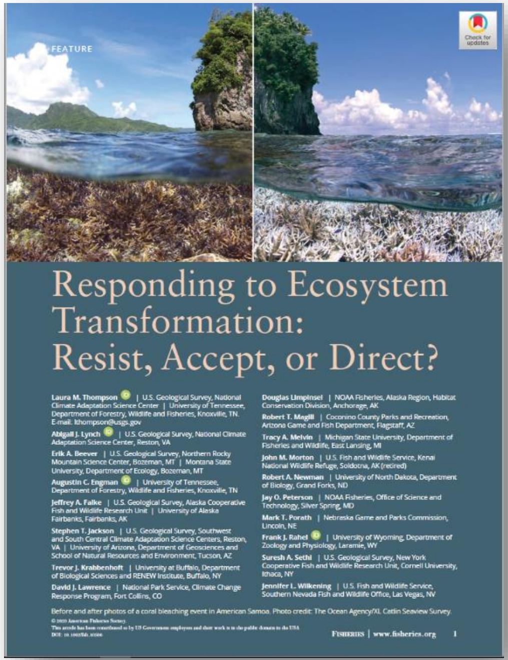
A larger context (RAD) to local-scale climate adaptation actions (BDA)

John Morton, PhD

ALICE
Alaska Institute for Climate and Energy

ALASKA WILDLIFE ALLIANCE

A new way of thinking about adapting to climate change


FEATURE

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

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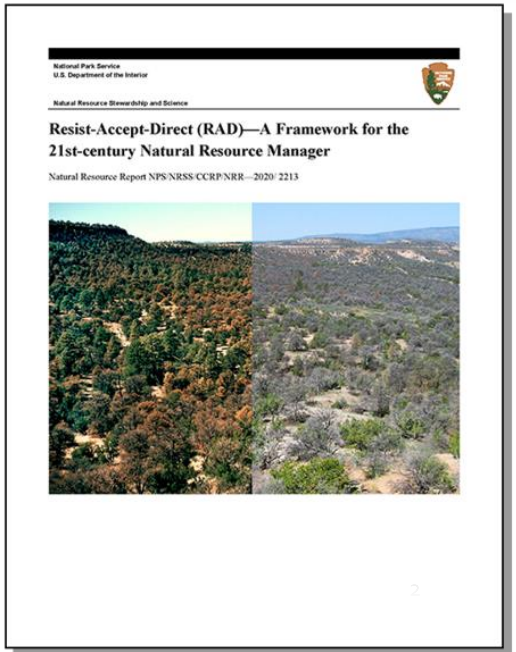
Jennifer L. Wilkening | U.S. Fish and Wildlife Service, Southern Nevada Fish and Wildlife Office, Las Vegas, NV

Before and after photos of a coral bleaching event in American Samoa. Photo credit: The Ocean Agency/XL Catlin Seaview Survey.

