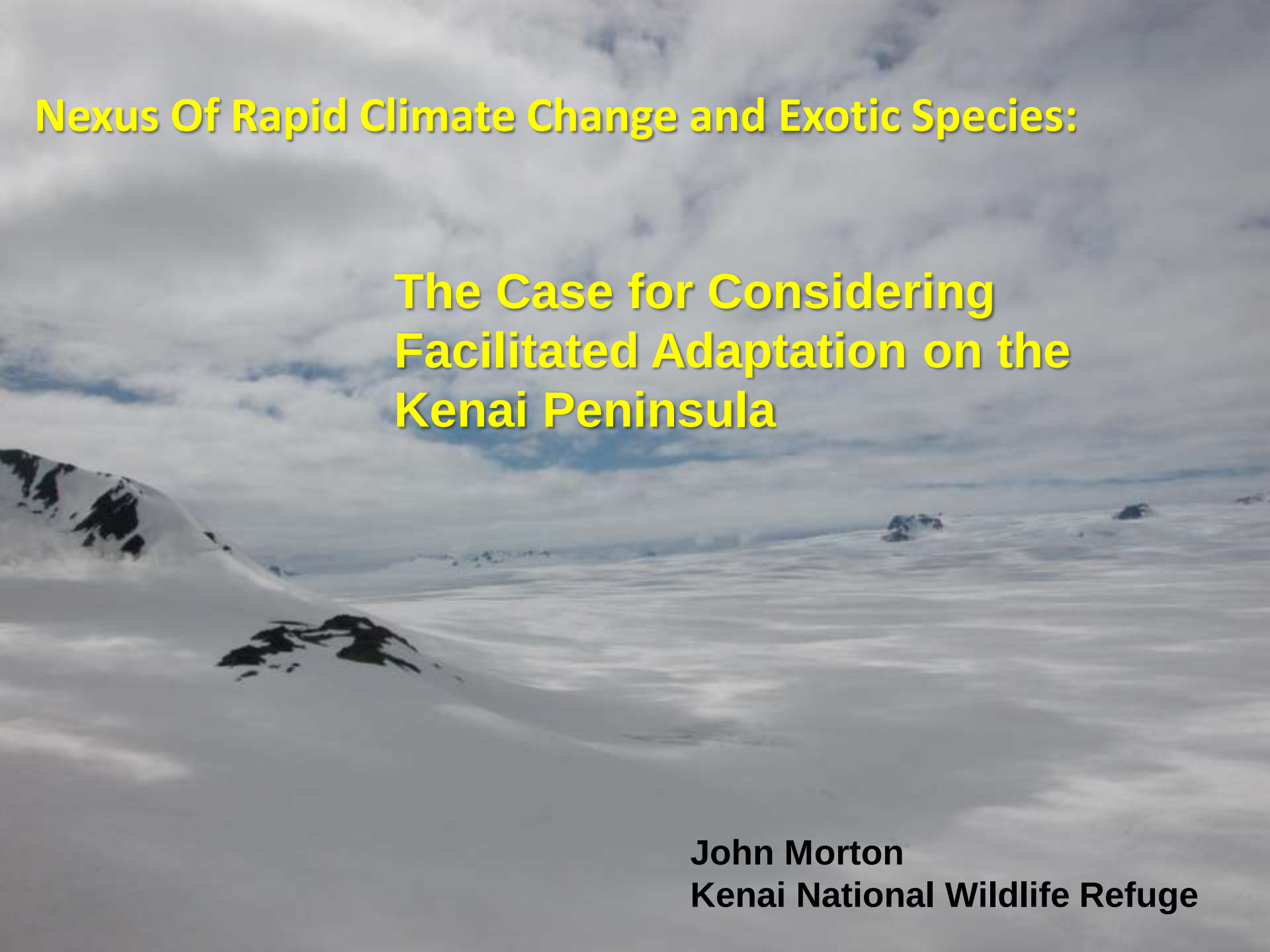


Nexus Of Rapid Climate Change and Exotic Species:

The Case for Considering Facilitated Adaptation on the Kenai Peninsula

John Morton
Kenai National Wildlife Refuge

Adapting to climate change impacts

Adaptation = *adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities* (IPCC)

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,[3] 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

Citation: Magness, D. R., J. M. Morton, F. Huettmann, F. S. Chapin, III, and A. D. McGuire. 2011. A climate-change adaptation framework to reduce continental-scale vulnerability across conservation reserves. Ecosphere 2(10):112. doi: 10.1890/ES11-00200.1

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 range, latitude range, watershed road density, and watershed protection) to evaluate refuge vulnerability. The vulnerability of individual refuges varied spatially within and among biomes. We suggest that the spatial variability in vulnerability be used to define suites of management approaches that capitalize on local conditions to facilitate adaptation and spread risk across the reserve network. We conceptually define four divergent management strategies to facilitate adaption: refugia, ecosystem maintenance, "natural" adaptation, and facilitated transitions. Furthermore, we recognize that adaptation approaches can use historic (i.e., retrospective) and future (prospective) condition as temporal reference points to define management goals.

Key words: climate change; conservation reserve; National Wildlife Refuge System; prospective adaptation; resilience; retrospective adaptation; species extinction; U.S. Fish and Wildlife Service; vulnerability.

Received 8 July 2011; revised 25 August 2011; accepted 26 August 2011; final version received 30 September 2011; **published** 18 October 2011. Corresponding Editor: D. P. C. Peters.

