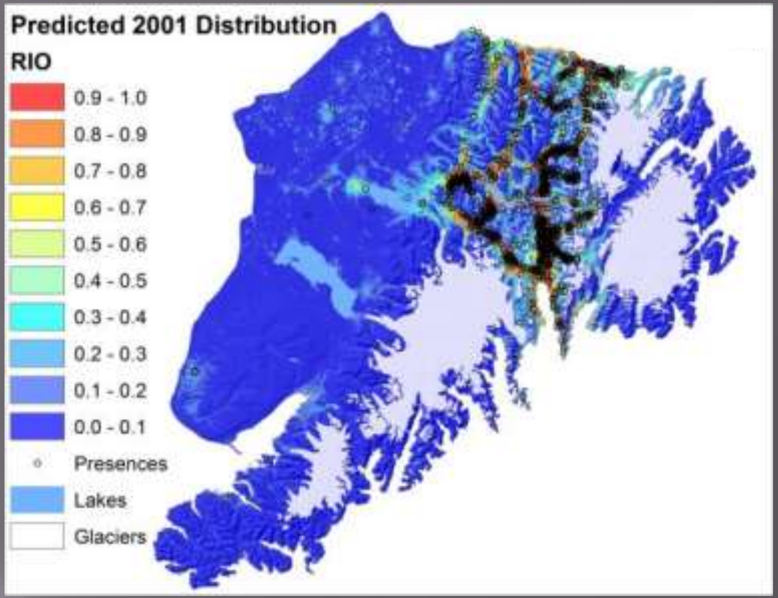


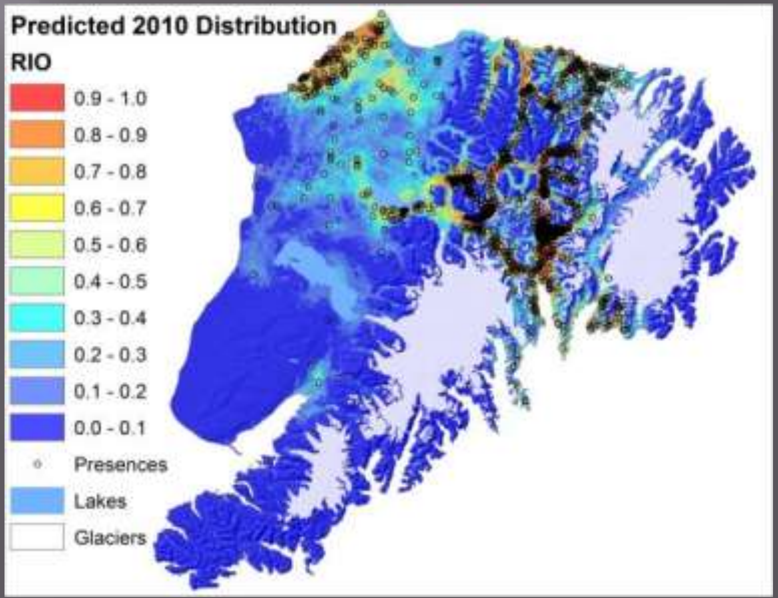
Woody shrub encroachment into 8000 year old Spagnum peatlands



Berg et al. 2009

American marten colonized western Kenai Peninsula ~2002



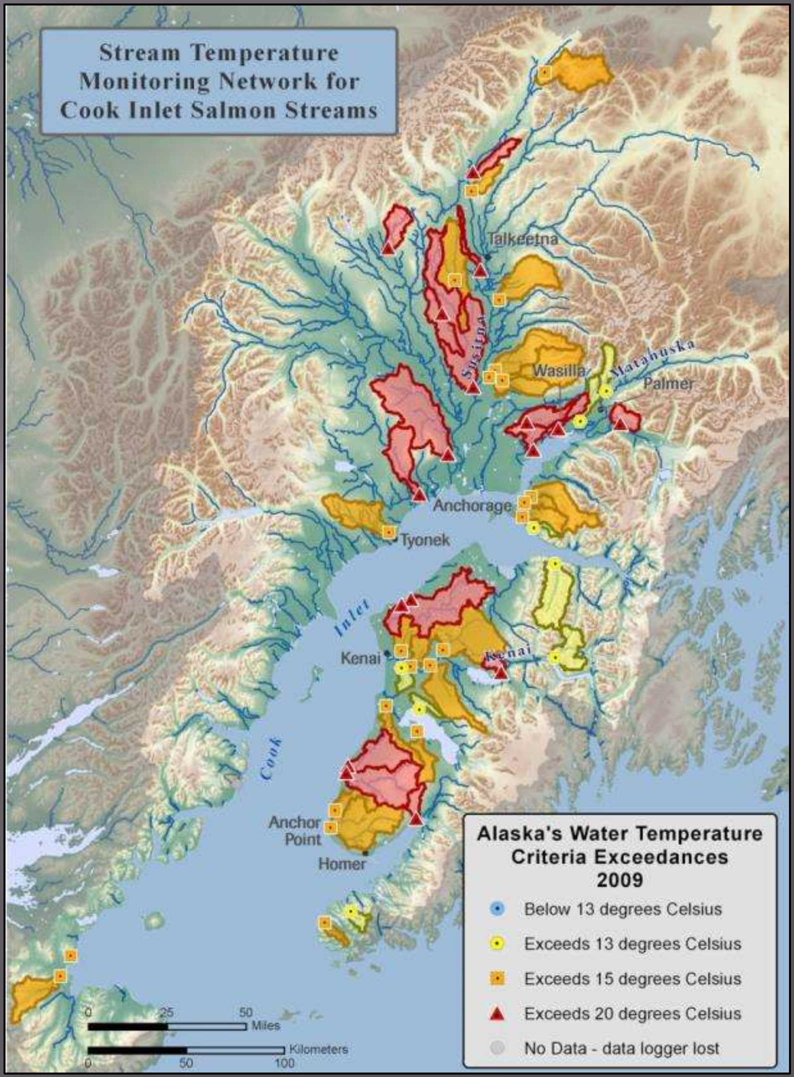


Baltensperger, Morton & Huettmann 2017

Salmon in 47 of 48 non-glacial streams experience thermal stress in July

These maximum temperatures shall not be exceeded:

- egg & fry incubation = 13°C
- spawning areas = 13°C
- migration routes = 15°C
- rearing areas = 15°C
- and may not exceed 20°C at any time



Mauger et al. 2017

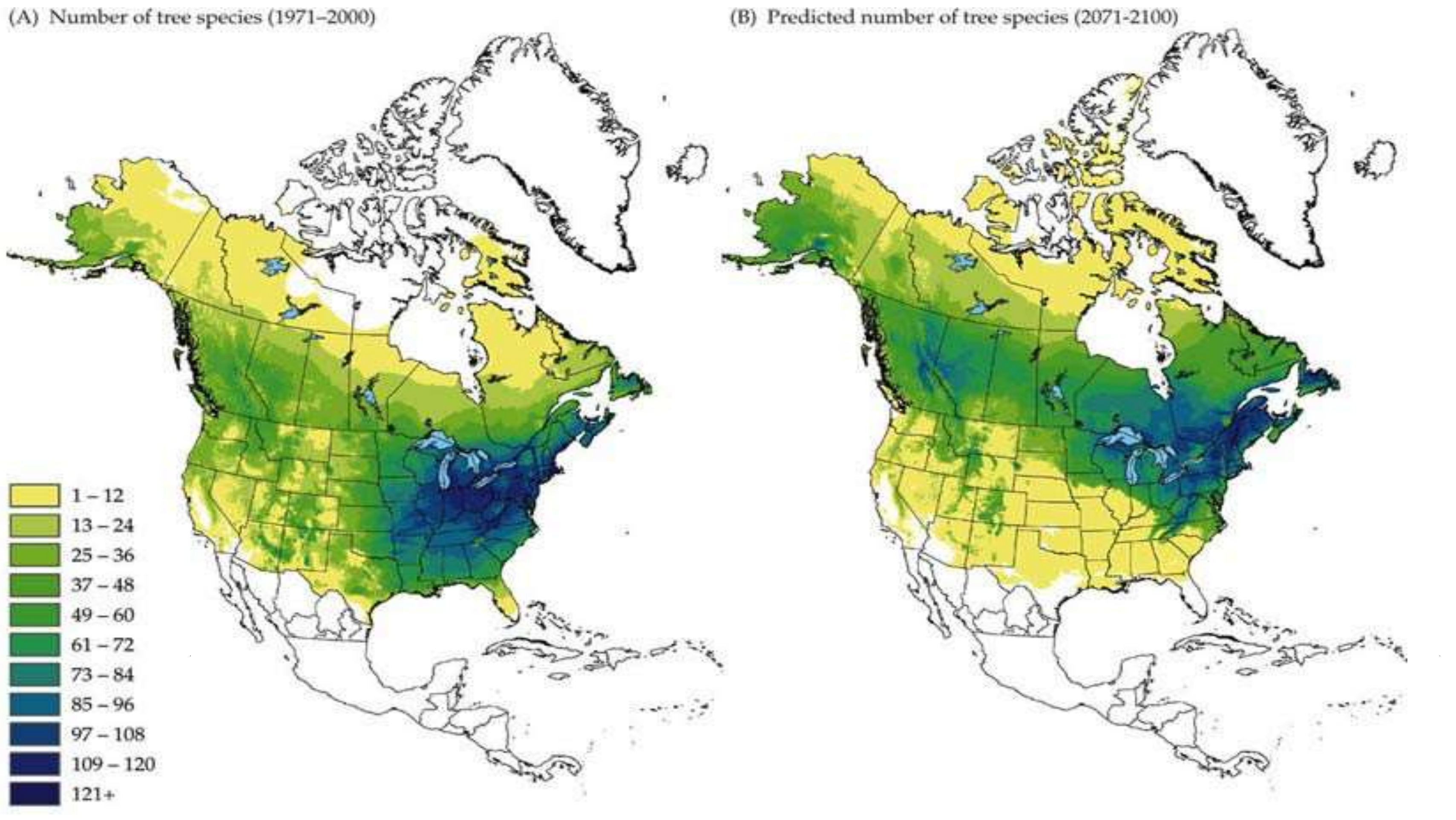
Changing migration window in last decade

eBird data

- ✓ **Earlier arrival records for 33 species**
- ✓ **Later departure records for 38 species**
- ✓ **27 new species since 2007**

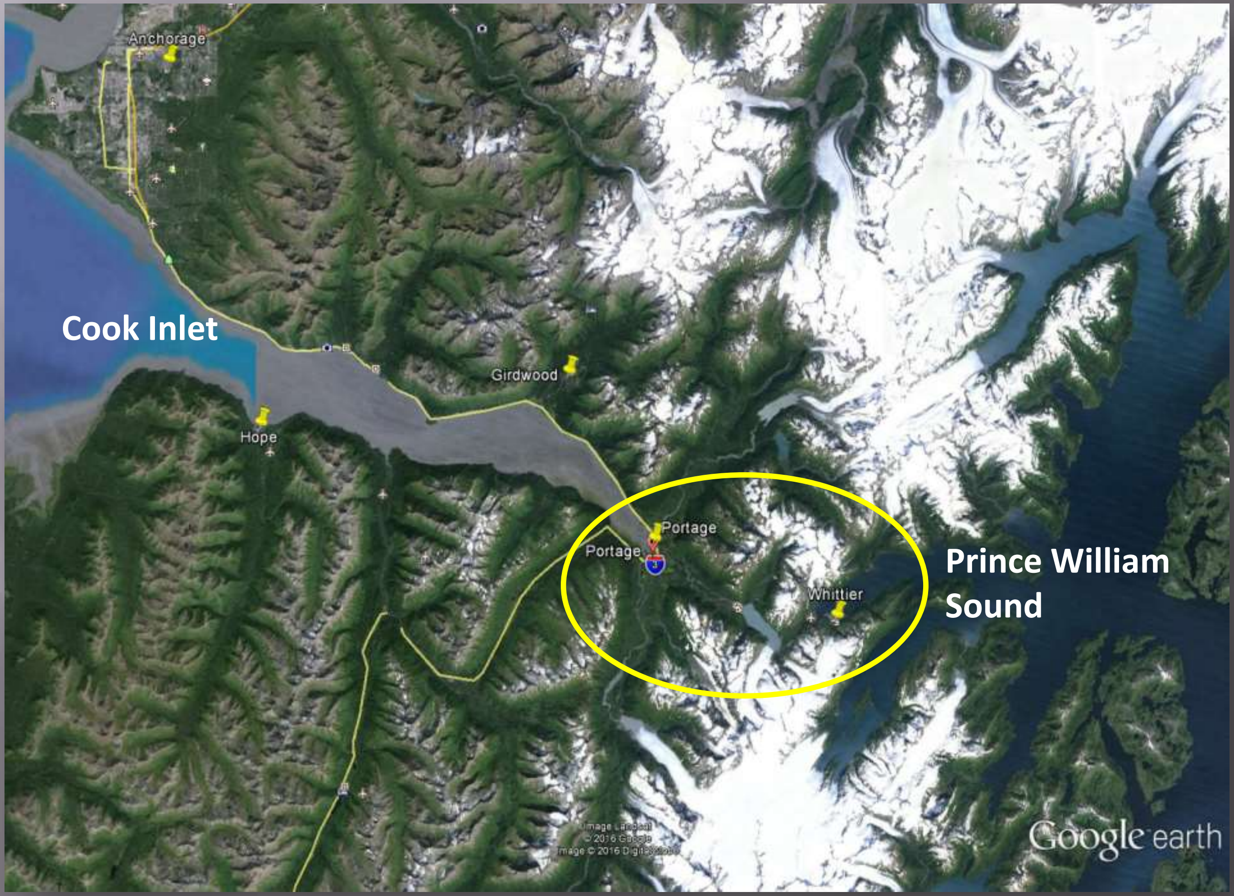
Eurasian-collared dove*
Redwing*
Jack snipe*
Skylark*
Long-billed murrelet*
Black-tailed godwit*
Northern mockingbird
Spotted towhee
Turkey vulture
Western kingbird
Western meadowlark
Willow flycatcher
Northern wheatear
Western tanager
Yellow-bellied sapsucker
Warbling vireo
Swamp sparrow
Tennessee warbler
Cape May warbler
Nashville warbler
Wilsons's phalarope
Great egret
Willet
Red-footed booby
Black guillemot
Heerman's gull
Lesser black-backed gull