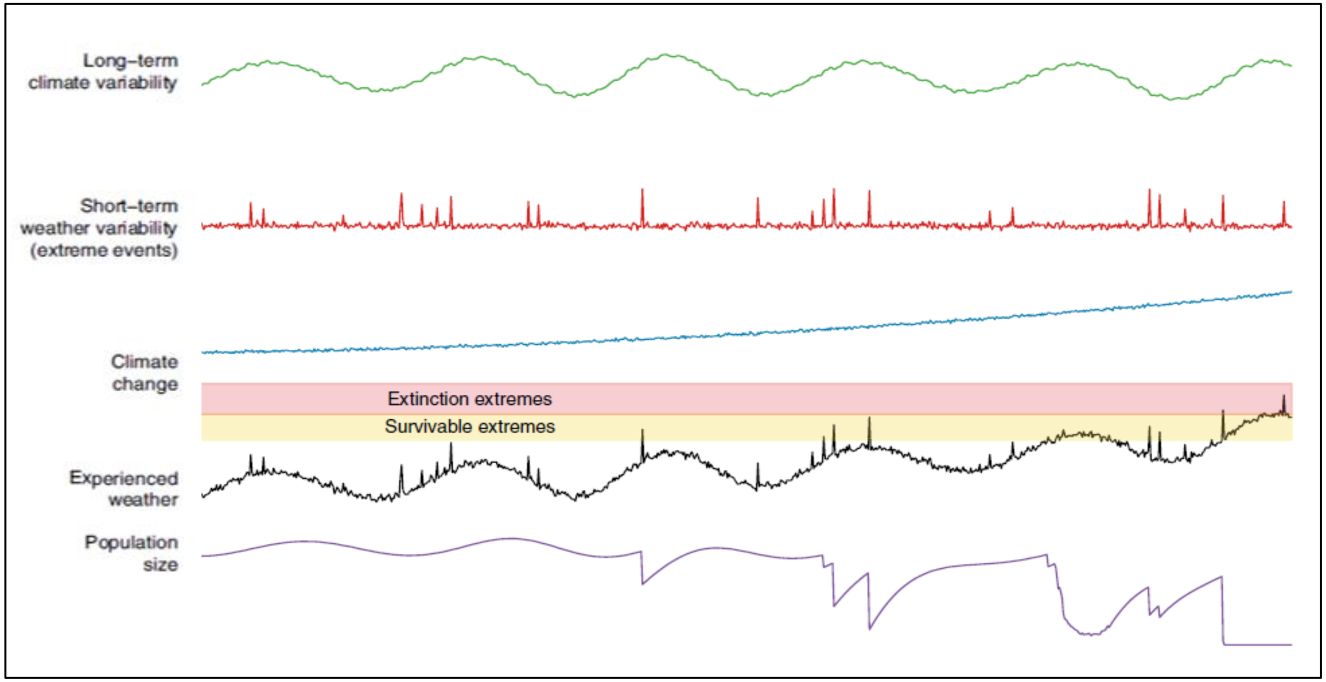

National Park Service
U.S. Department of the Interior

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

RAD addresses Directional Change and Ecological Transformation

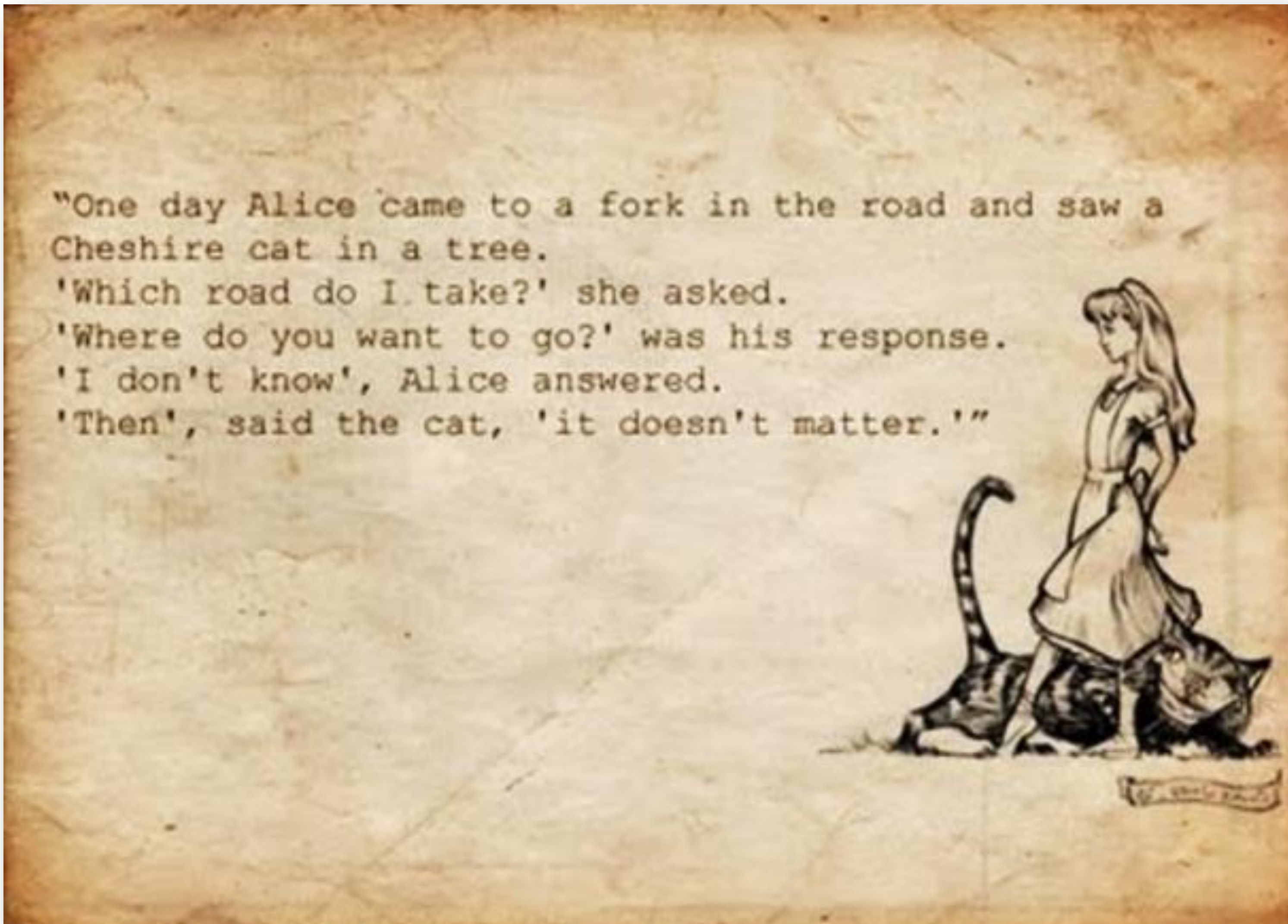


Harris et al. 2018. Nature Climate Change 8:579-587

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 is a decision framework



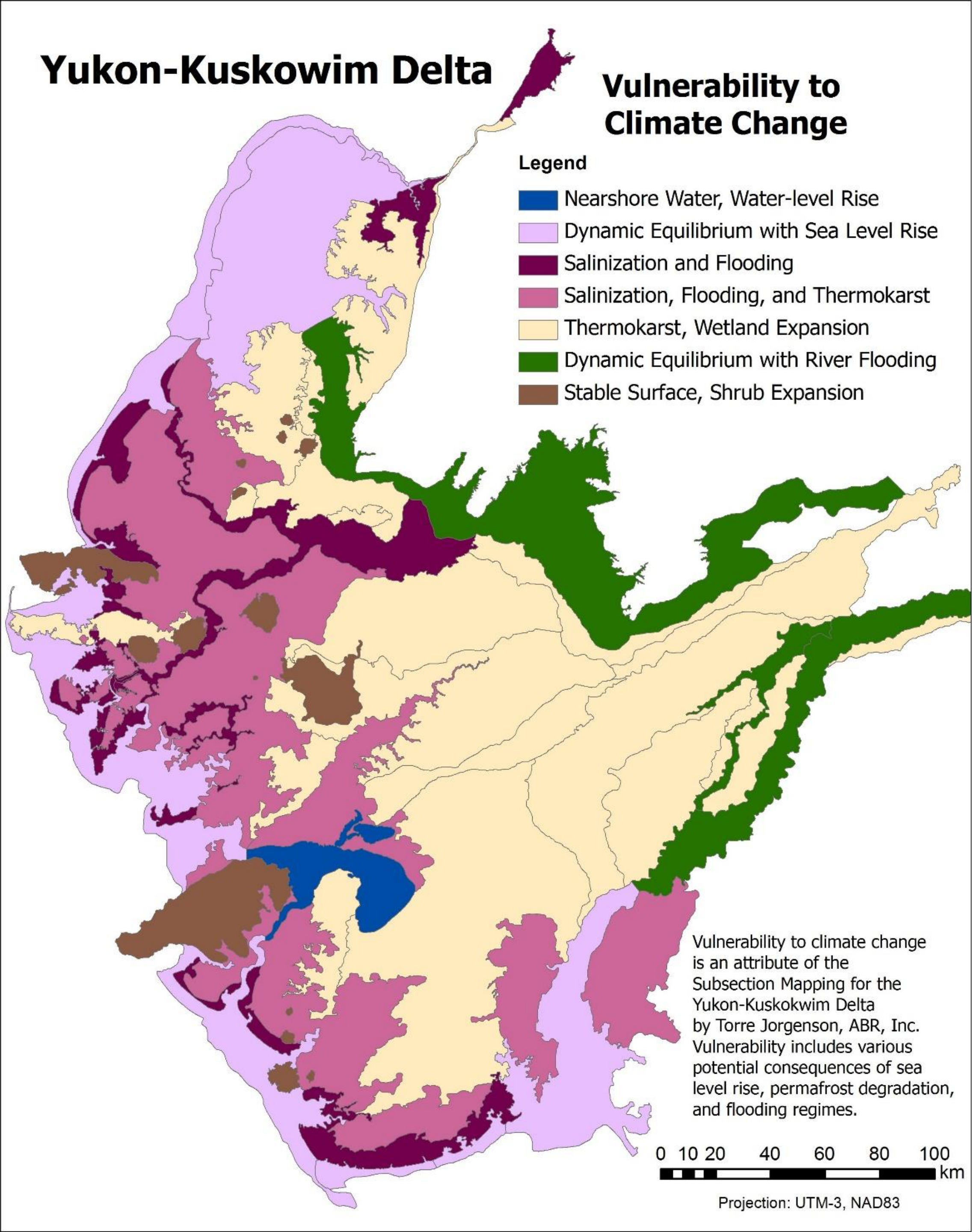
RAD framework squarely assigns the adaptation response to a managerial/societal decision

