

Resist-Accept-Direct (RAD): A way of thinking about climate adaptation



John Morton, PhD



Co-evolution of two groups



FEATURE

Responding to Ecosystem Transformation: Resist, Accept, or Direct?

Laura M. Thompson | U.S. Geological Survey, National Climate Adaptation Research Center | University of Tennessee, Department of Forestry, Wildlife and Fisheries, Knoxville, TN, E-mail: lthompson@usgs.gov
Alanna J. Lynch | U.S. Geological Survey, National Climate Adaptation Science Center, Reston, VA
Eric A. Weaver | U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, MT | Montana State University, Department of Ecology, Bozeman, MT
Angela C. Spang | University of Tennessee, Department of Forestry, Wildlife and Fisheries, Knoxville, TN
Jeffrey A. Webb | U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit | University of Alaska, Fairbanks, Fairbanks, AK
Stephan J. Jackson | U.S. Geological Survey, Southeast and South Central Climate Adaptation Science Centers, Reston, VA | University of Arizona, Department of Geosciences and School of Natural Resources and Environment, Tucson, AZ
Trevor J. Kivshinich | University at Buffalo, Department of Biological Sciences and Richard Niessens, Buffalo, NY
David J. Lawrence | National Park Service, Climate Change Response Program, Fort Collins, CO
Douglas Limpricht | NOAA Fisheries, Alaska Region, Public Conservation District, Anchorage, AK
Robert T. Magle | Coconino County Parks and Recreation, Arizona Game and Fish Department, Flagstaff, AZ
Tracy A. Meloni | Michigan State University, Department of Fisheries and Wildlife, East Lansing, MI
John M. Morton | U.S. Fish and Wildlife Service, Kona National Wildlife Refuge, Goldens, WA (retired)
Robert A. Newman | University of North Dakota, Department of Biology, Grand Forks, ND
Jay O. Peterson | NOAA Fisheries, Office of Science and Technology, Silver Spring, MD
Mark E. Renshaw | Nebraska Game and Parks Commission, Lincoln, NE
Frank J. Rulifson | University of Wyoming, Department of Zoology and Physiology, Laramie, WY
Sarah A. Seidl | U.S. Geological Survey, New York Cooperative Fish and Wildlife Research Unit, Cornell University, Ithaca, NY
Jennifer L. Wilkening | U.S. Fish and Wildlife Service, Southern Nevada Fish and Wildlife Office, Las Vegas, NV

Before and after photos of a coral bleaching event in American Samoa. Photo credit: The Ocean Agency/OL Catin Seawave Survey (www.seawave.gov.fu)

The article has been reviewed by a US Government employee and does not work for the public domain in the USA.
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FISHBIRDS | www.fishbirds.org | 1



National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Resist-Accept-Direct (RAD)—A Framework for the 21st-century Natural Resource Manager

Natural Resource Report NPS/NRSS/CCRP/NRR—2020/2213

2

RAD is a decision framework

"One day Alice came to a fork in the road and saw a Cheshire cat in a tree.

'Which road do I take?' she asked.

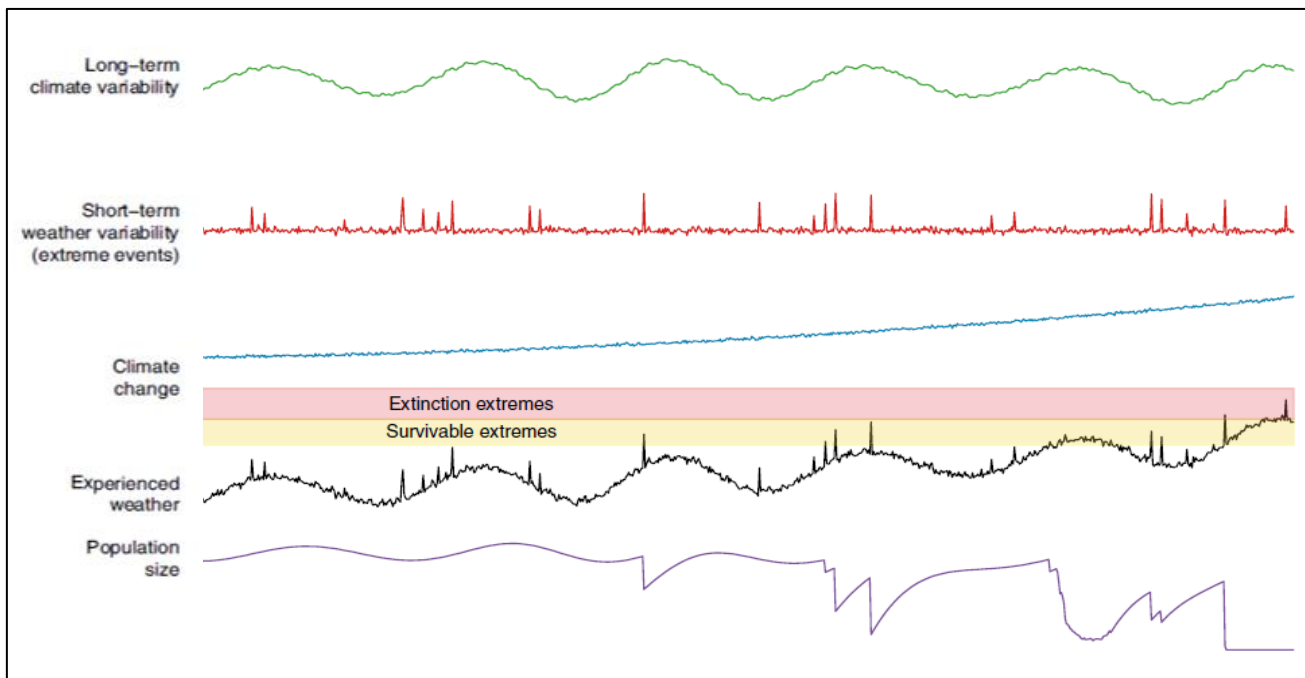
'Where do you want to go?' was his response.

'I don't know', Alice answered.

'Then', said the cat, 'it doesn't matter.'"