Northward migrations of tree distributions



(McKenney et al. 2011)

10-mile wide isthmus is a migration barrier

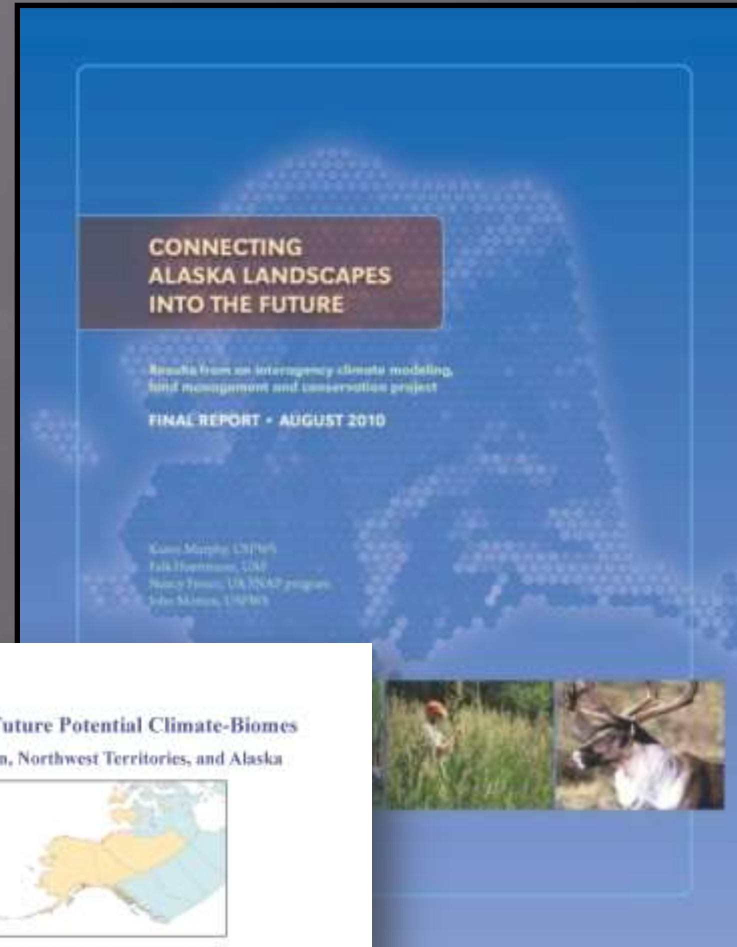


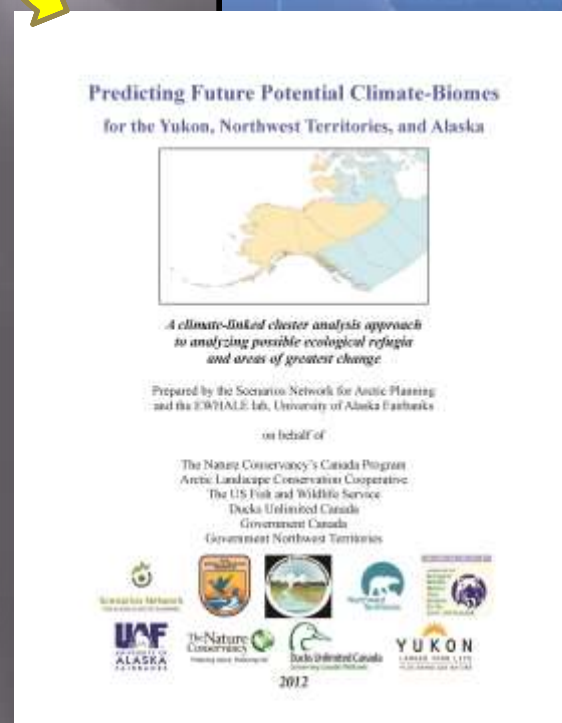
Wilson et al. 2015

Tomasik and Cook 2005

Jackson et al. 2008

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




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

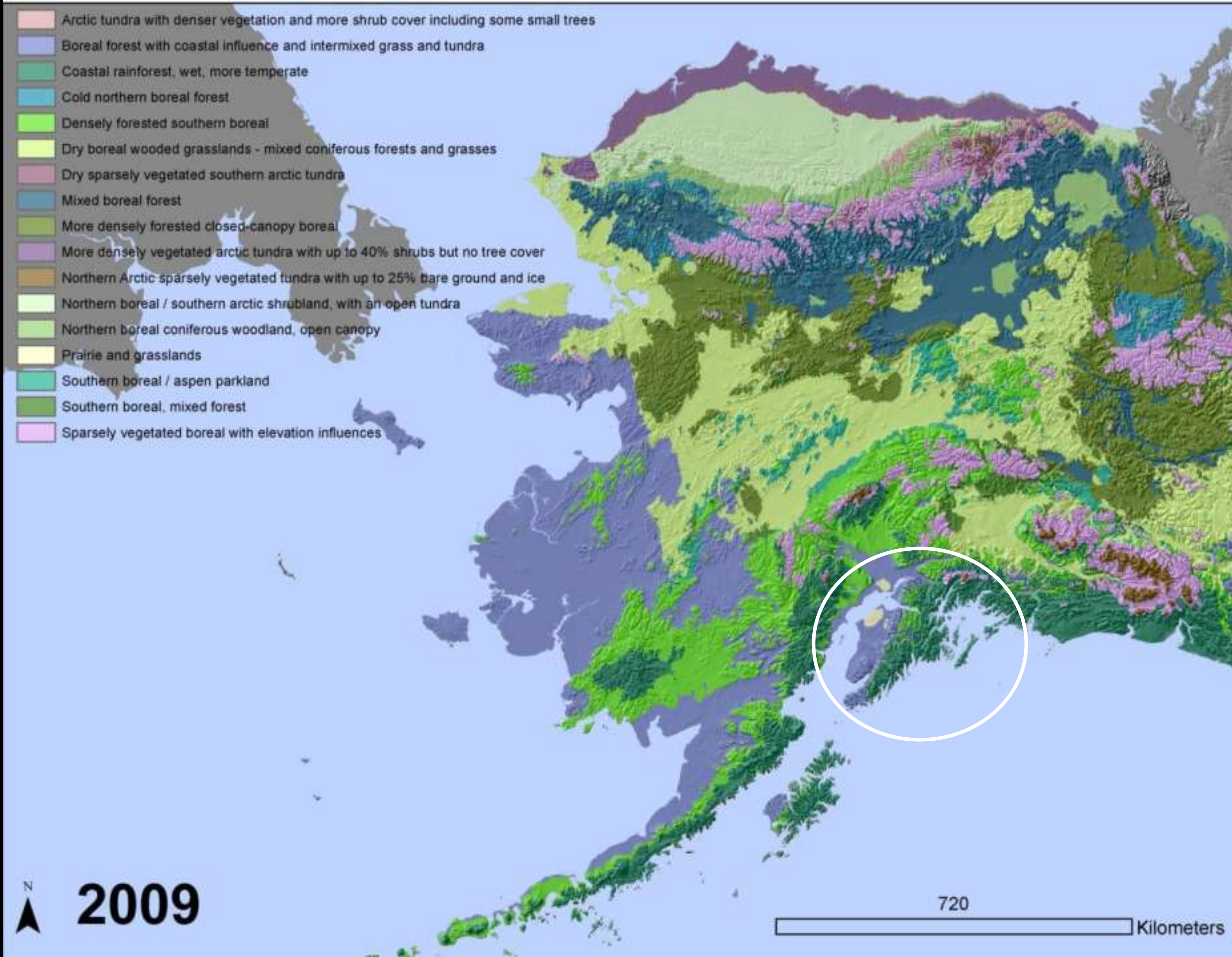
A climate-linked cluster analysis approach to analyzing possible ecological refugia and areas of greatest change

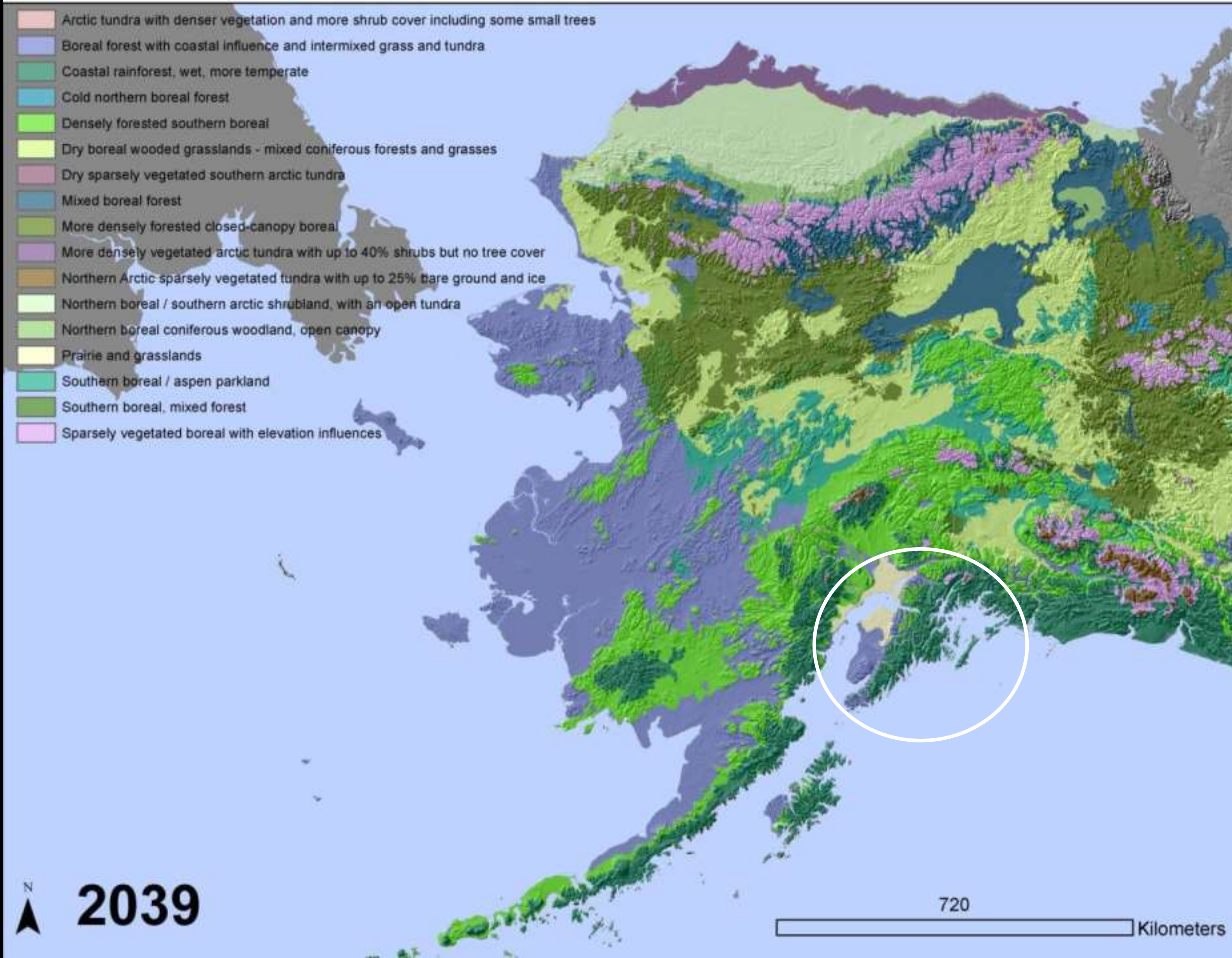
Prepared by the Scenarios Network for Arctic Planning and the EWHALE lab, University of Alaska Fairbanks

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

2012


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
N
2009
720
Kilometers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N
2039
720
Kilometers

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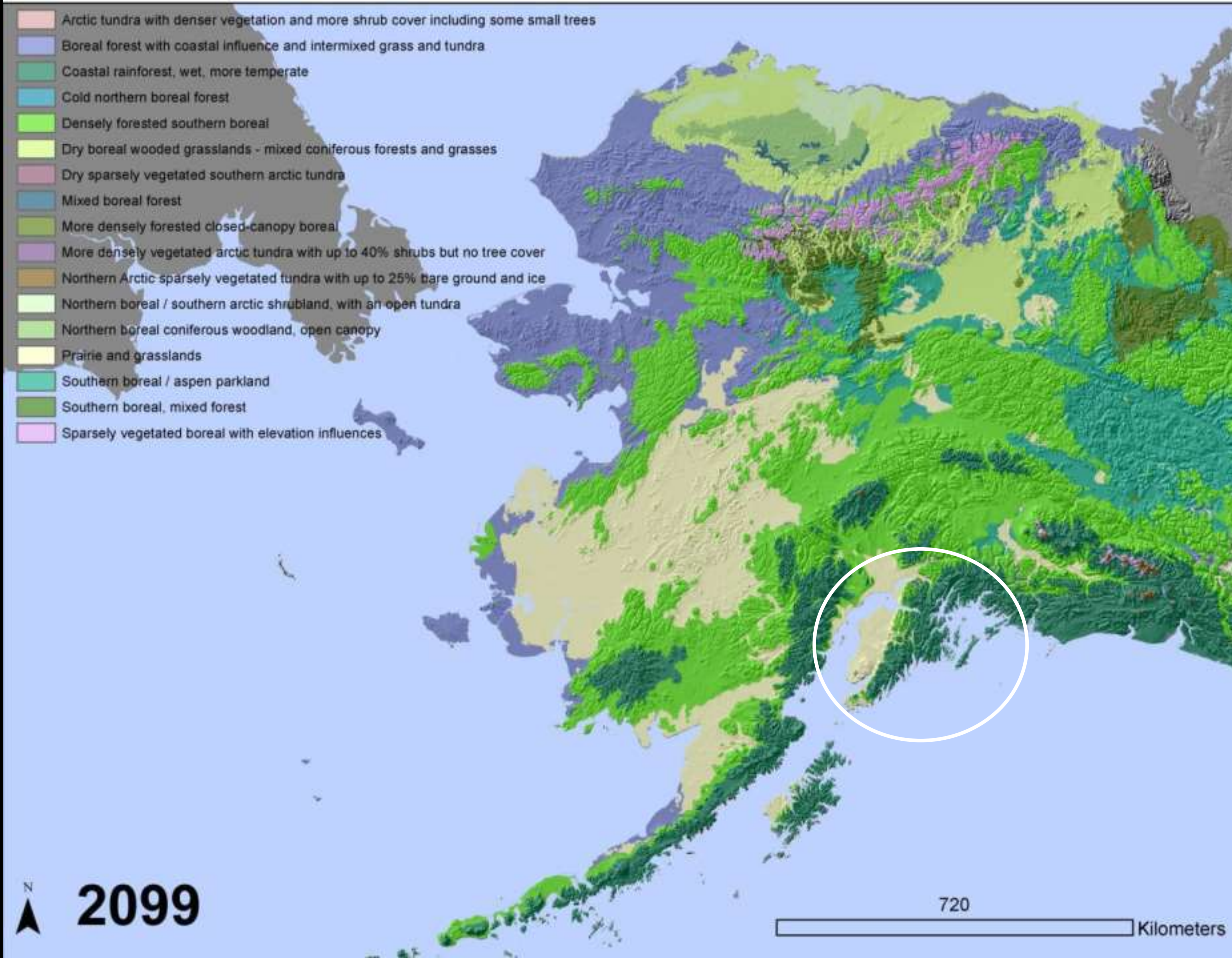
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
N
2069
720
Kilometers