RESIST	ACCEPT	DIRECT
Many changes will be **RESISTED** by managers, to maintain ecosystem processes, function, and composition toward a historical baseline	Many changes will be **ACCEPTED** by managers, perhaps because… • 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 future 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

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)



Predicted changes on Y-K Delta

- ✓ **~40% of 18.2 million acres subject to salinization, flooding and sea-level rise**
- ✓ **Sea level will rise 0.5-1 m**
- ✓ **Decreasing winter sea ice and open water throughout winter**
- ✓ **Storm flooding season all year**
- ✓ **Overbank flooding on biweekly basis affecting nesting birds**
- ✓ **Loss of fresh drinking water and camping sites**
- ✓ **Permafrost mostly gone by 2040**
- ✓ **Loss of important bird nesting habitats**
- ✓ **Increased tundra fires**
- ✓ **Coastal erosion/flooding of villages**

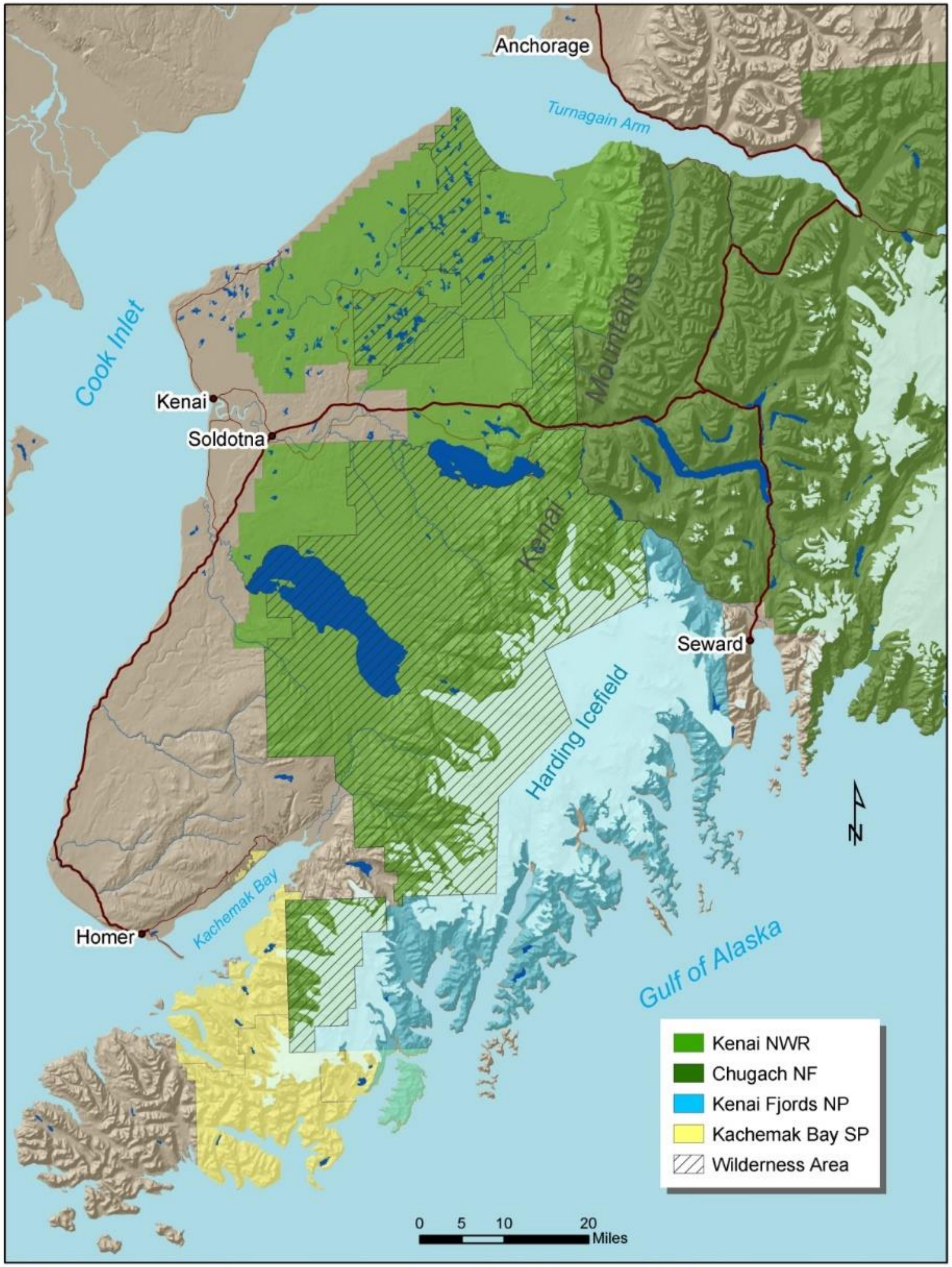
Jorgenson & Roth 2010

Same problem but three structural adaptation approaches

RESIST: Hard armoring of Kivalina

ACCEPT: Allow the loss of Newtok

DIRECT: Construct Evacuation Road/Center at Mertarvik



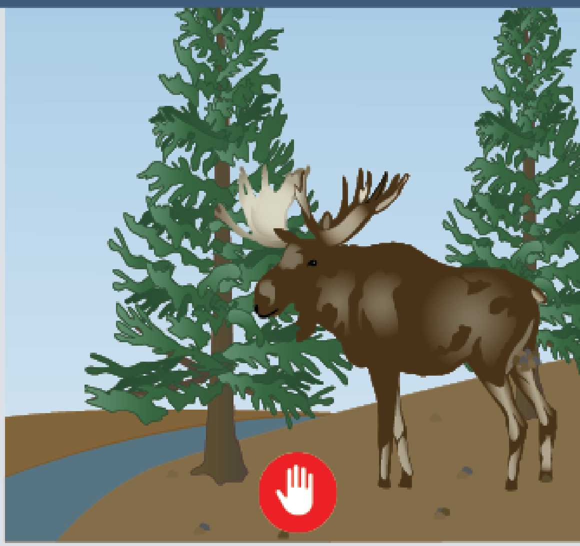
Anchorage
Turnagain Arm
Cook Inlet
Kenai
Soldotna
Kenai Mountains
Seward
Harding Icefield
Kachemak Bay
Homer
Gulf of Alaska
Kenai NWR
Chugach NF
Kenai Fjords NP
Kachemak Bay SP
Wilderness Area
0 5 10 20
Miles

