RAD Decisions in Rad Landscapes

Black Ridge Canyons Wilderness

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The Wilderness Context

- The 1964 Wilderness Act was created to protect landscapes from the impacts of rapidly expanding human development
- Mandated to preserve "wilderness character"
- Managers have identified five qualities to describe and monitor changes in wilderness character:

Untrammeled and Undeveloped: No intentional manipulation of the ecosystem; no permanent human habitation

Natural: Affected primarily by forces of nature; historic ecological character and influence

Opportunities for **solitude** or **primitive** recreation

Other features of value:

- Refugia for numerous flora and fauna
- Preservation of important ecosystem services

Ecological Transformation

- Emergence of a new or novel ecological community
- Transformation triggered by acute or prolonged disturbance or compounding disturbance effects
- Species composition, structure, or function permanently altered

Sieber Fire in the McInnis Canyons NCA, 2020, CCA

Untrammeled and Natural?

- Climate change is a human-caused problem contributing to transformation within wilderness

- Do we have a responsibility to intervene or to not intervene?

The Wilderness Wicked Problem

How do wilderness managers maintain wilderness character in an era of climate change?

- If naturalness means maintaining historical ecosystem structure and function, then trammeling may be warranted to preserve naturalness

- Management actions are not prohibited, but are highly scrutinized
  - Use of minimal allowable tools
  - Minimize impacts to wilderness character qualities

- Risk of litigation
  - Active management entails trammeling

The Wilderness Wicked Problem

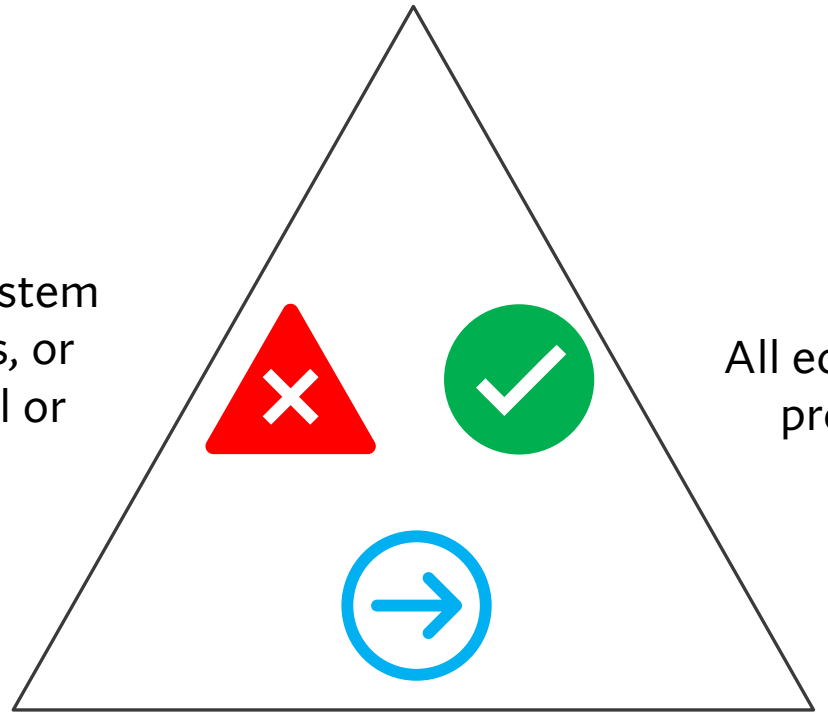
There is no right or wrong answer, but…

- Be intentional and mindful in how to respond to climate change-driven transformation
  - Avoid pitfalls of resorting to default actions and escape decision paralysis
- Carefully weigh the trade-offs, including those of wilderness character
- Use the best available science and decision-support frameworks to help make robust and defensible decisions

A Conceptual Framework for Stewarding Ecological Transformation

Resist

Work to maintain or restore ecosystem composition, structure, processes, or function on the basis of historical or acceptable current conditions



Accept

All ecosystem composition, structure, processes, or function to change autonomously

Direct

Actively shape change in ecosystem composition, structure, processes, or function toward preferred new conditions

Credit: Gregor Schuurman

Agency: USDA Forest Service
Location: FS Public Lands and Wilderness
Study Subject: Whitebark pine
Climate Change Threat: altered precipitation patterns, air temperature ↑

Agency: DOI National Park Service
Location: Isle Royale National Park
Study Subject: Changing forest composition
Climate Change Threat: altered precipitation patterns, ↑ air and water temperature, ↑ high wind events

Agency: DOI Fish and Wildlife Service
Location: Cabeza Prieta and Kofa NWRs
Study Subject: Sonoran pronghorn
Climate Change Threat: altered precipitation patterns, ↑ air temperature

Agency: DOI Bureau of Land Management
Location: Black Ridge Canyons Wilderness
Study Subject: Native and non-native amphibians
Climate Change Threat: drought, ↑ air and water temperature

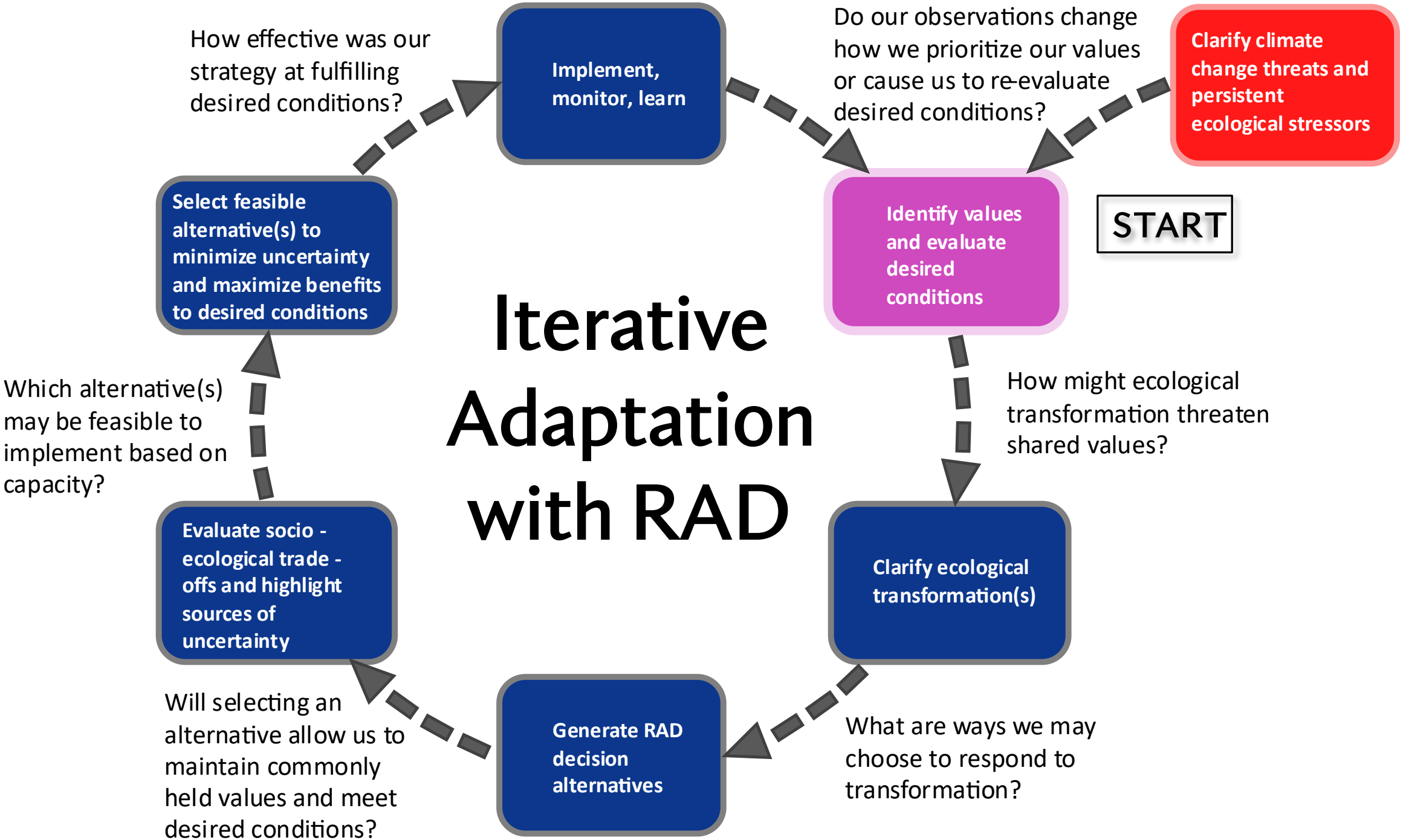
Untangling the Wicked Problem for the Black Ridge Canyons Wilderness