† **E-mail:** Dawn_Magness@fws.gov

INTRODUCTION

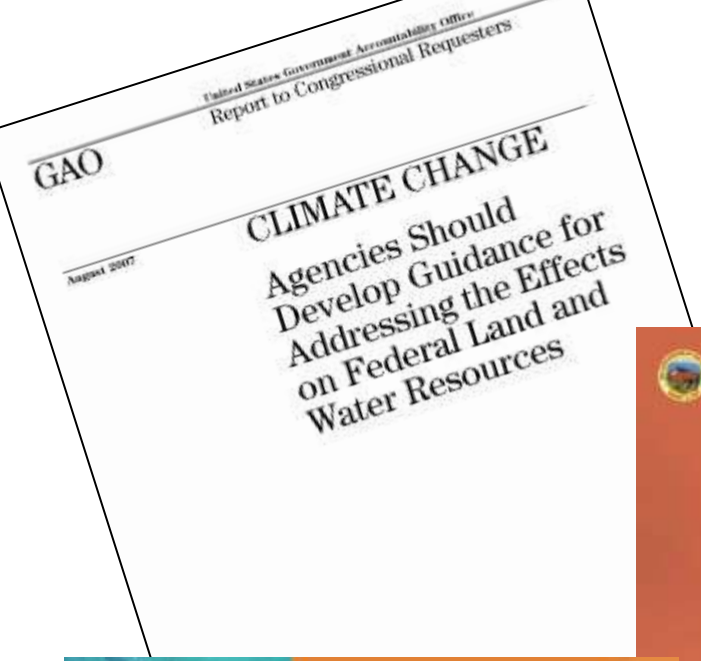
Rapid climate change heightens the need for coordinated reserve networks to accommodate dynamic ecological patterns (Halpin 1997, Hannah 2010). However, to be effective, conservation reserve networks must be coordinated at continental, regional and local scales (Soule and Terborgh 1999). This criterion of planning at multiple spatial scales for multiple resources within a reserve network is problematic because many climate change vulnerability assessments have been based on single species or resources, such as a habitat or ecosystem type (Dawson et al. 2011). A new approach is needed for assessing the vulnerability of reserve units, which are

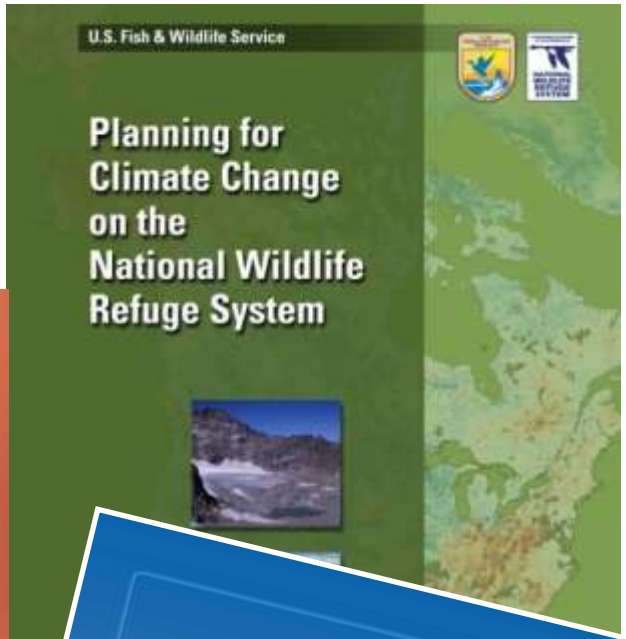
We have choices….

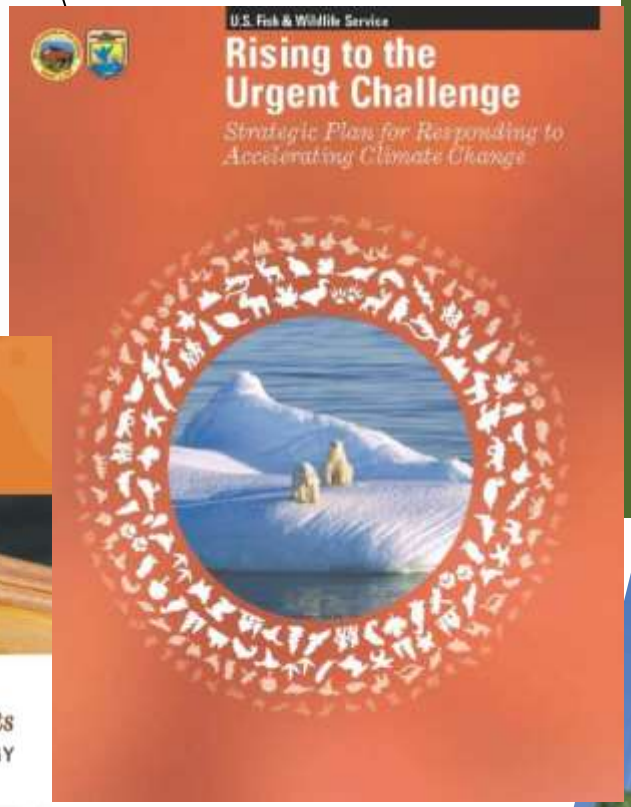
(1) Retrospective adaption =
Managing towards historical conditions

(2) Prospective adaptation =
Managing towards future conditions

(3) Do nothing 


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
Planning for Climate Change on the National Wildlife Refuge System


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


CONNECTING ALASKA LANDSCAPES INTO THE FUTURE
FINAL REPORT • AUGUST 2010

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.

art by Don Davis, courtesy NASA

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.

