

Decisively adapting to a rapidly changing climate: Resist-Accept-Direct (RAD)



John Morton, PhD



Co-evolution of two groups



FEATURE

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

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Before and after photos of a coral bleaching event in American Samoa. Photo credit: The Ocean Agency/US Coast and Geodetic Survey. www.usgs.gov

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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

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.

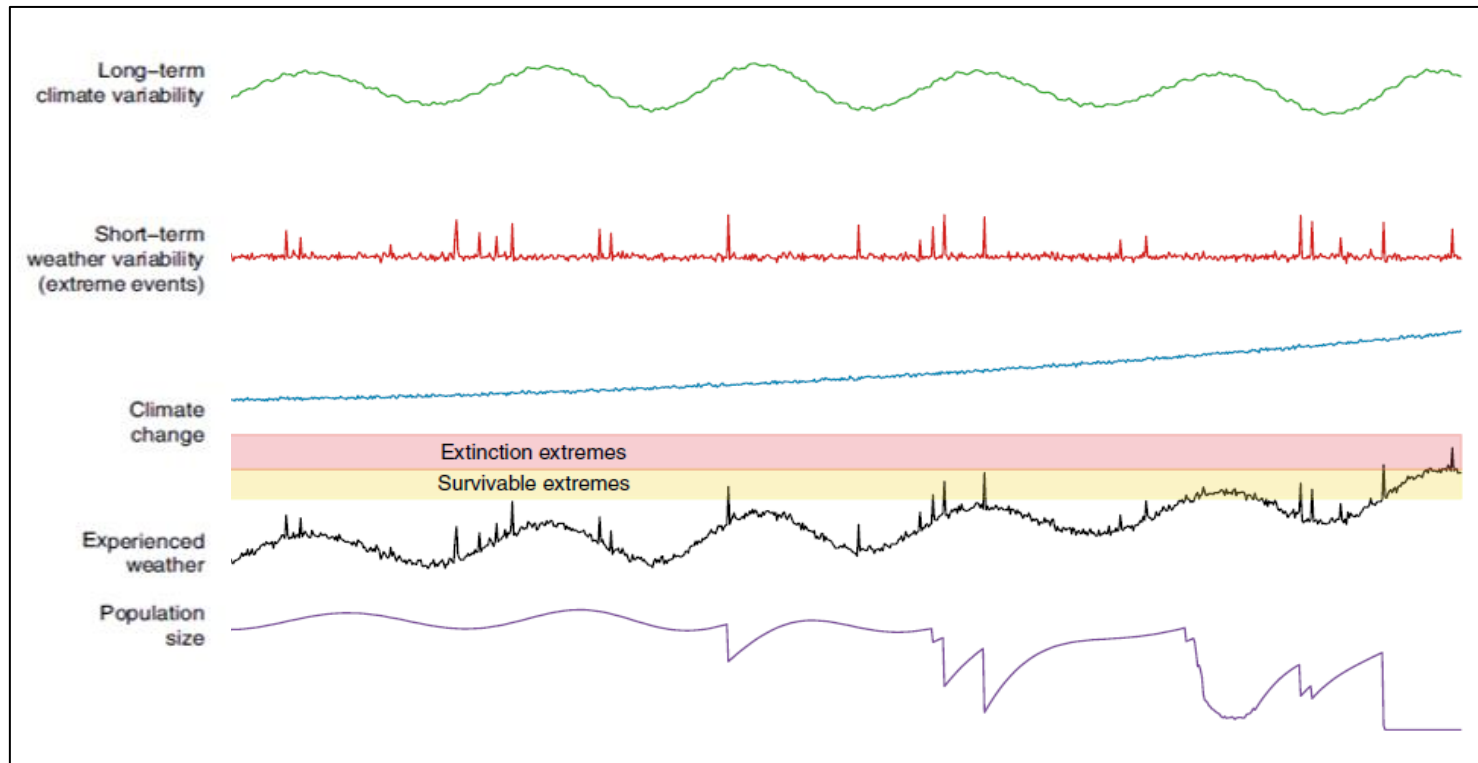
'Where do you want to go?' was his response.

'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 |
|---|---|---|
| Many changes will be RESISTED by managers, to maintain ecosystem processes, function and composition toward a <u>historical</u> baseline | Many changes will be ACCEPTED by managers, perhaps because... <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 | Some changes will be DIRECTED by managers toward a specific <u>future</u> state because... 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 |

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

Same problem but three structural adaptation approaches



ACCEPT: Allow the loss of Newtok (strategic retreat)



RESIST: Hard armoring of Kivalina

DIRECT: Construct Evacuation Road and Center at Mertarvik



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ACCEPT: Allow the loss of Newtok (strategic retreat)