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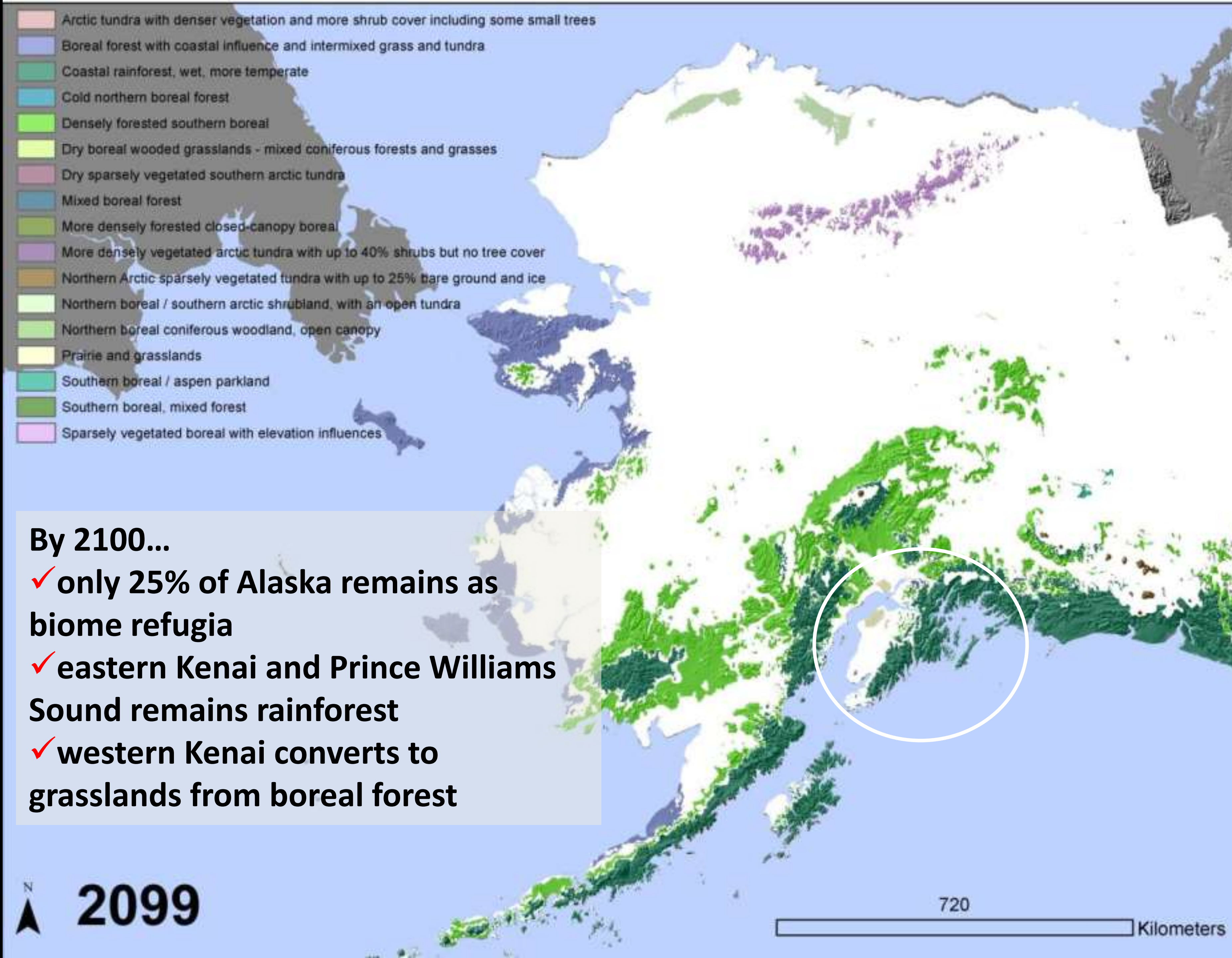
Southern boreal, mixed forest
Sparsely vegetated boreal with elevation influences
N
2099
720
Kilometers



By 2100…

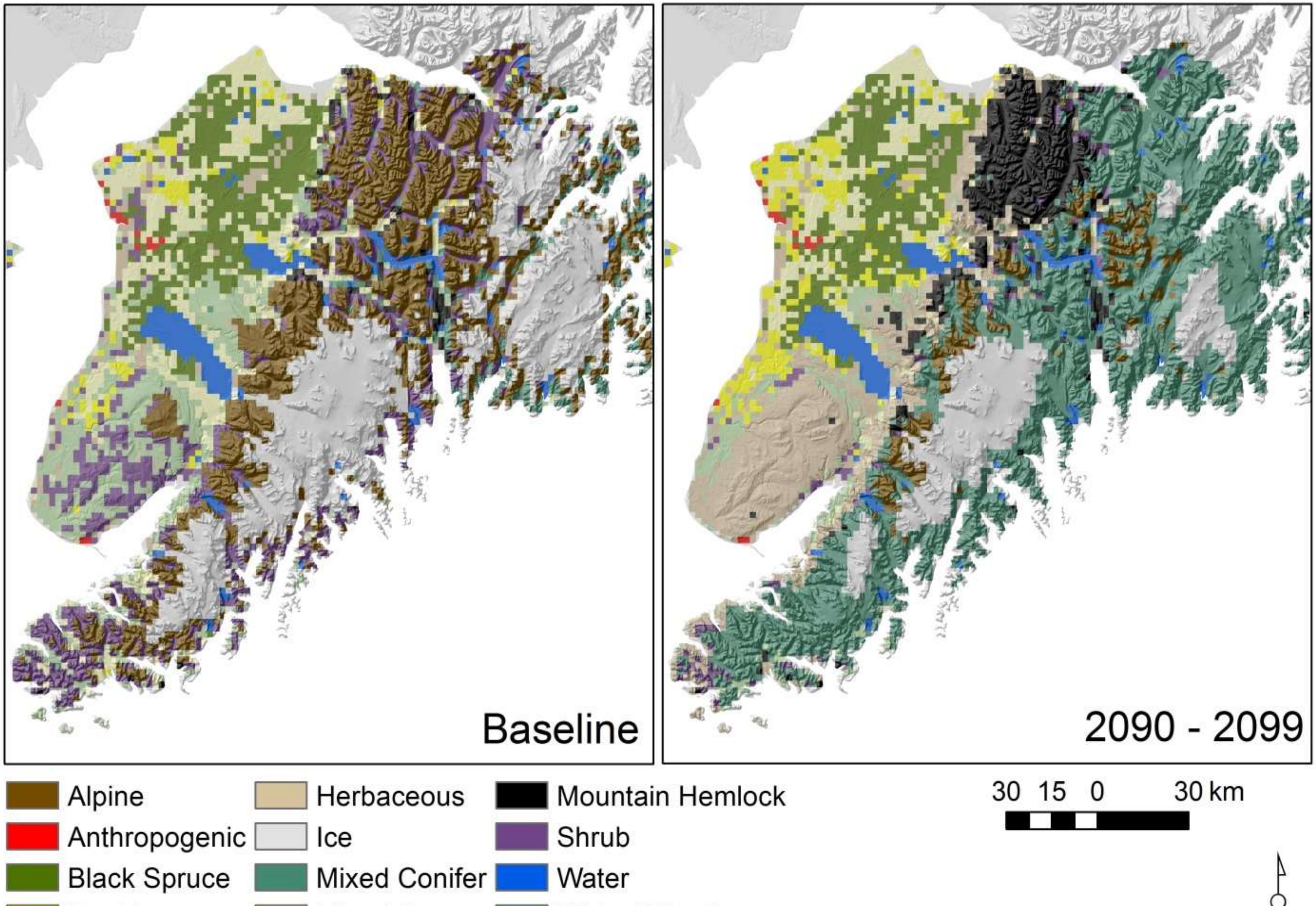
✓**only 25% of Alaska remains as biome refugia**

✓**eastern Kenai and Prince Williams Sound remains rainforest**

✓**western Kenai converts to grasslands from boreal forest**

Forecasting the Kenai Peninsula's landscape through 2100

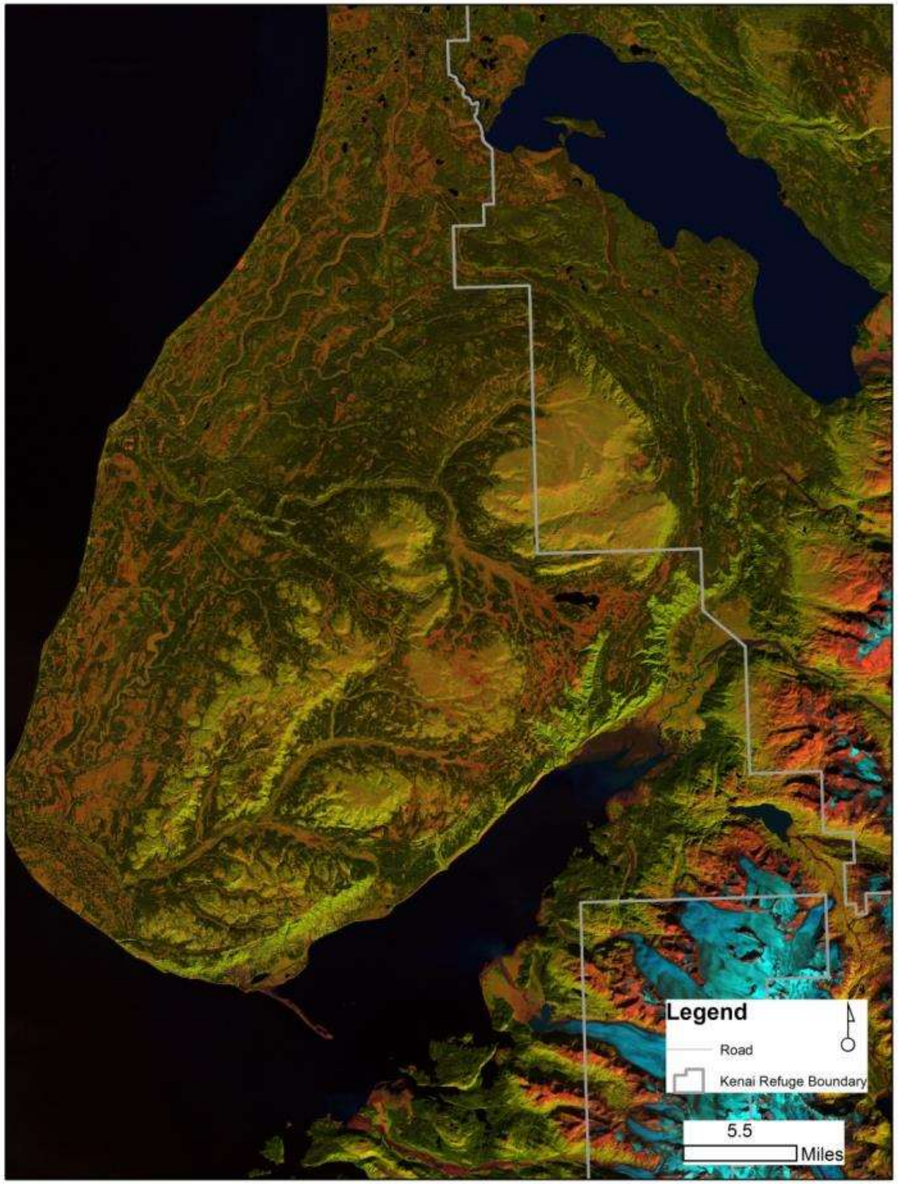
- ✓ Climate envelope modeling using Random Forests™
- ✓ a1b scenario decadal averages for temperature, precipitation (SNAP)
- ✓ landcover type with the greatest % cover in 2km pixels
- ✓ if previous landcover type for each timestep (2039, 2069, 2099) P >0.5 then stay; if P <0.5 then landcover type with highest probability