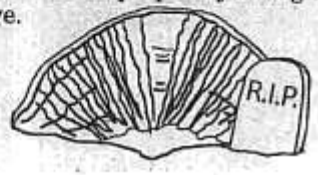
Over millions of years, newer types of life develop. Diversity increases again. The makeup of the planet changes yet again.

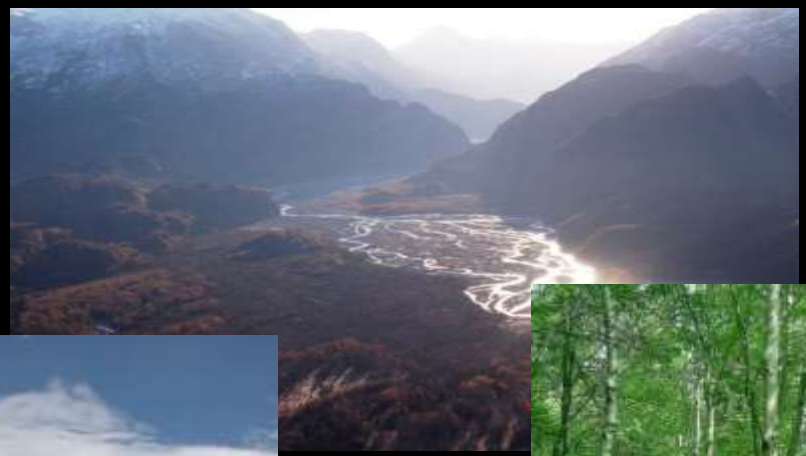
Let's explore Earth's earlier mass extinctions.

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.

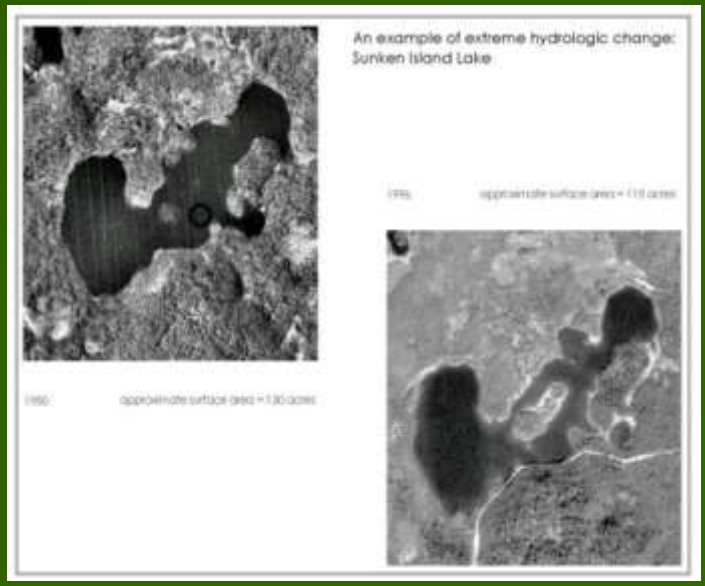
One reason for the extinctions might have been a drop in sea level. Huge glaciers might have formed, locking up much of the planet's water. This would have caused sea levels to drop. Life in shallower waters might not have been able to adapt quickly enough to survive.