RAD addresses Directional Change and Ecological Transformation



Directional Change
unrelenting and unprecedented
change in key drivers of
ecological conditions

Ecological Transformation
“a dramatic, persistent, and
statistically ‘extreme’ shift in
multiple ecological
characteristics, the basis of which
is dramatic changes in species
composition”

RAD framework squarely assigns the adaptation response to a managerial/societal/tribal decision

RESIST	ACCEPT	DIRECT
<p>Many changes will be RESISTED by managers, to maintain ecosystem processes, function and composition toward a <u>historical</u> baseline</p>	<p>Many changes will be ACCEPTED by managers, perhaps because...</p> <ul style="list-style-type: none"> • Infeasible to be managed • insufficiently impactful to warrant response • acceptable to (even desirable by) stakeholders • unknowingly occurring • lack of will or impetus despite sufficient knowledge or resources 	<p>Some changes will be DIRECTED by managers toward a specific <u>future</u> state because...</p> <p>so dramatic that resisting is untenable and there is a feasible opportunity to steward change towards a more desirable outcome than what would be achieved with acceptance</p>

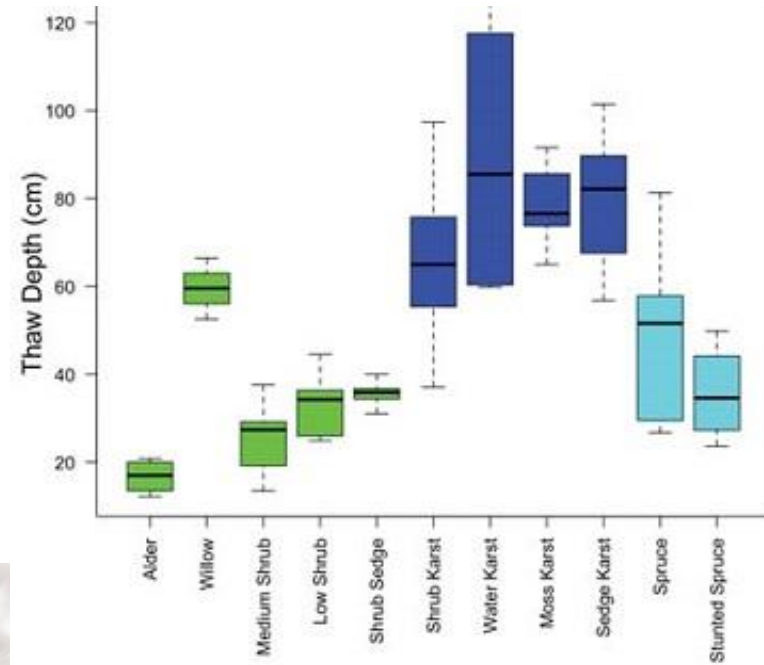
...with the goal of a self-sustaining, self-organizing system

Crib Notes

- 1) Goal is a self-sustaining, self-organizing system; not continual intervention
- 2) Three bins are all encompassing (i.e., nothing outside decision space), mutually exclusive, and NOT a continuum
 - however, one or all three bins can be applied sequentially or concurrently (i.e., portfolio approach)
 - comparison is among the three choices (all of which involve change), not with a static historic or natural baseline
 - awareness of all three bins promotes bet hedging
- 3) Technology (or the absence of it) does not dictate whether approach is R, A or D
- 4) ACCEPT does not imply the absence of management
- 5) Decision paralysis because of uncertainty is NOT an option; consider experimentation to test ecological outcomes and/or pilot studies of novel climate adaptation that can be scaled up (if successful)

Reducing uncertainty: Experiments to test ecological trajectories

Permafrost Thaws, it Doesn't Melt



Reducing uncertainty: Pilot studies of potential adaptation

YEAR	CONTROL	TRMT 1	TRMT 2
2023	beaver dam	beaver dam	no BDA
2024	beaver dam	no beaver dam	BDA



- Beaver dams increase groundwater discharge 70% (no clay) to 90% (clay pan)
- 17 acre average footprint

Same problem but three structural adaptation approaches



RESIST: Hard armoring of Kivalina



ACCEPT: Allow the loss of Newtok (strategic retreat)

DIRECT: Construct Evacuation Road & Center at Mertarvik



Same problem but three structural adaptation approaches



RESIST: Hard armoring of Kivalina



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Qutekcak

Tatilek

Valdez

Cordova

Chenega

Nanwalek
Port Graham

50 mi

Image IBCAO
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA

Google Earth

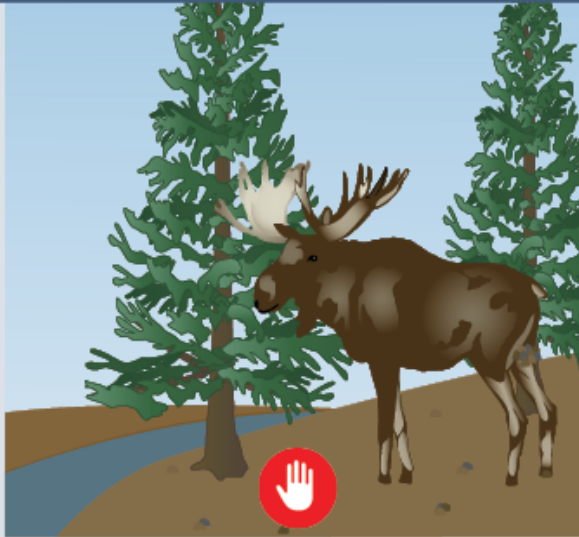
61°40'21.06" N 145°45'14.78" W elev 3028 ft eye alt 212.42 mi

RESIST

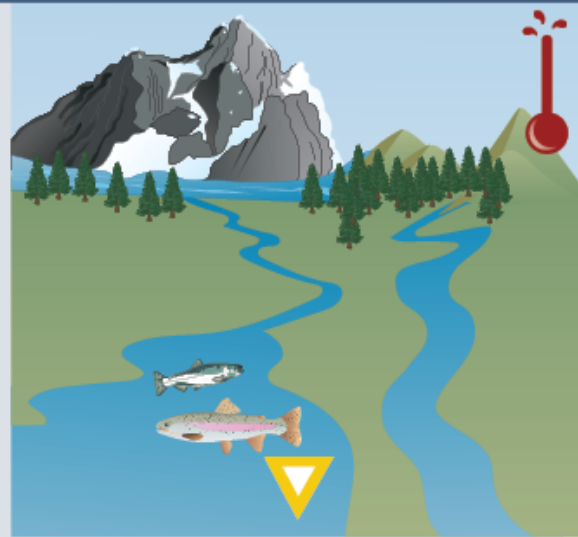
ACCEPT

DIRECT

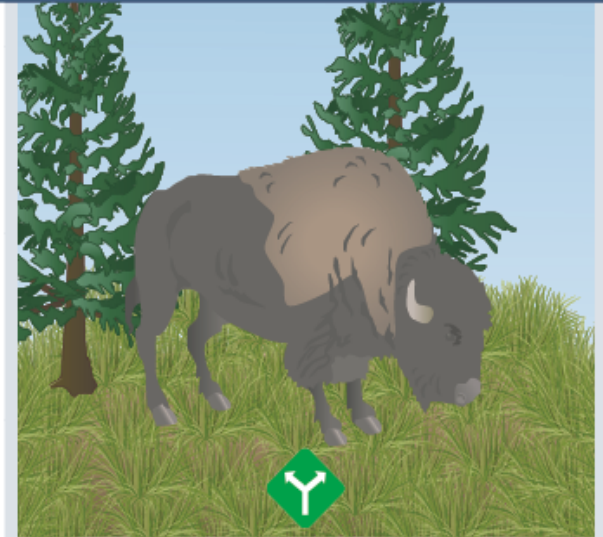
Kenai Peninsula, Alaska: A Case Study



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.