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Crib Notes

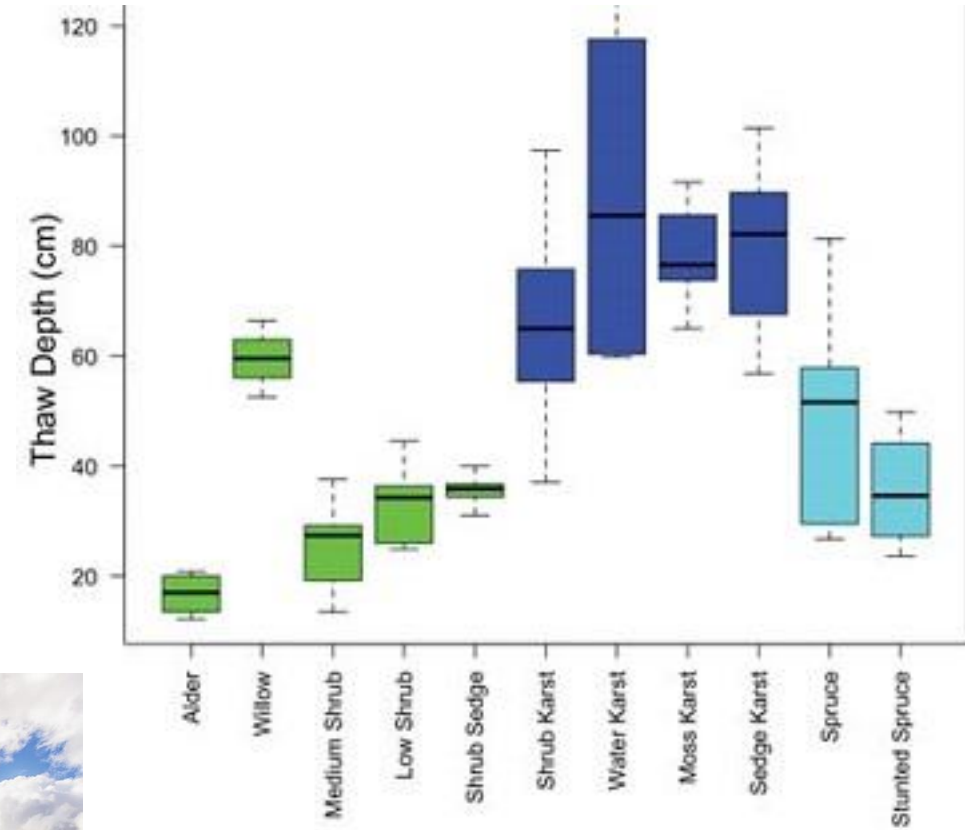
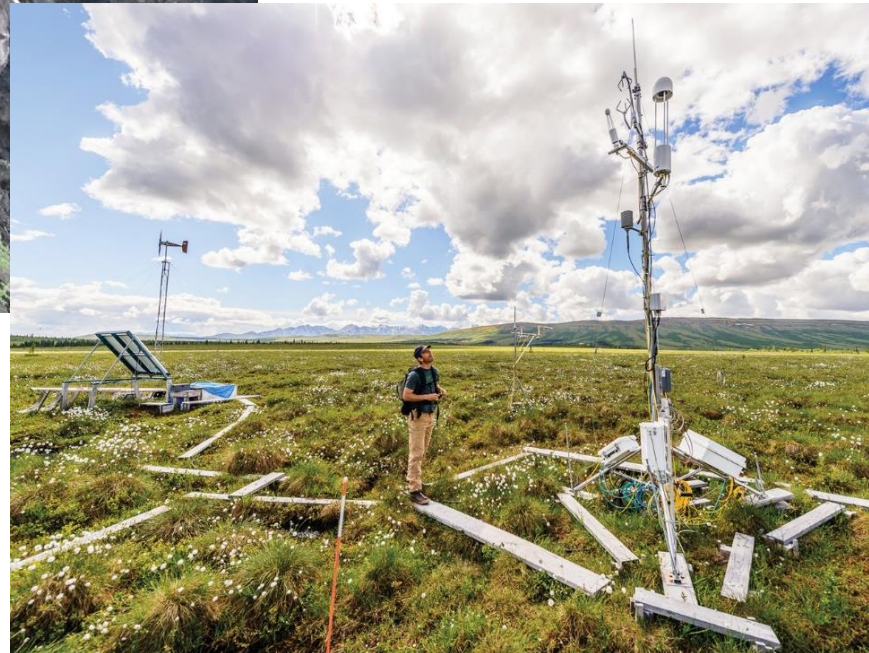
- 1) Define your ecological trajectory (directionality)
- 2) Goal is a self-sustaining, self-organizing system; not continual intervention
- 3) Three bins are all encompassing (i.e., nothing outside decision space), mutually exclusive, and NOT a continuum
 - however, one or all three bins can be applied 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
- 4) Technology does not dictate whether approach is R, A or D
- 5) ACCEPT does not imply the absence of management
- 6) Decision paralysis because of uncertainty is NOT an option; consider experimentation to test ecological outcomes and pilot studies of novel climate adaptation that can be scaled up (if successful)

Climate emission scenarios are not the big uncertainty for those of us in natural resource management...

the greatest uncertainties are the cascading ecological effects and how we respond to them.

Reducing uncertainty: Experiments to test ecological trajectories

Permafrost Thaws, it Doesn't Melt



Reducing uncertainty: Demonstration projects of potential adaptation

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

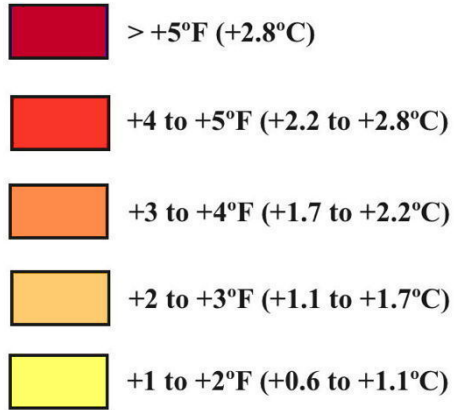


- Peatlands drying 6–11% per decade on Kenai Peninsula
- Beaver dams increase groundwater discharge 70% (no clay) to 90% (clay pan)
- 17-acre average footprint

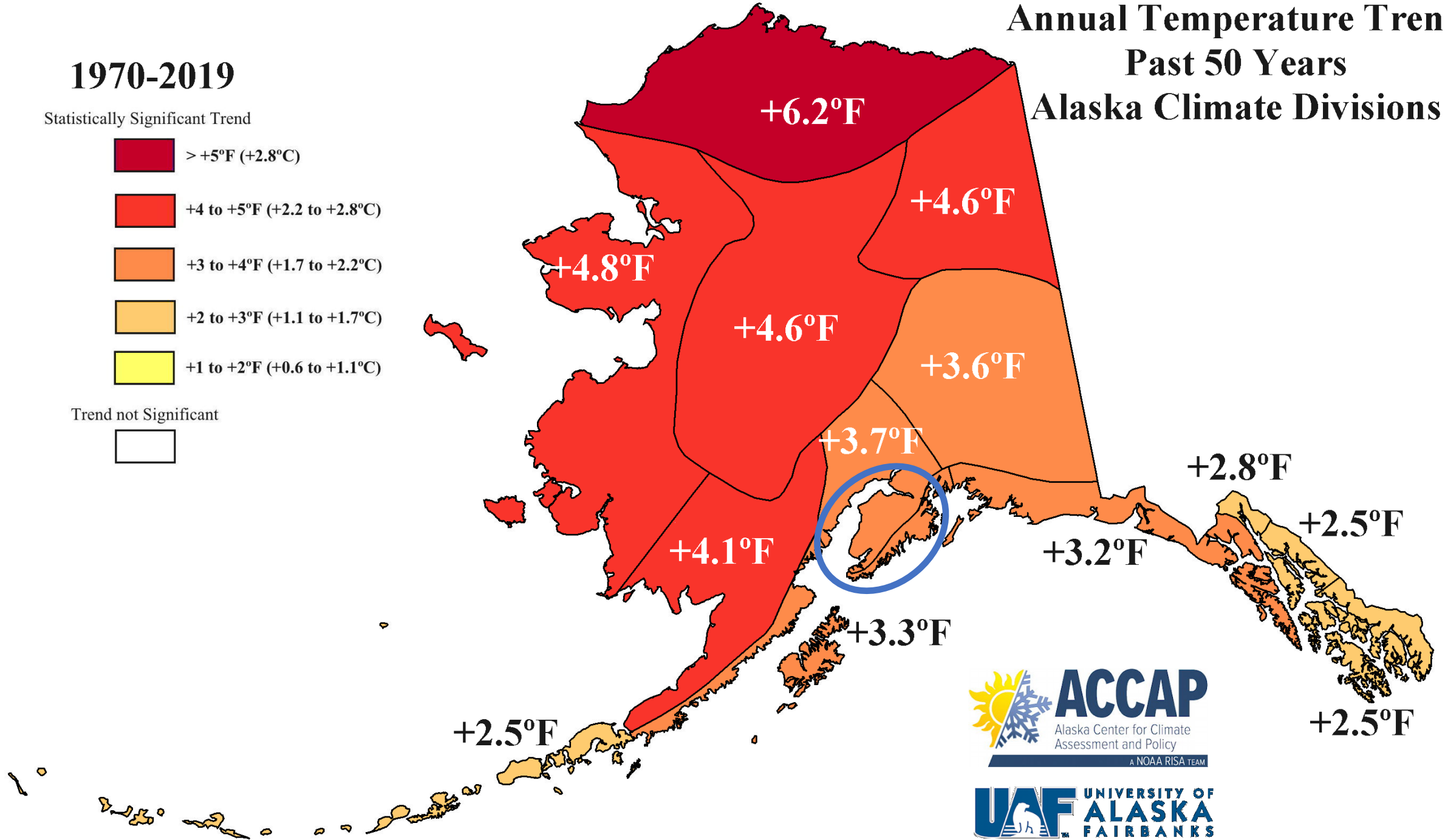
Annual Temperature Trend Past 50 Years Alaska Climate Divisions