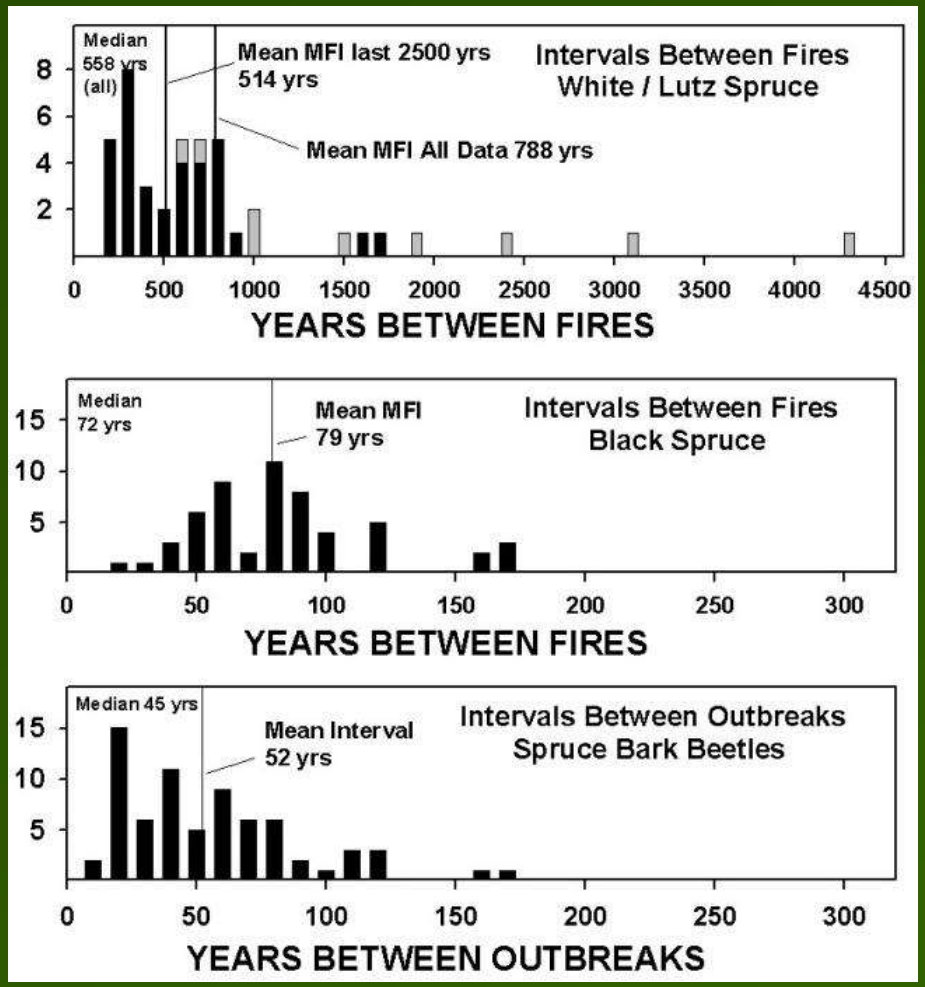


Measured rates of climate change impacts on the Kenai Peninsula

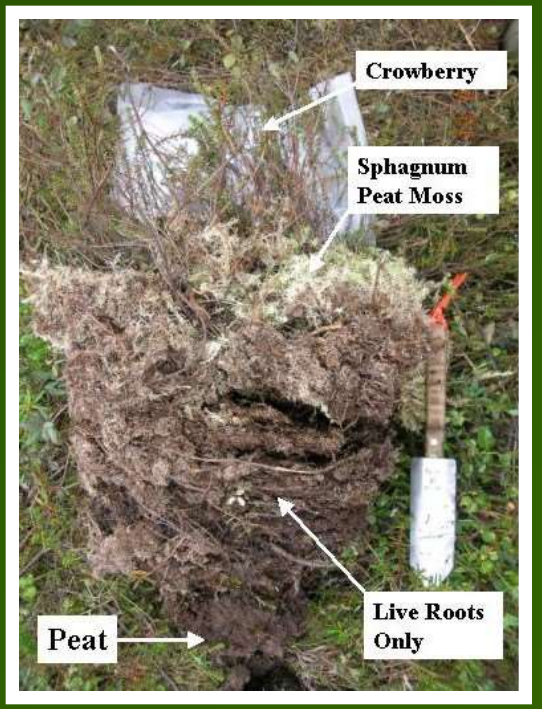
- wetlands (6 – 11% per decade since 1950)
- glaciers (5% surface area, 21 m elevation since 1950)
+ SB beetle outbreaks (triggered by 2 consecutive warm summers)
Δ wildfire (spring, grass)
+ treeline (10 m per decade)
- available water (60% loss since 1968)
Δ species distributions



Changing fire regime? 2005 fire season



Woody shrub encroachment into Sphagnum peatlands



Conversion of white/Lutz spruce forests to *Calamagrostis* savannah

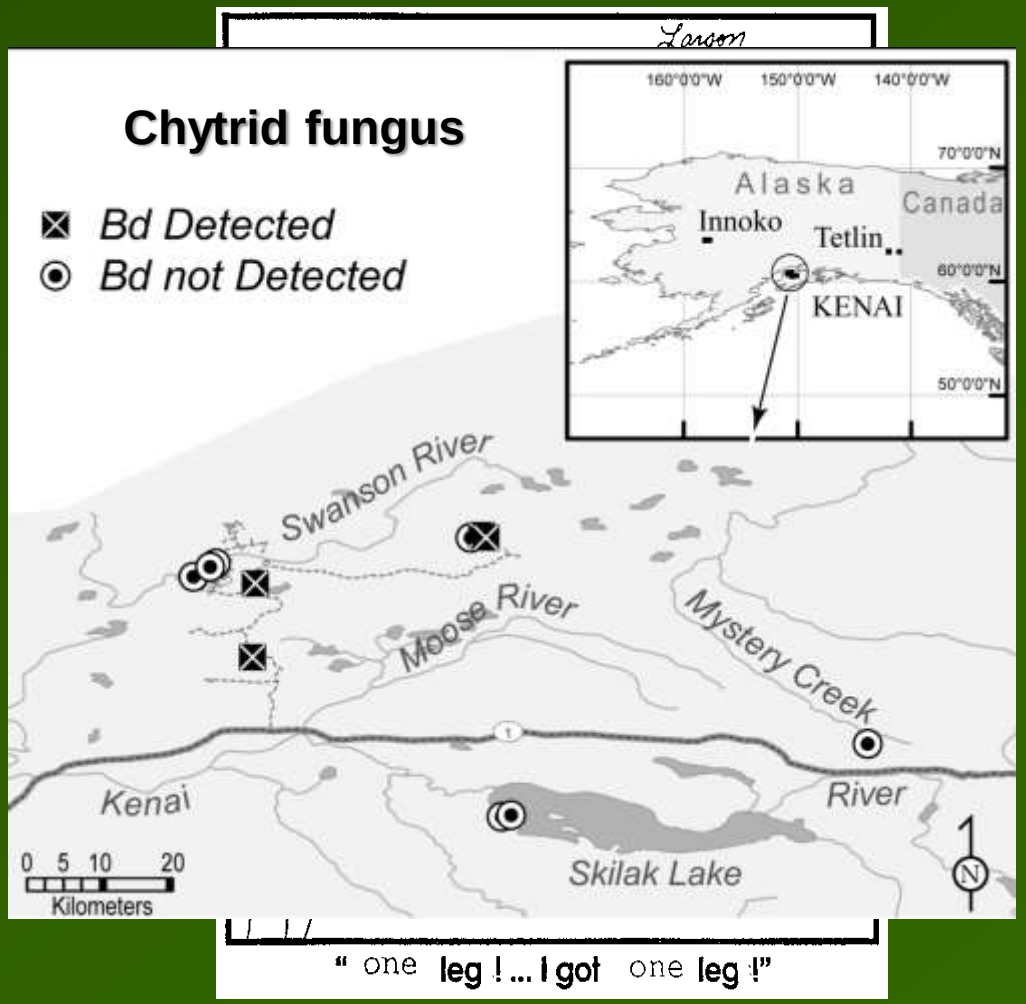
Changing migration window

- eBird records for the Kenai Peninsula in 2007-12

- ✓ 13 new species in last 5 years
- ✓ Earlier arrival records for 33 species
- ✓ Later departure records for 38 species