- Devising conservation strategies for sensitive riparian communities within the 75,000 acre wilderness area experiencing multiple stressors

- Current climate typical of the arid Colorado Plateau
  - winter precipitation and mid- to late summer rainfall

- Most canyons experience low-moderate recreation use
  - Most recreation and access occurs from the CO River to the north

- Ephemeral streams and pools support persistence of native amphibians, including:
  - Woodhouse's toad
  - Red-spotted toad
  - Canyon tree frog


Iterative Adaptation with RAD
Implement, monitor, learn
How effective was our strategy at fulfilling desired conditions?
Do our observations change how we prioritize our values or cause us to re-evaluate desired conditions?
Clarify climate change threats and persistent ecological stressors
Identify values and evaluate desired conditions
START
How might ecological transformation threaten shared values?
Clarify ecological transformation(s)
What are ways we may choose to respond to transformation?
Generate RAD decision alternatives
Will selecting an alternative allow us to maintain commonly held values and meet desired conditions?
Evaluate socio - ecological trade - offs and highlight sources of uncertainty
Which alternative(s) may be feasible to implement based on capacity?
Select feasible alternative(s) to minimize uncertainty and maximize benefits to desired conditions

Clarify climate change threats & persistent ecological stressors

Persistent Ecological Threats

- Invasive American bullfrog
  - Spread of chytrid fungus (Bd)
  - Competition over resources
  - Direct predation

- Non-native, invasive upland and riparian vegetation
  - Cheatgrass
  - Tamarisk

Emerging Climate Change Threats

Direct Impacts
- Increasing temperatures
- Fluctuating precipitation patterns
- Increasing climatic water deficit and vapor pressure deficit

Indirect Impacts
- Increasing wildfire potential
- Facilitate spread of plant and animal invasives

Sieber Fire in the McInnis Canyons NCA, 2020, CCA

Emerging Climate Change Threats

Persistent Stressors x Climate Change ==

Ecological Transformation

Sieber Fire in the McInnis Canyons NCA, 2020, CCA

Identify Values and Desired Conditions

Values of Black Ridge Canyons Wilderness

- **Recreation** – BRCW offers unique recreational opportunities due fostering feelings of solitude and remoteness while being near Grand Junction
- **Natural communities and features** – BRCW provides viable, defensible habitat for wildlife and has unique geologic features
- **Education and connection to place** – BRCW offers outstanding opportunities for education, community outreach, and volunteer stewardship. These opportunities foster place attachment in interest in stewardship
- **Inspirational space** – BRCW is an inspirational space for visitors, specifically for art and science

Desired Conditions for Black Ridge Canyons Wilderness

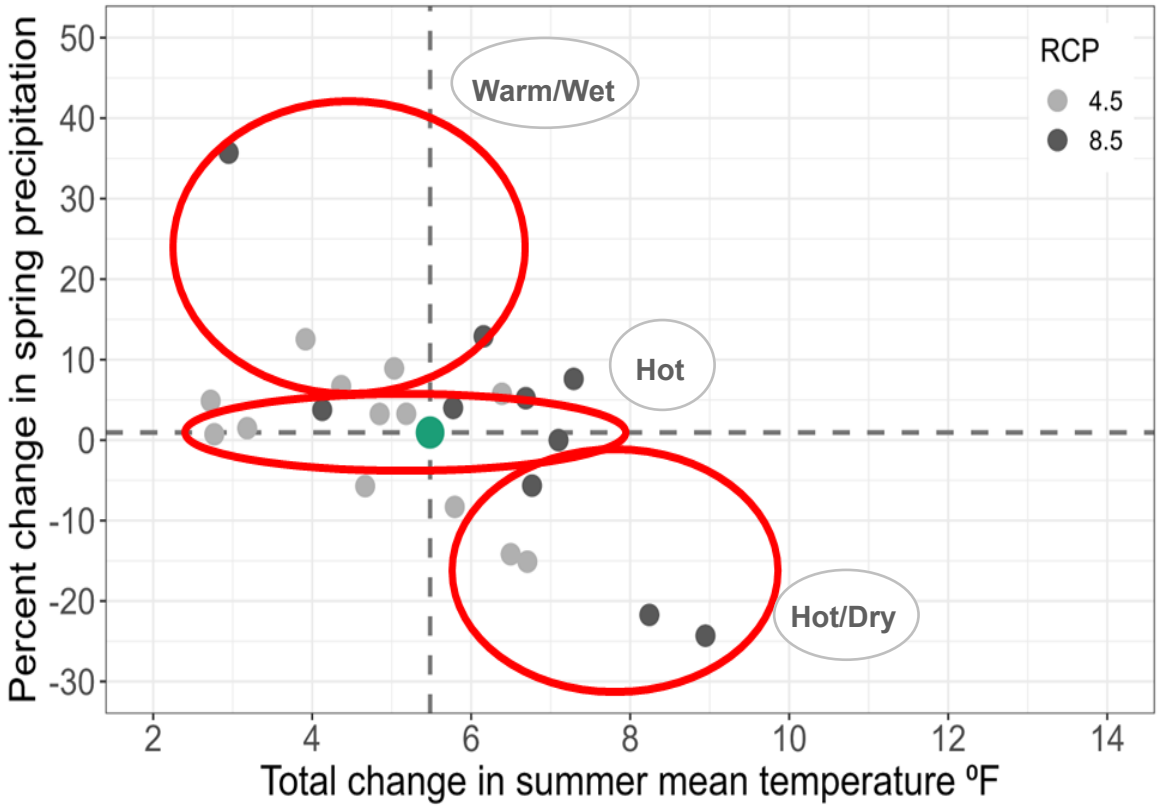
- **Maintain thriving populations of native flora and fauna** – Native species are important for the historical, natural quality of wilderness
- **Leadership of innovative management**– Proactive planning and management grounded in best available science and supported by partnerships
- **Keep wilderness wild**– Balance of encouraging recreation and educational opportunities while also protecting opportunities for solitude and vulnerable ecosystems