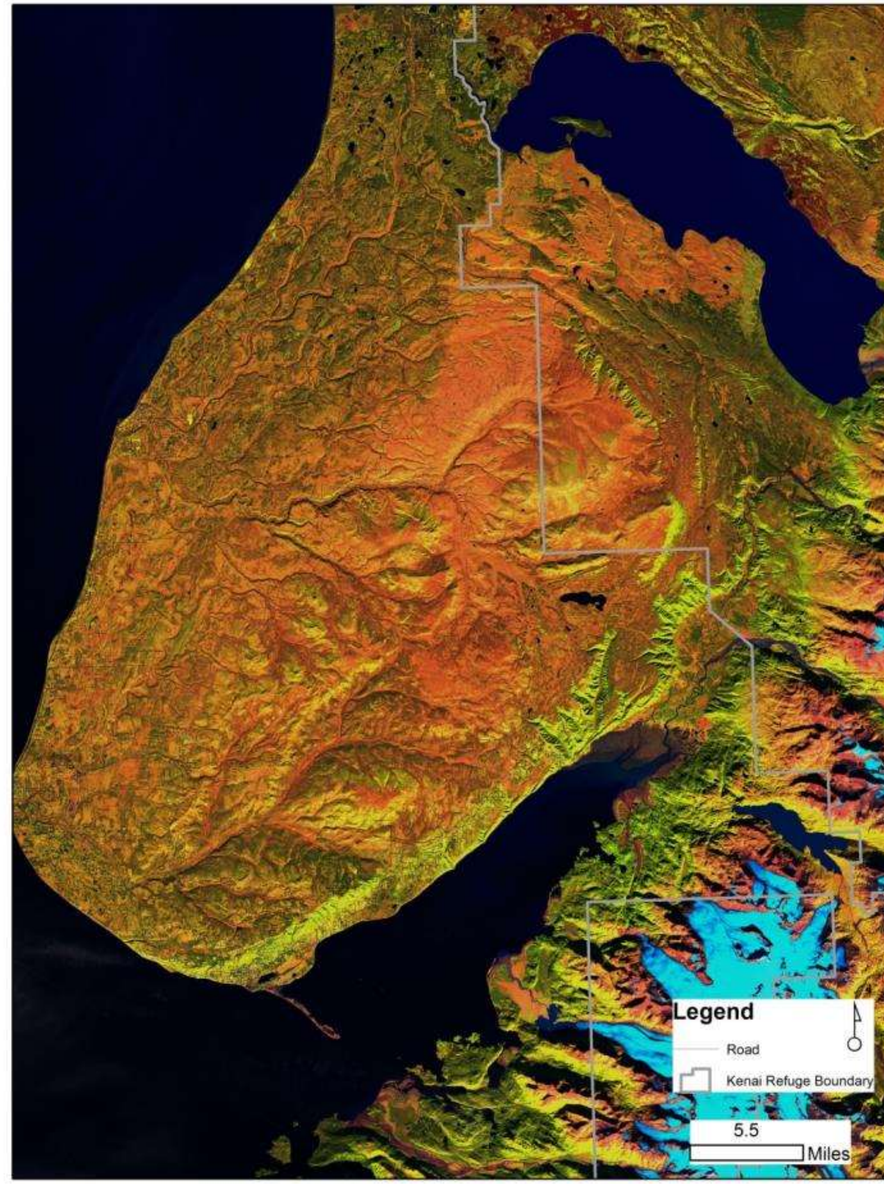

Baseline
2090 - 2099
Alpine
Anthropogenic
Black Spruce
Deciduous
Herbaceous
Ice
Mixed Conifer
Mixed Forest
Mountain Hemlock
Shrub
Water
White-Sitka Spruce
30 15 0 30 km

37% of Kenai Peninsula landcover types are forecasted to change by 2099!

✓ Eastern side shows **afforestation** of alpine (hemlock) and coast (Sitka spruce)

✓ Western side shows **deforestation** (white and black spruce), expanding grasslands

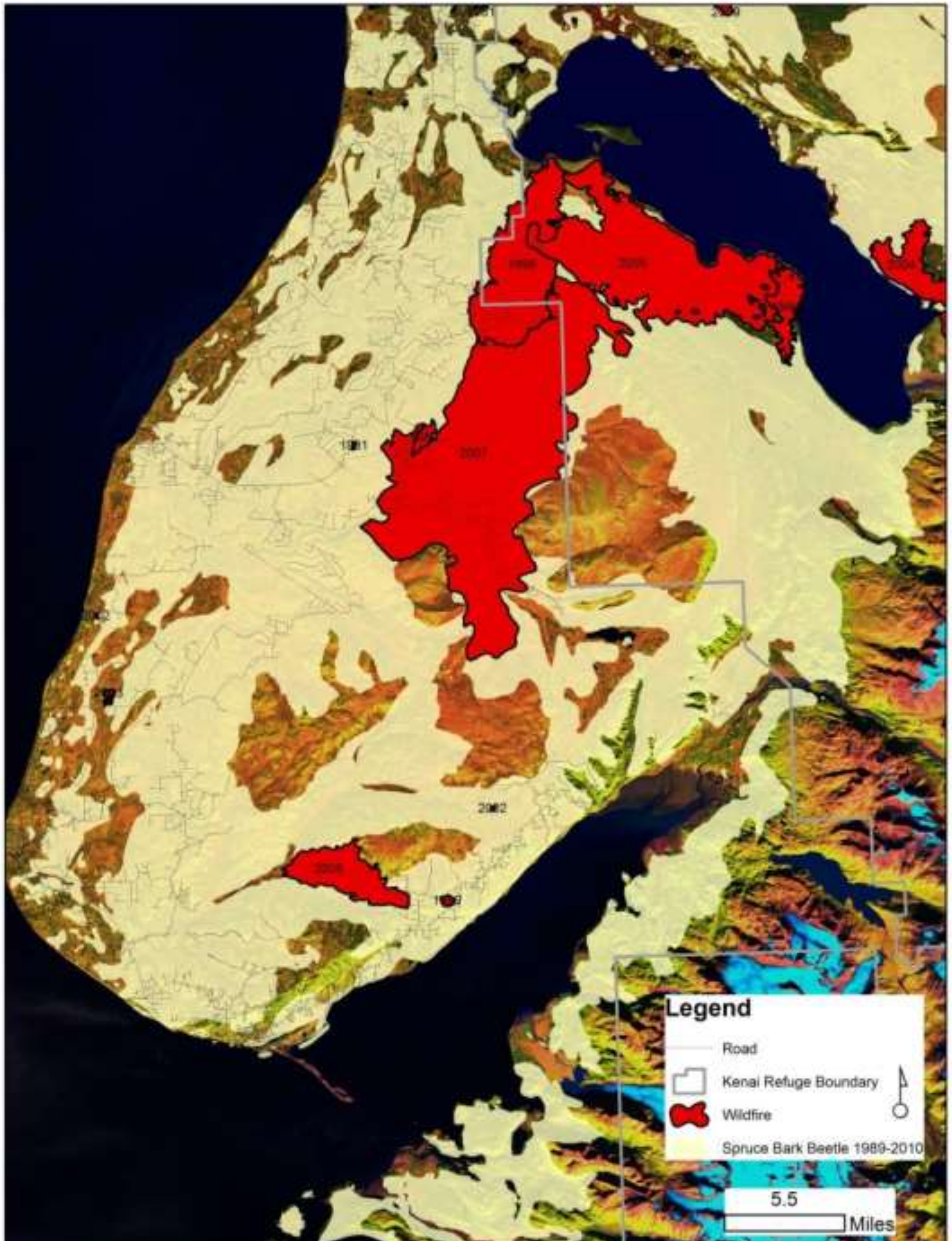




SEPT 1985

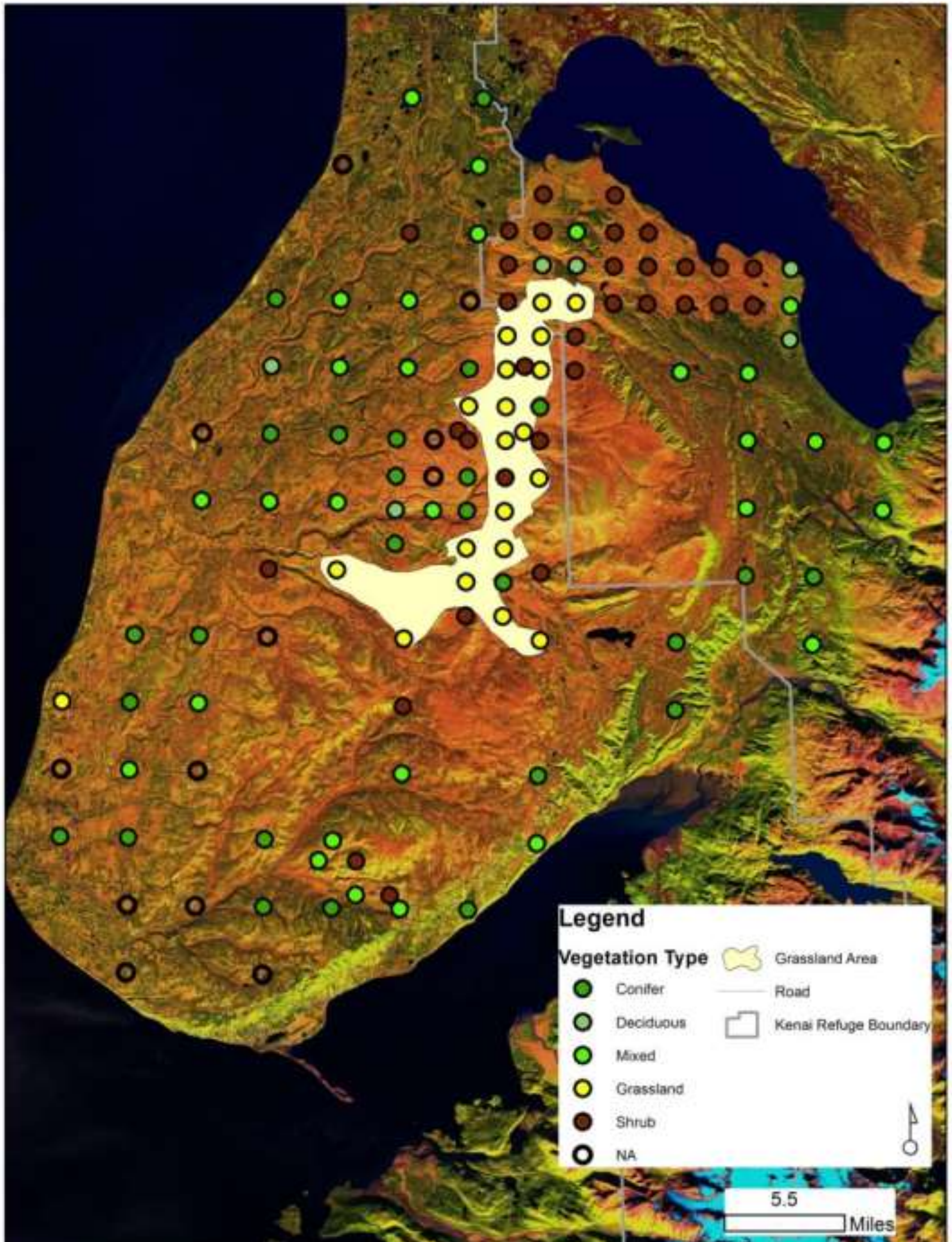
SEPT 2014

Spruce Bark Beetle Mortality (1989-2010)



Wildfires (1994–2007)

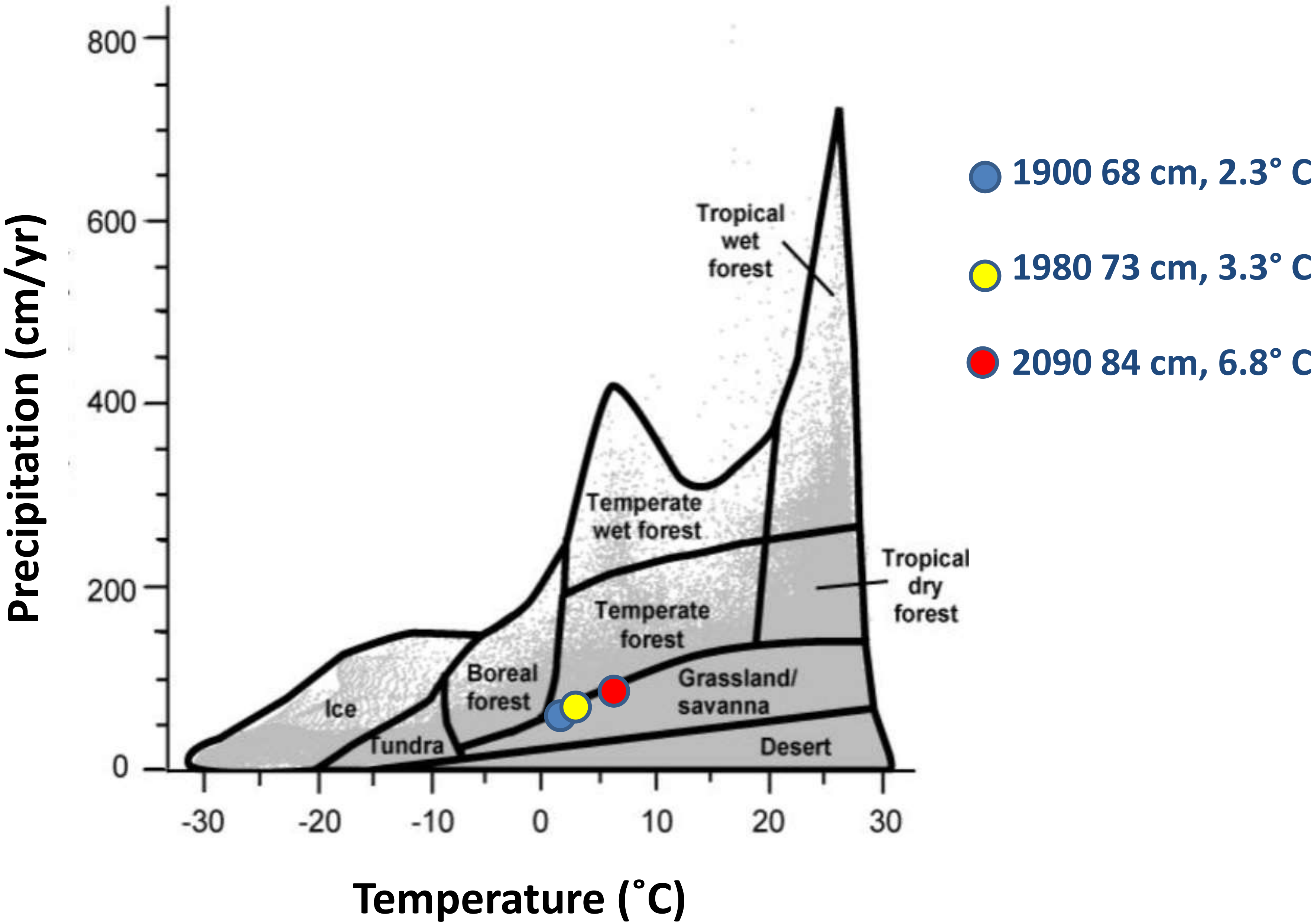
1994 Windy Point
1996 Crooked Creek
2005 Glacier Creek
2005 Fox Creek
2005 Tracy Avenue
2007 Caribou Hills