1970-2019

Statistically Significant Trend



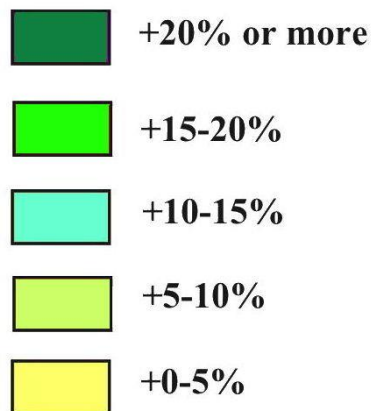
Trend not Significant



Annual Precipitation Trend Past 50 Years Alaska Climate Divisions

1970-2019

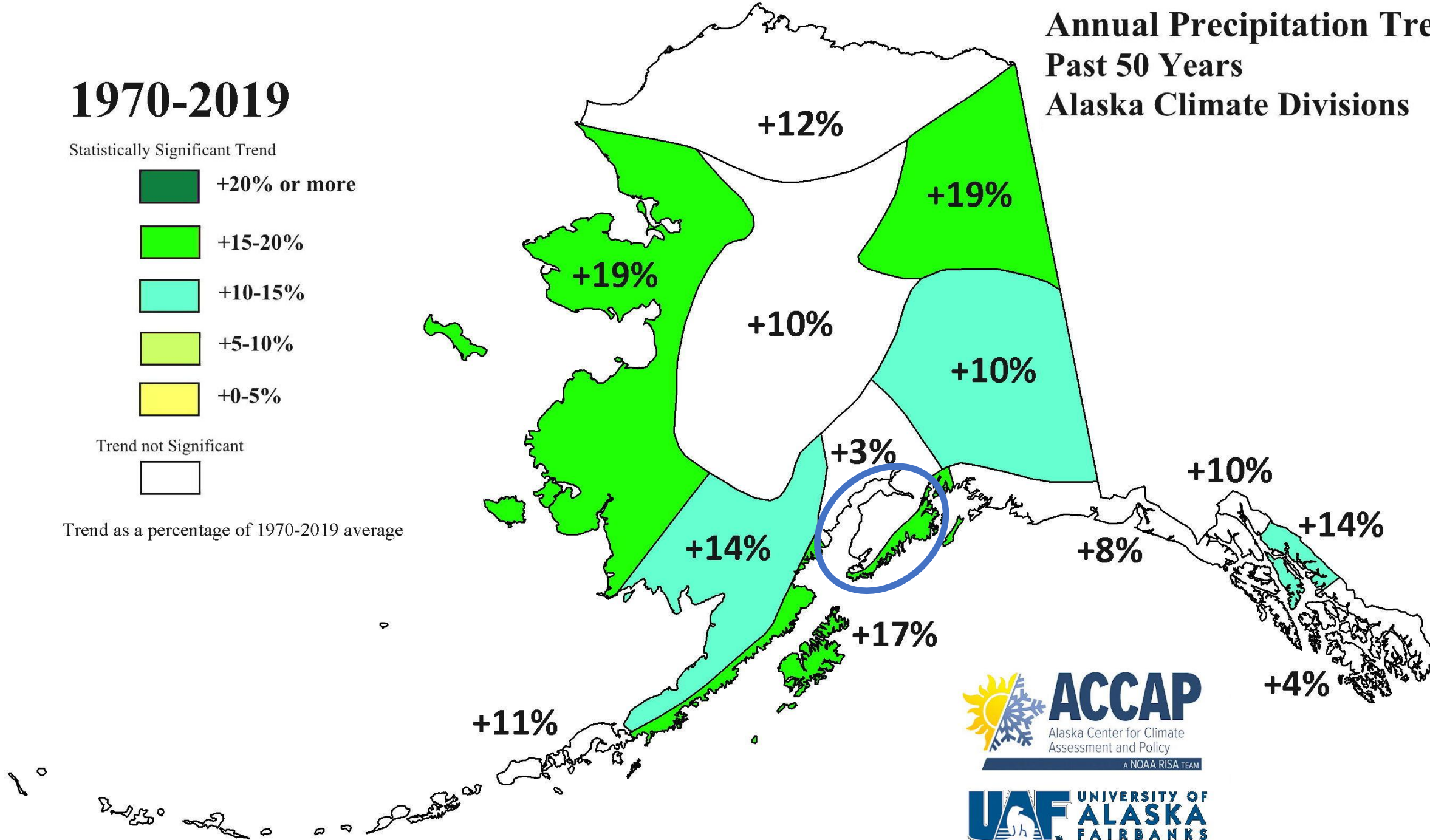
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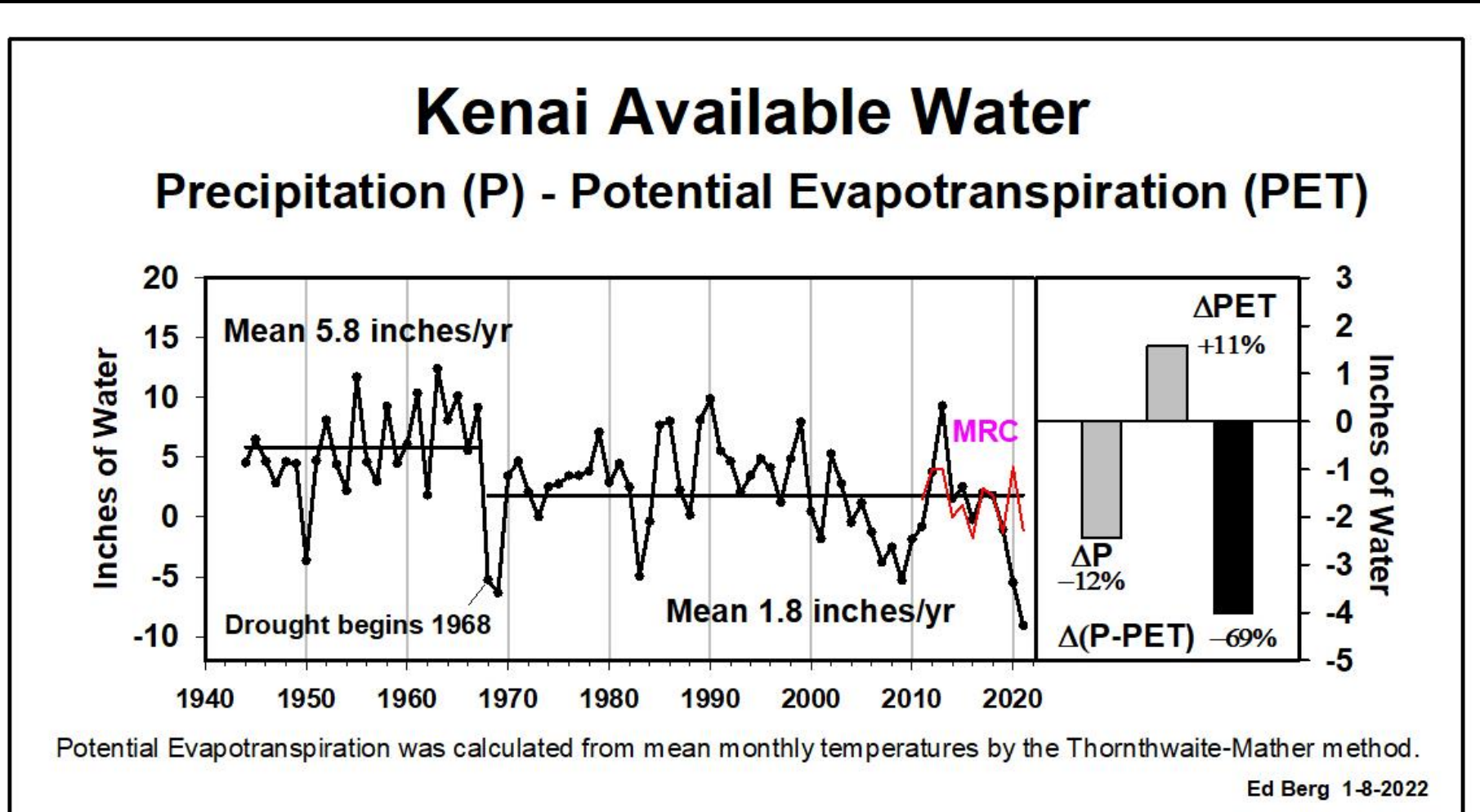
Trend not Significant