Clarify the Ecological Transformation

Evaluating Ecological Transformation

Team of Experts for the Black Ridge Canyons Wilderness

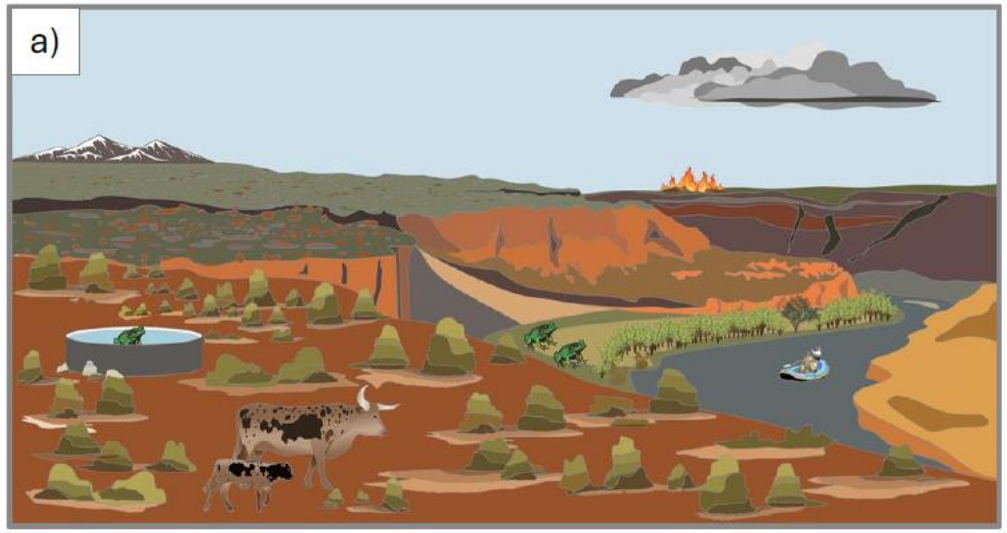
- Local or species/ecosystem relevant expertise
- Hydrology, climatology, herpetology, natural resources management

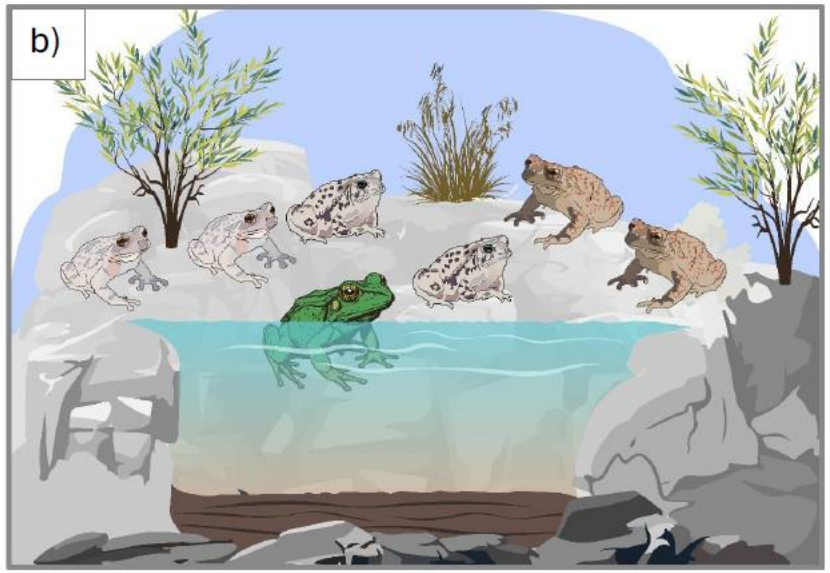


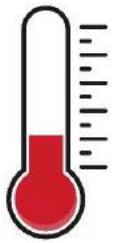
Objective: Generate a suite of plausible, divergent future ecological scenarios to help guide RAD decision-making for native amphibians in the Black Ridge Canyons Wilderness

1) Determine appropriate timeline(s) for forecasting future change
2) Identify likely climatic and ecological trajectories of transformation
3) Determine likely impacts to native amphibian populations under changing habitat conditions
4) Identify environmental conditions that may facilitate or suppress competitive exclusion by invasive bullfrogs

Current Conditions in Black Ridge Canyons Wilderness







Box 2: Current baseline climate, land use, disturbance, and species assemblages in the Black Ridge Canyons Wilderness, Colorado, USA. Graphics represent current landscape-level conditions (a), and site-specific conditions of ephemeral pools (b). Non-native, invasive plant species (cheatgrass, tamarisk) and invasive bullfrogs represented. Three climate scenarios were generated to describe potential ecological transformations at both spatial scales. Key transformations examined for each scale include:

Landscape (a):

1) **Disturbance regime change**, including wildfire and summer convective storm patterns
2) **Non-native, invasive species** persistence or expansion and replacement of native species
3) **Precipitation pattern changes** including conversion of winter snowfall to rain

Ephemeral Pools (b):

1) **Altered patterns of amphibian species diversity** including species richness and abundance
2) **Conversion of riparian vegetation** to upland or non-native invasive vegetation
3) **Conversion of deepwater pools** characterized by long hydroperiods to shallow pools characterized by short hydroperiods