Conventional management issues

Most ecological responses to climate change (directional)

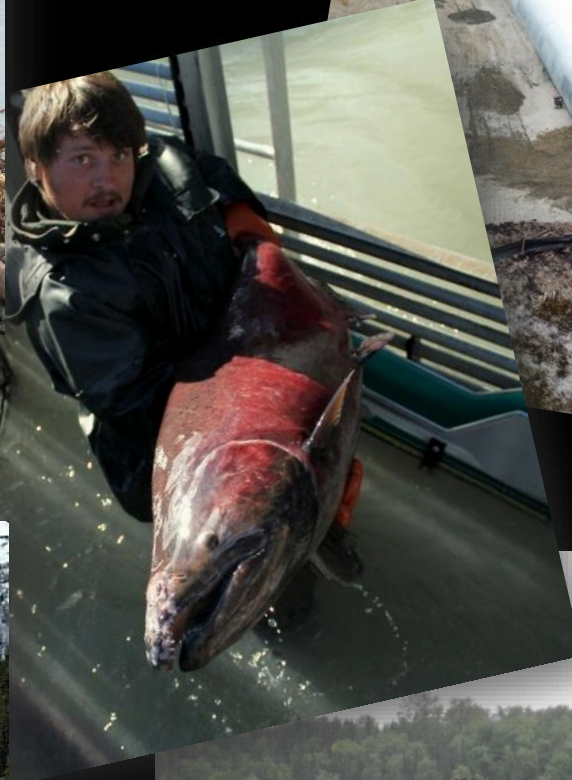
Deforestation (transformational)

An aerial photograph capturing a massive fire plume. The plume is a towering wall of dark, billowing smoke and ash, rising vertically from a landscape below. At the top of the plume, a bright sun is partially obscured, creating a dramatic lens flare effect. The sky is a mix of pale blue and golden-yellow, suggesting a sunset or sunrise. In the foreground, a winding road or path is visible on the ground, leading towards the base of the fire. A dark, diagonal shape, likely a wing or part of an aircraft, is visible in the upper right corner. The word "RESIST" is overlaid in white, bold, sans-serif capital letters in the upper left quadrant.

RESIST

2019 Swan Lake Fire

RESIST

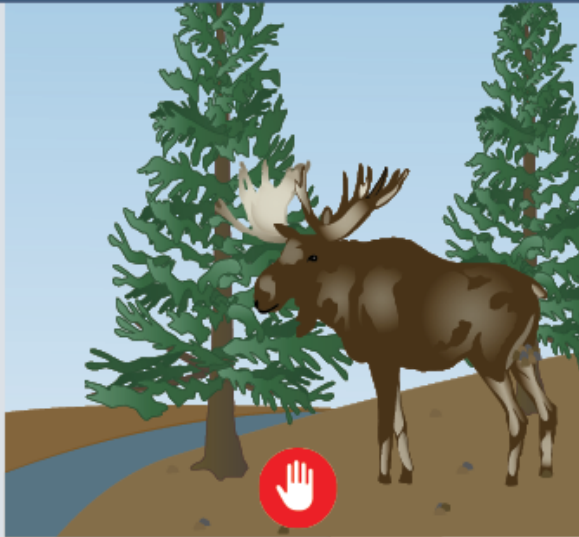


RESIST

ACCEPT

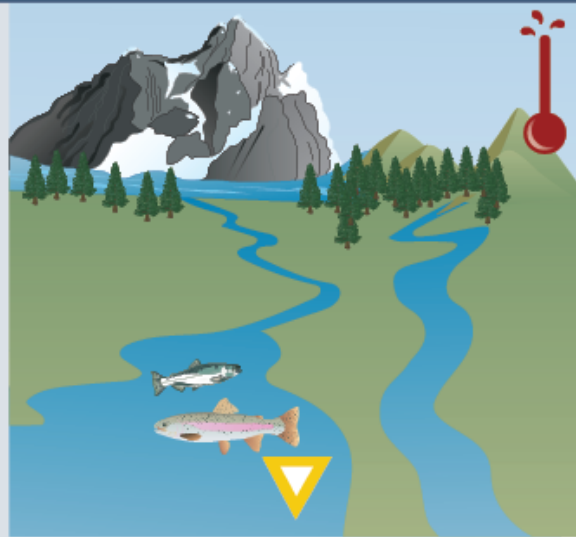
DIRECT

Kenai Peninsula, Alaska: A Case Study



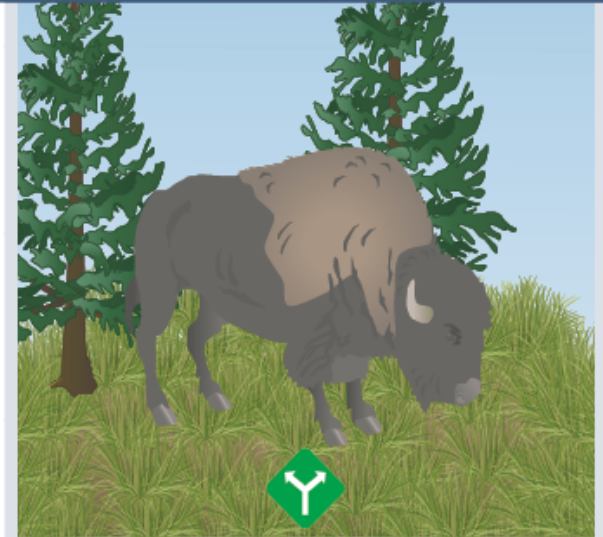
Stream banks are restored, some invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Many invasives are not managed either due to infeasibility or lack of perceived threat.

Conventional management issues



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Most ecological responses to climate change (directional)



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.