Eurasian-collared dove
Heerman's gull
Jack snipe
Lesser black-backed gull
Long-billed murrelet
Northern Mockingbird
Redwing
Spotted towhee
Turkey vulture
Western Kingbird
Western meadowlark
Willow flycatcher
Wilson's phalarope

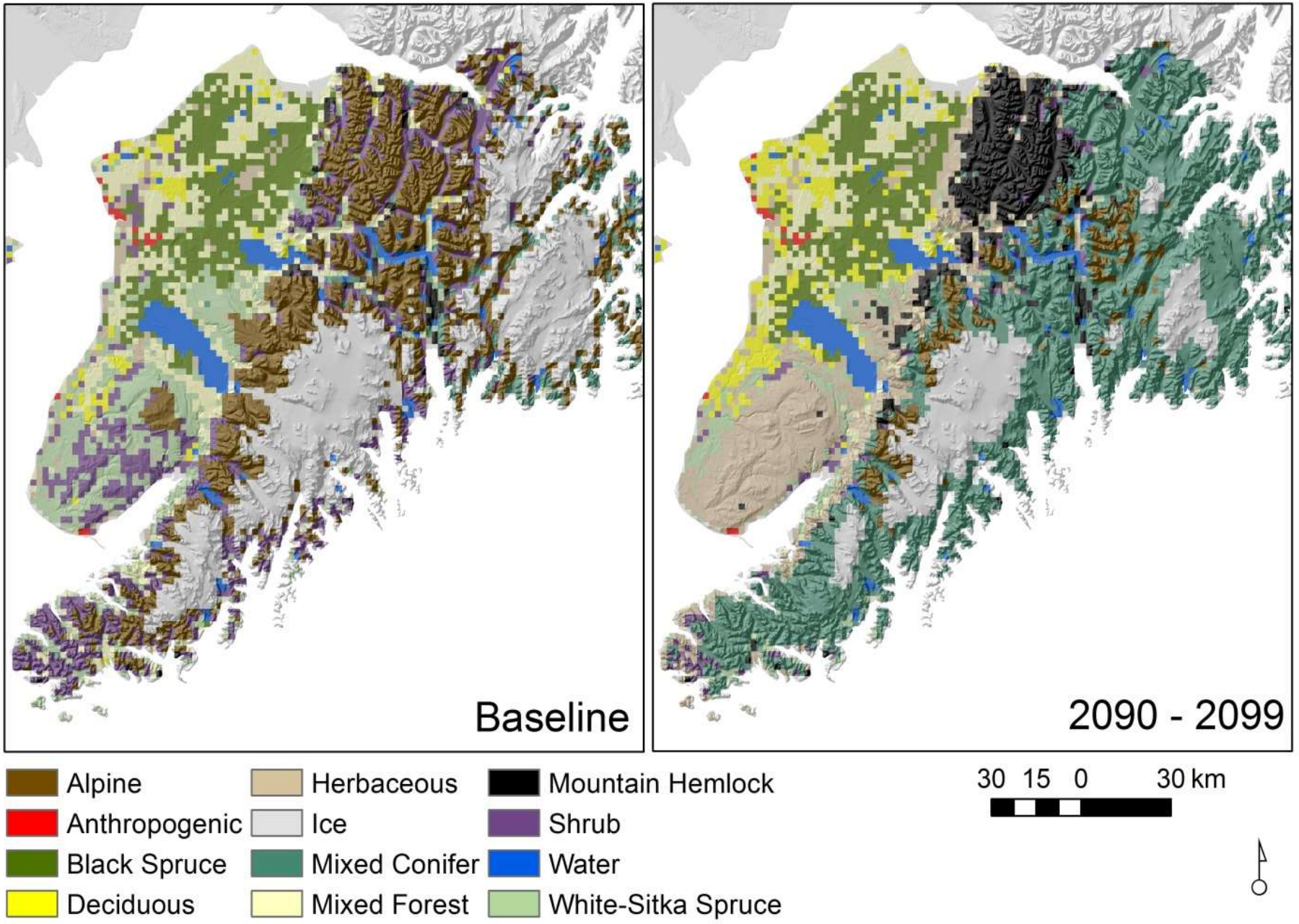
Abnormal wood frogs