Canyon treefrog


Red-spotted toad


Woodhouse's toad


American bullfrog

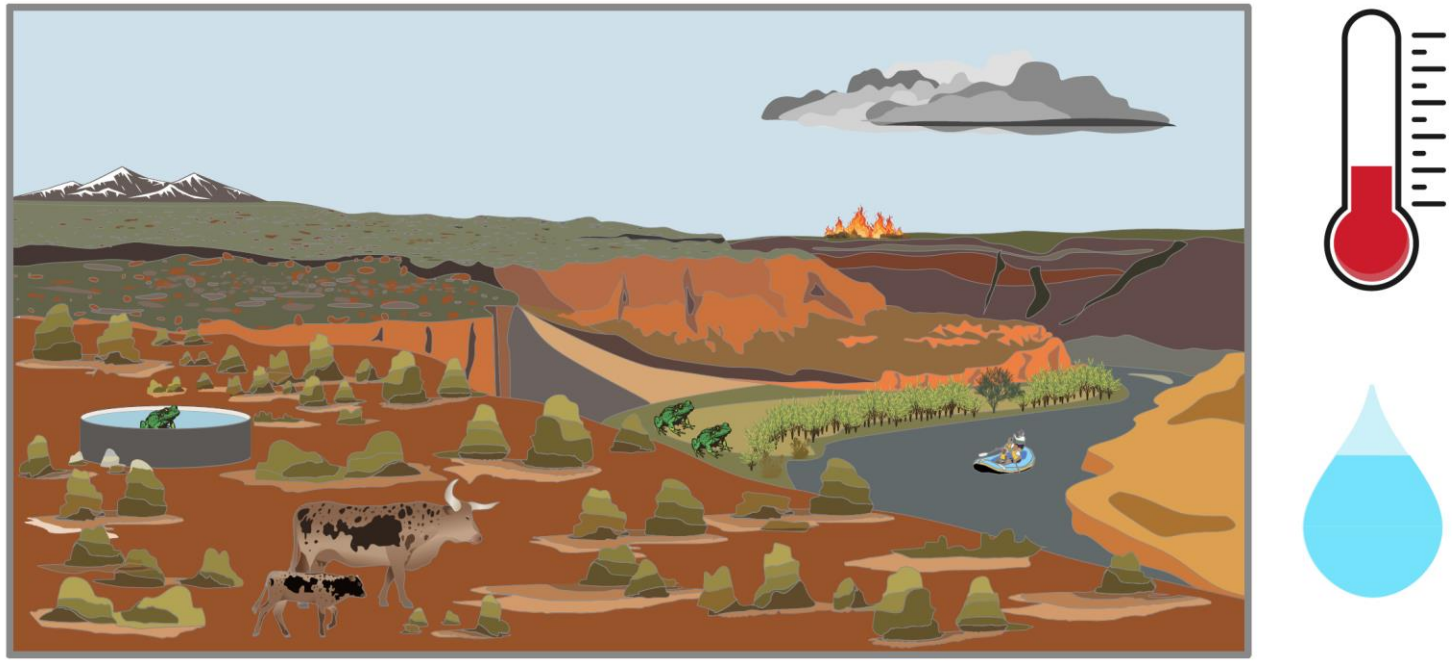

Native willow


Cheatgrass

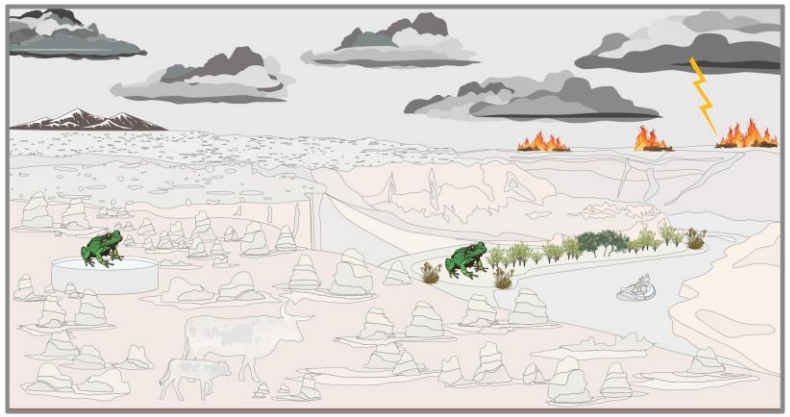

Tamarisk

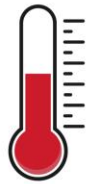
Future Ecological Scenarios

Landscape Conditions

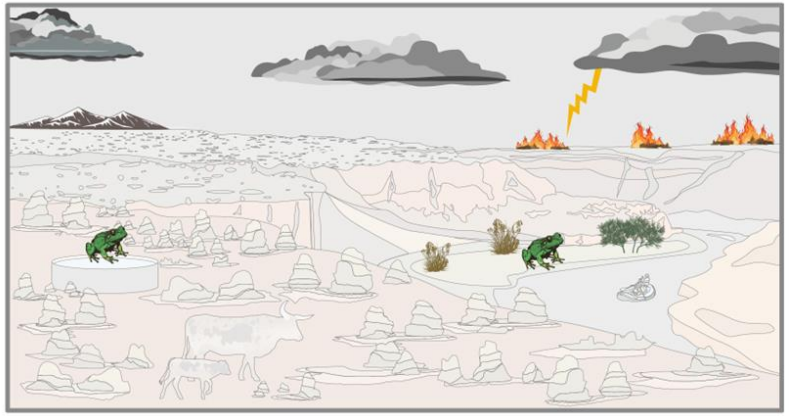


Warm/Wet Scenario

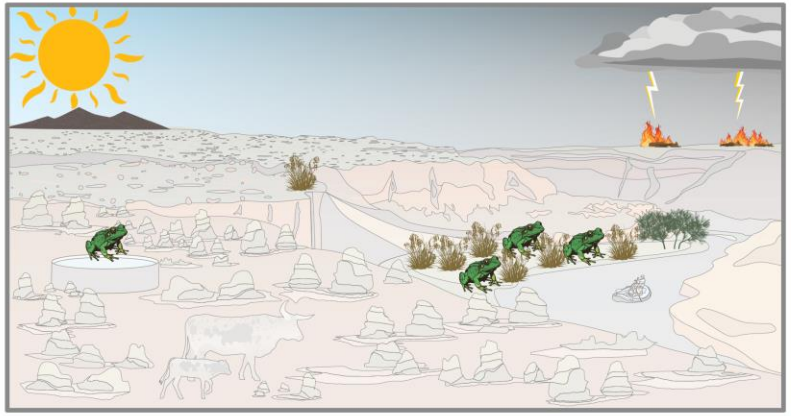




Hot Scenario

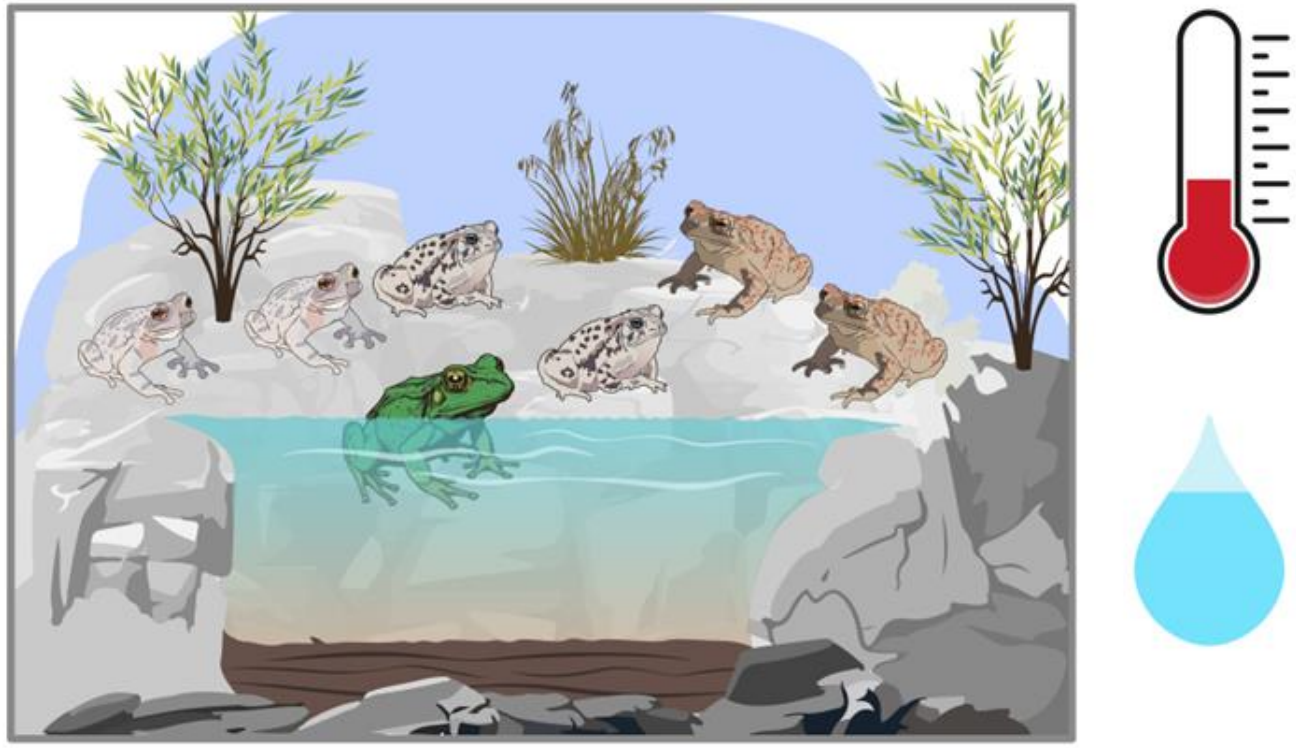


Hot/Dry Scenario

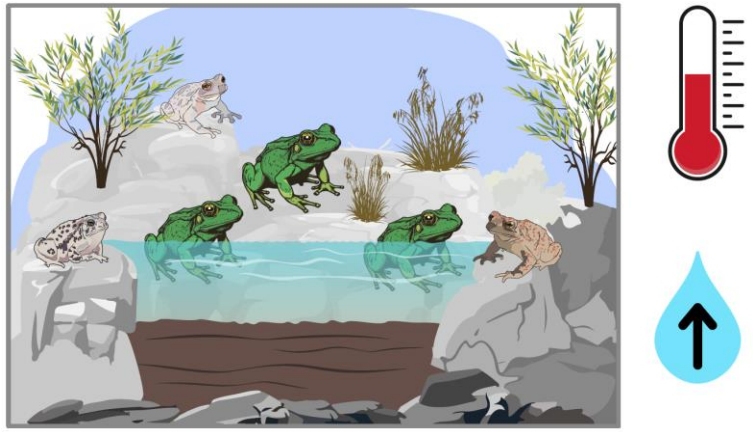


Future Ecological Scenarios

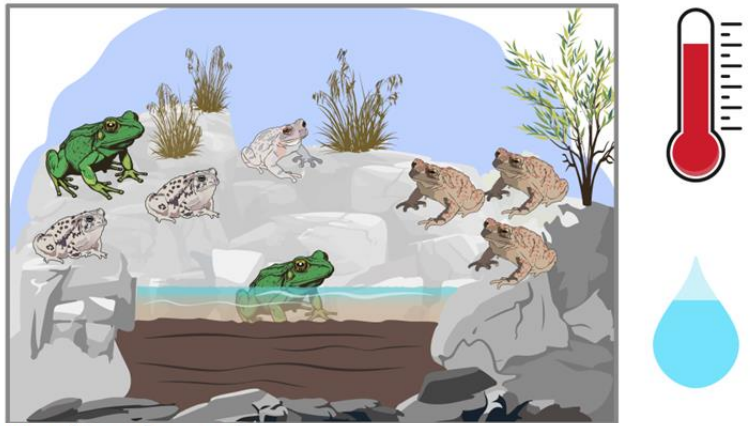
Pool Conditions



Warm/Wet Scenario



Hot Scenario



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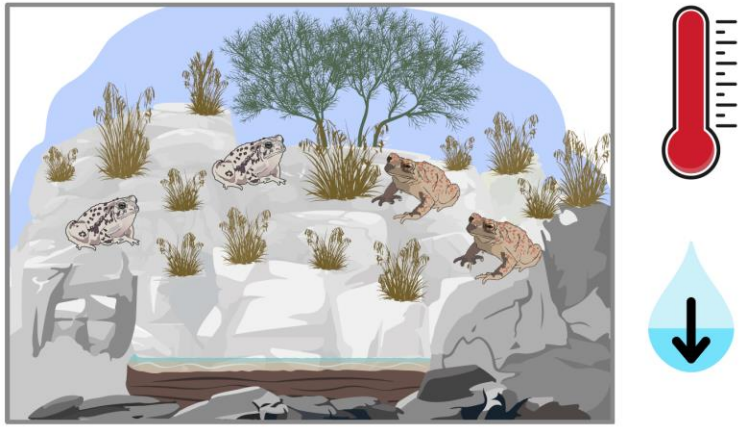

Key Ecological Transformations (all scenarios)

- Conversion of riparian communities to upland communities
- Conversion of native vegetation to annual and riparian invasive-dominated communities
- Conversion of winter snow to winter rain
- Trend to higher intensity disturbance events (wildfire and summer storms)

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Impacts to native amphibians

Proximate consequences:

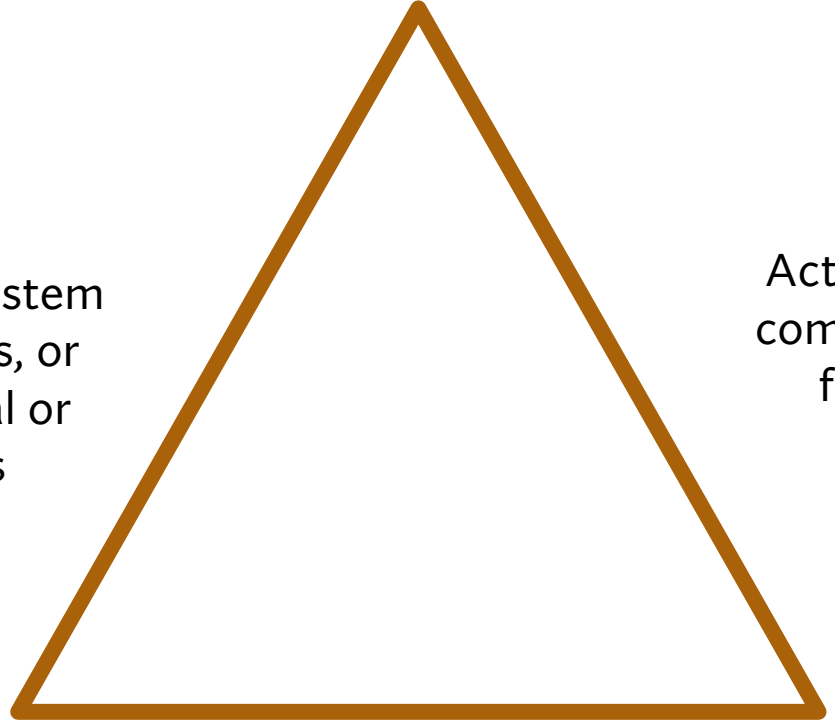
- Heightened disease transmission due to higher population densities and/or invasion by bullfrogs
- Increased competition for resources
- Decreased recruitment of native amphibians

Ultimate consequences:

- Decreased richness of native amphibians
- Genetic drift and decreased heterozygosity