40,000-acre contiguous grassland polygon in 2015

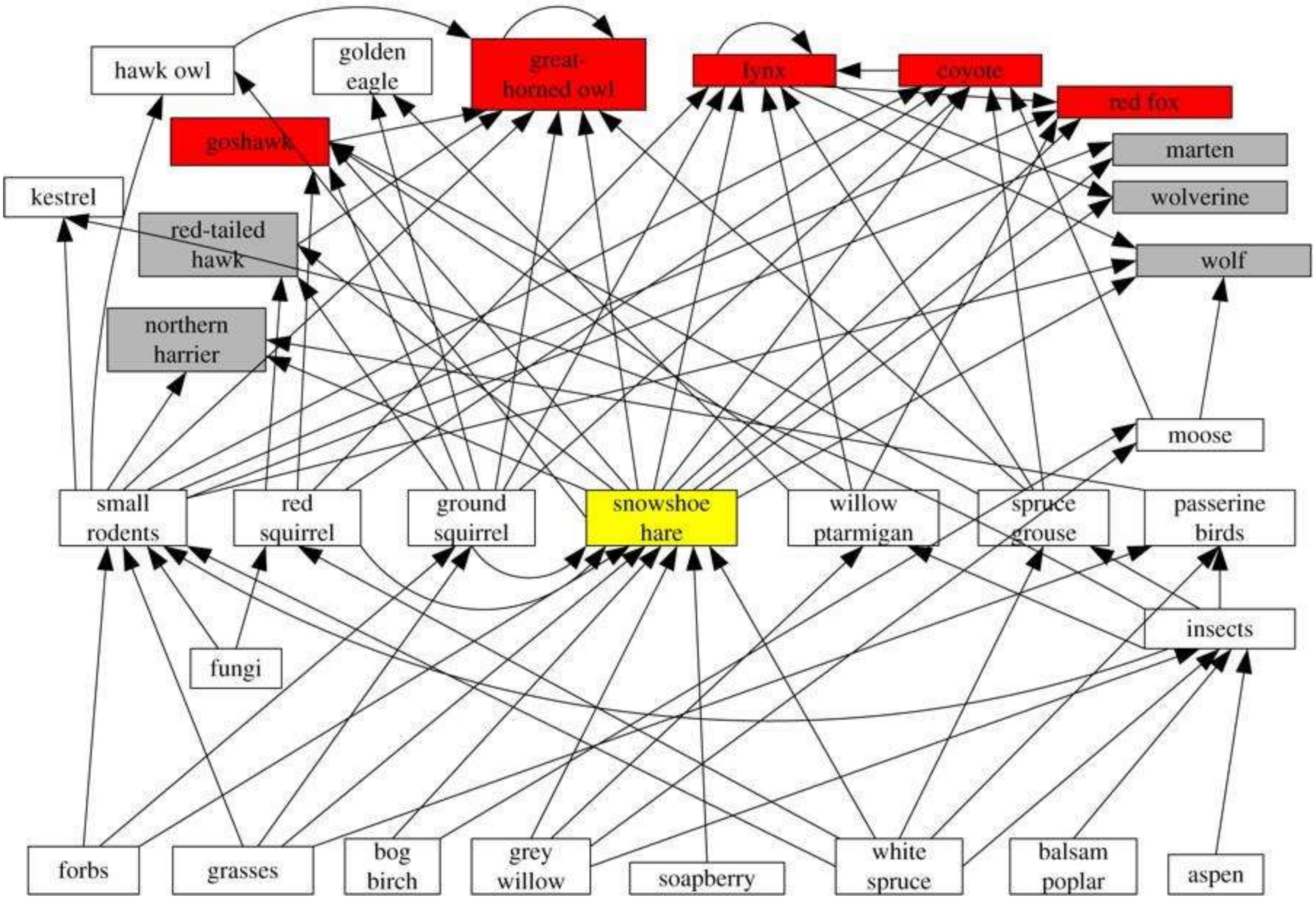
2002 imagery
- Forest 55%
- Other 40%
- Herbaceous 5%


2015/07/19

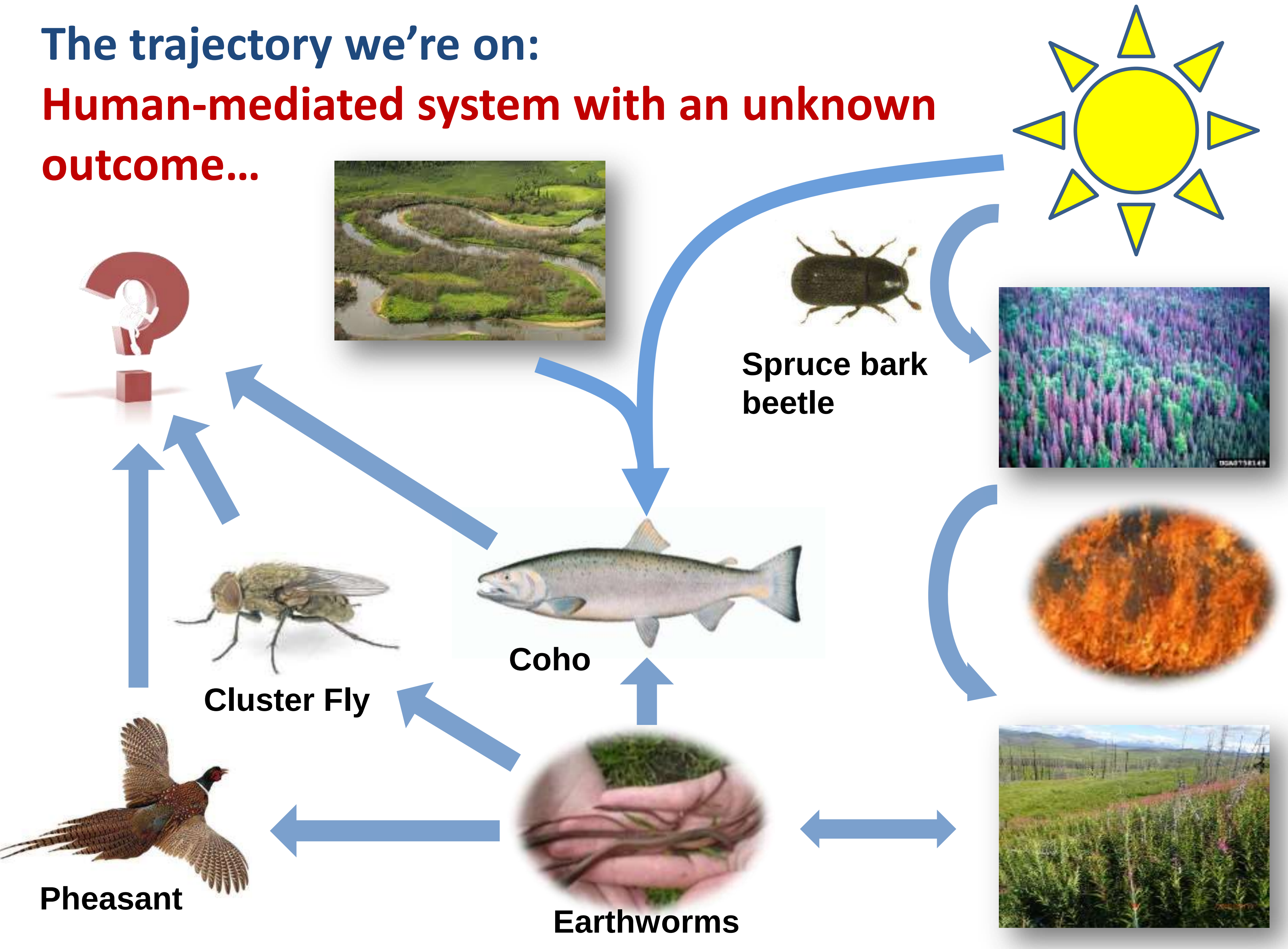


Staudinger et al. (2012)

The boreal system as we're taught…



The trajectory we're on:
Human-mediated system with an unknown outcome…



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

2 questions we need to ask ourselves….

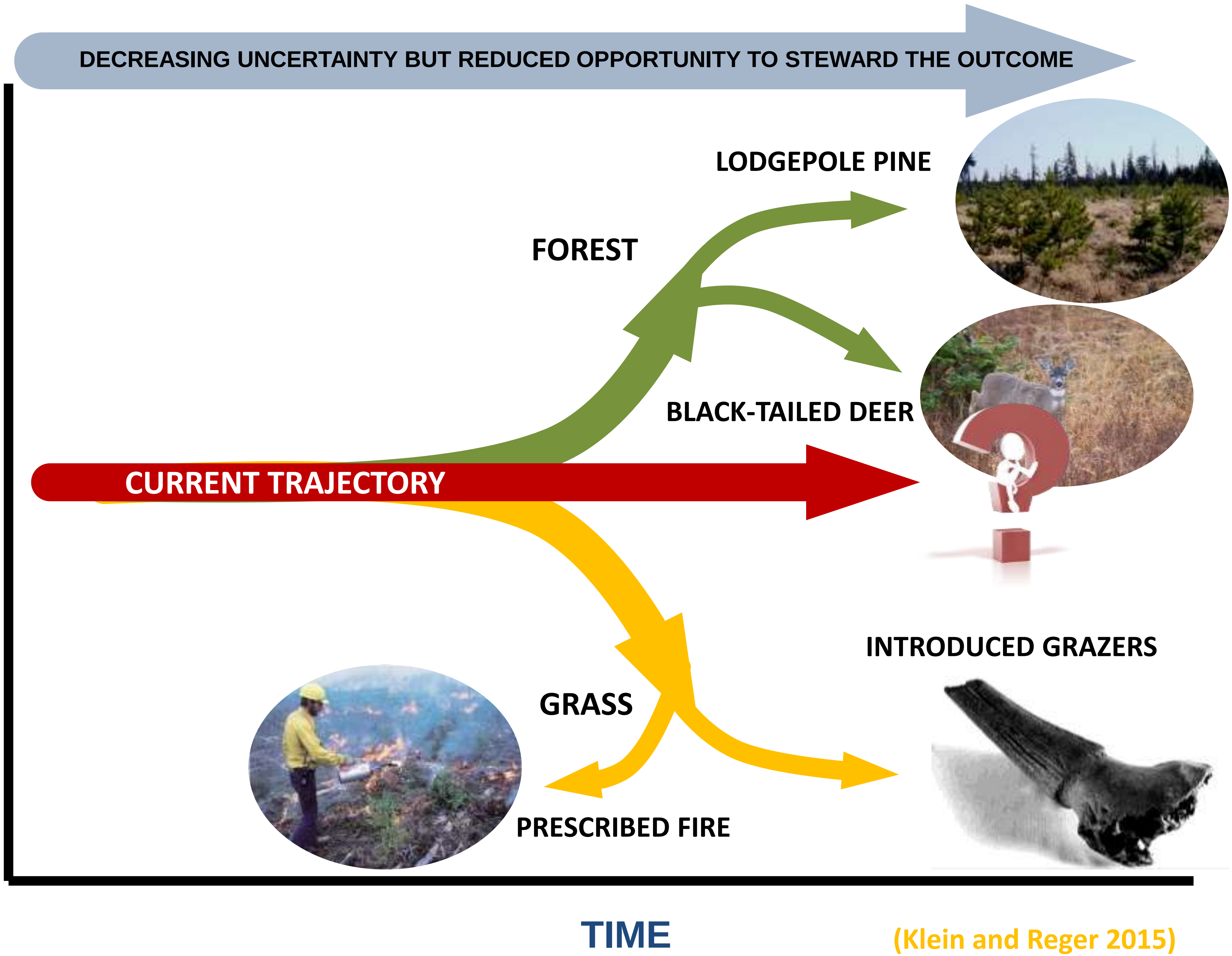
What's the risk of doing nothing?

What's the risk of doing something wrong?

----Rosa Meehan
10 Feb 2010

Doing nothing is really doing something… just incoherently and haphazardly

- ✓ Kenai Peninsula is already responding to a warming climate and forecasted to continue doing so
- ✓ Latitudinal migration is constrained by the 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!