Trend as a percentage of 1970-2019 average



Average annual available water has declined 69% in past five decades on western Kenai Peninsula

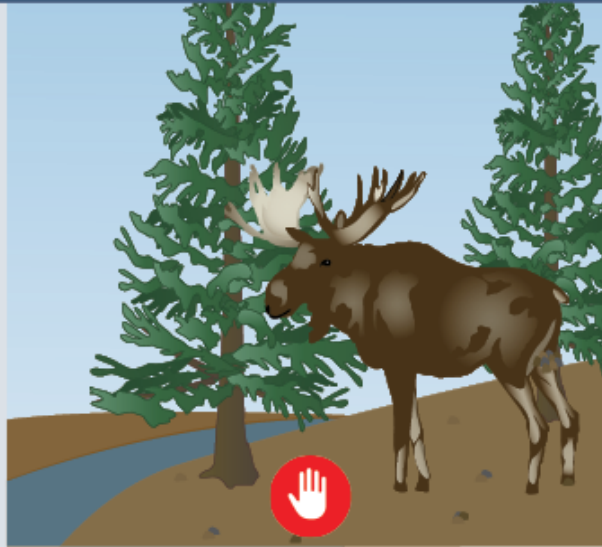


RESIST

ACCEPT

DIRECT

Kenai Peninsula, Alaska: A Case Study



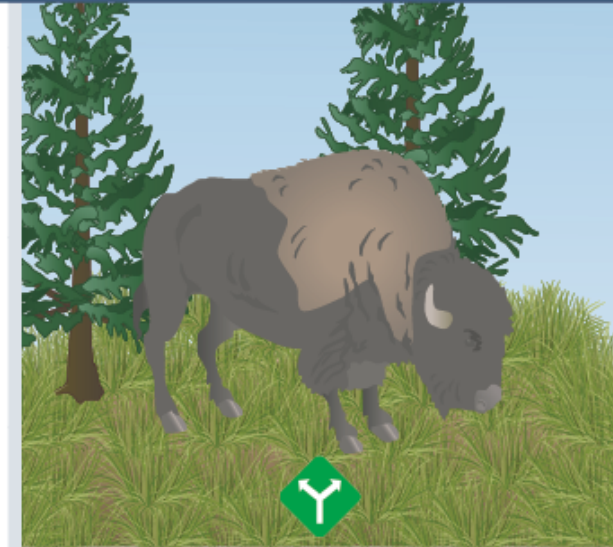
Stream banks are restored, some invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Many invasives are not managed either due to infeasibility or lack of perceived threat.

Conventional management issues



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.