- Local or widespread extirpation of native amphibians

Resist

Work to maintain or restore ecosystem composition, structure, processes, or function on the basis of historical or acceptable current conditions



Direct

Actively shape change in ecosystem composition, structure, processes, or function toward preferred new conditions

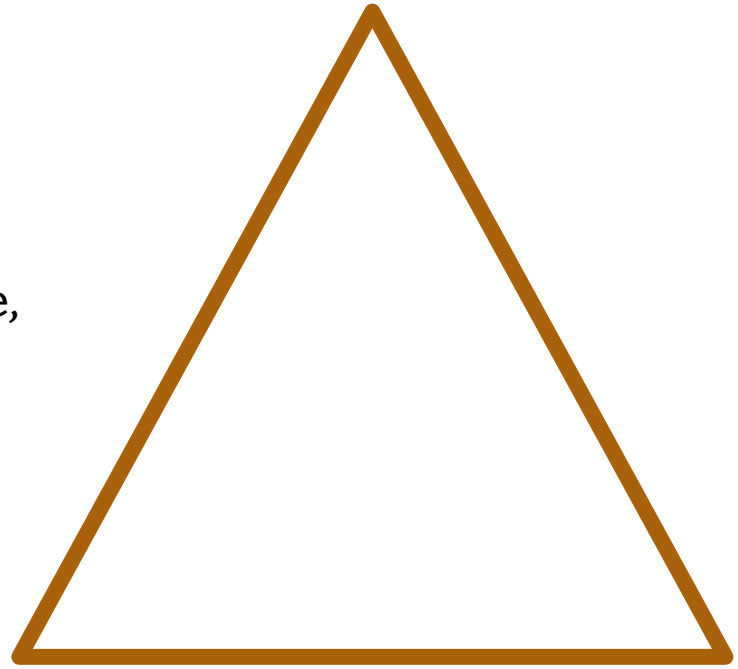
Accept

All ecosystem composition, structure, processes, or function to change autonomously

Generate RAD Alternatives

Resist

- Bullfrog removal
- Herbicide treatment for non-native, invasive vegetation
- Shade structures over pools
- Plant native plant species to shade pools
- Supplemental water drops
- Snow fences for water retention
- Stop grazing within wilderness
- Create more flexible and proactive grazing management



Direct

- Beaver dam analogs outside of wilderness to create new habitat
- Move species out of unsuitable habitat in critical situations
- Remove bullfrogs from golf courses and relocate native species
- Captive breeding and release into new habitat

Accept

- Fine scale inventory and monitoring to learn about system changes

Our Alternatives

Resist: Remove bullfrogs from upstream source populations on public and private land within and outside the NCA. Removal includes capture and removal of bullfrogs. Capture methods include net or hand capture of any age class of bullfrogs. Access includes a diverse range of options (water, land, road).