ALASKA

Headquarters
Kenai
National
Wildlife
Refuge
U.S. FISH AND WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

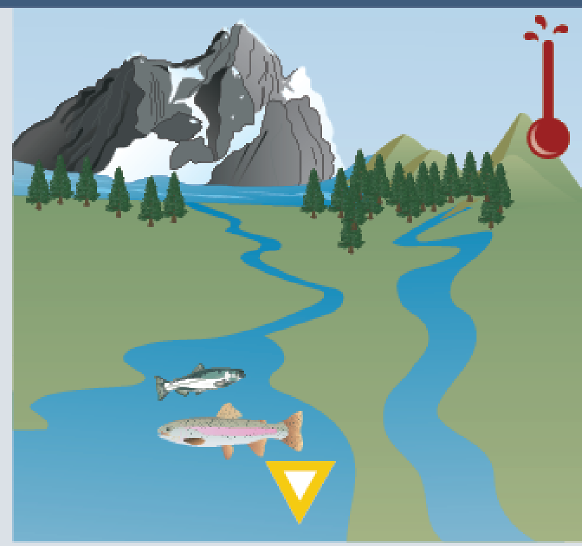
RESIST ACCEPT DIRECT

Kenai Peninsula, Alaska: A Case Study



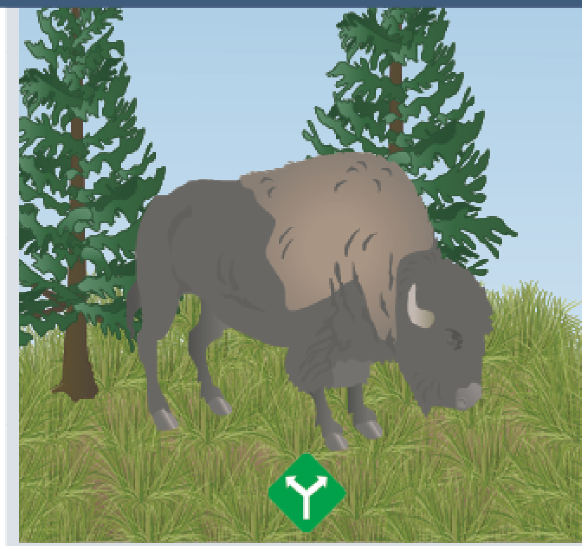
Stream banks are restored, some invasive species are eradicated, fire is managed progressively, and landscape connectivity is maintained through fish and wildlife passages under or over highways. Many invasives are not managed either due to infeasibility or lack of perceived threat.

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)

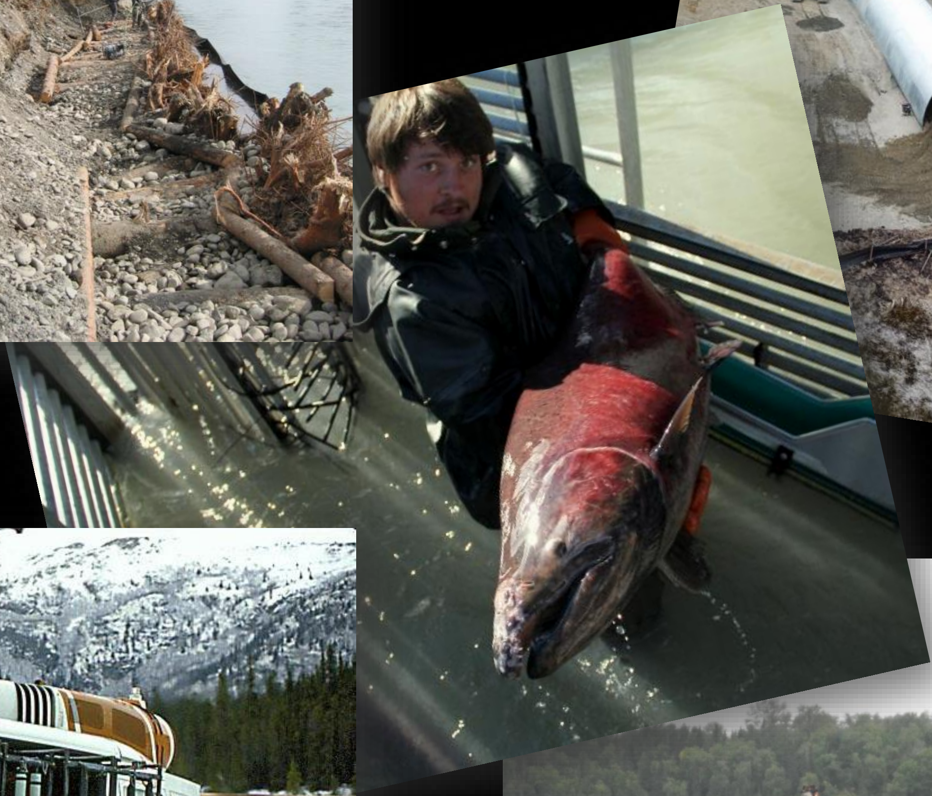


A spruce bark beetle epidemic and human-caused fire have shifted white spruce forests into a novel grassland ecosystem. Non-native trees are being planted, and the introduction of large grazers is being considered to stabilize the new grasslands and related communities.

Deforestation (transformational)