Deforestation (transformational)

ACCEPT



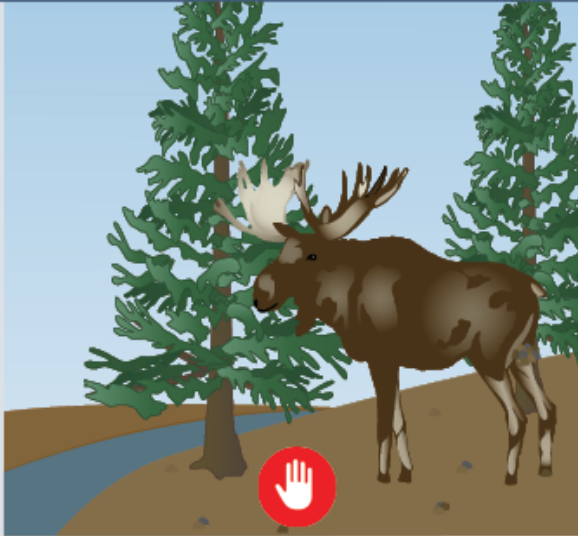
- declining mean annual available water (69% loss since 1968)
- drying wetlands(6 – 11% loss per decade) with shrubification
- receding glaciers (11% surface area, 21 m elevation loss)
- + warming nonglacial streams in July exceed physiological thresholds for salmon and temperatures not forecasted until 2069
- + afforesting alpine tundra (trees~1 m/yr, shrubs~2.8 m/yr)
- + unprecedented spruce bark beetle outbreaks (triggered by 2 consecutive warm summers)

RESIST

ACCEPT

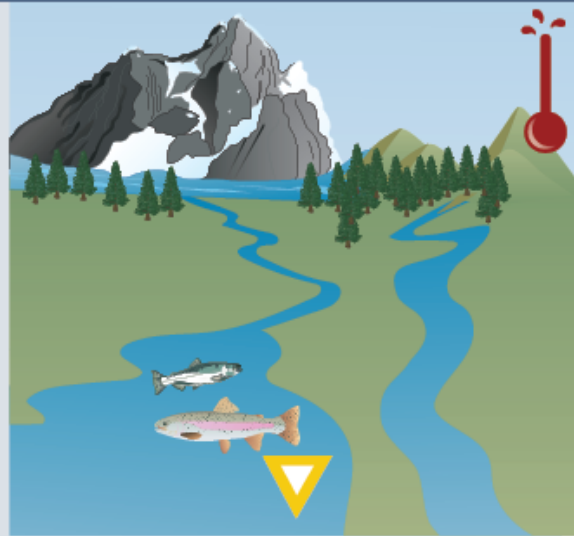
DIRECT

Kenai Peninsula, Alaska: A Case Study



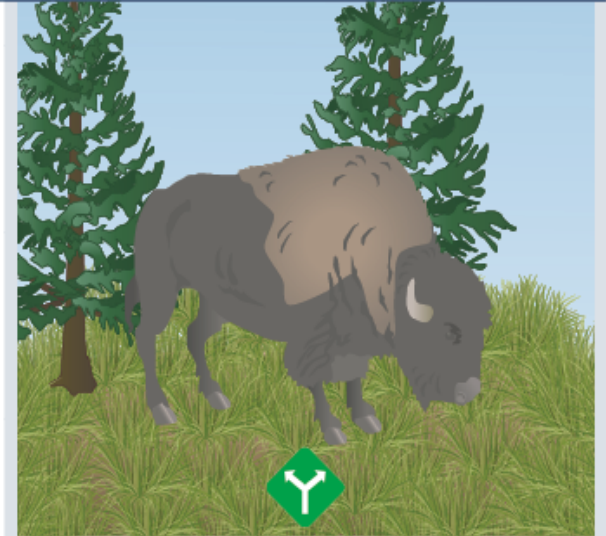
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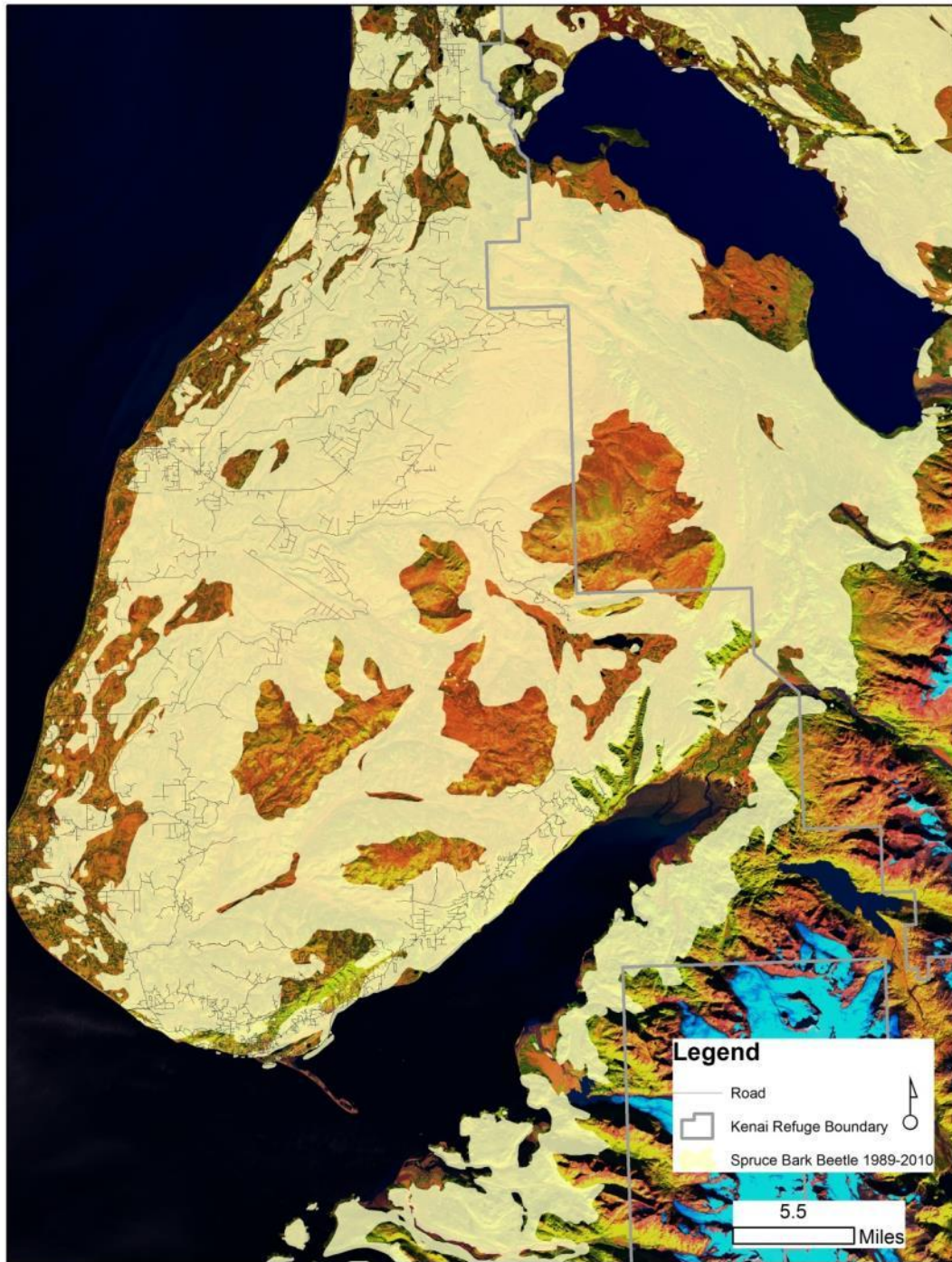
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Most ecological responses to climate change