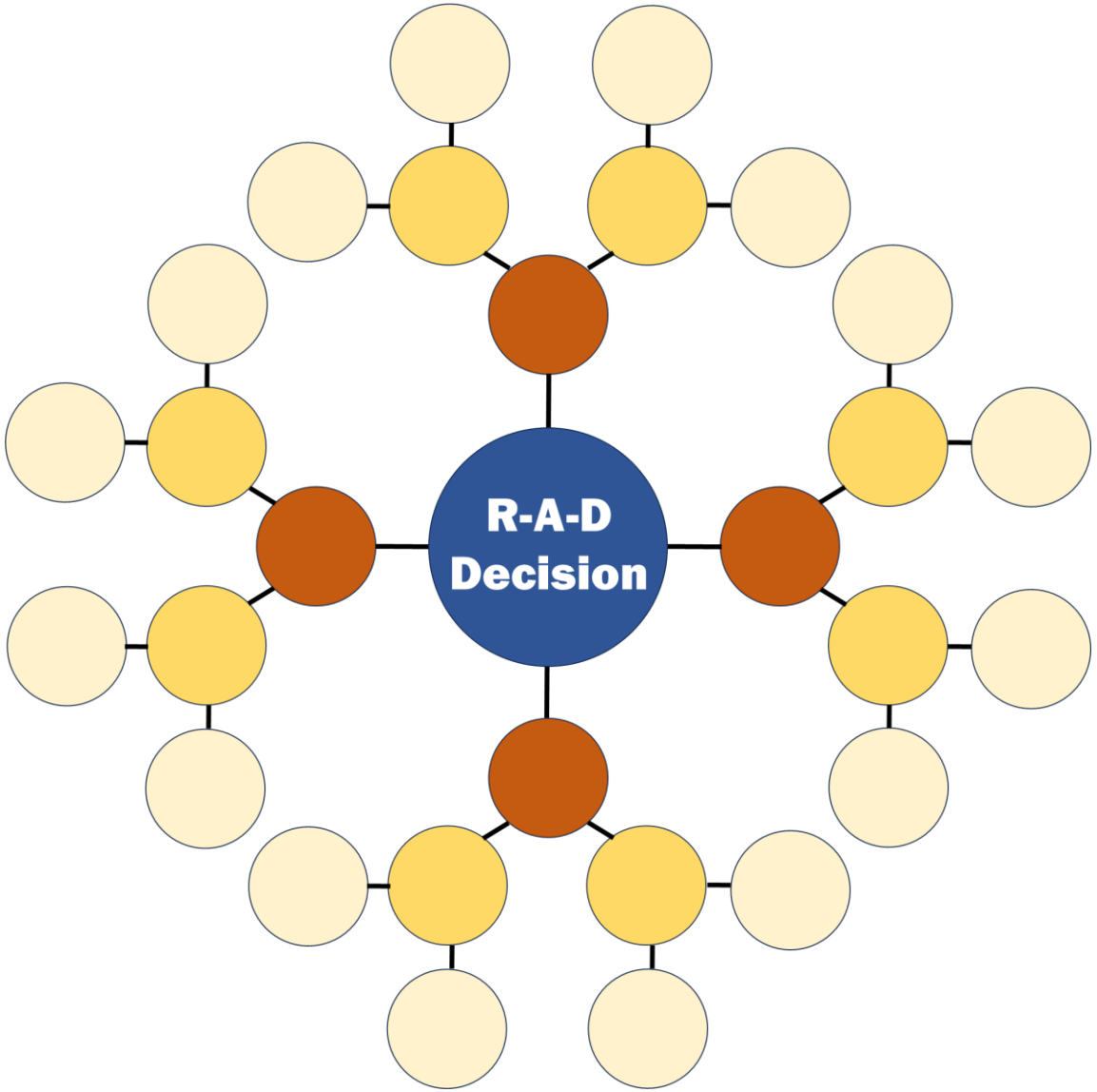
Accept: In lieu of implementing active management, fund and support monitoring of changing ecological conditions. Work includes audio inventory and temporary installation (up to five years) of ecological monitoring equipment such as temperature loggers, acoustic monitors, water depth sensors. Necessitate travel to monitoring sites ~3 times/year. Access sites from the river—boat/raft in.

Direct: Move native amphibians to other natural water sources within and outside the NCA that is not currently occupied by native species. Still requires removal of bullfrogs. Capture similar to bullfrog methods. Collect ~30% of wilderness populations from viable populations. Collect tadpoles only from native range. Combined introduction strategies: 1) introduce directly to new habitat, 2) observation in controlled tank environments.

Evaluate Social-Ecological Tradeoffs

Breaking Down the Decision: The Futures Wheel

- Identify the trade-offs and implications of making R-A-D decisions in wilderness
- Visualize first-order…i^{th} order consequences



Futures Wheel

- Identify the trade-offs and implications of making R-A-D decisions in wilderness
- Visualize first-order…ith order consequences
- Capture uncertainty and reduce unintended consequences
- Assess cumulative impacts of R-A-D decision by scoring each implication based on its likelihood and desirability

Score **Likelihood** on a 9-1 scale as follows;