Thompson et al. 2020

RESIST



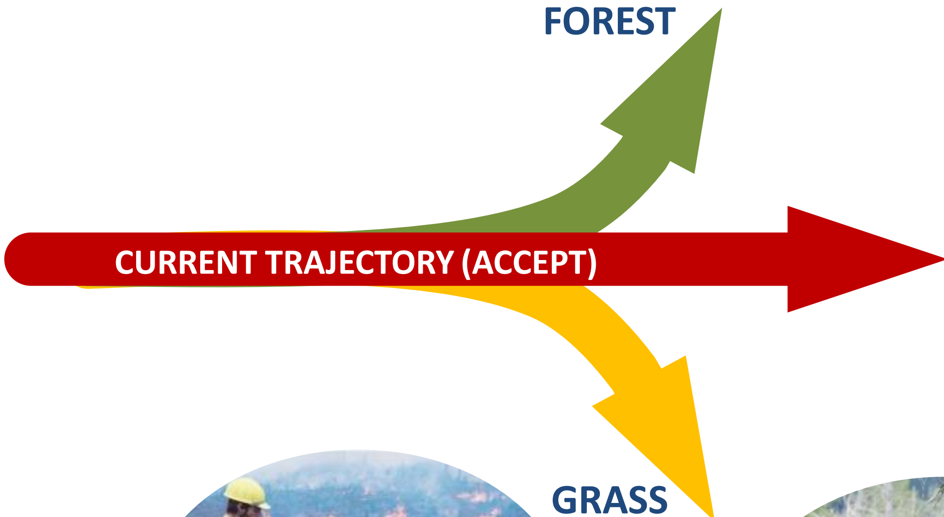

RESIST

DIRECT

DIRECT

LODGEPOLE PINE

BLACK-TAILED DEER



PRESCRIBED FIRE

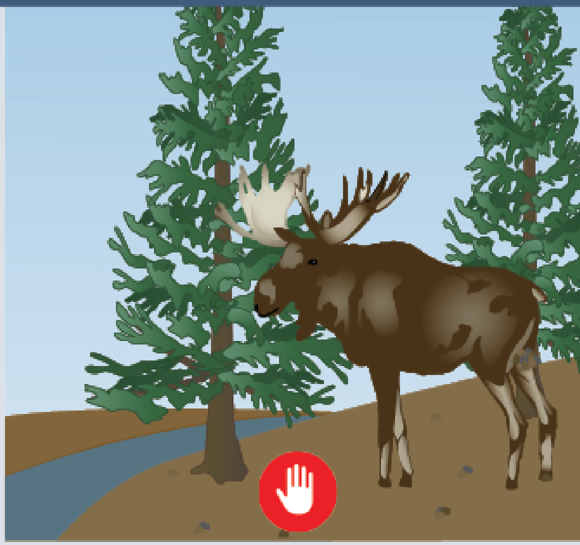
INTRODUCED GRAZERS

RESIST

ACCEPT

DIRECT

Kenai Peninsula, Alaska: A Case Study



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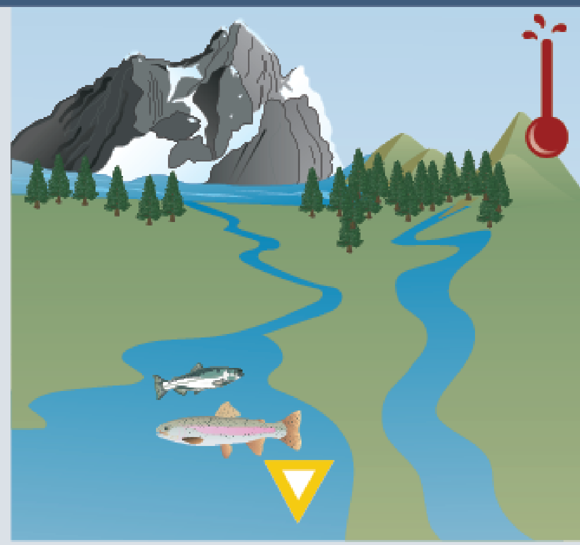

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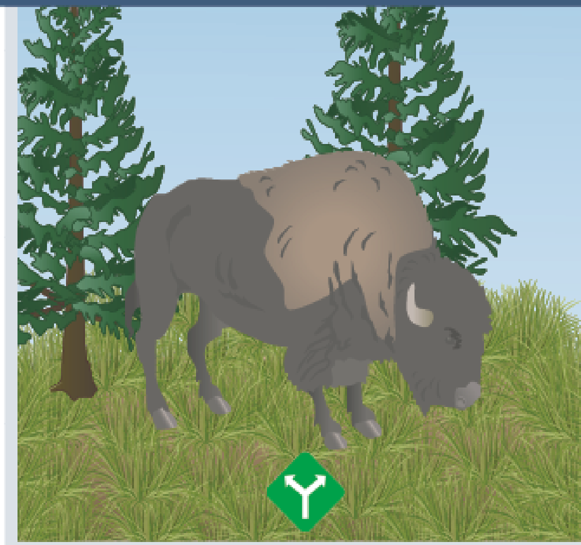

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Conventional management issues

Most ecological responses to climate change

Deforestation

Dramatic changes in last 5 decades in response to warming and drying

- — annual available water declines (62% loss since 1968)
- — wetlands dry (6 – 11% per decade), peatlands afforest
- — glaciers recede (11% surface area, 21 m elevation)
- + nonglacial salmon streams warm (17 of 48 sublethal in July)
- + afforestation (trees~1 m per yr, shrubs~2.8 m per yr)
- + spruce bark beetle outbreaks (triggered by 2 consecutive warm summers)
- Δ fire regime (lightning, grass, spring, shorter MFRI)

Dramatic changes in last 5 decades in response to warming and drying

— annual available water declines (60% loss since 1968)

— wetlands dry (6 – 11% per decade), peatlands afforest

— glaciers recede (11% surface area, 21 m elevation)

\+ nonglacial salmon streams warm (17 of 48 sublethal in July)

\+ afforestation (trees~1 m per yr, shrubs~2.8 m per yr)

\+ spruce bark beetle outbreaks (triggered by 2 consecutive warm summers)

Δ fire regime (lightning, grass, spring, shorter MFRI)

RESIST: Could engineering by beavers and humans recharge drying peatlands?


Contents lists available at ScienceDirect

Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

Analyzing peatland discharge to streams in an Alaskan watershed: An integration of end-member mixing analysis and a water balance approach

Michael B. Gracz, Mary F. Moffett, Donald I. Siegel, Paul H. Glaser

ARTICLE INFO

SUMMARY

1. Introduction


Contents lists available at ScienceDirect

Journal of Hydrology: Regional Studies

journal homepage: www.elsevier.com/locate/ejrh

Simulating the effects of a beaver dam on regional groundwater flow through a wetland