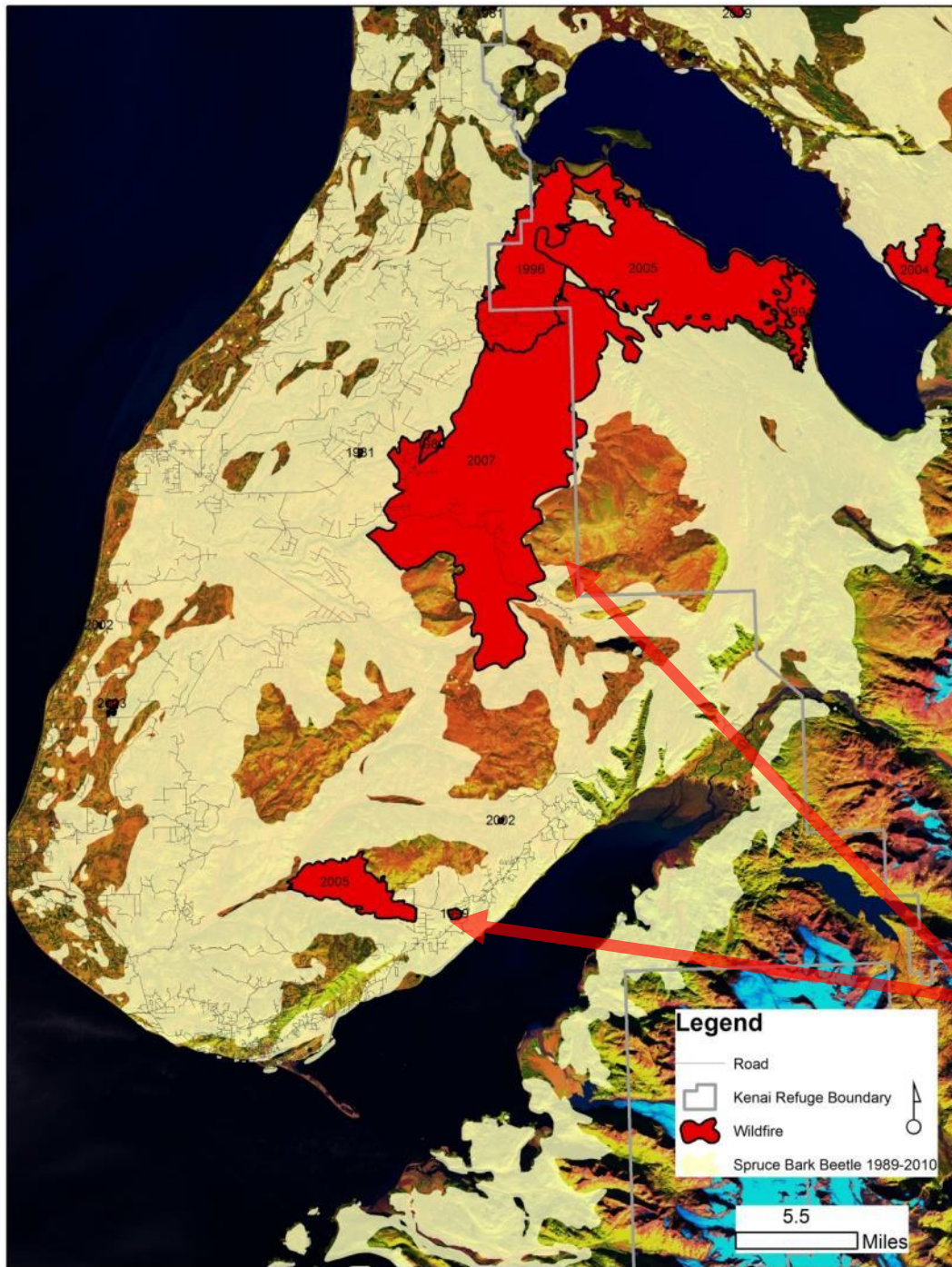


A spruce bark beetle epidemic and human-caused fire have shifted white spruce forests into a novel grassland ecosystem. Non-native trees are being planted, and the introduction of large grazers is being considered to stabilize the new grasslands and related communities.