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



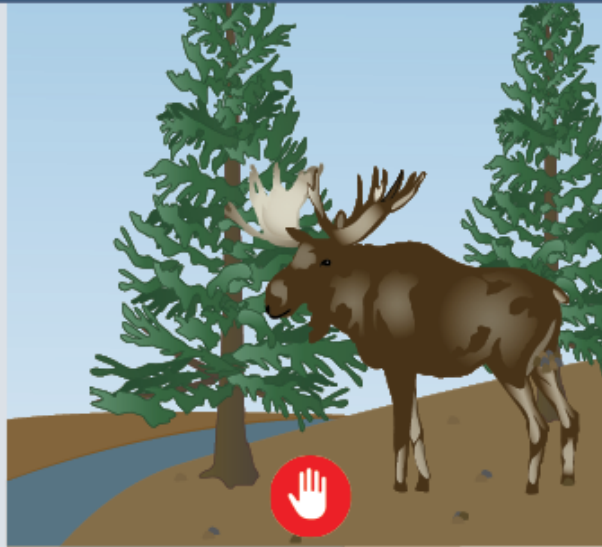
- drying wetlands (6 – 11% loss per decade) with shrubification
- receding glaciers (11% surface area, 21 m elevation loss)
- + warming nonglacial streams in July 2019 exceed physiological thresholds for salmon and temperatures not forecasted until 2069
- + afforesting alpine tundra (trees~1 m/yr, shrubs~2.8 m/yr)
- + unprecedented spruce bark beetle outbreaks (triggered by 2 consecutive warm summers)

RESIST

ACCEPT

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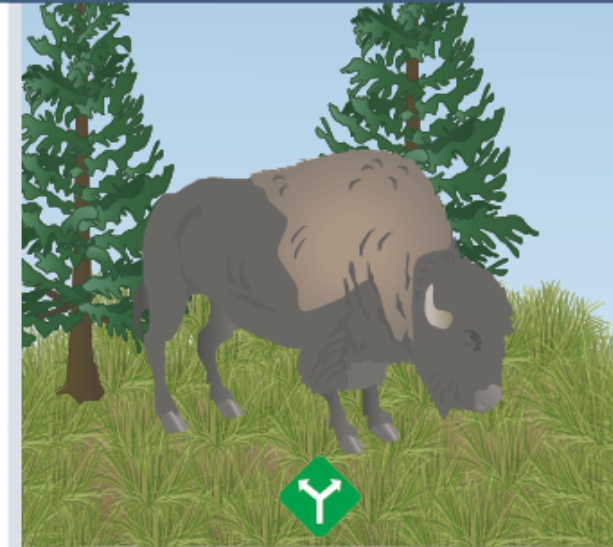
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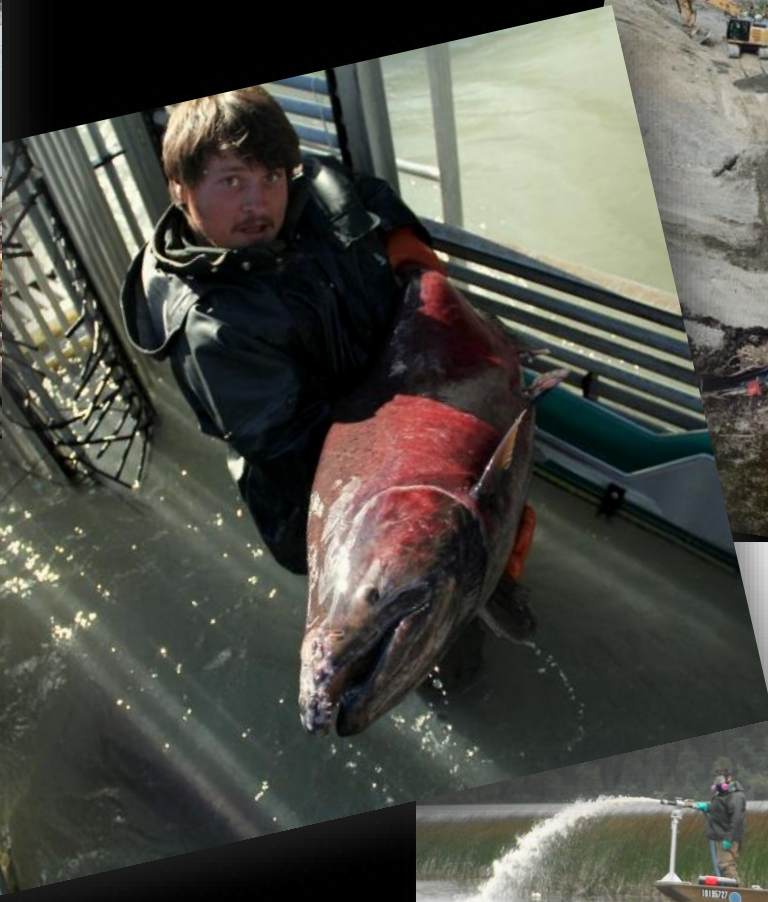
Deforestation (transformational)

An aerial photograph taken from a high altitude, likely from a firefighting aircraft, showing a massive, dark, billowing plume of smoke and ash rising from a fire. The sun is visible through a gap in the plume, creating a bright orange and yellow glow. The sky is a pale blue, and the ground below is a hazy landscape with a winding road. A portion of the aircraft's wing is visible in the upper right corner.