Kathleen Feiner, Christopher S. Lowry

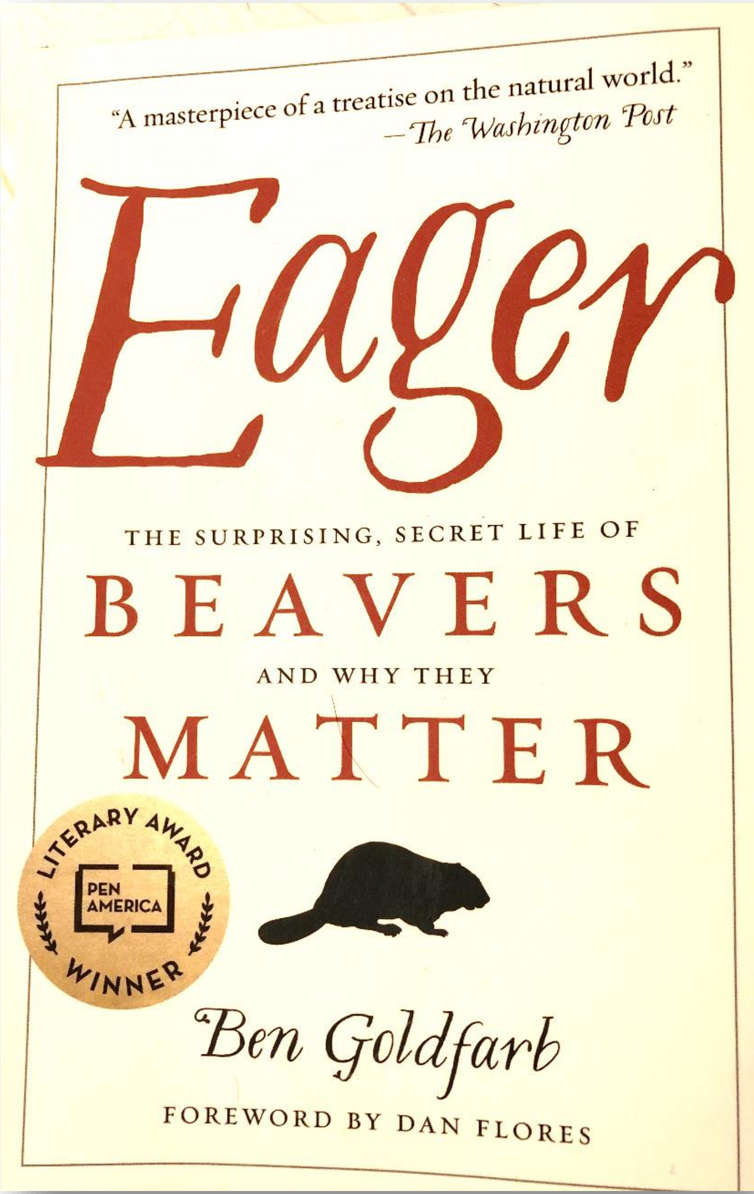
ARTICLE INFO

ABSTRACT

1. Introduction

Peatlands 55% of streamflow during low flow

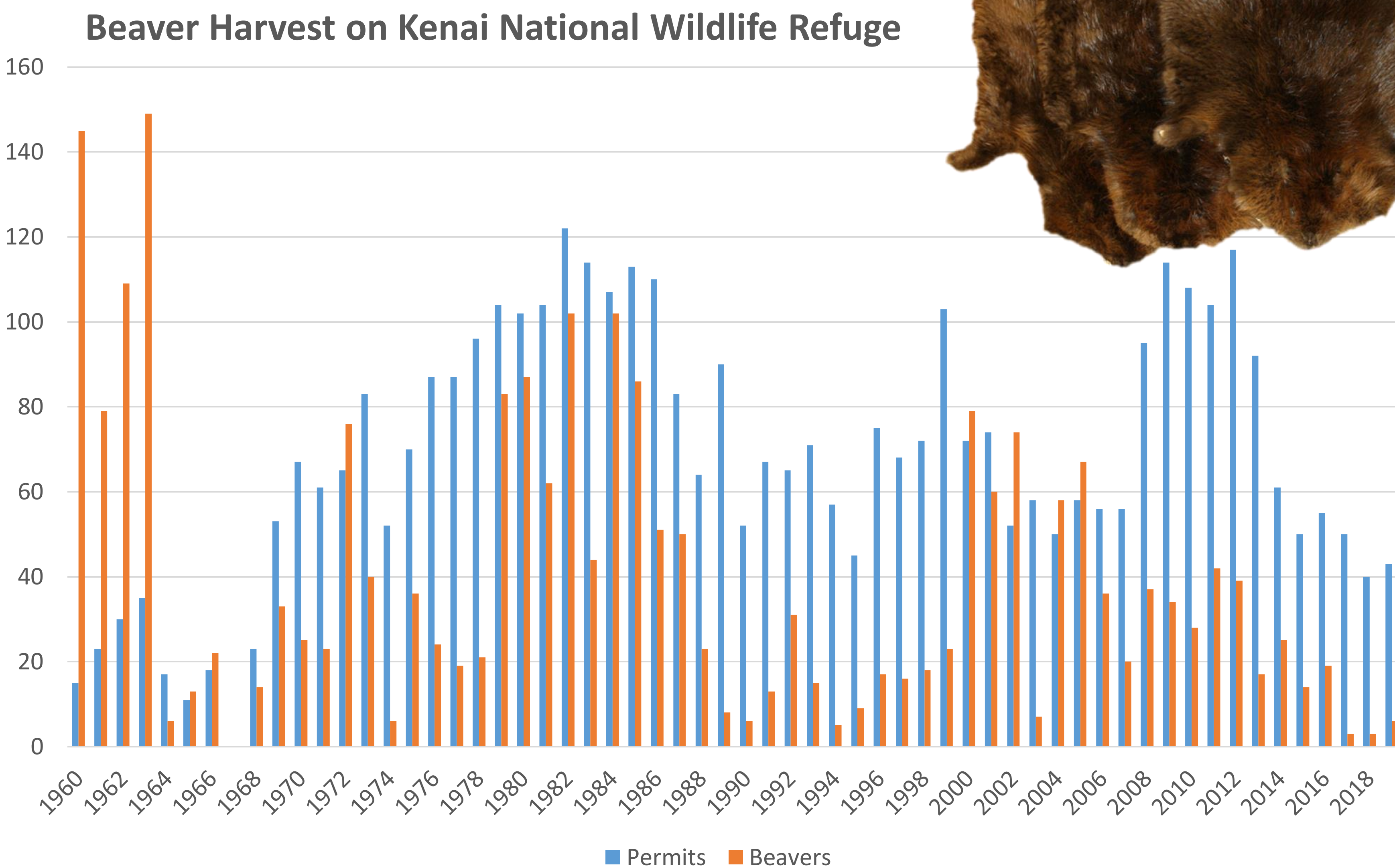
Beaver dams increase groundwater discharge 70% (no clay) to 90% (clay pan)