Deforestation



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

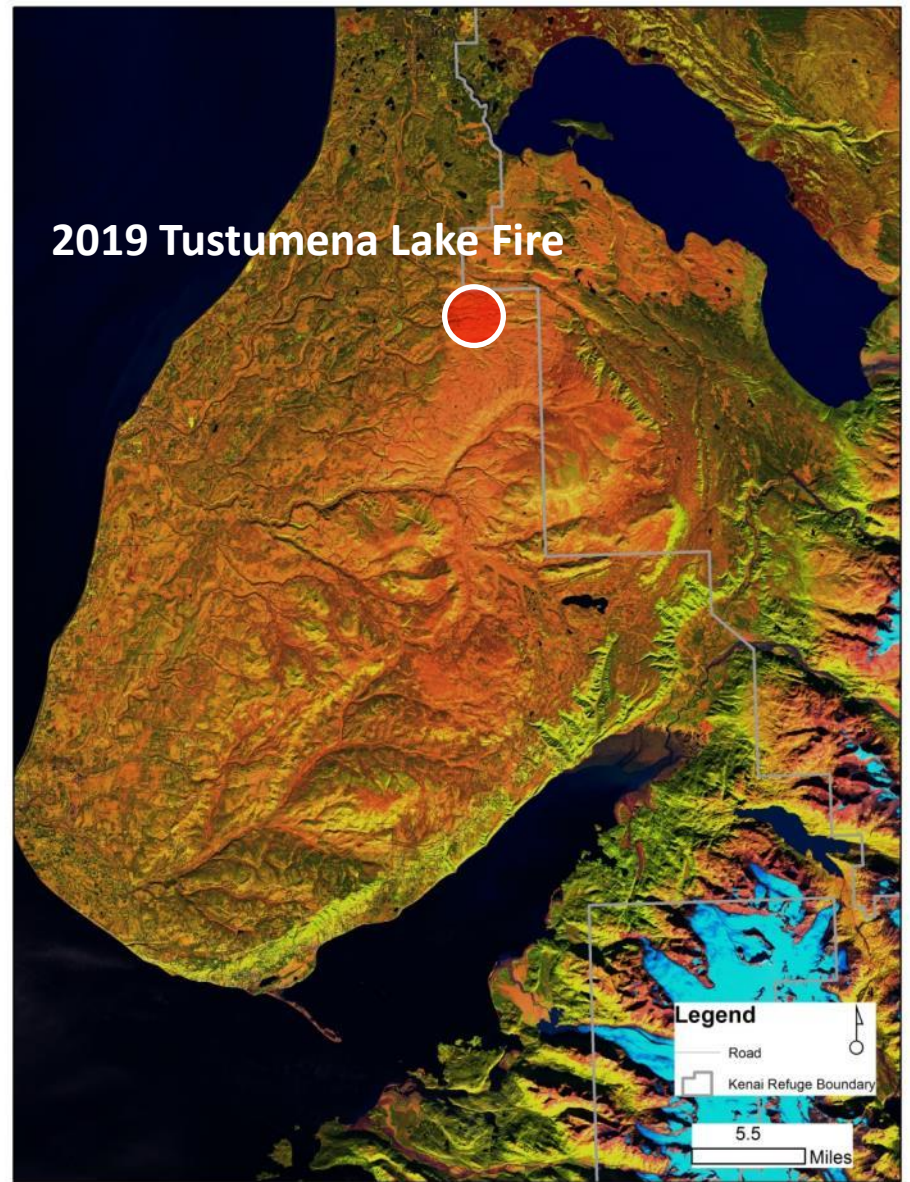
**First lightning-
caused grassland
fire in spring on
Kenai Peninsula**

2019 Tustumena Lake Fire





SEPT 1985



SEPT 2014



CURRENT TRAJECTORY (ACCEPT)



DIRECT



LOGEPOLE PINE



BLACK-TAILED DEER

FOREST



CURRENT TRAJECTORY (ACCEPT)



DIRECT

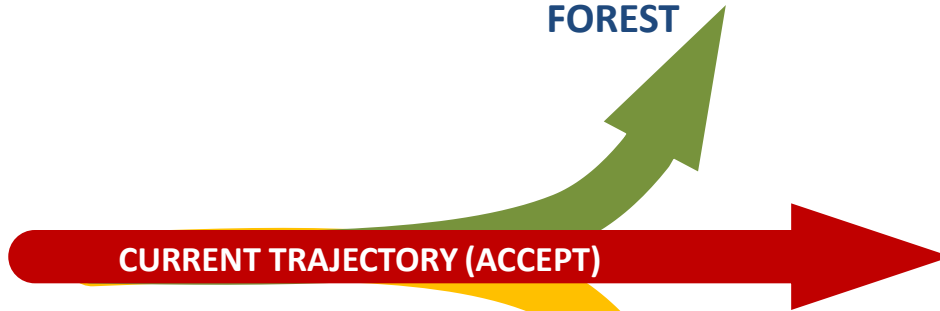


LOGEPOLE PINE



BLACK-TAILED DEER

FOREST



CURRENT TRAJECTORY (ACCEPT)