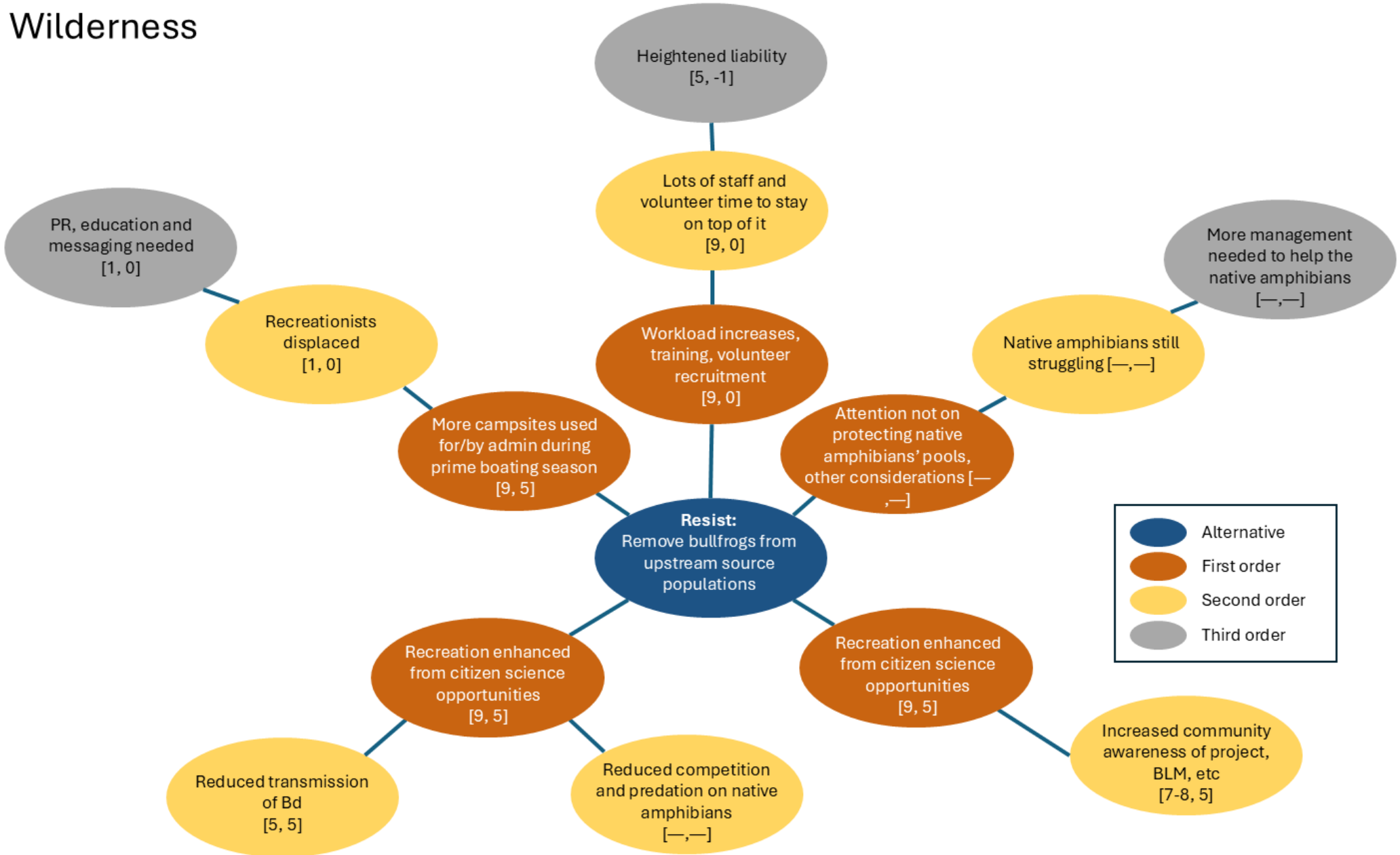
9 = Extremely Likely
8 = Very Likely
7 = Likely
6 = Somewhat Likely
5 = 50/50
4 = Somewhat Unlikely
3 = Unlikely
2 = Very Unlikely
1 = Extremely Unlikely

Desirability is scored on the following scale:

+ 50 = Triumph (Breakthrough)
+5 = Extremely desirable
+4 = Very Desirable
+3 = Desirable
+2 = Somewhat Desirable
+1 = Minimally Desirable
0 = Neutral
-1 = Minimally Undesirable
-2 = Somewhat Undesirable
-3 = Undesirable
-4 = Very Undesirable
-5 = Extremely Undesirable
-50 = Catastrophe

Credit: Ranch Management Consultants, Inc.

Black Ridge Canyons Wilderness



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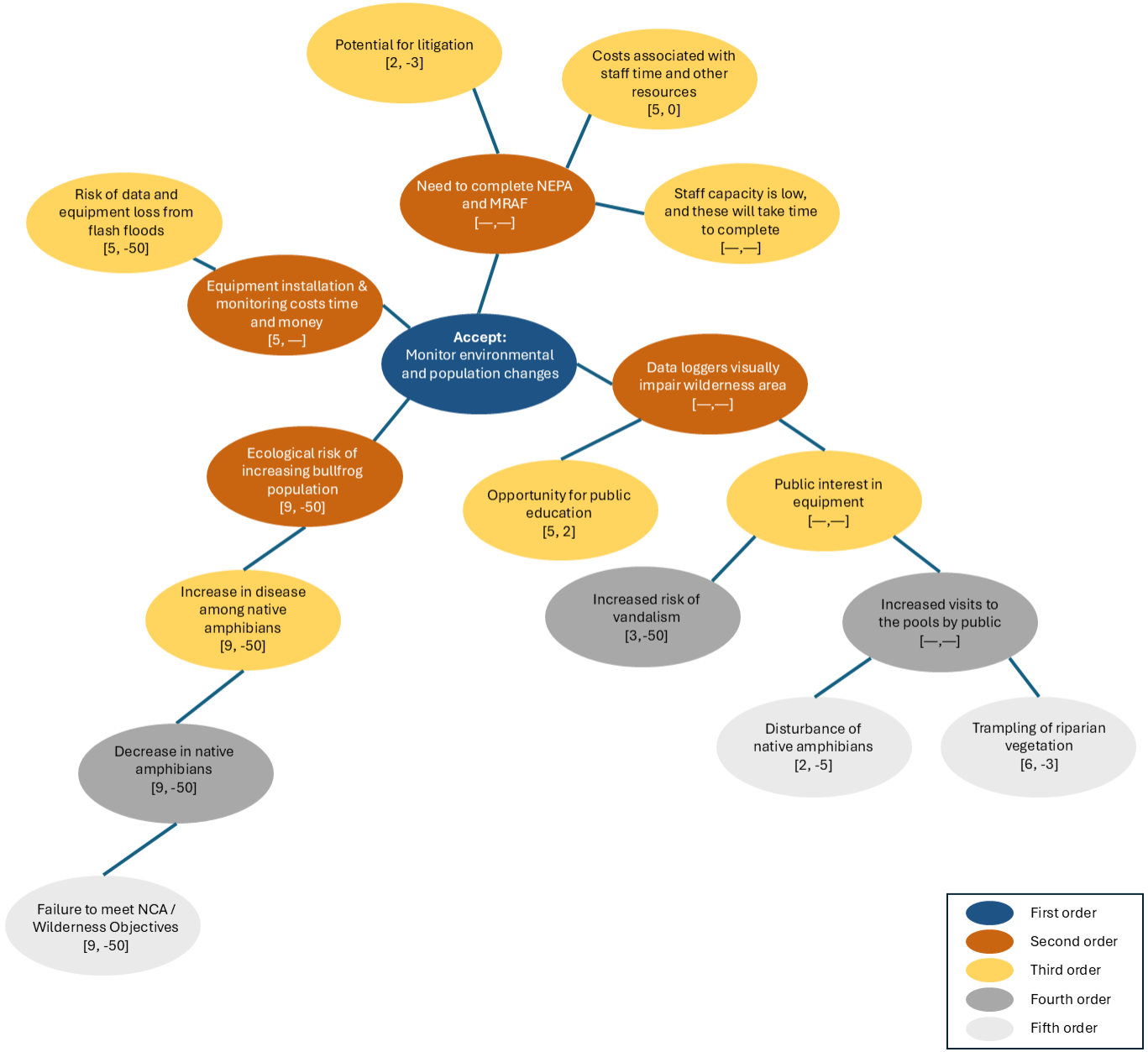