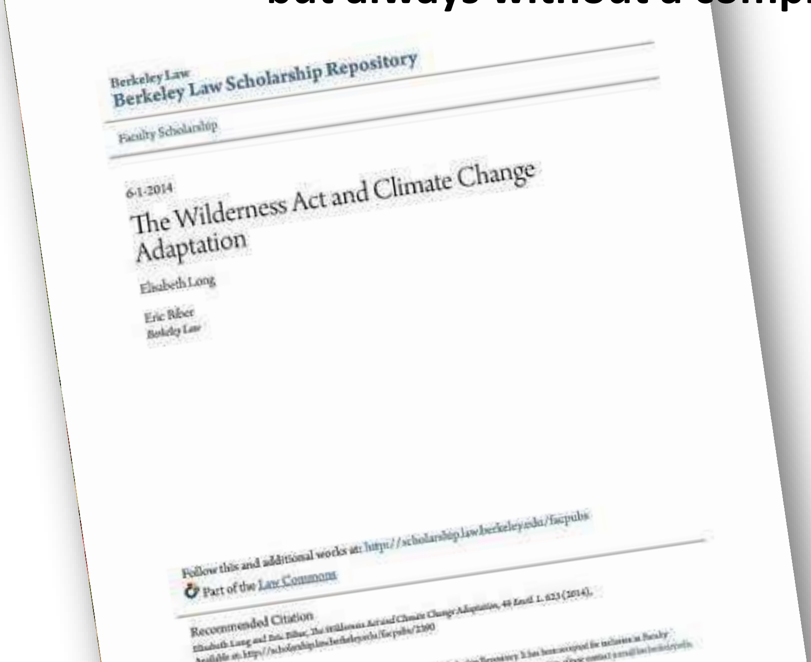
DECREASING UNCERTAINTY BUT REDUCED OPPORTUNITY TO STEWARD THE OUTCOME
LODGEPOLE PINE
FOREST
BLACK-TAILED DEER
CURRENT TRAJECTORY
INTRODUCED GRAZERS
GRASS
PRESCRIBED FIRE
TIME
(Klein and Reger 2015)

Elements of resilience theory…

- We want systems to be self-organizing and self-sustaining
- Biodiversity is important as a way to hedge bets for future conditions
- Multiple possible ecosystem pathways and what's available to colonize matters
- Catastrophic, nonlinear change will coincide with incremental changes

Constraints on moving forward…

- There is still some uncertainty about the ecological trajectory
- But…scientific uncertainty is NOT the deterrent to adaptation that many think
- We need different goals (but who is the authority?)
- We need more exploratory manipulative field studies
- We need different data, not necessarily more data
- We need to challenge existing policy constraints
- Personal values of "-ologists" are constraining novel approaches
- Decisions are being made by agencies and private citizens…
  sometimes without climate change as context,
  but always without a comprehensive and coherent strategy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The Wilderness Act and Climate Change Adaptation

Elisabeth Long

Eric Biber
Berkeley Law

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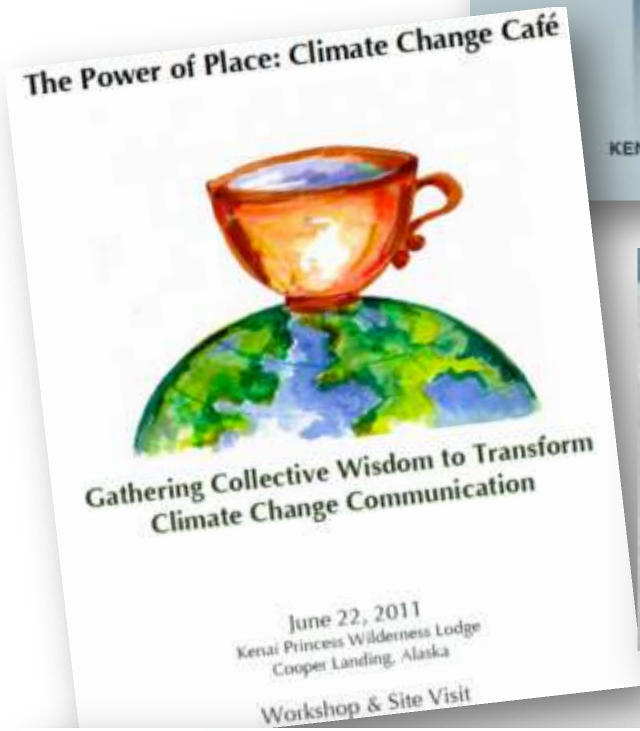
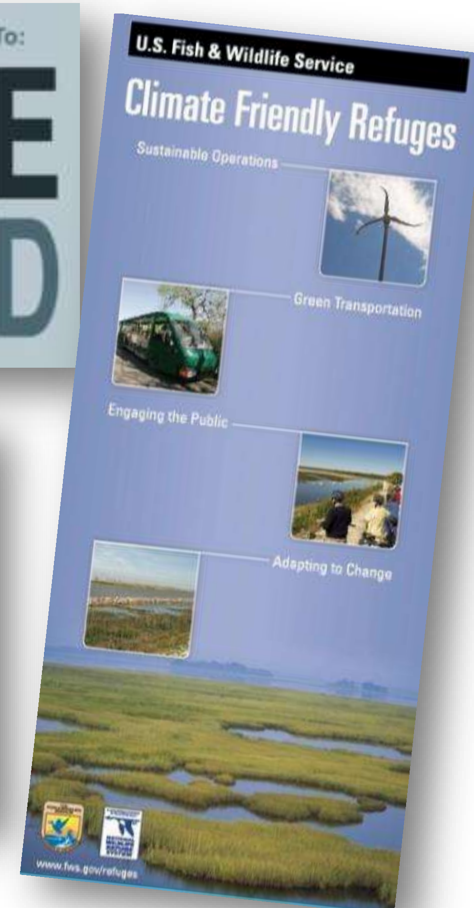
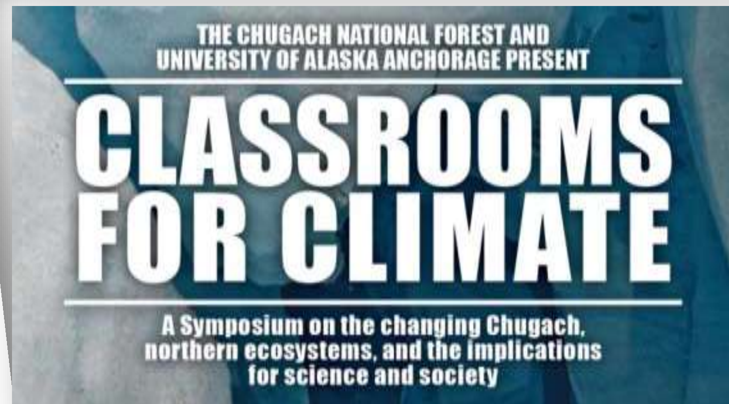
United States Government Accountability Office
Report to Congressional Requesters
GAO
August 2007
CLIMATE CHANGE
Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources
U.S. Fish & Wildlife Service
Rising to the Urgent Challenge
Strategic Plan for Responding to Accelerating Climate Change
Strategic Plan for Inventories and Monitoring on National Wildlife Refuges: Adapting to Environmental Change
U.S. Fish and Wildlife Service, National Wildlife Refuge System
September 1, 2010
NATIONAL fish, wildlife & plants
CLIMATE ADAPTATION STRATEGY
Issues and Perspectives
A National Geographic Framework for Guiding Conservation on a Landscape Scale
Abstract
U.S. Fish & Wildlife Service
Planning for Climate Change on the National Wildlife Refuge System
CONSERVING THE FUTURE


The Power of Place: Climate Change Café
Gathering Collective Wisdom to Transform Climate Change Communication
June 22, 2011
Kenai Princess Wilderness Lodge
Cooper Landing, Alaska
Workshop & Site Visit


Central Peninsula League of Women Voters & KPC Student Union Invite You To:
CLIMATE CHANGE IN OUR BACKYARD
SATURDAY
MARCH 28
9AM - 4PM FREE
KENAI PENINSULA COLLEGE


U.S. Fish & Wildlife Service
Climate Friendly Refuges
Sustainable Operations
Green Transportation
Engaging the Public
Adapting to Change
www.fws.gov/refuges


THE CHUGACH NATIONAL FOREST AND UNIVERSITY OF ALASKA ANCHORAGE PRESENT
CLASSROOMS FOR CLIMATE
A Symposium on the changing Chugach, northern ecosystems, and the implications for science and society


Chugach Regional Resources Commission
2016 CLIMATE CHANGE WORKSHOP
ASSESSMENT PHASE
VULNERABILITY ASSESSMENT
ADAPTATION PLAN
OUR OCEANS
OUR LANDS
ACCAP


NATIONAL PARK SERVICE
SNAP
Climate Change Planning in Alaska's National Parks
SOUTHWEST ALASKA INVENTORY AND MONITORING NETWORK (SWAN)
February 22-25, 2011
Anchorage, Alaska

Perceptions of Climate Change					
Institution	Unit or Division	Climate change ranking	Does climate change exist?	Is climate change being accelerated by humans?	Do humans have a moral obligation to adapt?
USFS	Chugach National Forest	5	Yes	Yes	No
USFWS	Kenai National Wildlife Refuge	7.5	Yes	Yes	Yes
*NPS	Kenai Fjords National Park	-	Yes	Yes	Yes
*NPS	Kenai Fjords National Park	-	Yes	Yes	Yes
USFS	Chugach National Forest	8	Yes	Yes	Yes
NPS	Kenai Fjords National Park	7.5	Yes	Yes	-
USFWS	Kenai National Wildlife Refuge	9	Yes	Yes	Yes
Alaska DNR	Alaska State Parks	2.5	Yes	Yes	Yes
‡Alaska DNR	Mining, Land, and Water	-	-	-	-
CIRI	Land and Resources	2	Yes	-	Yes
KPB	Land Management Division	4	Yes	-	Yes
‖KPB	Mayor's Office	-	Yes	Yes	Yes
KPB	The Donald E. Gilman River Center	4	Yes	Yes	-

How should we prepare for mass extinction, novel assemblages and non-analog futures?

By stewarding ecological trajectories

Change our goals! We need to minimize species extinction (a backdoor way of conserving biodiversity)

The Mini Page

Betty Debnam, Founding Editor and Editor at Large

Humans Causing Fast Changes

Earth in Sixth Major Extinction

As most kids probably know, dinosaurs came to a sudden end about 65 million years ago. Did you know that there have been four other super-big, or **mass**, extinctions of life on Earth?

Most scientists believe we are in the middle of a sixth mass extinction. But this time, the extinction isn't being caused by an asteroid or volcanoes. Its causes can be traced to us.

To find out more about this event, The Mini Page talked with Michael Brett-Surman from the Smithsonian National Museum of Natural History.

What is a mass extinction?

When a **species**, or type of life, becomes **extinct**, it means there are no more members of that species alive.

Extinctions are normal. Usually, there is a steady rate of extinctions during every million years. Life-forms naturally appear and disappear over time.

In a **mass extinction**, at least one-fourth of all plants and animals on the planet might be wiped out very quickly, much faster than normal. Huge numbers of species die, and no new species appear in that time.

Scientists are seeing this happen now on Earth.

The most famous mass extinction was at the end of the Cretaceous Period, when six out of seven of all dinosaur groups were wiped out, along with half of all life. There is evidence that a giant asteroid hit the Earth then.

Climate change

Each time there has been a mass extinction, it was because something caused the climate to change. Many types of life could not **adapt**, or change, quickly enough, and they died.

During the current mass extinction, humans will be able to adapt, but our crops and animals might not. Life as we know it will keep changing.

The ages of Earth

Each time there is a mass extinction, a new age begins on Earth. As older species die out, other species suddenly have no competition. They begin to fill in the Earth's habitats.

Over millions of years, newer types of life develop. Diversity increases again. The makeup of the planet changes yet again.

Let's explore Earth's earlier mass extinctions.

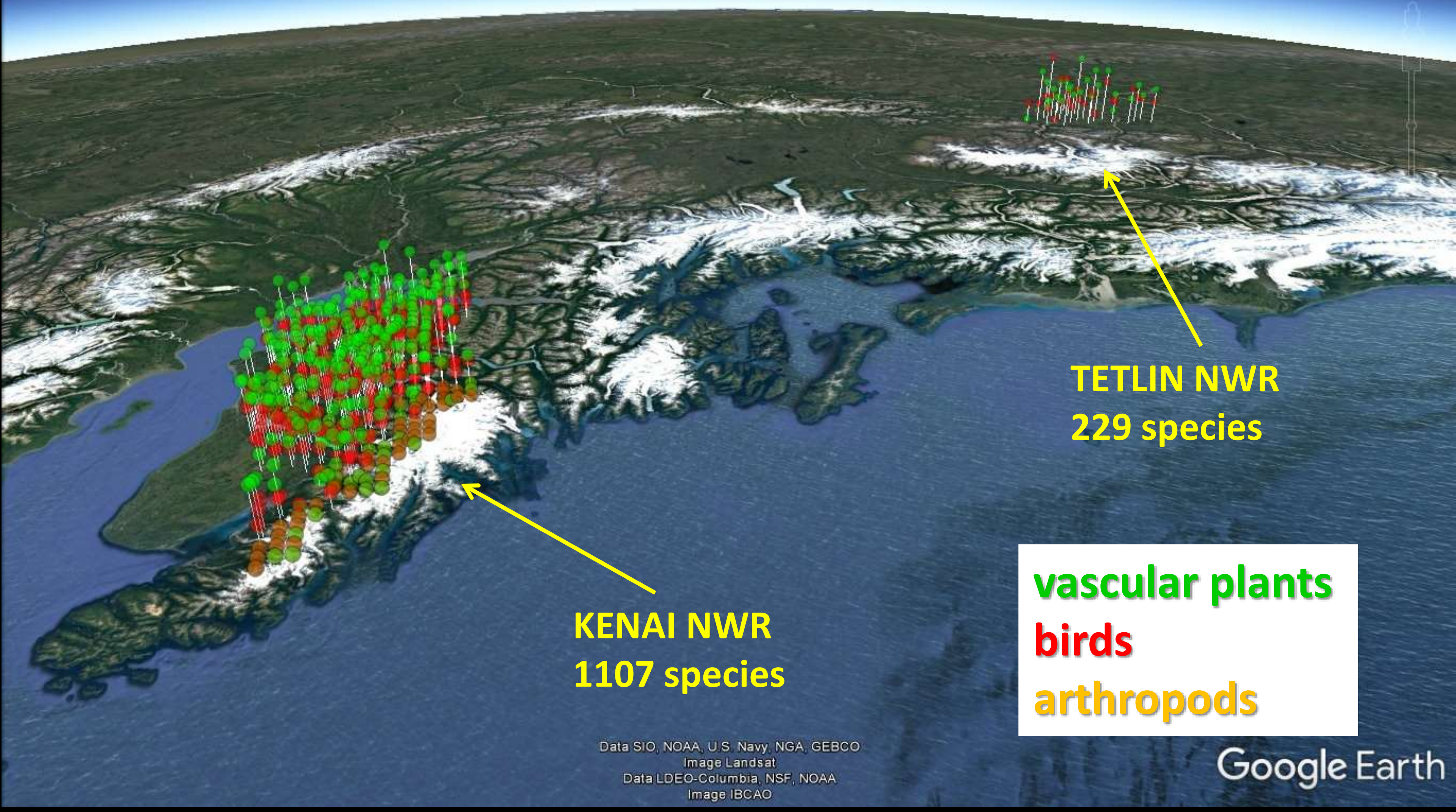
End of the Ordovician

The Ordovician (or-doh-VIH-shun) Period ended about 445 million years ago. Most life lived in the oceans at this time. Experts believe more than 50 percent of life was wiped out at the end of this age.