Harvested species likely to diminish in abundance on the Kenai Peninsula

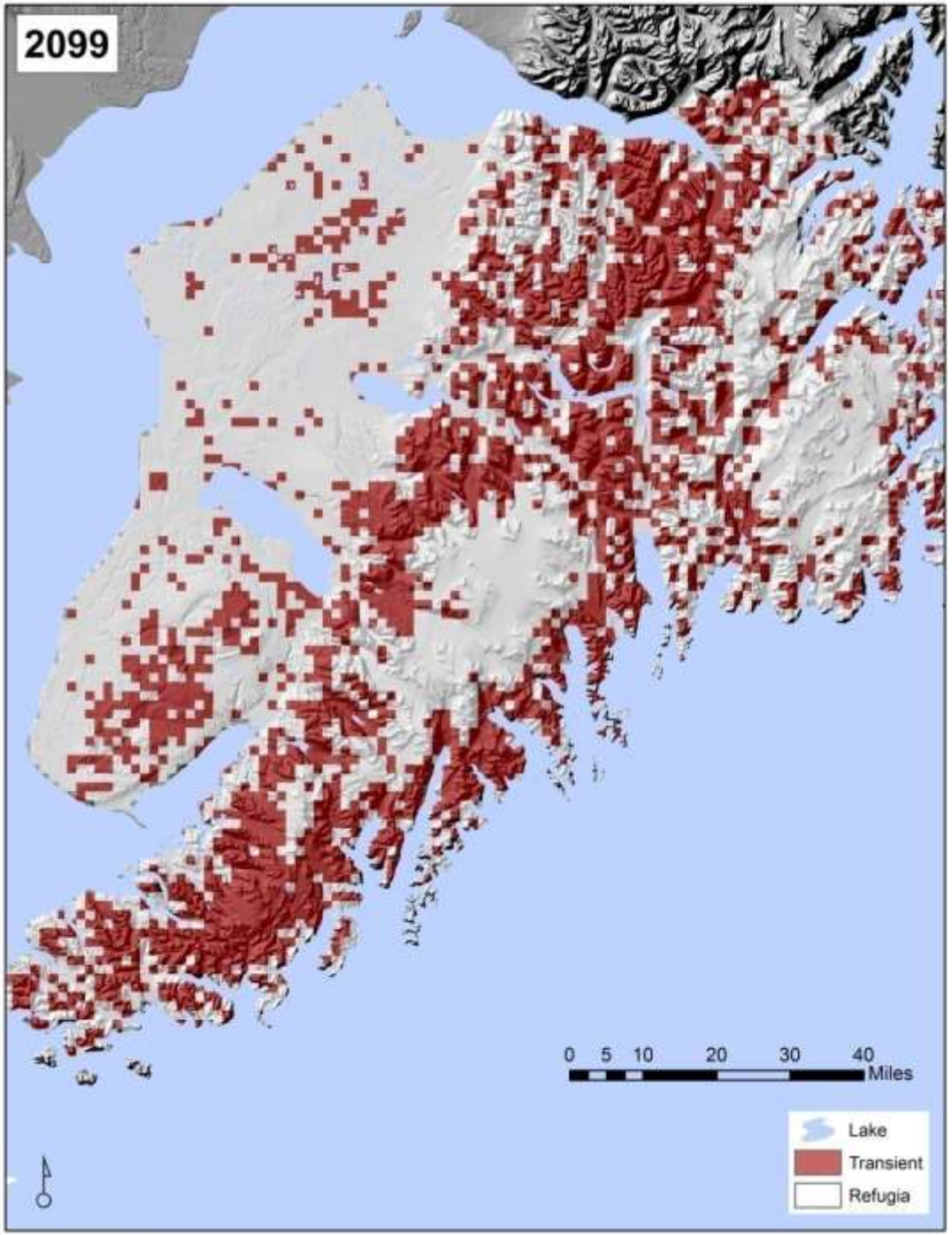
Forecasting the Kenai Peninsula's landscape through 2100

- ✓ 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

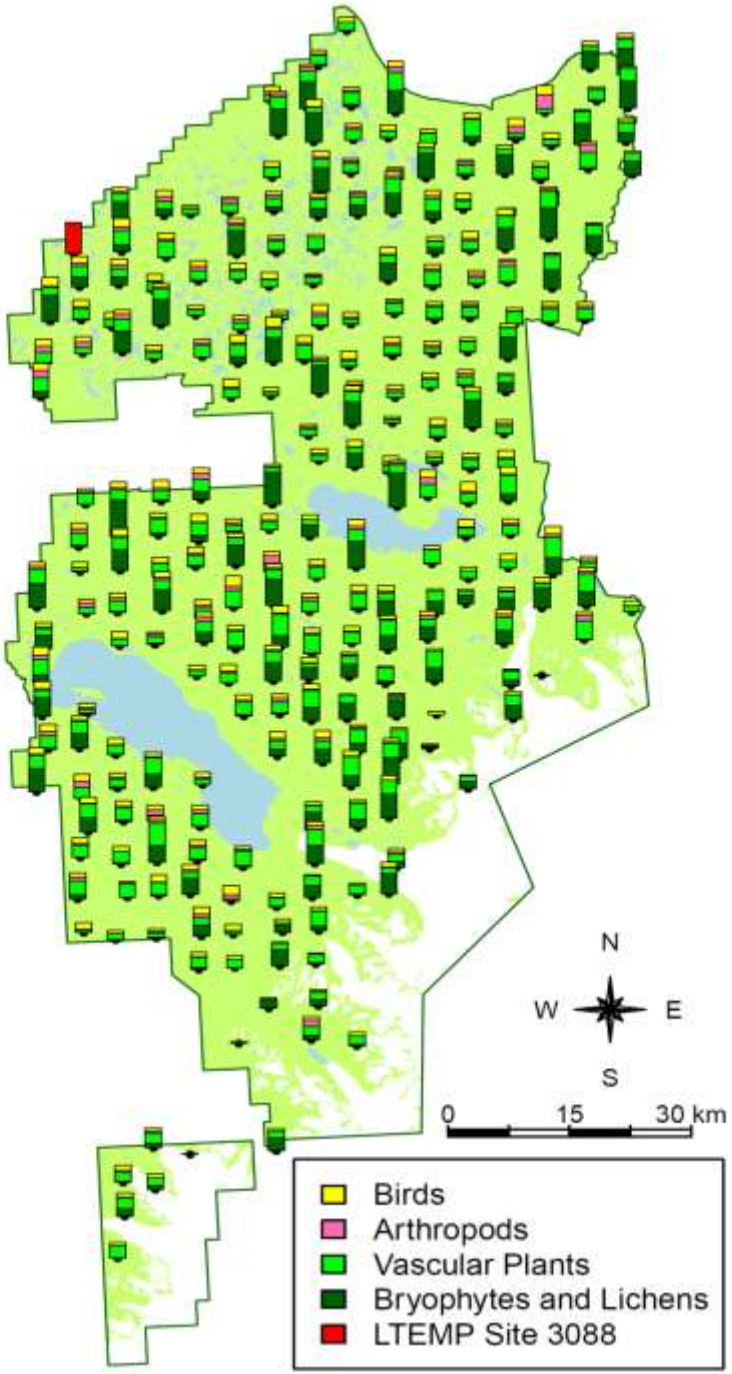
37% of the Kenai Peninsula is forecasted to change landcover type by 2099!