RESIST

2019 Swan Lake Fire

RESIST

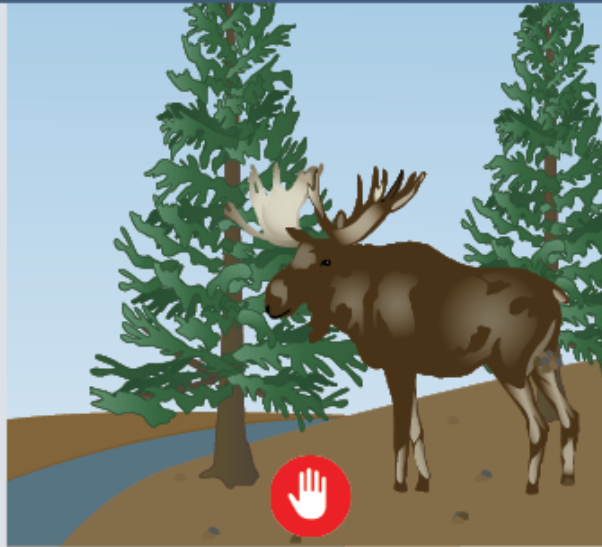


RESIST

ACCEPT

DIRECT

Kenai Peninsula, Alaska: A Case Study



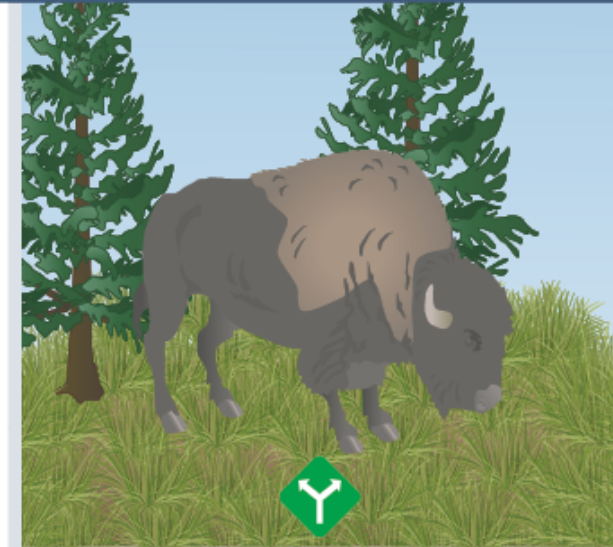
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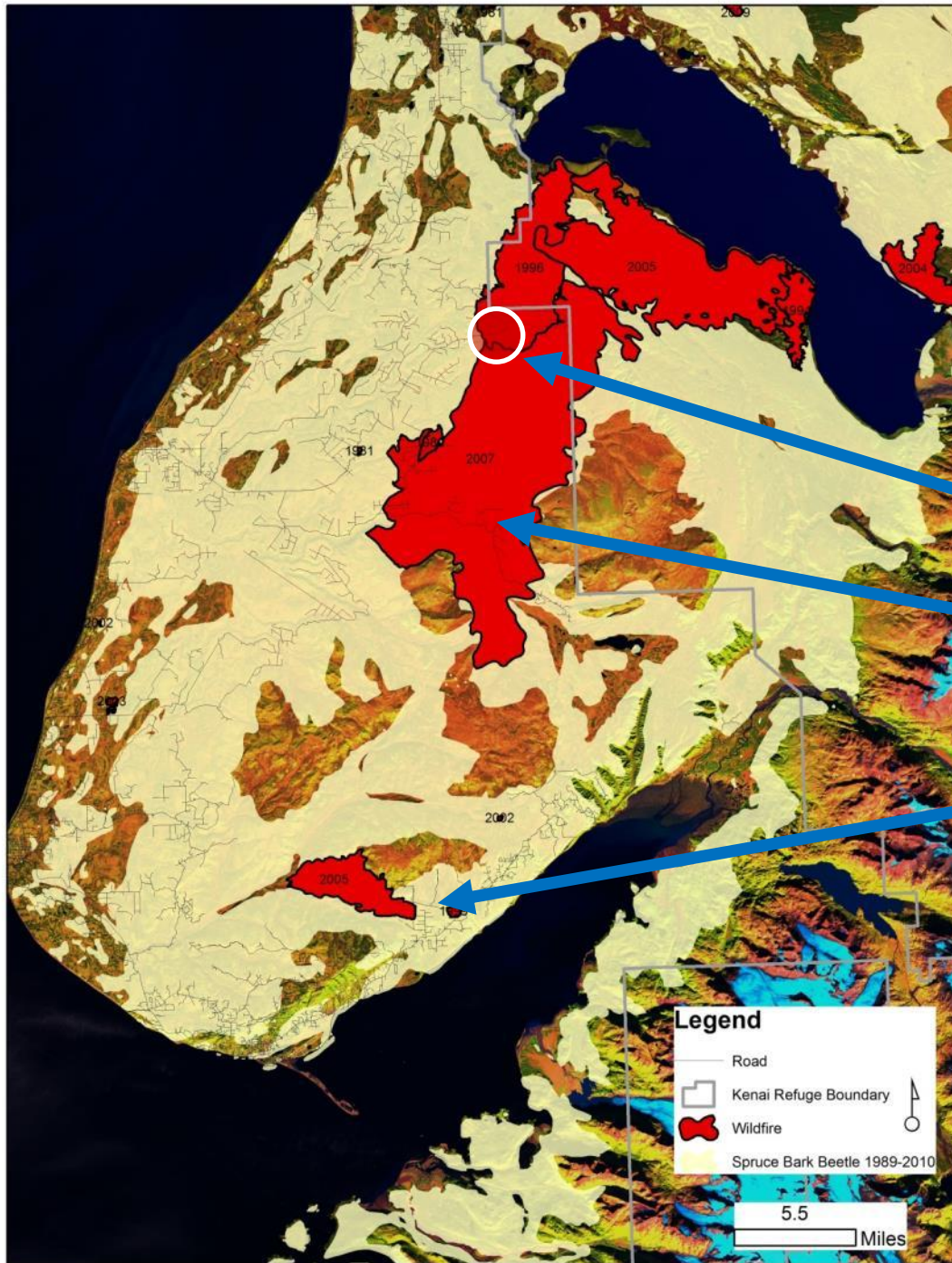
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Deforestation (transformational)



Southwestern Kenai Peninsula was the epicenter of 1990s spruce bark beetle outbreak

- 2019 Tustumena Lake**
- 2007 Caribou Hills**
- 2005 Tracy Avenue**
- 2005 Fox Creek**
- 2005 Glacier Creek**
- 1996 Crooked Creek**
- 1994 Windy Point**

Morton et al. 2023. The dynamics of a changing Lutz spruce (*Picea x Lutzii*) hybrid zone on the Kenai Peninsula, Alaska. Canadian J. Forest Research. 10.1139/cjfr-2022-0212.

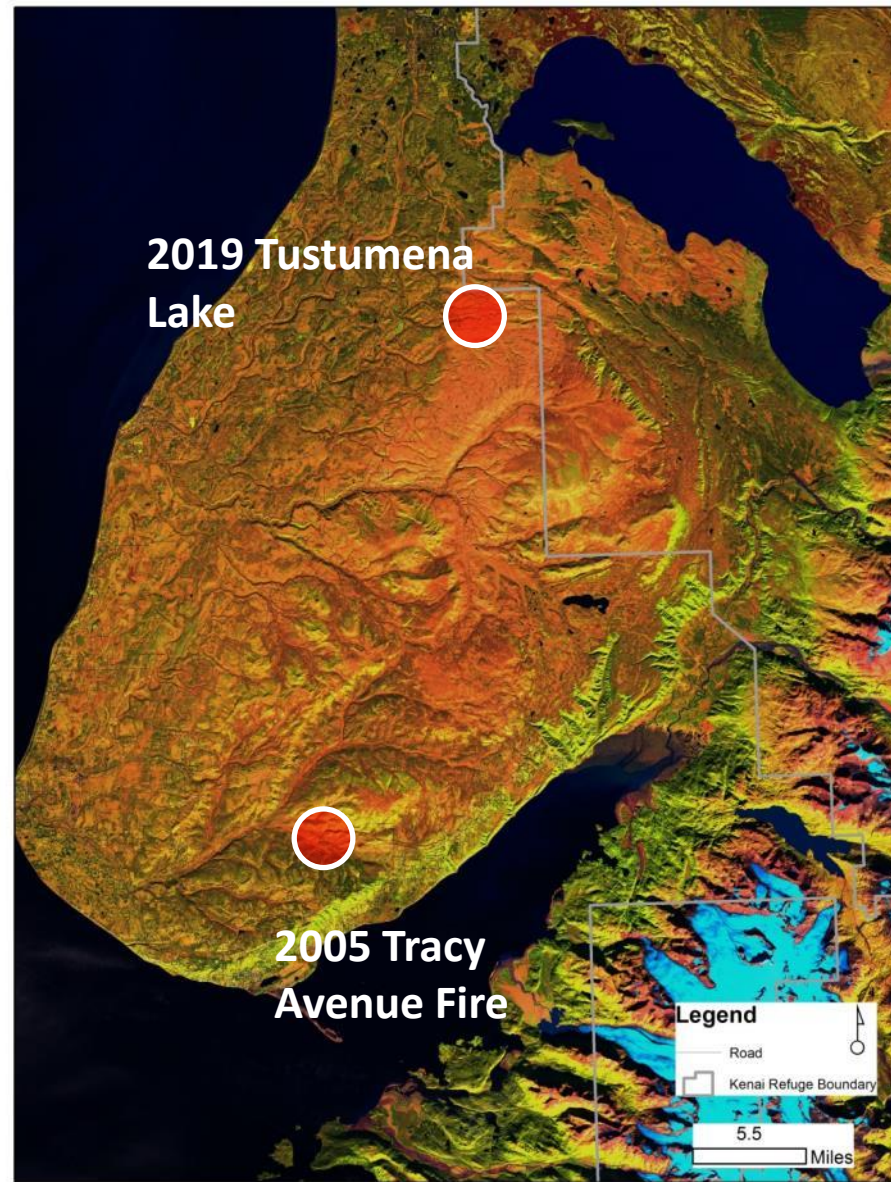
**First lightning-
caused grassland
fire in spring on
Kenai Peninsula**