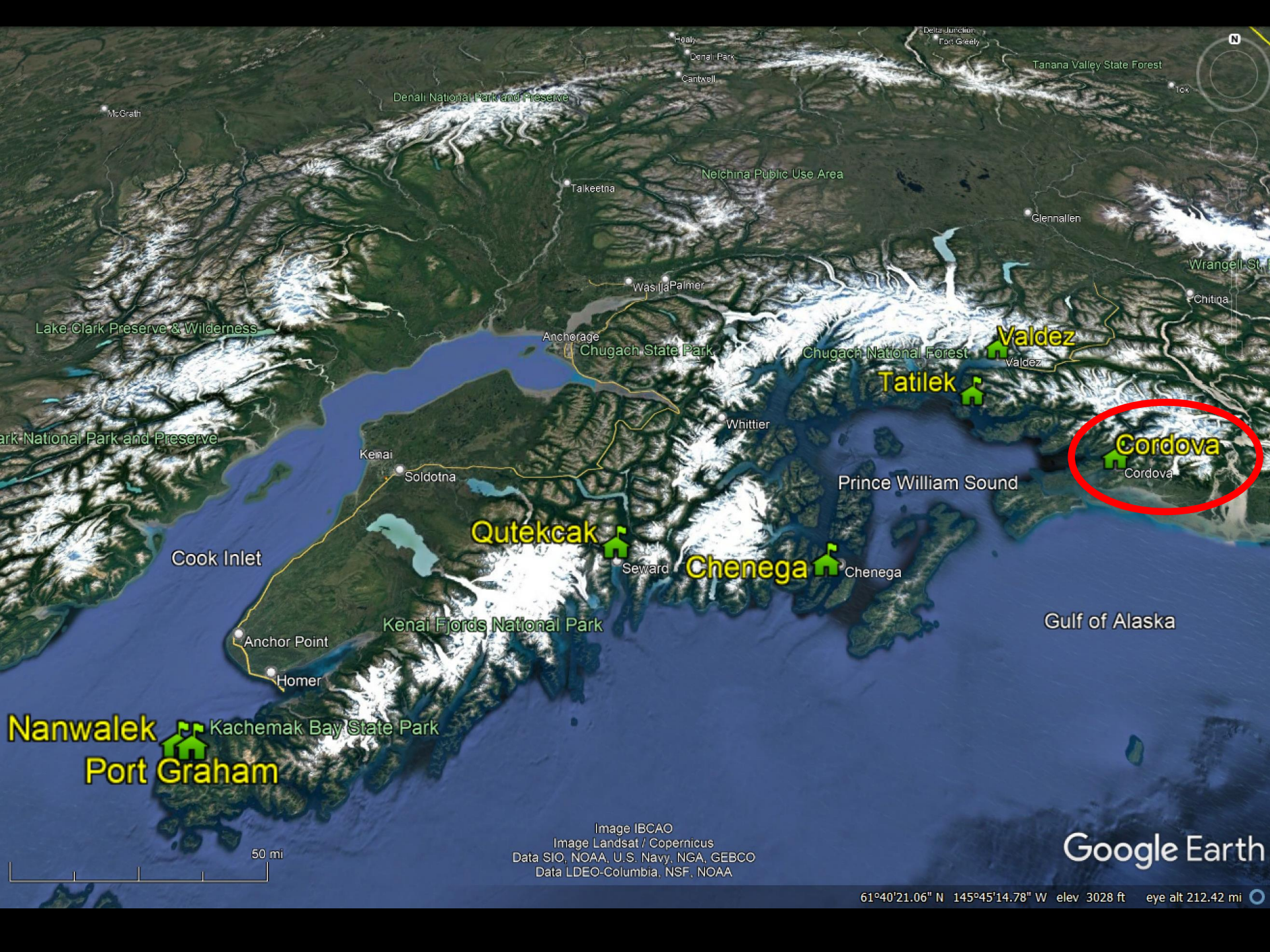
GRASS



PRESCRIBED FIRE



INTRODUCED GRAZERS



Denali National Park and Preserve

Healy
Denali Park
Cantwell

Delta Junction
Fort Greely

Tanana Valley State Forest

Lake Clark Preserve & Wilderness

Talkeetna

Nelechina Public Use Area

Glennallen

Wrangell State Forest

Chitina

Anchorage

Chugach State Park

Chugach National Forest

Valdez

Tatilek

Valdez

Whittier

Cordova

Cordova

Prince William Sound

Kenai

Soldotna

Qutekcak

Seward
Chenega

Chenega

Cook Inlet

Kenai Fjords National Park

Gulf of Alaska

Anchor Point

Homer

Kachemak Bay State Park

Nanwalek

Port Graham

Image IBCAO

Image Landsat / Copernicus

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

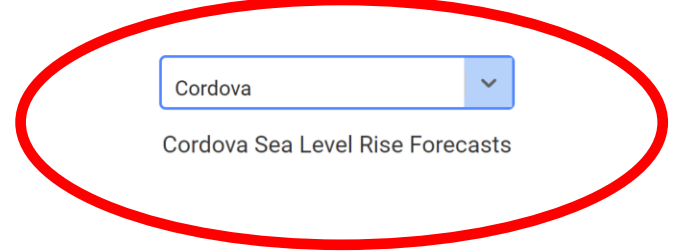
Data LDEO-Columbia, NSF, NOAA

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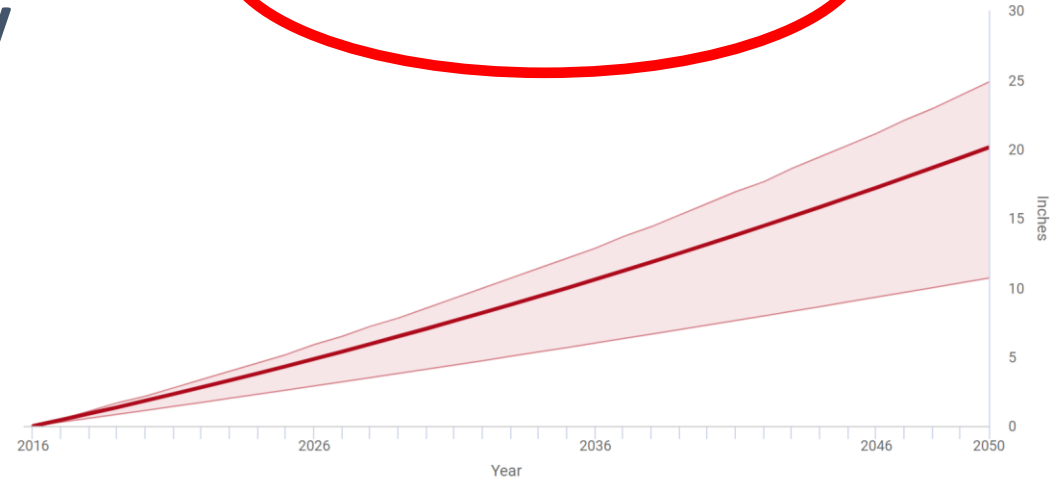
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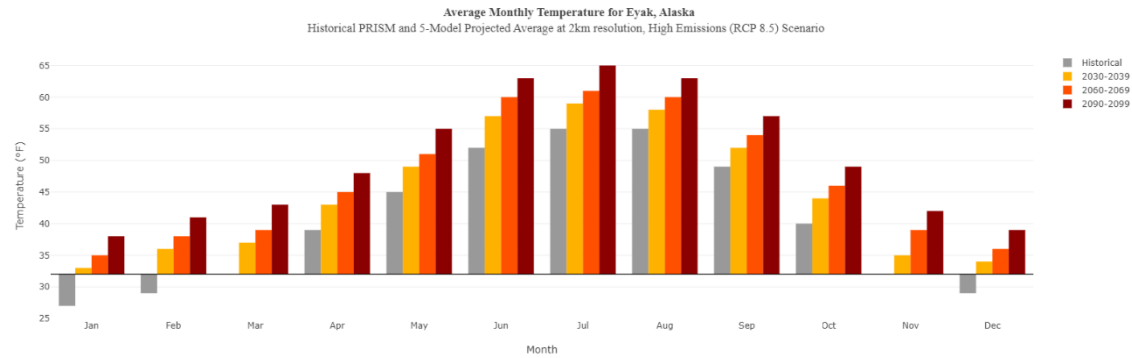
Know your directionality