One reason for the extinctions might have been a drop in sea level. Huge glaciers might have formed, locking up much of the planet's water. This would have caused sea levels to drop. Life in shallower waters might not have been able to adapt quickly enough to survive.

R.I.P.

We need better information on species richness and distributions!



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Building a DNA barcode library of Alaska's non-marine arthropods

PDF (1095 K)
PDF-Plus (600 K)

Derek S Sikes, Matthew Bowser, John M. Morton, Casey Bickford, Sarah Meierotto, Kyndall Hildebrandt

Published on the web 21 October 2016.
Received December 01, 2015.

Genome, 10.1139/gen-2015-0203

ABSTRACT

Climate change may result in ecological futures with novel species assemblages, trophic mismatch, and mass extinction. Alaska has a limited taxonomic workforce to address these changes. We are building a DNA barcode library to facilitate a metabarcoding approach to monitoring non-marine arthropods. Working with the Canadian Centre for DNA Barcoding, we obtained DNA barcodes from recently collected and authoritatively identified specimens in the University of Alaska Museum Insect Collection and the Kenai National Wildlife Refuge collection. We submitted tissues from 4,776 specimens, of which 81% yielded DNA barcodes representing 1,662 species and 1,788 BINs, of primarily terrestrial, large-bodied arthropods. This represents 84% of the species available for DNA barcoding in the UAM Insect Collection. There are now 4,020 Alaskan arthropod species represented by DNA barcodes, after including all records in BOLD of species that occur in Alaska – i.e. 48.5% of the 8,277 Alaskan, non-marine-arthropod, named species have associated DNA barcodes. An assessment of the identification power of the library in its current state yielded fewer species-level identifications than expected, but the results were not discouraging. We believe we are the first to deliberately begin development of a DNA barcode library of the entire arthropod fauna for a North American state or province. Although far from complete, this library will become increasingly valuable as more species are added and costs to obtain DNA sequences fall.


Biodiversity Data Journal 5: e10792
doi: 10.3897/BDJ.5.e10792
Research Article
Arthropod and oligochaete assemblages from grasslands of the southern Kenai Peninsula, Alaska
Matthew L. Bowser, John M. Morton, John Delton Hanson, Dawn R. Magness, Mallory Okuly
Abstract
Background
By the end of this century, the potential climate-biome of the southern Kenai Peninsula is forecasted to change from transitional boreal forest to prairie and grasslands, a scenario that may already be playing out in the Caribou Hills region.

50% of 8,421 terrestrial arthropod species known from Alaska now barcoded!

We need a sophisticated perspective on managing exotic species!

Lodgepole Pine

Elodea spp

We need a continental perspective on managing wildlife!

Colville River

Togiak NWR

Chronic wasting disease

Heat stress

Meningeal Worm

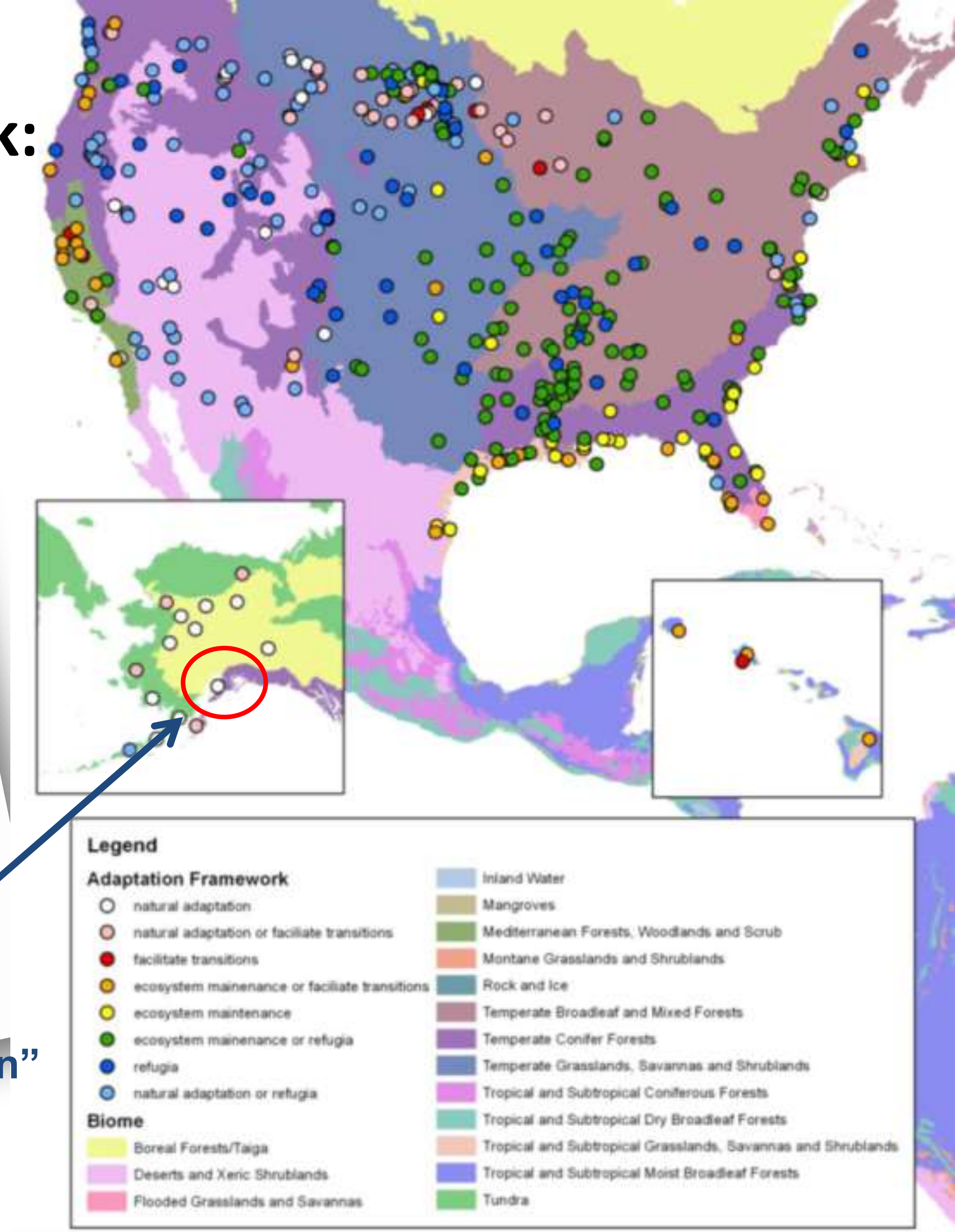
Adaptation Framework: NWRS


ECOSPHERE

esa

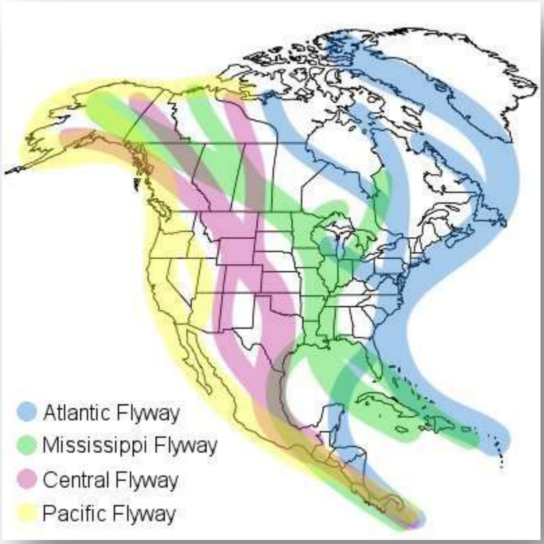
A climate-change adaptation framework to reduce continental-scale vulnerability across conservation reserves

Dawn R. Magness, John M. Morton, Falk Huettmann, F. Stuart Chapin, III, and A. David McGuire

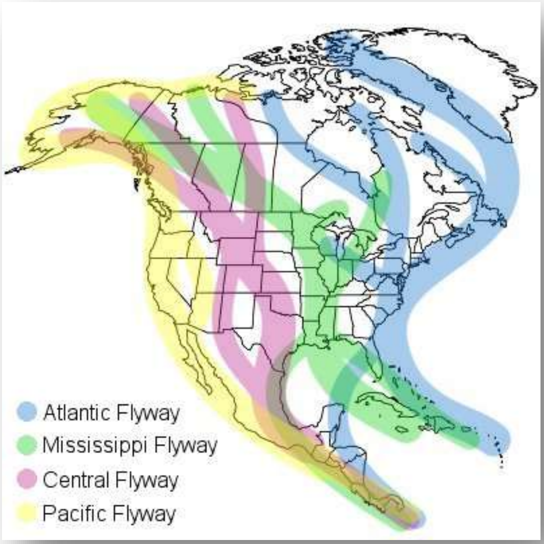


Kenai NWR = "natural adaptation"
but planning for the worst…

Hierarchal organization	Migratory Bird Management	Climate Change Adaptation
Treaty	Canadian Convention (1916) President Woodrow Wilson, King George V (federal authority)	
Implementing legislation	Migratory Bird Treaty Act (1918)	
Tri-lateral plan	North American Waterfowl Management Plan (1986)	
Spatial framework	Migratory Bird Flyways	
Implementing body	Joint Ventures (22)	



Hierarchal organization	Migratory Bird Management	Climate Change Adaptation
Treaty	Canadian Convention (1916) President Woodrow Wilson, King George V (federal authority)	?
Implementing legislation	Migratory Bird Treaty Act (1918)	?
Tri-lateral plan	North American Waterfowl Management Plan (1986)	?
Spatial framework	Migratory Bird Flyways	Geographic Areas
Implementing body	Joint Ventures (22)	Landscape Conservation Cooperatives (22)



Same problem but two adaptation approaches


esa

ECOSPHERE

A climate-change adaptation framework to reduce continental-scale vulnerability across conservation reserves

Dawn R. Magness,[1,2,†] John M. Morton,[1] Falk Huettmann,[2] F. Stuart Chapin, III,[2] and A. David McGuire[3]

[1]U.S. Fish & Wildlife Service, Kenai National Wildlife Refuge, Soldotna, Alaska 99669 USA
[2]Institute of Arctic Biology, Department of Biology and Wildlife, University of Alaska, Fairbanks, Alaska 99775 USA
[3]U.S. Geological Survey, Alaska Cooperative Fish & Wildlife Research Unit, University of Alaska, Fairbanks, Alaska 99775 USA