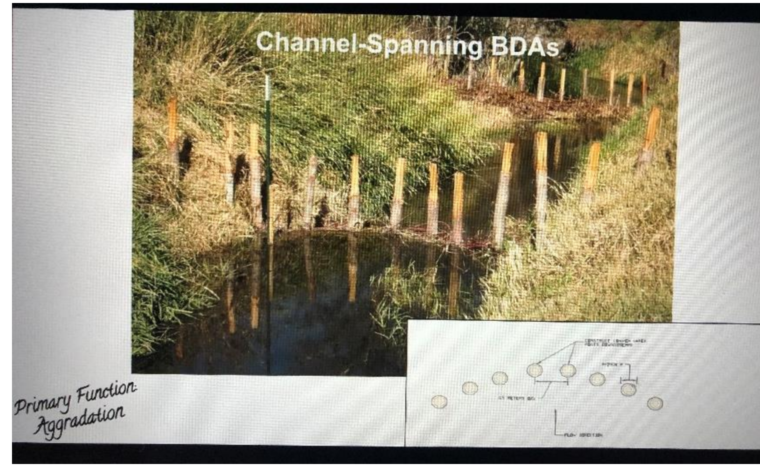
- 15-250 million ponds in North America
- 0.1 – 4.5 acre average pond
- 234,400 miles^2 ponded water
- 150m radius (17 acres) stabilized and raised water table

Karran 2018

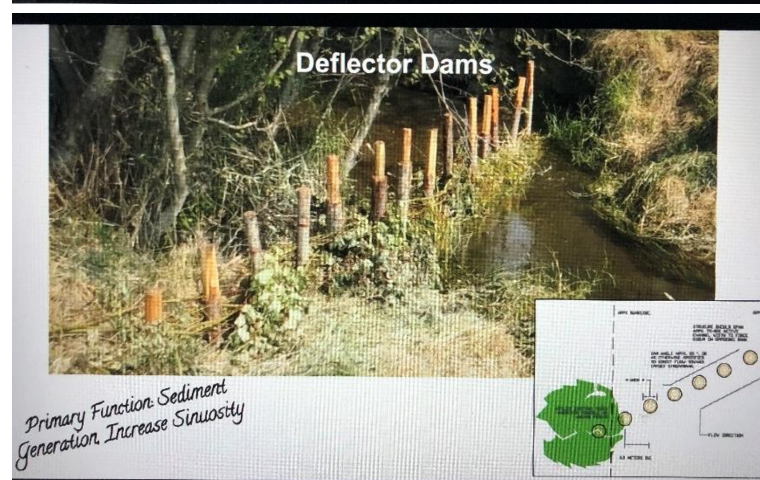
Beaver populations may have been 7 – 30 times higher on the Kenai Peninsula

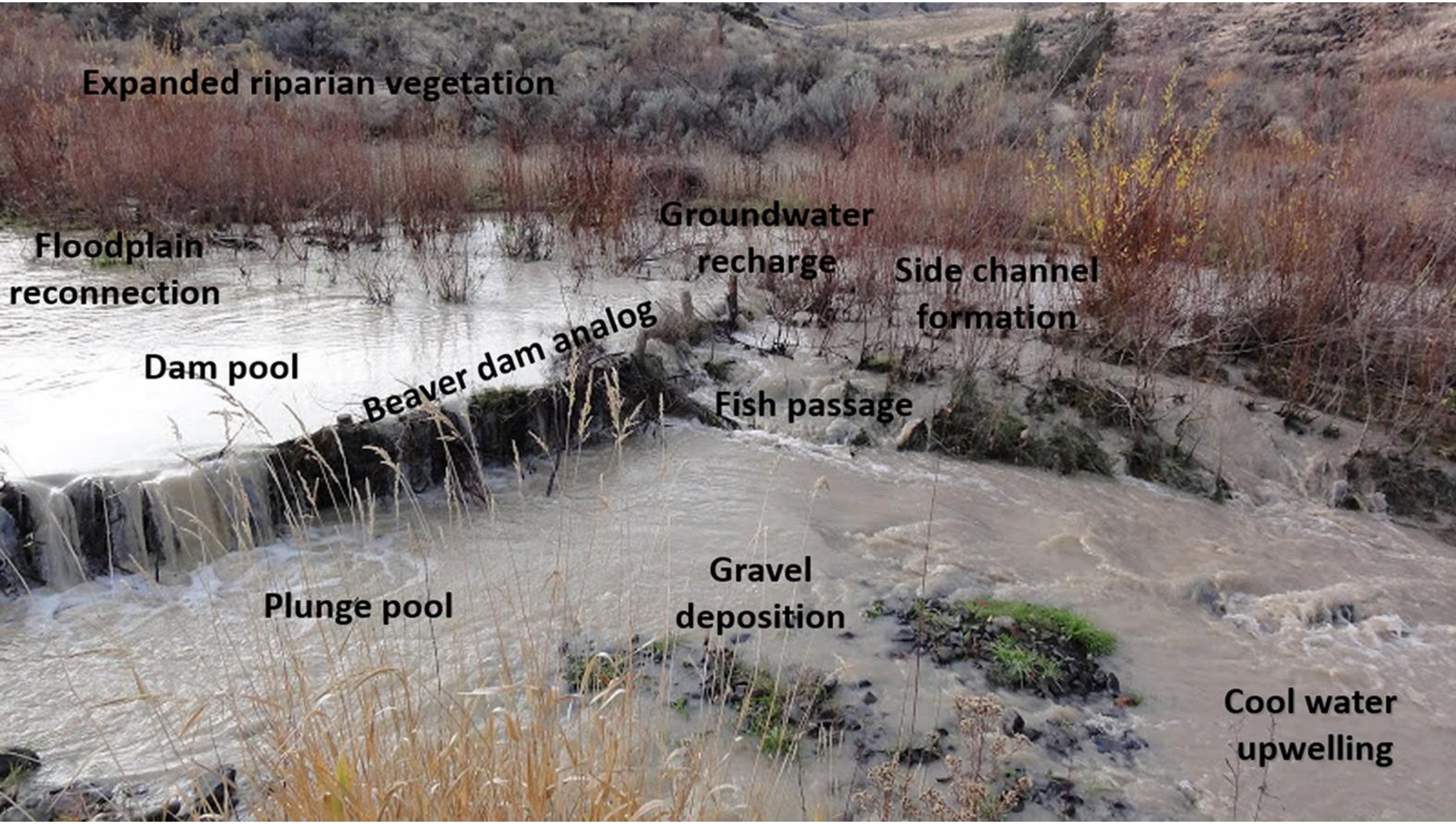


Why Beaver Dam Analogs?