- ✓Eastern side shows afforestation of alpine (hemlock) and coast (Sitka spruce)
- ✓Western side shows deforestation (white and black spruce), expanding grasslands



44% of 1,037 native species are unique to one of 10 landcover types

86 birds
333 vascular plants
477 nonvascular plants
141 arthropods

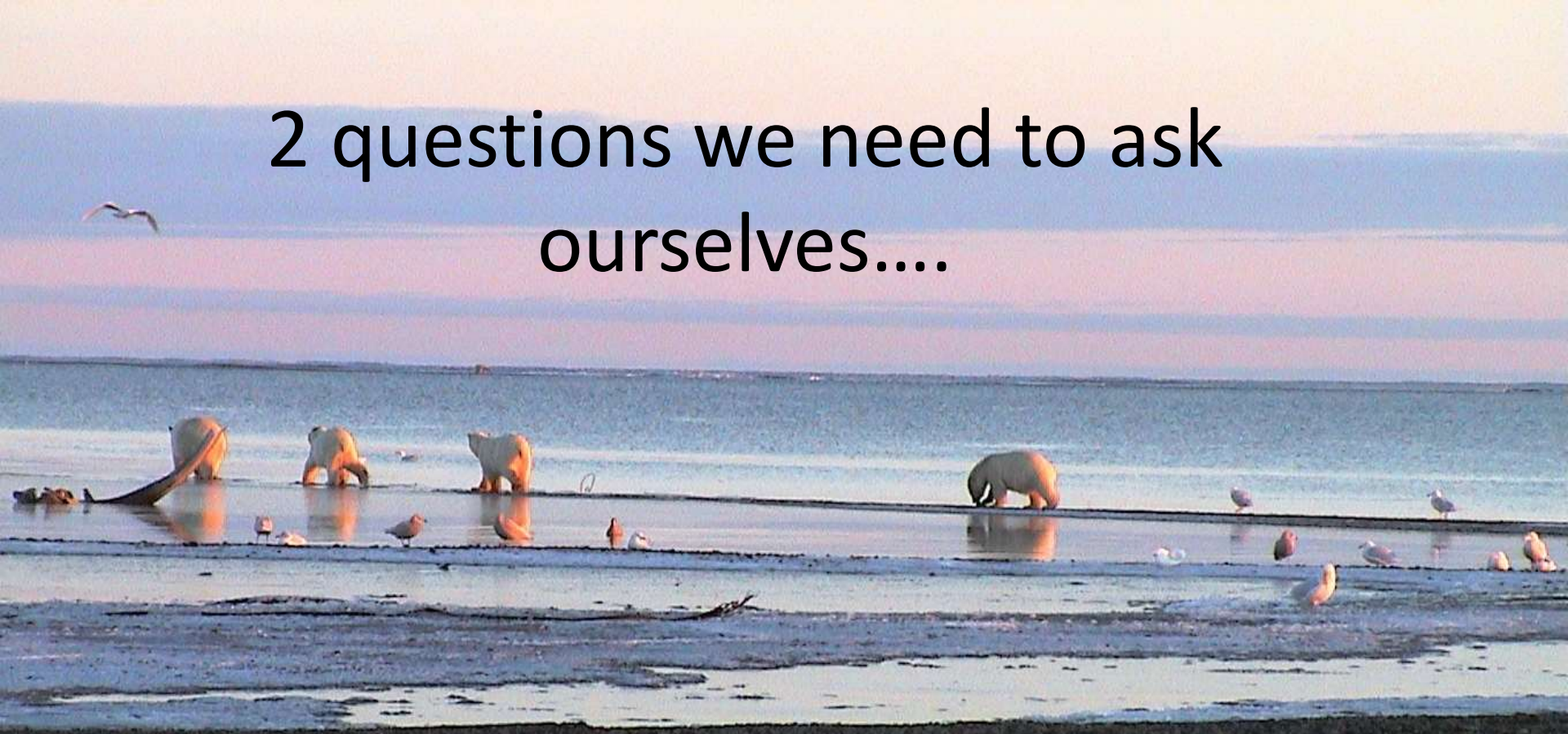


In a worst case scenario, > 400 native species are on a trajectory for extirpation from the Kenai Peninsula by 2099!