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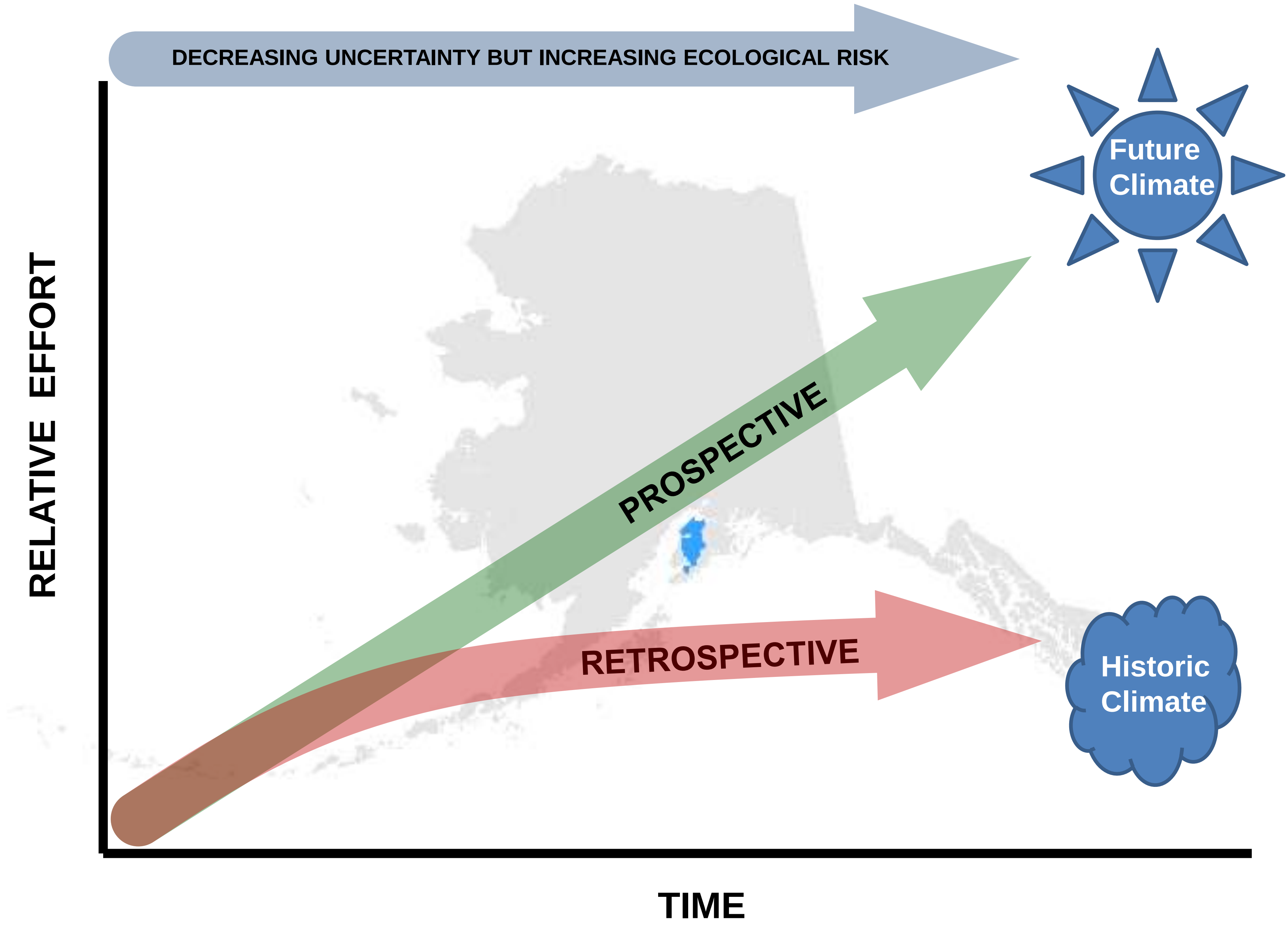
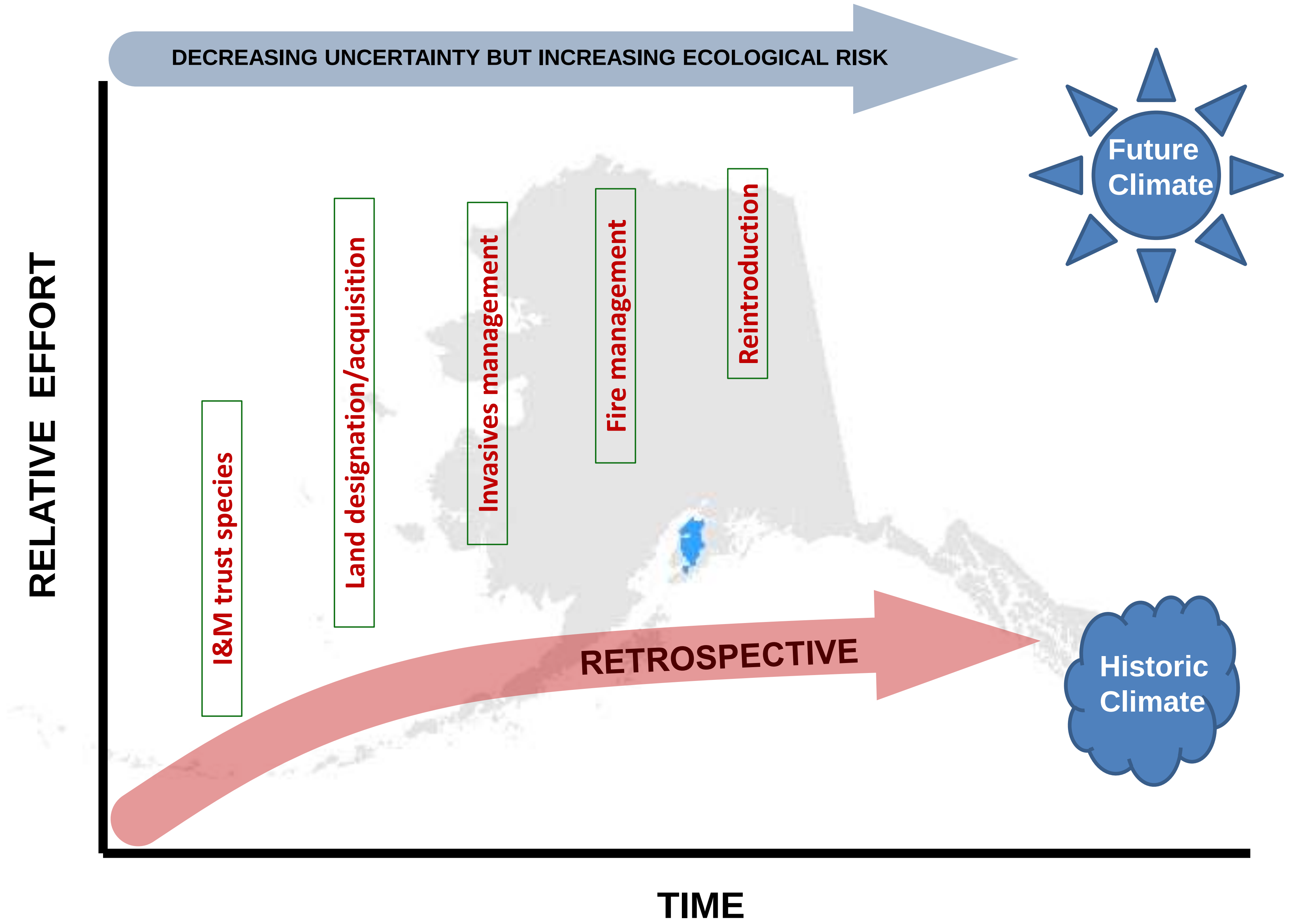
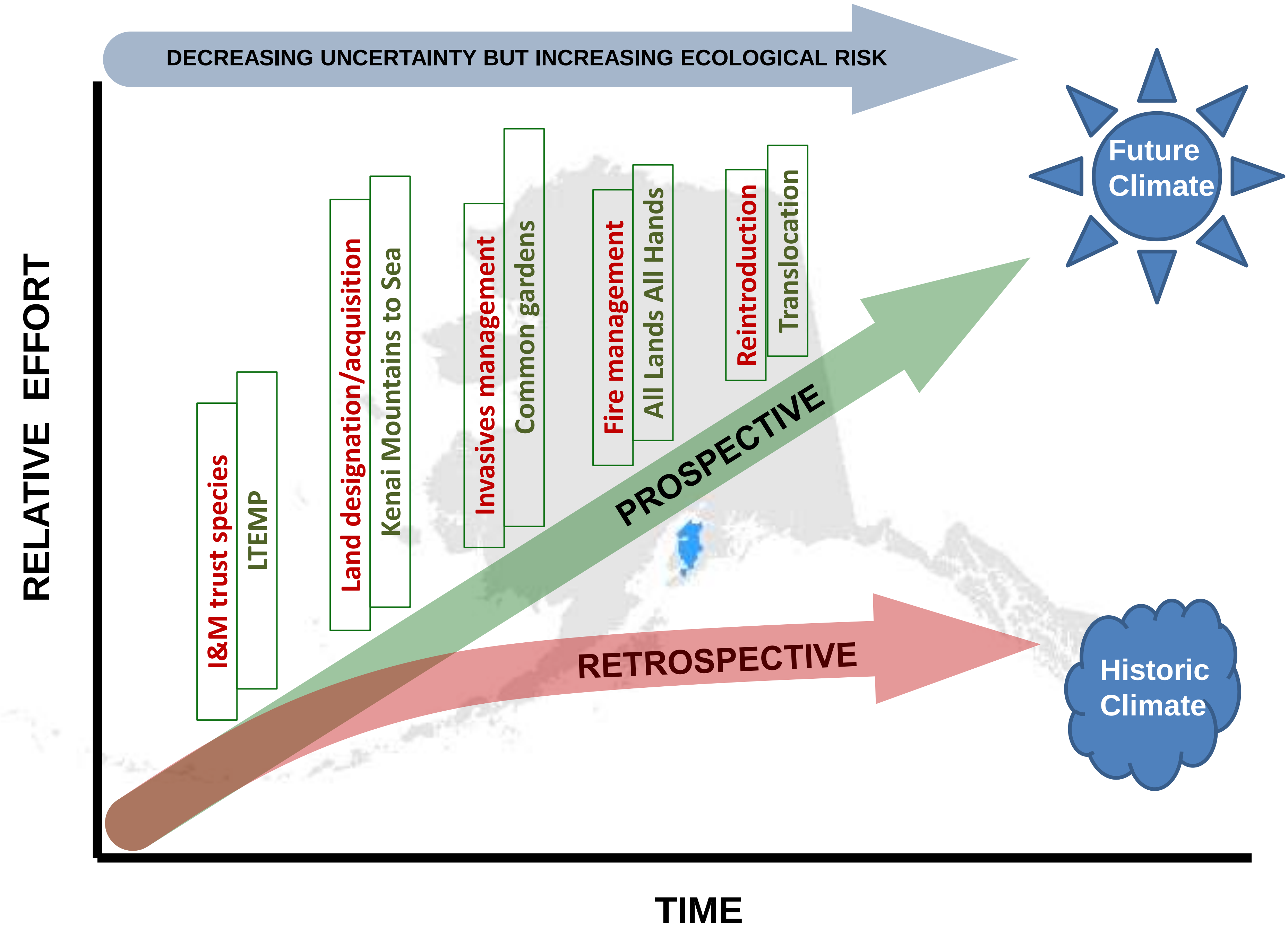
Abstract. Rapid climate change, in conjunction with other anthropogenic drivers, has the potential to cause mass species extinction. To minimize this risk, conservation reserves need to be coordinated at multiple spatial scales because the climate envelopes of many species may shift rapidly across large geographic areas. In addition, novel species assemblages and ecological reorganization make future conditions uncertain. We used a GIS analysis to assess the vulnerability of 501 reserve units in the National Wildlife Refuge System as a basis for a nationally coordinated response to climate change adaptation. We used measures of climate change exposure (historic rate of temperature change), sensitivity (biome edge and critical habitat for threatened and endangered species), and adaptive capacity (elevation latitude range, watershed road density, and watershed protection) to evaluate refuge vulnerability of individual refuges varied spatially within and among variability in vulnerability be used to define suites of conditions to facilitate adaptation and divergent management adaptation

retrospective adaptation

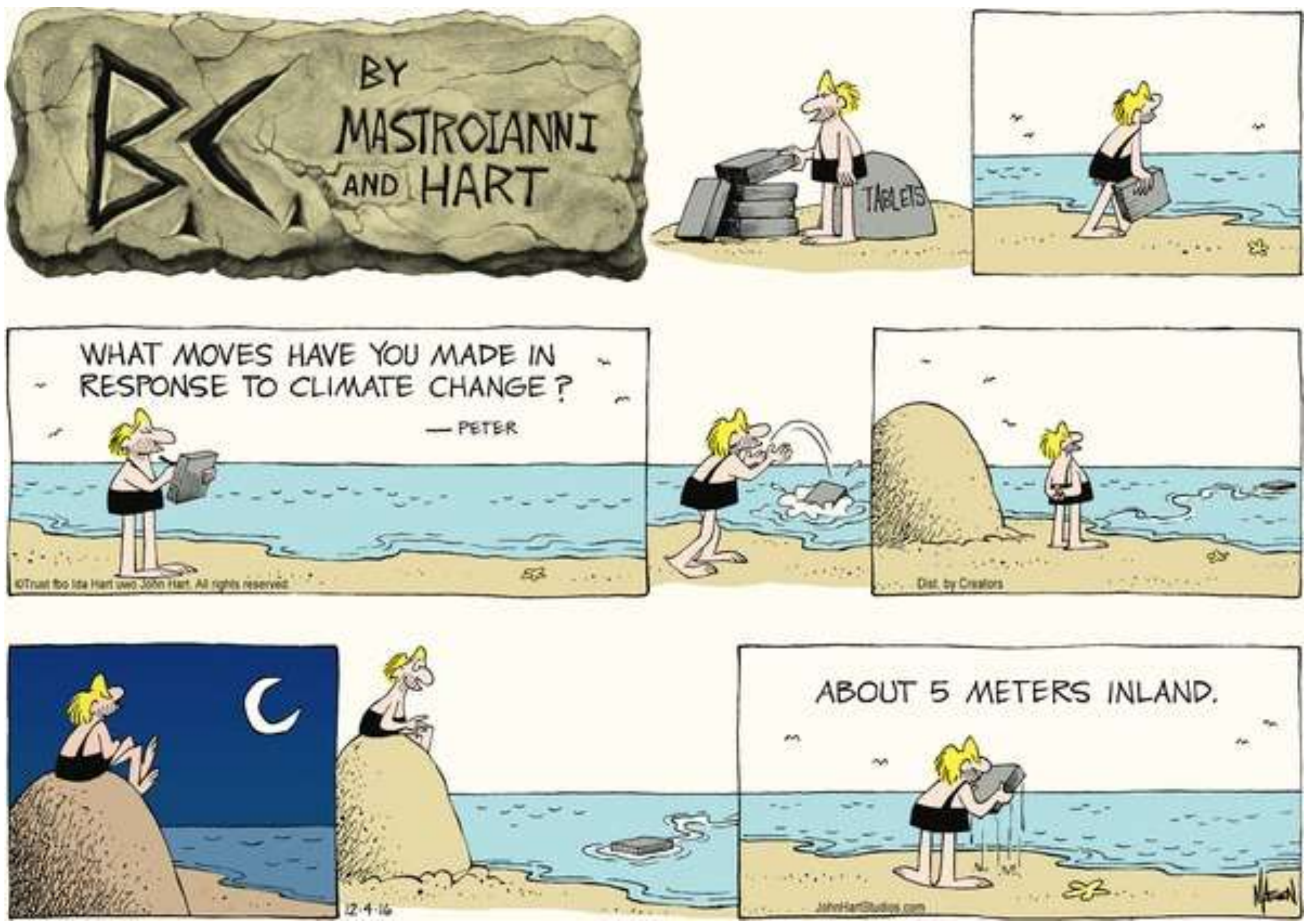
prospective adaptation


DECREASING UNCERTAINTY BUT INCREASING ECOLOGICAL RISK
RELATIVE EFFORT
PROSPECTIVE
RETROSPECTIVE
Future Climate
Historic Climate
TIME


DECREASING UNCERTAINTY BUT INCREASING ECOLOGICAL RISK
Future Climate
RELATIVE EFFORT
I&M trust species
Land designation/acquisition
Invasives management
Fire management
Reintroduction
RETROSPECTIVE
Historic Climate
TIME


DECREASING UNCERTAINTY BUT INCREASING ECOLOGICAL RISK
RELATIVE EFFORT
I&M trust species
LTEMP
Land designation/acquisition
Kenai Mountains to Sea
Invasives management
Common gardens
Fire management
All Lands All Hands
Reintroduction
Translocation
Future Climate
PROSPECTIVE
RETROSPECTIVE
Historic Climate
TIME

Questions????


B.C.
BY MASTROIANNI AND HART
TABLETS
WHAT MOVES HAVE YOU MADE IN RESPONSE TO CLIMATE CHANGE?
— PETER
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12·4·16
ABOUT 5 METERS INLAND.