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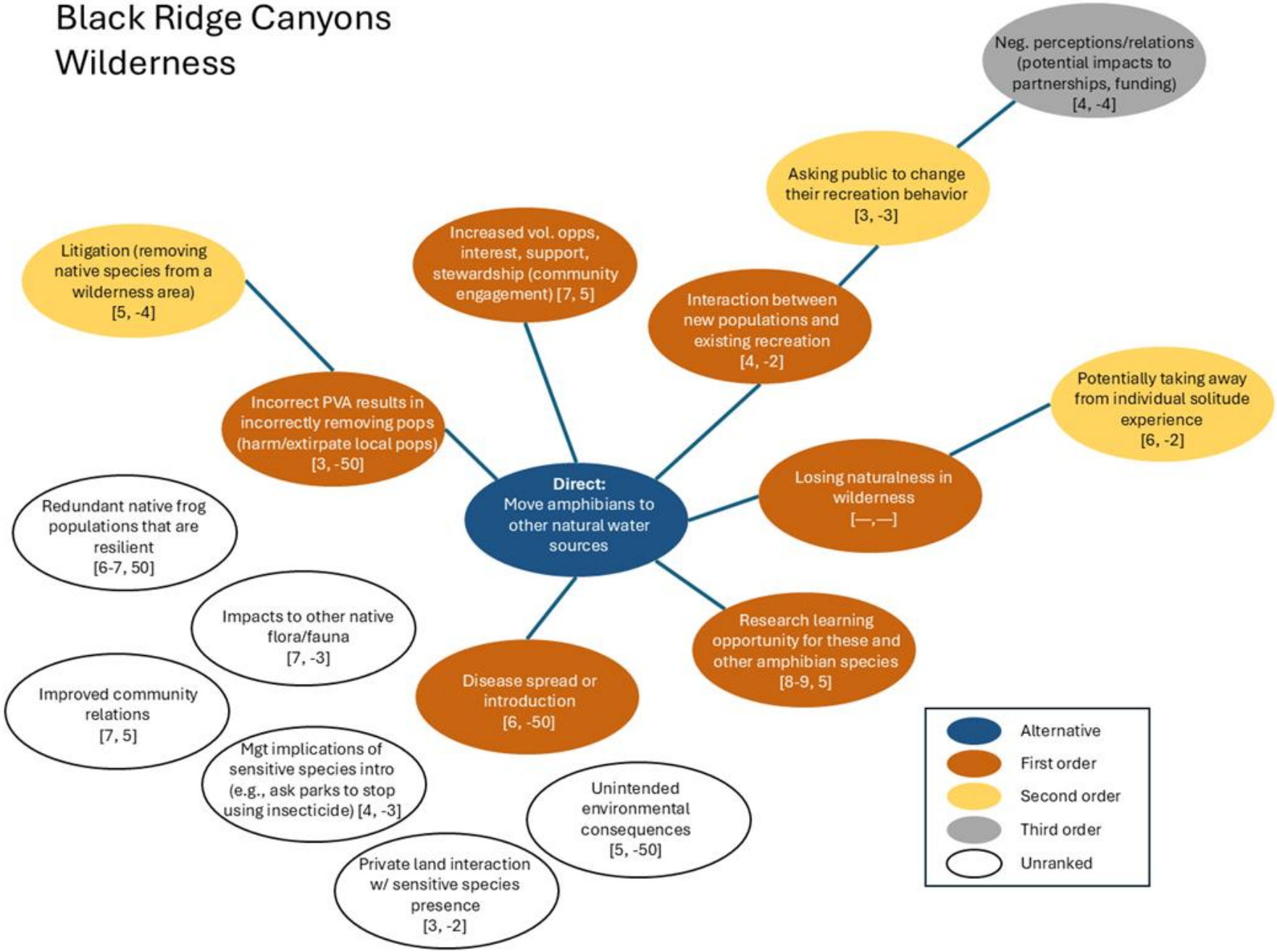


Key findings from the futures wheel exercise

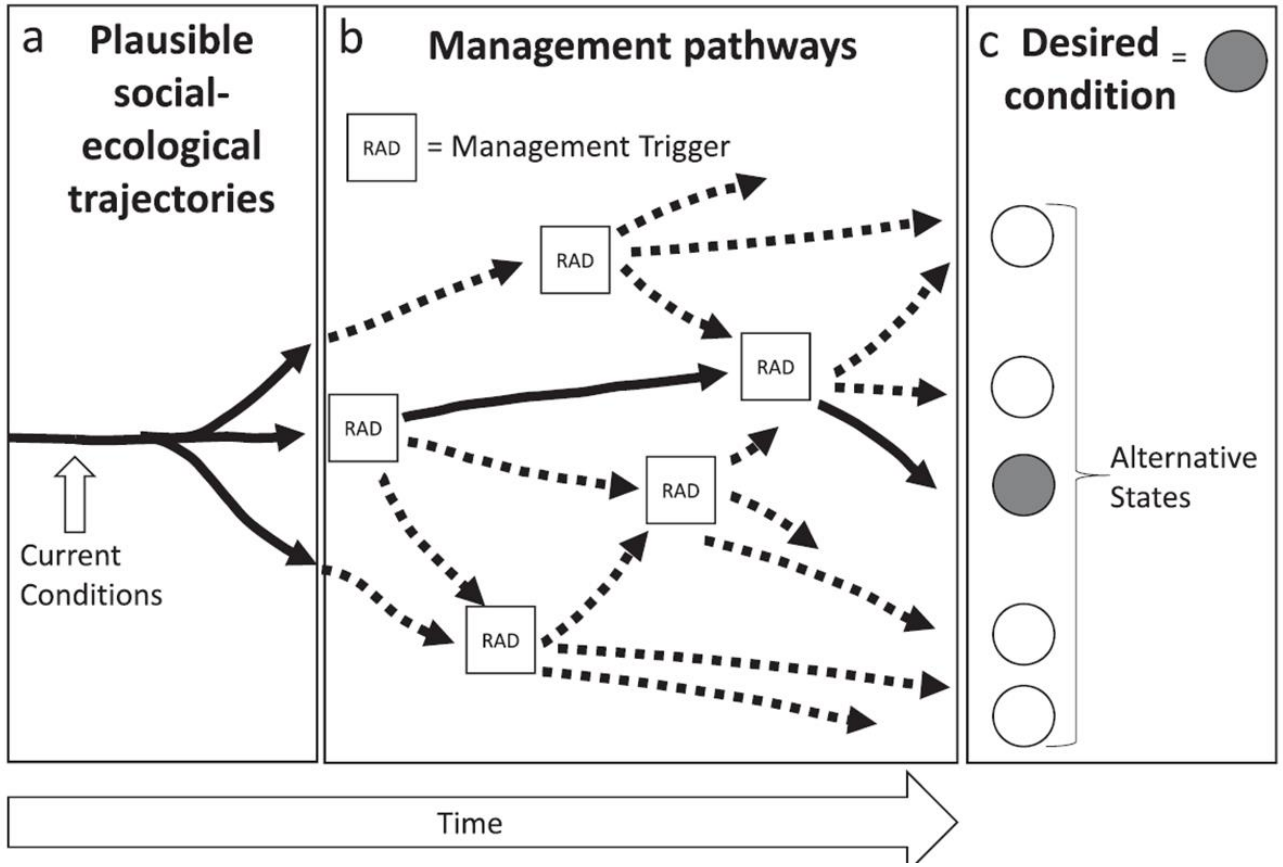
- Resist was a desirable short-term strategy
- Accept was an appropriate interim solution to inform future decisions
- Direct was less desirable, but may be more durable over time
- There was a good deal of uncertainty in the outcomes for all alternatives

Key findings across case studies

- Managers and partners are observing climate and landscape changes
- Generally, managers preferred resist strategies
- A lot of uncertainty associated with direct strategies
- For most case studies, accept was not viewed as a viable long-term option

For future research and practice

- Futures wheels were time consuming but useful
- Need for more legal clarity at the intersection of the Wilderness Act with other laws (e.g., Endangered Species Act)
- Identify triggers and tipping points to change strategy



Magness, D.R. et al. 2022. Management foundations for navigating ecological transformation by resisting, accepting, or directing social–ecological change. BioScience, 72: 30-44.

Thank you!

Questions?

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