Land cover Type	2009 (Ha)	2099 (Min Ha)	Trend	Unique Species
Alpine	556,419	0	-	170
Black Spruce	188,406	0	-	56
Deciduous	38,401	37,601		21
Herbaceous	48,001	65,202	+	15
Mixed Conifer	79,603	330,411	+	1
Mixed Forest	249,209	0	-	86
Mountain Hemlock	34,401	109,604	+	10
Shrub	330,011	0	-	57
Snow or Ice	550,419	50,802	-	8
White-Sitka Spruce	230,408	0	-	38

> 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?

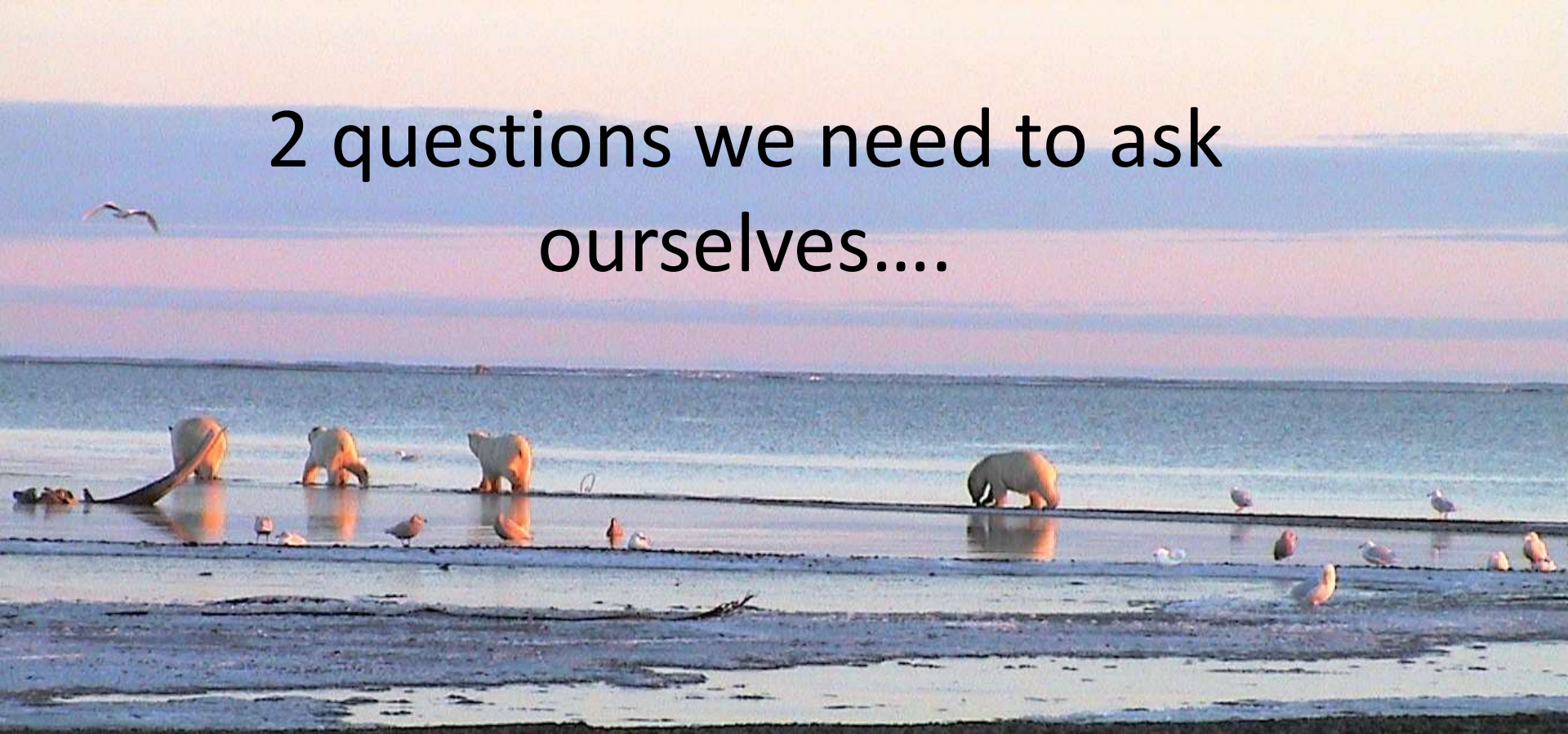
What's the risk of doing something wrong?

----Rosa Meehan
10 Feb 2010

What is the risk of doing nothing?

- ✓ Kenai Peninsula has already changed in response to a changing climate and is forecasted to continue doing so
- ✓ Novel assemblages are not likely to be a simple re-shuffling of native flora and fauna
- ✓ Many extant native species are on a trajectory for extirpation
- ✓ Many exotic species are already on the Kenai Peninsula and more are enroute
- ✓ Do we accept these outcomes or are we willing to accept responsibility for stewarding these outcomes?

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

A human-mediated system on the Kenai with an unknown outcome….

Spruce bark beetle

Cluster Fly

Pheasant

Earthworms

Same climate forecast but potentially different outcomes….

Boreal Transitional

We are already making choices!

“To keep every cog and wheel is the first precaution of intelligent tinkering”.

- Aldo Leopold

But instead of conserving biodiversity, we minimize species extinction…