2019 Tustumena Lake Fire



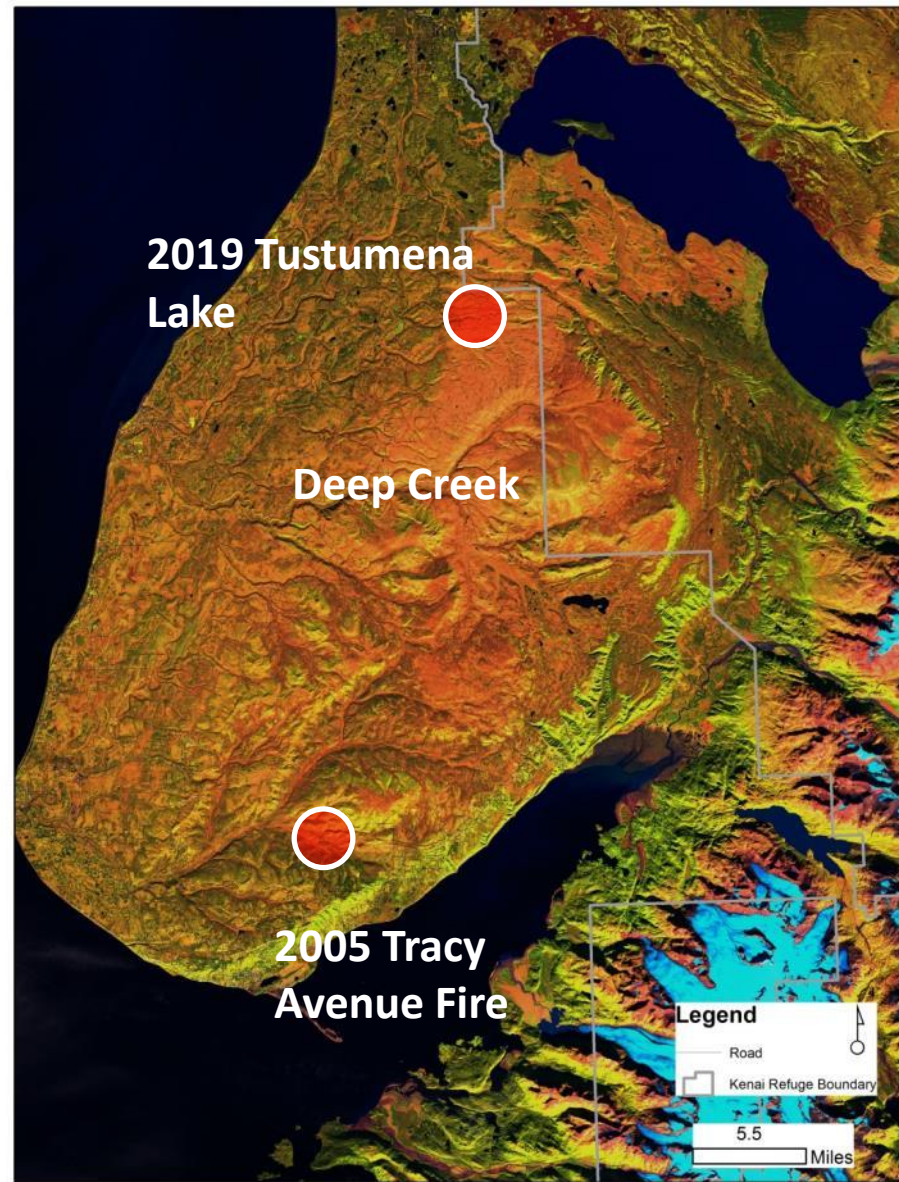
SEPT 1985



SEPT 2014

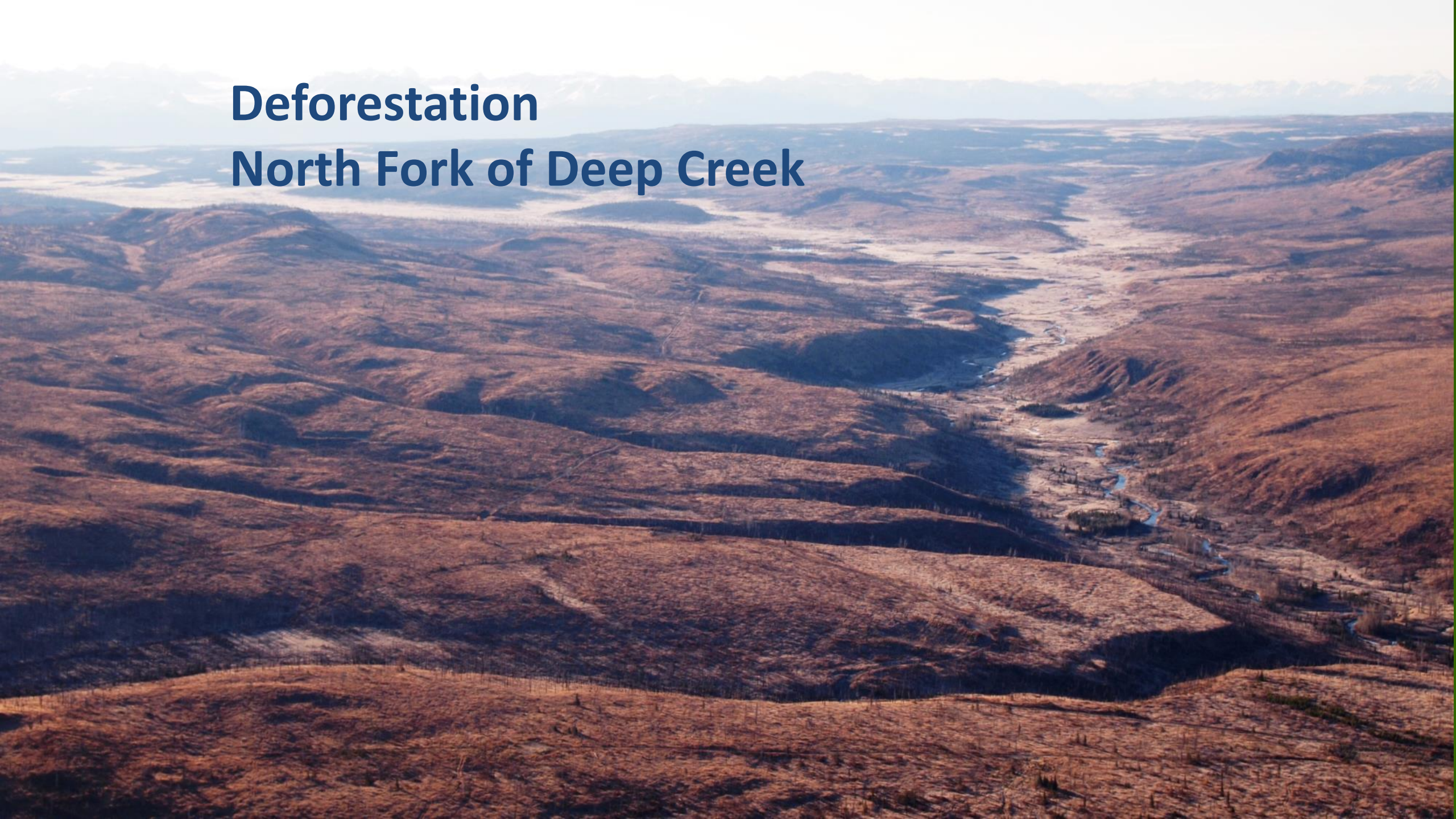


SEPT 1985



SEPT 2014

Deforestation North Fork of Deep Creek



ACCEPT

CURRENT TRAJECTORY (ACCEPT)



DIRECT



LOGEPOLE PINE



BLACK-TAILED DEER

FOREST

CURRENT TRAJECTORY (ACCEPT)



DIRECT



LOGEPOLE PINE



BLACK-TAILED DEER