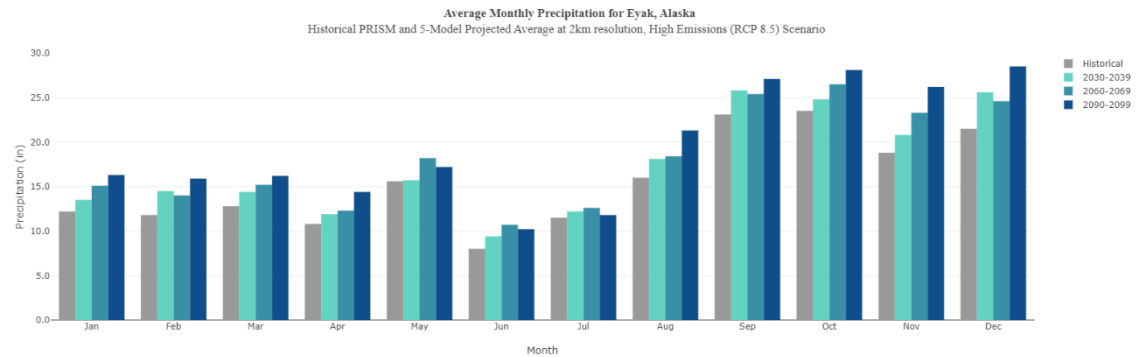
20" rise in seas



No more winters!
10F warmer summers

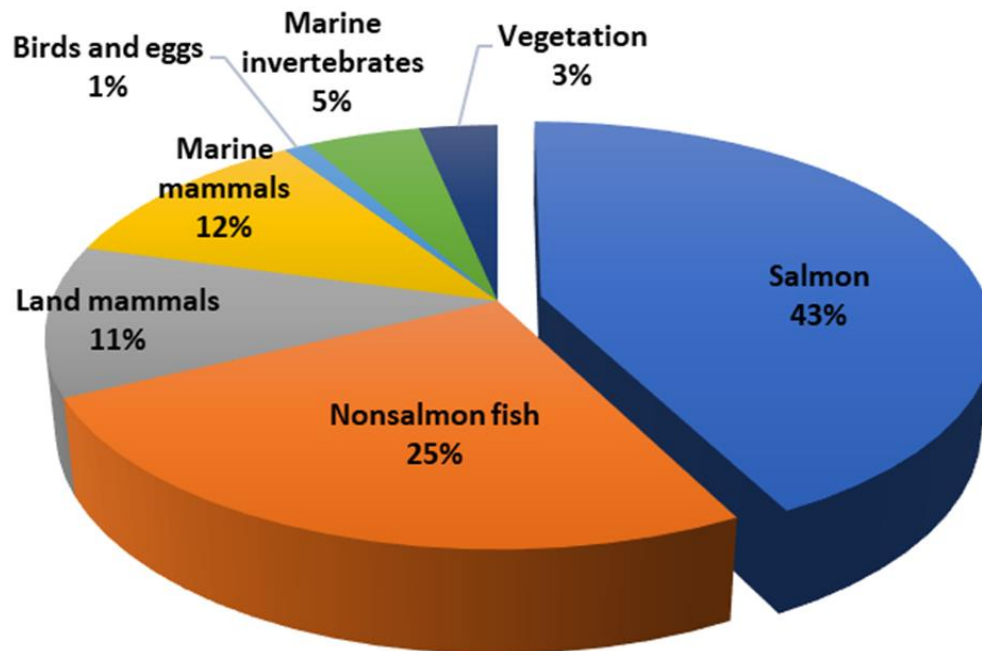


Wetter but less snow



Food security

Average per capita harvests (lbs) of > 140 fish, wildlife and plant species in 7 resource categories for Chenega, Cordova, Nanwalek, Port Graham and Tatitlek



7 representative species

- Pink salmon
- Blueberry
- Razor clam
- Black oystercatcher
- Harbor seal
- Sitka Black-tailed deer
- Eulachon

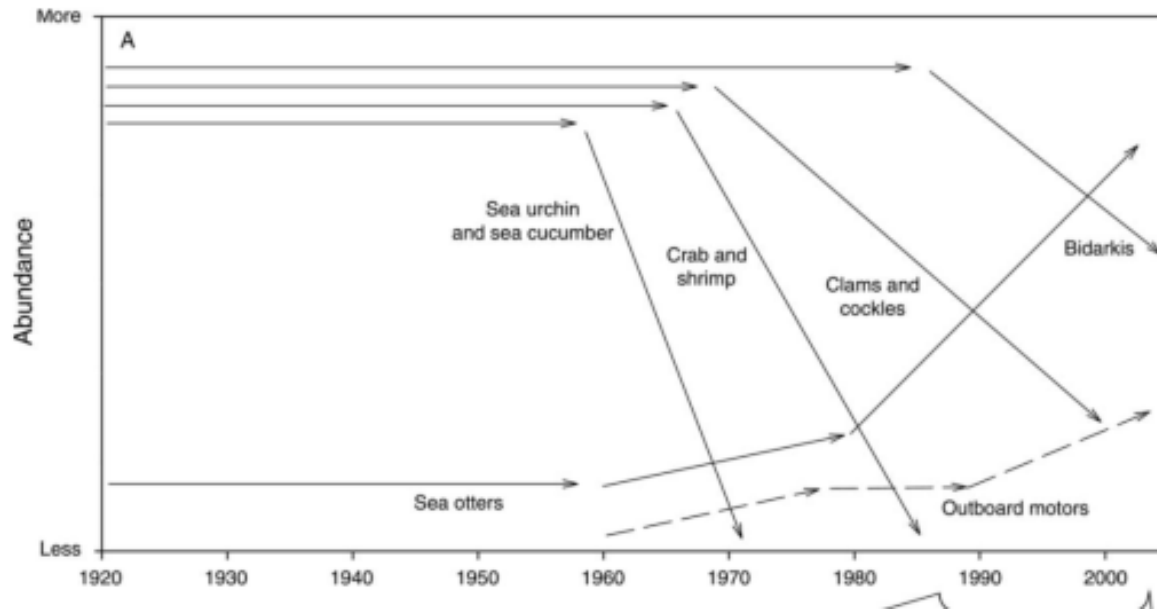
(data averaged over all years from Fall and Zimpelman 2016, Jones and Kostick 2016)

Only 2 are declining now, but 6 of 7 representative species likely to decrease in future!

	Climate stressors					Non-climate stressors			Trend	
	Mean annual temperature	Annual precipitation	Snowpack	Marine heat wave	Ocean acidification	Oil spill	Earthquake or tsunami	Extreme biological event	Current	Likely future
Pink salmon	+	?	-	-	-	-	0	?	+	-
Eulachon	?	?	-	-	-	-	0	0	0	-
Sitka black-tailed deer	+	0	+	0	0	0	0	-	+	+
Harbor seal	?	?	?	-	-	-	0	-	-	-
Black oystercatcher	-	0	0	-	-	-	-	?	0	-
Razor clams	-	0	0	-	-	-	-	-	-	-
Blueberry	-	0	+	0	0	0	0	-	0	-



So don't put all your eggs in one basket



Nanwalek



Salomon, A.K., N.M. Tanape, Sr. and H.P. Huntington. 2007. Serial depletion of marine invertebrates leads to the decline of a strongly interacting grazer. *Ecological Applications* 17(6):1752–1770.



Our values influence our choices

We ACCEPT treeline rise into tundra, but hesitate when a white spruce is accidentally transplanted to the North Slope



We hesitate to RESIST the loss of sea ice by providing artificial haul-out platforms for walrus, but enthusiastically extend the range of Anna's and Rufous hummingbirds northward with year-round feeders



We hesitate to DIRECT a novel grassland on the southern Kenai Peninsula by introducing bison but welcome feral Chinese ring-necked pheasants that now breed there

Littell, J, GW Schuurman, JH Reynolds, JM Morton & N Schmitt. 2022. A RADical approach to conservation in Alaska. *The Wildlife Professional* 16(4):26-30.

It's not rocket science...



...it's harder