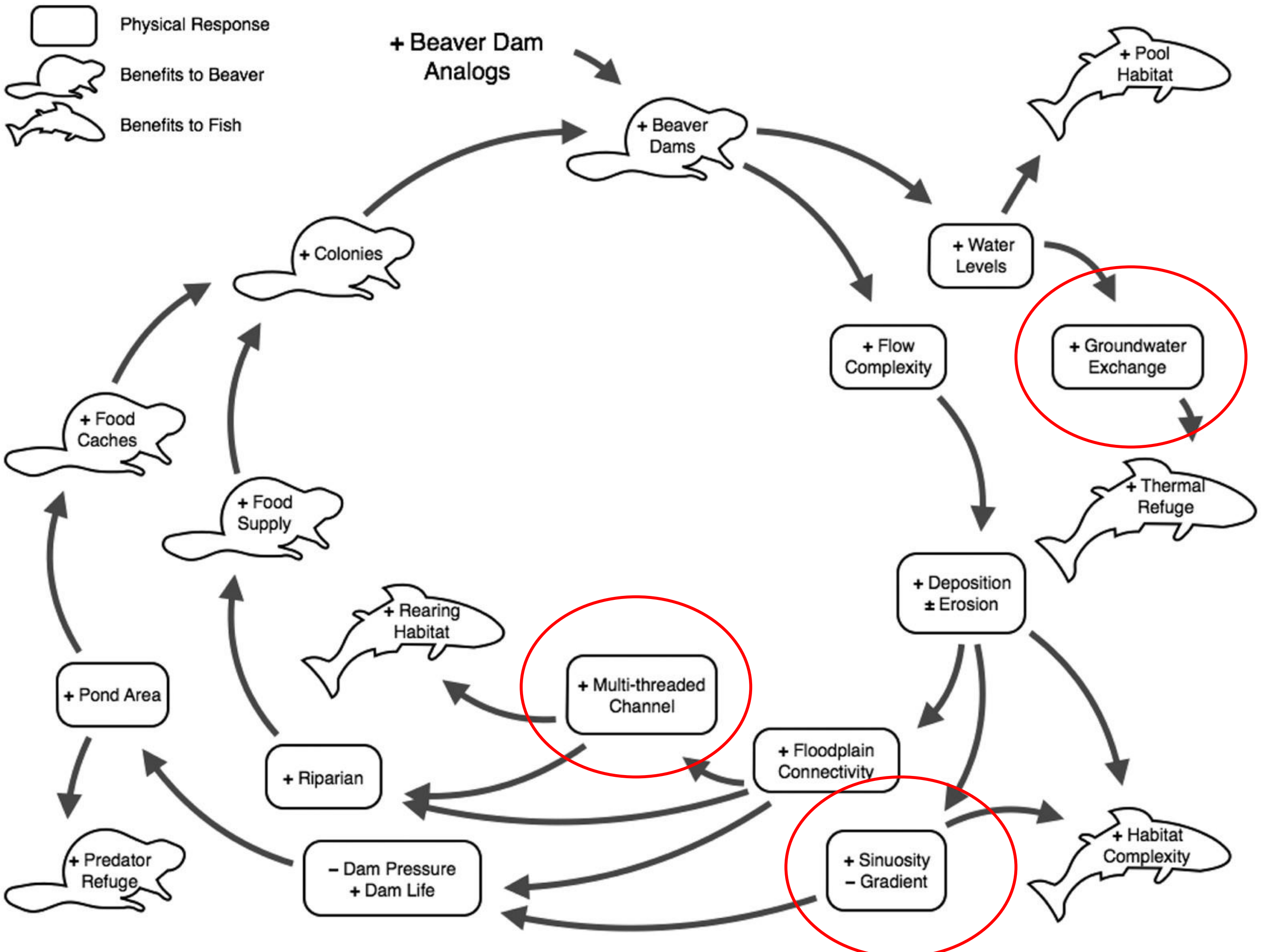
- Stream aggradation (incised channels)
- Sediment capture
  (post-fire or sediment-prone watersheds)
- Channel complexity for fish habitat
- Wetland creation or expansion
- Water storage (slow release)
- Flood attenuation
- Climate change amelioration



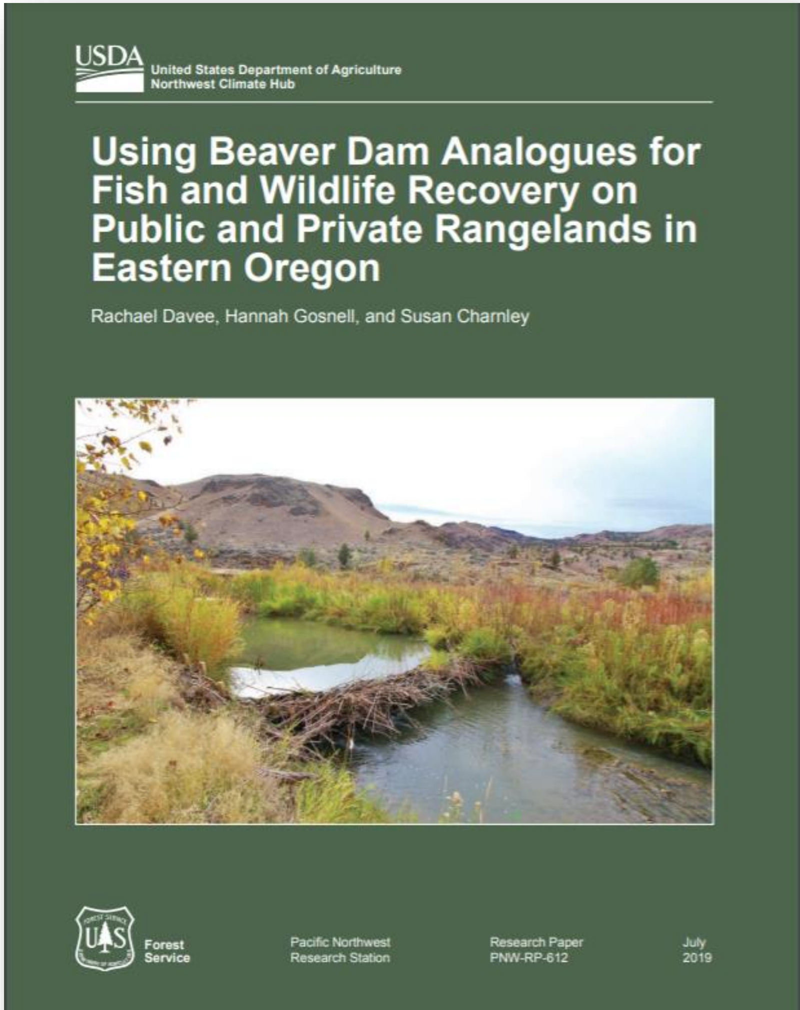


Bouwes et al. 2016

Benefits of natural and simulated beaver dams to steelhead



Bouwes et al. 2016



Questions?

https://www.peninsulaclarion.com/sports/healthy-peatlands-store-carbon-and-help-salmon/