FOREST



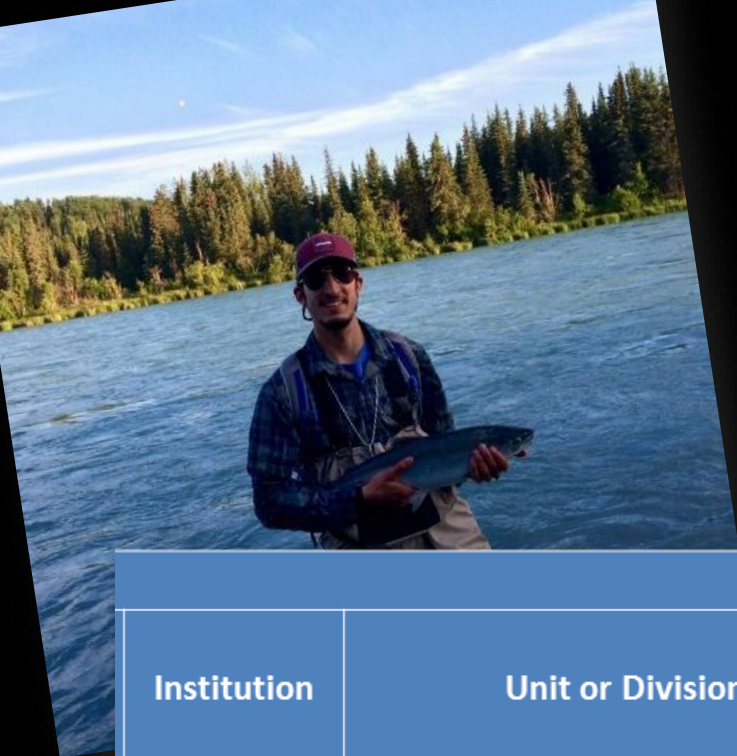
GRASS



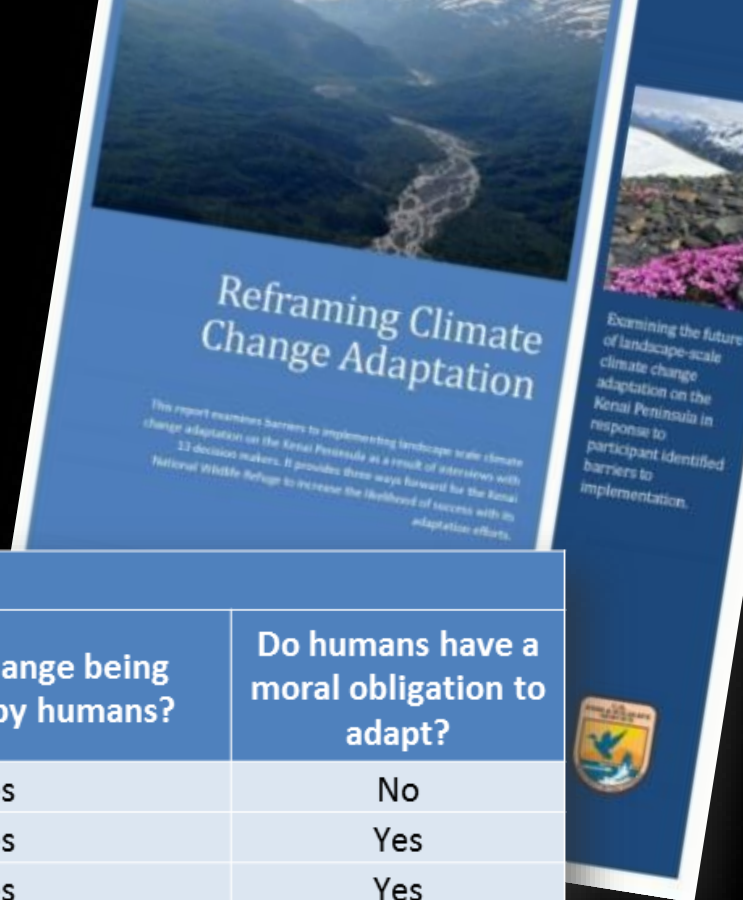
PRESCRIBED FIRE



INTRODUCED GRAZERS



How bad do you think its really going to be?



| 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 | - |





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

It's not rocket science...



...it's harder

